Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas[(1)]

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
	U-238	2.8E-01	14-16
	Pu-238	1.7E-01	14-16
	Pu-239/240	1.6E-01	14-16
	Pu-241	< 1.1E+00	14-16
	Am-241	1.1E-01	14-16

NOTE: (1) Data are from the 1993 RCRA facility investigation and the other Geoprobe® studies described in Section 4.

2.0 Information Provided in Attachment 1

Other information associated with the dose modeling is provided in Attachment 1. As explained in Section 5, the dose calculations were performed using RESRAD 6.4 and the results were exported to Microsoft Excel for post-processing. Attachment 1 provides:

- RESRAD input files to verify input parameters and model setup,
- RESRAD output files to verify input parameters and results,
- Excel result files containing (1) RESRAD output results (exported from the RESRAD summary report), (2) summaries of data [maximum dose-source ratios (DSRs) and times of maxima], (3) calculation of $DCGL_W$ values from the maximum DSRs, (4) calculation of area factors and $DCGL_{EMC}$ values, and (5) summary of sensitivity results

DCGL development was based on entering unit source concentrations (1pCi/g) for 18 radionuclides into RESRAD to generate DSRs in units of mrem/y per pCi/g (RESRAD output results based on unit concentrations can be interpreted as either the dose or DSR, and the terms are used interchangeably in this document). The individual, peak DSRs are then used to generate DCGLs for each radionuclide based on the following equation:

DCGL (pCi/g) = Dose Limit (mrem/y) / Maximum DSR (mrem/y per pCi/g) (Eq.1)

The dose limit of 25 mrem/y and maximum DSRs were used as the basis for developing the DCGLs. Further details regarding the Attachment 1 files are presented below. Because of the uncertainty in the actual distributions and mixtures of radionuclides in the environmental media, the DCGL for each radionuclide is calculated individually. Following characterization, the working cleanup levels for mixtures can be developed using the sum of fractions method discussed in Chapter 5 of the MARSSIM.

2.1 Input Parameters Tables

The parameters input to the RESRAD model include:

- Base case values for the $DCGL_W$ calculations,
- Modification of source area only for $DCGL_{EMC}$ calculations, and
- Variation of key parameters to evaluate model sensitivity

The Excel file "WV Sensitivity Parameters Table – Rev1.xls" (Table C.5) provides a summary of the following parameters which were varied to evaluate model sensitivity.

- Surface Soil Sources
  - Indoor/outdoor time fraction
  - Source thickness
  - Unsaturated zone thickness
  - Irrigation/well pumping rate
  - Soil/water distribution coefficients
  - Hydraulic conductivity (Vertical/Horizontal)
  - Runoff/Evapotranspiration coefficients/ Infiltration rate
  - Depth of well intake
  - Length of contaminated area parallel to aquifer flow
  - Hydraulic gradient
  - Gamma shielding factor
  - Indoor air filtration factor
  - Mass loading for dust inhalation
  - Depth of roots
  - Food transfer factors
  - Use of mass balance instead of non-dispersion groundwater model
- Subsurface Soil Sources (subsurface soil distributed on the surface):
  - Indoor/outdoor time fraction
  - Source thickness
  - Unsaturated zone thickness
  - Irrigation/well pumping rate
  - Soil/water distribution coefficients
  - Hydraulic conductivity (Vertical/Horizontal)
  - Runoff/Evapotranspiration coefficients/ Infiltration rate
  - Gamma shielding factor
  - Indoor air filtration factor
  - Mass loading for dust inhalation
  - Depth of roots
  - Food transfer factors
- Stream Bank Sediment sources:
  - Outdoor time fraction
  - Source thickness

- Unsaturated zone thickness
- Soil/water distribution coefficients
- Runoff/Evapotranspiration coefficients/ Infiltration rate
- Mass loading for dust inhalation
- Root depth
- Food transfer factors

These sensitivity parameters were selected based on preliminary model simulations and consideration of parameter priorities presented in Table 4.2 of NUREG-6697, Attachment B (Yu, et al. 2000). The parameters selected for analysis are discussed further below.

Sensitivity parameter values were selected to represent a reasonable range in order to provide bounds on the uncertainty in the DCGL calculations. The basis for particular parameter values are discussed below.

Indoor/Outdoor fraction – varied from 0.45/0.45 to 0.8/0.1 from the base case values of 0.66/0.25. The lower indoor fraction represents equal time indoors and outdoors, while the higher fraction was selected to represent a farmer spending inordinate amounts of time indoors.

Source thickness – for surface soil and sediment, varied from 0.5 to 3m to bound the base case value of 1m with potential thicknesses resulting from remedial activities and to account for potential source erosion uncertainty. For subsurface soil, the source volume was evaluated for three thickness/area configurations to conserve the total amount of excavated material. The source thickness/area was varied from 0.1m/300m^2 to 0.6 m/50 m^2, to bound the base case of 0.3 m/100 m^2. The subsurface source thickness is dependent on the amount of material excavated during well/cistern installation, and depths less than the base case would correspond with a smaller source area for a given excavated volume (assumed to be ~30 m^3).

Unsaturated zone thickness – varied from 1 to 5 m to bound the 2 m base case value with the range possible for the site. The range of results also provides an assessment of potential source erosion uncertainty. The sediment model assumes that there is no unsaturated zone for the stream bank.

Irrigation/well pumping rate - varied from 0.2/2720 to 0.8/8720 (m/y)/(m^3/y) to bound the base case of 0.5/5720 (m/y)/(m^3/y). The irrigation rate and well pump rate are directly related and the range reflects changes in crop irrigation only. For all cases, the assumed household and livestock water ingestion rates were held constant. This parameter is applicable to soil exposure only, not to sediment exposure

Soil/Water distribution coefficients – varied for each radionuclide based on site-specific data where available. If a range of site-specific distribution coefficients was not available (as was the case for the majority of radionuclides), values were selected from the literature to provide a bound on the base case uncertainty. The conceptual models assume the sand and gravel unit is representative of the three RESRAD zones (contaminated, unsaturated and saturated), except that in the SB and SD analyses, the contaminated zone is assumed to be represented by the Lavery till.

Hydraulic conductivity – for the contaminated and unsaturated zone, varied the vertical conductivity from 63 m/y (2.0E-04 cm/s) to 220 m/y (7.0E-03 cm/s) to bound the base case value of 140 m/y (4.4E-04 cm/s) which is the average for the sand and gravel unit divided by 10 to account for anisotropy (DEIS Appendix E, Table E-3). Similarly for the saturated zone, the horizontal conductivity was varied from 630 to 2200 m/y from the base case of 1400 m/y. The conceptual model assumes the sand and gravel unit is representative of the unsaturated and saturated zone. Values were selected to ensure that the site-specific groundwater conceptual model assumptions (that the well captures the entire width of the plume, but that there is some vertical dilution within the water table) were maintained.

Runoff/evapotranspiration coefficient – varied from 0.41/0.6 to 0.41/0.9 to bound the base case of 0.41/0.78. The base case was selected to achieve infiltration rate of 0.26m/y which corresponds to the calibrated three dimensional groundwater model used in the Decommissioning EIS (DEIS Appendix E). The upper and lower bounds are assumed values for these parameters that maintain the site-specific groundwater dilution assumptions.

Depth of well intake – applicable to non-dispersion model only (surface soil base case). Varied from 3 to 10 m to bound the base case value of 5m. The lower bound represents the minimum for a 1 m contaminated thickness and 2 m unsaturated zone. The upper bound represents the upper end of observed thickness of the saturated zone on site. The upper and lower bound values for these parameters also maintain the site-specific groundwater dilution assumptions.

Length of contaminated area parallel to aquifer flow - applicable to non-dispersion model only (surface soil base case). Varied from 50 m to 200 m to bound the base case of 165 m. Base value was selected to achieve site-specific groundwater dilution factor of 0.2. Values were selected to ensure that the site-specific groundwater conceptual model assumptions (that the well captures the entire width of the plume, but that there is some vertical dilution within the water table) were maintained.

Hydraulic gradient – applicable to non-dispersion model only (surface soil base case). Varied from 0.02 to 0.04 to bound the base case of 0.03.

Gamma shielding factor – applicable to the surface and subsurface soil models. Varied from 0.17 to 0.51 to bound base case of 0.273, representing a range of possible home construction methods.

Indoor air filtration factor – applicable to the surface and subsurface soil models. Varied from 0.4 to 0.75 to evaluate less conservative assumptions than the base case value of 1.0.

Mass loading for inhalation – applicable to all models. For the soil models, the range of 4.5E-06 to 2.5E-05 bound the base case of 1.5E-05 g/m^3. For sediment, the base case of 3.2E-06 is bounded by the range of 1E-06 to 1E-05.

Root depth – applicable to all models. Varied from 0.3 to 3.0 from the base case of 0.9 m to reflect a range of potential crops.

Food transfer factors – varied from the constituent specific base cases by increasing and decreasing each parameter an order of magnitude.

Groundwater model – the surface soil base case non-dispersion model is varied to provide results for the mass balance model for comparison. The RESRAD User's Manual suggests the non-dispersion model for areas >1,000 m^2 (Yu et al. 2001, p.E-18).

2.2 RESRAD Input Files

The following RESRAD input files are provided to allow verification of input parameters and reproduction of the output files and summary graphics:

- $DCGL_W$ input files:
  - WV Surface – 10k Base.RAD (Surface soil source of 10,000 m^2)
  - WV Subsurface – 100 Base.RAD (Subsurface material as a surface source of 100 m^2)
  - WV Sediment - 1k Base.RAD (Sediment source of 1,000 m^2)
- $DCGL_{EMC}$ input files (varying only source area from $DCGL_W$ files):
  - Surface Soil Source
    - WV Surface - 5k EMC.RAD (5,000 m^2 source)
    - WV Surface - 1k EMC.RAD (1,000 m^2 source)
    - WV Surface - 500 EMC.RAD (500 m^2 source)
    - WV Surface - 100 EMC.RAD (100 m^2 source)
    - WV Surface - 50 EMC.RAD (50 m^2 source)
    - WV Surface - 10 EMC.RAD (10 m^2 source)
    - WV Surface - 5 EMC.RAD (5 m^2 source)
    - WV Surface - 1 EMC.RAD (1 m^2 source)
  - Subsurface Source
    - WV Subsurface - 50 EMC.RAD (50 m^2 source)
    - WV Subsurface - 10 EMC.RAD (10 m^2 source)
    - WV Subsurface - 5 EMC.RAD (5 m^2 source)
    - WV Subsurface - 1 EMC.RAD (1 m^2 source)
  - Stream Bank Sediment Source
    - WV Sediment - 500 EMC.RAD (500 m^2 source)
    - WV Sediment - 100 EMC.RAD (100 m^2 source)
    - WV Sediment - 50 EMC.RAD (50 m^2 source)
    - WV Sediment - 10 EMC.RAD (10 m^2 source)
    - WV Sediment - 5 EMC.RAD (5 m^2 source)
    - WV Sediment - 1 EMC.RAD (1 m^2 source)

Note: sediment source area width was maintained at 3 m when varying areas to represent assumed stream bank configuration.

- Sensitivity analysis input files:
  - Surface soil Source
    - WV Surface - SENS1.RAD (decreased indoor fraction)
    - WV Surface - SENS2.RAD (increased indoor fraction)
    - WV Surface - SENS3.RAD (decreased source layer thickness)
    - WV Surface - SENS4.RAD (increased source layer thickness)
    - WV Surface - SENS5.RAD (decreased unsaturated zone thickness)
    - WV Surface - SENS6.RAD (increased unsaturated zone thickness)
    - WV Surface - SENS7.RAD (decreased well pumping rate)
    - WV Surface - SENS8.RAD (increased well pumping rate)
    - WV Surface - SENS9.RAD (decreased K_d values)
    - WV Surface - SENS10.RAD (increased K_d values)
    - WV Surface - SENS11.RAD (decreased K_d value)
    - WV Surface - SENS12.RAD (increased K_d value)
    - WV Surface - SENS13.RAD (decreased runoff/evapotranspiration)
    - WV Surface - SENS14.RAD (increased runoff/evapotranspiration)
    - WV Surface - SENS15.RAD (decreased well intake depth)
    - WV Surface - SENS16.RAD (increased well intake depth)
    - WV Surface - SENS17.RAD (decreased length parallel to flow)
    - WV Surface - SENS18.RAD (increased length parallel to flow)
    - WV Surface – SENS19.RAD (decreased hydraulic gradient)
    - WV Surface – SENS20.RAD (increased hydraulic gradient)
    - WV Surface – SENS21.RAD (decreased gamma shielding factor)
    - WV Surface – SENS22.RAD (increased gamma shielding factor)
    - WV Surface – SENS23.RAD (decreased indoor air filtration factor)
    - WV Surface – SENS24.RAD (increased indoor air filtration factor)
    - WV Surface – SENS25.RAD (decreased mass loading factor for inhalation)
    - WV Surface – SENS26.RAD (increased mass loading factor for inhalation)
    - WV Surface – SENS27.RAD (decreased root depth)
    - WV Surface – SENS28.RAD (increased root depth)
    - WV Surface - SENS29.RAD (decreased food transfer factors)

  - WV Surface – SENS30.RAD (increased food transfer factors)
  - WV Surface - SENS31.RAD (mass balance groundwater model)
- Subsurface Soil Source
  - WV Subsurface - SENS1.RAD (decreased indoor fraction)
  - WV Subsurface - SENS2.RAD (increased indoor fraction)
  - WV Subsurface - SENS3.RAD (decreased source layer thickness)
  - WV Subsurface - SENS4.RAD (increased source layer thickness)
  - WV Subsurface - SENS5.RAD (decreased unsaturated zone thickness)
  - WV Subsurface - SENS6.RAD (increased unsaturated zone thickness)
  - WV Subsurface - SENS7.RAD (decreased well pumping rate)
  - WV Subsurface - SENS8.RAD (increased well pumping rate)
  - WV Subsurface - SENS9.RAD (decreased K_d values)
  - WV Subsurface - SENS10.RAD (increased K_d values)
  - WV Subsurface - SENS11.RAD (decreased K_h value)
  - WV Subsurface - SENS12.RAD (increased K_h value)
  - WV Subsurface - SENS13.RAD (decreased runoff/evapotranspiration)
  - WV Subsurface - SENS14.RAD (increased runoff/evapotranspiration)
  - WV Subsurface – SENS15.RAD (decreased gamma shielding factor)
  - WV Subsurface – SENS16.RAD (increased gamma shielding factor)
  - WV Subsurface – SENS17.RAD (decreased indoor air filtration factor)
  - WV Subsurface – SENS18.RAD (increased indoor air filtration factor)
  - WV Subsurface – SENS19.RAD (decreased mass loading factor for inhalation)
  - WV Subsurface – SENS20.RAD (increased mass loading factor for inhalation)
  - WV Subsurface – SENS21.RAD (decreased root depth)
  - WV Subsurface – SENS22.RAD (increased root depth)
  - WV Subsurface - SENS23.RAD (decreased food transfer factors)
  - WV Subsurface – SENS24.RAD (increased food transfer factors)
- Sediment Source
  - WV Sediment - SENS1.RAD (decreased outdoor fraction)
  - WV Sediment - SENS2.RAD (increased outdoor fraction)
  - WV Sediment - SENS3.RAD (decreased source layer thickness)

- WV Sediment - SENS4.RAD (increased source layer thickness)
- WV Sediment - SENS5.RAD (increased unsaturated zone thickness)
- WV Sediment - SENS6.RAD (largest unsaturated zone thickness)
- WV Sediment - SENS7.RAD (decreased K_d values)
- WV Sediment - SENS8.RAD (increased K_d values)
- WV Sediment – SENS9.RAD (decreased runoff/evapotranspiration)
- WV Sediment – SENS10.RAD (increased runoff/evapotranspiration)
- WV Sediment - SENS11.RAD (decreased root depth)
- WV Sediment – SENS12.RAD (increased root depth)
- WV Sediment - SENS13.RAD (decreased food transfer factors)
- WV Sediment – SENS14.RAD (increased food transfer factors)

The dose results from the above input files were the basis for calculation of $DCGL_W$ and $DCGL_{EMC}$ values. The DCGLs were calculated in Excel spreadsheets, based on exported data from the RESRAD summary output report. The following section describes the RESRAD output files, which are provided for informational purposes.

2.3 RESRAD Output Files

The RESRAD output files are provided to allow review of results without running the simulations. For the $DCGL_W$ simulations, summary, detailed, daughter, and concentration reports are included in the QA files. The summary report is also available for the $DCGL_{EMC}$ simulations. As indicated in the previous section, DCGL calculations are based on data exported from the RESRAD summary output report. RESRAD output files generated are as follows;

- $DCGL_W$ output files:
  - Surface Soil Source
    - WV Surface – 10k Base_sum.TXT (summary report)
    - WV Surface – 10k Base_ det.TXT (detailed report)
    - WV Surface – 10k Base _dtr.TXT (daughter report)
    - WV Surface – 10k Base _conc.TXT (concentration report)
  - Subsurface Soil Source
    - WV Subsurface – 100 Base_sum.TXT (summary report)
    - WV Subsurface – 100 Base_det.TXT (detailed report)
    - WV Subsurface – 100 Base_dtr.TXT (daughter report)
    - WV Subsurface – 100 Base_conc.TXT (concentration report)
  - Sediment Source
    - WV Sediment – 1k Base_sum.TXT (summary report)

    - WV Sediment – 1k Base_det.TXT (detailed report)
    - WV Sediment – 1k Base_dtr.TXT (daughter report)
    - WV Sediment – 1k Base_conc.TXT (concentration report)
- $DCGL_{EMC}$ output files (varying only source area from $DCGL_W$ files):
  - Surface Soil Source
    - WV Surface - 5k EMC_sum.TXT (5,000 m^2 source)
    - WV Surface - 1k EMC_ sum.TXT (1,000 m^2 source)
    - WV Surface - 500 EMC_sum.TXT (500 m^2 source)
    - WV Surface - 100 EMC_sum.TXT (100 m^2 source)
    - WV Surface - 50 EMC_sum.TXT (50 m^2 source)
    - WV Surface - 10 EMC_sum.TXT (10 m^2 source)
    - WV Surface - 5 EMC_sum.TXT (5 m^2 source)
    - WV Surface - 1 EMC_sum.TXT (1 m^2 source)
  - Subsurface Soil Source
    - WV Subsurface - 50 EMC_sum.TXT (50 m^2 source)
    - WV Subsurface - 10 EMC_sum.TXT (10 m^2 source)
    - WV Subsurface - 5 EMC_sum.TXT (5 m^2 source)
    - WV Subsurface - 1 EMC_sum.TXT (1 m^2 source)
  - Sediment Source
    - WV Sediment - 500 EMC_sum.TXT (500 m^2 source)
    - WV Sediment - 100 EMC_sum.TXT (100 m^2 source)
    - WV Sediment - 50 EMC_sum.TXT (50 m^2 source)
    - WV Sediment - 10 EMC_sum.TXT (10 m^2 source)
    - WV Sediment - 5 EMC_sum.TXT (5 m^2 source)
    - WV Sediment - 1 EMC_sum.TXT (1 m^2 source)
- Sensitivity analysis output files:
  - Surface Soil Source
    - WV Surface - SENS1_sum.TXT (decreased indoor fraction)
    - WV Surface - SENS2_sum.TXT (increased indoor fraction)
    - WV Surface - SENS3_sum.TXT (decreased source layer thickness)
    - WV Surface - SENS4_sum.TXT (increased source layer thickness)
    - WV Surface - SENS5_sum.TXT (decreased unsaturated zone thickness)
    - WV Surface - SENS6_sum.TXT (increased unsaturated zone thickness)

- WV Surface - SENS7_sum.TXT (decreased well pumping rate)
- WV Surface - SENS8_sum.TXT (increased well pumping rate)
- WV Surface - SENS9_sum.TXT (decreased K_d values)
- WV Surface - SENS10_sum.TXT (increased K_d values)
- WV Surface - SENS11_sum.TXT (decreased K value)
- WV Surface - SENS12_sum.TXT (increased K value)
- WV Surface - SENS13_sum.TXT (decreased runoff/evapotranspiration)
- WV Surface - SENS14_sum.TXT (increased runoff/evapotranspiration)
- WV Surface - SENS15_sum.TXT (decreased well intake depth)
- WV Surface - SENS16_sum.TXT (increased well intake depth)
- WV Surface - SENS17_sum.TXT (decreased length parallel to flow)
- WV Surface - SENS18_sum.TXT (increased length parallel to flow)
- WV Surface - SENS19_sum.TXT (decreased hydraulic gradient)
- WV Surface - SENS20_sum.TXT (increased hydraulic gradient)
- WV Surface - SENS21_sum.TXT (decreased gamma shielding factor)
- WV Surface - SENS22_sum.TXT (increased gamma shielding factor)
- WV Surface - SENS23_sum.TXT (decreased indoor air filtration factor)
- WV Surface - SENS24_sum.TXT (increased indoor air filtration factor)
- WV Surface - SENS25_sum.TXT (decreased mass loading factor for inhalation)
- WV Surface - SENS26_sum.TXT (increased mass loading factor for inhalation)
- WV Surface - SENS27_sum.TXT (decreased root depth)
- WV Surface - SENS28_sum.TXT (increased root depth)
- WV Surface - SENS29_sum.TXT (decreased food transfer factors)
- WV Surface - SENS30_sum.TXT (increased food transfer factors)
- WV Surface - SENS31_sum.TXT (mass balance groundwater model)

- Subsurface Soil Source
  - WV Subsurface - SENS1_sum.TXT (decreased indoor fraction)
  - WV Subsurface - SENS2_sum.TXT (increased indoor fraction)
  - WV Subsurface - SENS3_sum.TXT (decreased source layer thickness)
  - WV Subsurface - SENS4_sum.TXT (increased source layer thickness)
  - WV Subsurface - SENS5_sum.TXT (decreased unsaturated zone thickness)

- WV Subsurface - SENS6_sum.TXT (increased unsaturated zone thickness)
- WV Subsurface - SENS7_sum.TXT (decreased well pumping rate)
- WV Subsurface - SENS8_sum.TXT (increased well pumping rate)
- WV Subsurface - SENS9_sum.TXT (decreased K_d values)
- WV Subsurface - SENS10_sum.TXT (increased K_d values)
- WV Subsurface - SENS11_sum.TXT (decreased K value)
- WV Subsurface - SENS12_sum.TXT (increased K value)
- WV Subsurface - SENS13_sum.TXT (decreased runoff/evapotranspiration)
- WV Subsurface - SENS14_sum.TXT (increased runoff/evapotranspiration)
- WV Subsurface – SENS15.RAD (decreased gamma shielding factor)
- WV Subsurface – SENS16.RAD (increased gamma shielding factor)
- WV Subsurface – SENS17.RAD (decreased indoor air filtration factor)
- WV Subsurface – SENS18.RAD (increased indoor air filtration factor)
- WV Subsurface – SENS19.RAD (decreased mass loading factor for inhalation)
- WV Subsurface – SENS20.RAD (increased mass loading factor for inhalation)
- WV Subsurface – SENS21.RAD (decreased root depth)
- WV Subsurface – SENS22.RAD (increased root depth)
- WV Subsurface - SENS23_sum.TXT (decreased food transfer factors)
- WV Subsurface – SENS24_sum.TXT (increased food transfer factors)

– Stream Bank Sediment Source

- WV Sediment - SENS1_sum.TXT (decreased outdoor fraction)
- WV Sediment - SENS2_sum.TXT (increased outdoor fraction)
- WV Sediment - SENS3_sum.TXT (decreased source layer thickness)
- WV Sediment - SENS4_sum.TXT (increased source layer thickness)
- WV Sediment - SENS5_sum.TXT (increased unsaturated zone thickness)
- WV Sediment - SENS6_sum.TXT (largest unsaturated zone thickness)
- WV Sediment - SENS7_sum.TXT (decreased K_d values)
- WV Sediment - SENS8_sum.TXT (increased K_d values)
- WV Sediment – SENS9_sum.TXT (decreased runoff/evapotranspiration)
- WV Sediment – SENS10_sum.TXT (increased runoff/evapotranspiration)
- WV Sediment - SENS11_sum.TXT (decreased root depth)

- WV Sediment – SENS12_sum.TXT (increased root depth)
- WV Sediment - SENS13_sum.TXT (decreased food transfer factors)
- WV Sediment – SENS14_sum.TXT (increased food transfer factors)

The following section presents the methods used to generate DCGLs from the RESRAD model output previously described.

2.4 Excel Result Files

The outputs of the RESRAD simulations (the DSR for each of the radionuclides at various future times) were exported to Excel from the RESRAD summary output report (specifically, the DSR values in the table presented at the bottom of page 45 of each RESRAD summary report). For each simulation, dose results were exported for each of the 18 radionuclides, which includes the simulation year and dose (for that year) for each radionuclide. These have been generated for $DCGL_W$, $DCGL_{EMC}$, and sensitivity simulations for each source media and isotope. The peak dose for each radionuclide is identified and used as the basis for the DCGL calculation as follows;

$DCGL_w$ = Dose Limit / Peak radionuclide DSR (Eq.2)

Specific Excel result files are described below.

2.4.1 Surface Soil DCGLs

Surface soil DCGLs were calculated to conform with the annual dose limit for large areas ($DCGL_W$), smaller areas of elevated concentrations ($DCGL_{EMC}$), and to evaluate the sensitivity of the model to variations in specific parameters. The files associated with these calculations are described below.

Surface Soil $DCGL_W$ Values

The soil $DCGL_W$ values were calculated based on resident farmer exposure for a 10,000 m^2 source area and results from the RESRAD summary output report are presented in the Excel file "WVDP Surface DCGLs_Rev1.XLS" in the sheet "Base" (Table C-6). The input files for the surface soil evaluation are presented in Section 2.2. These surface soil $DCGL_W$ values are the basis for calculation of surface soil area factors and $DCGL_{EMC}$ values.

Surface Soil $DCGL_{EMC}$ Values

The $DCGL_W$ values calculated on the Excel summary sheet previously discussed serve as the base case for subsequent $DCGL_{EMC}$ development; $DCGL_{EMC}$ values are based on varying the source area from the 10,000 m^2 value used for the $DCGL_W$ as discussed in Chapter 5 of the MARSSIM. The Excel file "WV Surface DCGLs_Rev1.XLS" has sheets for each of the source areas used to generate the $DCGL_{EMC}$ (Tables C-7 to C-14). The sheet "Summary" in the Excel file "WV Surface DCGLs_Rev1.XLS" summarizes the $DCGL_{EMC}$ (Table C-15) and Soil Area Factors (TableC-16) for each of the 18 radionuclides and selected source areas (ranging from 1 to 10,000 m^2).

Surface Soil $DCGL_W$ Sensitivity Analysis

The surface soil $DCGL_W$ sensitivity to key parameters was assessed by varying the input values for specific parameters and tabulating the results. The Excel file "WV Surface

DCGL Sensitivity_Rev1.XLS" contains the DSRs and DCGLs for each of 18 radionuclides from the RESRAD summary report output for each of the sensitivity simulations. Results of each run are in sheets SENS1 through SENS31 (Tables C-17 to C-47). Also included in the file are a summarization of the calculated DCGLs (Table C-48) and a summary of the percent change from the base case (Table C-49) for each of the sensitivity runs (also presented in Table 5-9). Table C-50 below presents a summary of the surface soil sensitivity results.

Table C-50 Summary of Surface Soil DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
Indoor/Outdoor Fraction	1	-32%	-22%	U-232	0%	Cm-244
	2	21%	0%	C-14 I-129 Np-237 Tc-99 U-234	28%	U-232
Source Thickness	3	-50%	9%	U-232	231%	C-14
	4	200%	-57%	C-14	0%	Am-241 Cm-243 Cm-244 Cs-137 Pu-239 Pu-240
Unsaturated Zone Thickness	5	-50%	-10%	Tc-99	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Sr-90 U-232
	6	150%	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Sr-90 U-232	12%	U-235
Irrigation/Pump Rate	7	-57%	-1%	U-232	65%	I-129
	8	70%	-36%	I-129	1%	U-232
Soil/Water Distribution Coefficients (Kd)	9	lower	-99%	Pu-239	2%	C-14
	10	higher	-3%	U-232	867%	U-234
Hydraulic Conductivity (K_h)	11	-55%	-36%	I-129	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Sr-90 U-232
	12	57%	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Sr-90 U-232	40%	I-129

Table C-50 Summary of Surface Soil DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
Runoff/Evaporation Coefficient	13	-23%	-29%	U-234	2%	U-232
	14	15%	-2%	U-232	81%	Np-237
Depth of Well Intake	15	-40%	-40%	I-129	0.0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Sr-90 U-232
	16	100%	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Sr-90 U-232	99%	I-129
Length Parallel to Aquifer Flow	17	-30%	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Sr-90 U-232	30%	I-129
	18	21%	-12%	I-129	0.0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Pu-241 Sr-90 U-232
Hydraulic Gradient	19	-33%	-23%	I-129	0.0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Sr-90 U-232
	20	33%	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Sr-90 U-232	23.3%	I-129
Gamma Shielding Factor	21	-38%	0%	no change	0.0%	no change
	22	87%	-24%	U-232	0.0%	Np-237
Indoor Dust Filtration Factor	23	-60%	0%	C-14 Cs-137 I-129 Np-237 Sr-90 Tc-99 U-234	0.6%	Cm-244

Table C-50 Summary of Surface Soil DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
	24	-25%	0%	C-14 Cs-137 I-129 Np-237 Sr-90 Tc-99 U-233 U-234	0.3%	Pu-241
Dust Loading Factor	**25**	-70%	0%	C-14 Cs-137 I-129 Np-237 Sr-90 Tc-99 U-234	1.0%	Cm-244
	26	67%	-1%	Cm-244	0.0%	C-14 Cs-137 I-129 Sr-90 Tc-99 U-235 U-238
Root Depth	**27**	-67%	0%	no change	0.0%	no change
	28	233%	0%	I-129	199.7%	C-14
Food Transfer Factors	**29**	lower	-38%	U-235	875%	Sr-90
	30	higher	-97%	Sr-90	-14%	Np-237
Mass Balance Model	**31**	NA	-67%	U-234	0.0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Sr-90 U-232

2.4.2 Subsurface Soil (Lavery till) DCGLs

To evaluate an excavation that would expose the resident farmer to subsurface material, DCGLs were developed to address this potential future source. It is possible that a farmer may install a cistern or well to access groundwater, and in the excavation process, contaminated Lavery till material from the subsurface may be spread on the ground surface and be a source of exposure. The following subsections discuss the files associated with this calculation.

Subsurface Soil $DCGL_W$ Values

The subsurface $DCGL_w$ values are presented in the Excel file "WV Subsurface DCGLs_Rev1.XLS" in the sheet "Base" (TableC-51), and are based on the RESRAD input file "WV Subsurface – 100 Base.RAD" and results from page 45 of the RESRAD summary output report "WV Subsurface – 100 Base.TXT".

For calculation of the distributed soil, $DCGL_W$ values for a 100 m^2 source area of Lavery till on the surface were increased by a factor of 10 to account for an assumed blending of residually contaminated till with clean overlying soil in the excavation process (assuming 0.5 m of till for each 5 m of total excavation). This factor is applied to the final RESRAD generated DCGLw as presented in the overall summary table (See "DCGL Summary" section).

The input files for the subsurface soil evaluation are discussed in Section 2.2. These Lavery Till $DCGL_W$ values are used as the basis for calculation of the subsurface soil $DCGL_{EMC}$ values and for sensitivity analysis as described below.

Subsurface Soil $DCGL_{EMC}$ Values

Calculation of $DCGL_{EMC}$ values for the subsurface Lavery till was based on the base case area of 100 m^2 used for development of the $DCGL_W$ values (after accounting for blending). The $DCGL_{EMC}$ values were generated by varying the source area. The RESRAD output for these simulations are presented and summarized in the Excel file "WV Subsurface DCGLs_Rev1.XLS". The results for each source area are presented in individual sheets (Tables C-52 to C-55). The sheet "Summary" presents the $DCGL_{EMC}$ values (Table C-56) and subsurface soil area factors (Table C-57) for each of the 18 radionuclides and selected source areas (ranging from 1 to 100 m^2).

Subsurface Soil Sensitivity Analysis

The subsurface soil $DCGL_W$ sensitivity to key parameters was assessed by varying the input values for specific parameters and tabulating the results. The Excel file "WV Subsurface DCGL Sensitivity_Rev1.XLS" contains the DSRs and DCGLs for each of 18 radionuclides from the RESRAD summary report output for each of the sensitivity simulations. Results of each run are in sheets SENS1 through SENS24 (Tables C-58 to C-81). Also included in the file is a summarization of the calculated DCGLs (Table C-82) and a summary of the percent change from the base case (Table C-83) for each of the sensitivity runs (also presented in Table 5-10). Table C-84 below presents a summary of the subsurface soil sensitivity results.

Table C-84 Summary of Subsurface Soil DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
Indoor/Outdoor Fraction	1	-32%	-25%	Cs-137	0.5%	Pu-238
	2	21%	0%	C-14	35%	U-232
Source Thickness	3	-67%	-65%	U-238	204%	Tc-99
	4	233%	-33%	C-14	98%	U-234
Unsaturated Zone Thickness	5	-50%	-2%	Np-237	58%	U-238
	6	150%	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Pu-241 Sr-90 Tc-99 U-232 U-235	2218%	U-234
Irrigation/Pump Rate	7	-57%	-39%	I-129	57%	U-238
	8	70%	0%	Am-241 Cm-243 Cm-244 Pu-238 Pu-239 Pu-240	20%	I-129

Table C-84 Summary of Subsurface Soil DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
Soil/Water Distribution Coefficients (Kd)	9	lower	-99%	Pu-239	116%	U-232
	10	higher	-20%	U-232	2168%	U-234
Hydraulic Conductivity (K_h)	11	-55%	0%	No change	0%	No change
	12	57%	0%	No change	0%	No change
Runoff/Evaporation Coefficient	13	-23%	-44%	U-234	61%	U-238
	14	15%	-11%	U-232	117%	U-234
Indoor Gamma Shielding Factor	15	-38%	0%	U-238	19%	U-232
	16	87%	-27%	Cs-137	1%	U-238
Indoor Dust Filtration Factor	17	-60%	0%	U-238	13%	Cm-244
	18	-25%	0%	C-14 Cs-137 I-129 Np-237 Sr-90 Tc-99 U-233 U-234 U-238	5%	Cm-244
Inhalation Dust Loading	19	-70%	0%	U-238	22%	Cm-244
	20	67%	-15%	Cm-244	0%	C-14 Cs-137 I-129 Np-237 Sr-90 Tc-99
Root Depth	21	-67%	-67%	Tc-99	1%	U-233
	22	233%	0%	U-238	227%	Tc-99
Food Transfer Factors	23	lower	-0.1%	U-238	582%	Tc-99
	24	higher	-93%	Sr-90	0%	U-234

2.4.3 Streambed Sediment DCGLs

DCGLs were also developed to account for potential exposure associated with stream bank sediment (including direct pathways, fish ingestion, and venison ingestion). The stream bank rather than the streambed was the focus of the analysis because the recreationist is assumed to be in direct contact with the stream bank, and not the stream bed.

Files associated with the calculations are discussed below and presented in the files attachment.

Streambed Sediment $DCGL_W$ Values

The sediment $DCGL_W$ values were calculated based on a recreationist exposure for a 1,000 m^2 source area and results from the RESRAD summary output report are presented in the Excel file "WVDP Surface DCGLs_Rev1.XLS" in the sheet "Base" (Table C-85). The input files for the sediment evaluation are discussed in Section 2.2. These sediment $DCGL_W$ values are the basis for calculation of Sediment Area Factors and $DCGL_{EMC}$ values.

Streambed Sediment $DCGL_{EMC}$ Values

The $DCGL_W$ values calculated on the Excel summary sheet previously discussed serve as the base case for subsequent $DCGL_{EMC}$ development, which are based on varying the source area from the 1,000 m^2 value used for the $DCGL_W$ values. The RESRAD output for these simulations are presented and summarized in the Excel file "WV Sediment DCGLs_Rev1.XLS". The results for each source area are presented in individual sheets (Tables C-86 to C-91). The sheet "Summary" presents the $DCGL_{EMC}$ values (Table C-92) and sediment area factors (Table C-93) the 18 radionuclides and selected source areas (ranging from 1 to 1,000 m^2).

Streambed Sediment Sensitivity Analysis

The sediment $DCGL_W$ sensitivity to key parameters was assessed by varying the input values and tabulating the results. The Excel file "WV Sediment DCGL Sensitivity_Rev1.XLS" contains the RESRAD summary report output for each of the sensitivity simulations. Results of each run are in sheets SENS1 through SENS14 (Tables C-94 to C-107). Also included in the file is a summarization of the calculated DCGLs (Table C-108) and percent change from the base case (Table C-109) for each of the sensitivity runs (also presented in Table 5-11). Table C-110 below presents a summary of the sediment sensitivity analysis.

Table C-110 Summary of Sediment DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
Outdoor Fraction	1	-50%	0%	C-14	98%	Cm-243
	2	100%	-50%	Cm-243	0%	C-14
Source Thickness	3	-50%	0%	Am-241 Cm-243	157%	C-14
	4	200%	-52%	C-14	0%	Am-241 Cm-243 Cm-244 Pu-238 Pu-239 Pu-240
Soil/Water Distribution Coefficients (Kd)	5	lower	-91%	Pu-239	26%	U-232
	6	higher	-65%	U-233	52%	U-234
Runoff/Evaporation Coefficient	7	-23%	0%	Am-241 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240	4%	U-232
	8	15%	-3%	I-129	0%	Am-241 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240

Table C-110 Summary of Sediment DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
Mass Loading for Inhalation	9	-70%	0%	Np-237	1%	Cm-244
	10	67%	-4%	Cm-244	0%	C-14 Cs-137 I-129 Sr-90
Root Depth	11	-67%	0%	no change	0%	no change
	12	233%	0%	Cm-243 U-232 U-235	50%	Sr-90
Food Transfer Factors	13	lower	1%	Cm-243	852%	Sr-90
	14	higher	-98%	Sr-90	-11%	Cm-243

Consideration of Subsurface Lavery till as a Continuing Source to Groundwater

An evaluation of the potential for the Lavery till to act as a continuing source to groundwater was conducted and concluded the following (See section 3.7 and Table 3-19 of the body of the plan):

- A well screened entirely in the Lavery Till could not produce enough groundwater for the resident farmer scenario.
- A well screened in both the sand and gravel unit and Lavery till would likely pump mostly groundwater from the sand and gravel unit due to the much higher relative hydraulic conductivity and subsequent development of preferential flowpaths, and contain highly diluted contributions of contaminated groundwater from the Lavery Till.
- Advective movement from the Lavery Till to the overlying Sand and Gravel Unit is unlikely considering the vertical downward groundwater gradient.
- Diffusive movement from the Lavery Till to the Sand and Gravel Unit is unlikely considering the very low diffusion coefficients for radionuclides.
- Migration vertically upward from the till through the aquifer and into a well that is screened several meters above the till is unlikely.

DCGL Summary

The Excel File "WV DCGL Summary Tables_Rev1.xls" (Table C-111) summarizes the DCGLs for the surface soil, subsurface soil and sediment, and presents $DCGL_W$ and $DCGL_{EMC}$ for a 1 m^2 area (also presented in Table 5-8).

Integrated Dose Assessment

In order to account for potential exposure to multiple sources, a combined dose assessment was conducted. The assessment considered which combination of exposures was likely, and concluded that the resident farmer may also spend time in recreation along the stream bank.

The Excel File "WV DCGL Summary Tables_Rev1.xls" presents the calculated $DCGL_W$ and $DCGL_{EMC}$ values when considering the combined doses from surface soil (90% x 25 mrem/y = 22.5 mrem/y) and sediment sources (10% x 25 mrem/y = 2.5 mrem/y), which are summarized in Tables C-112, C-113, and C-114 (also presented in Table 5-13). In the same Excel file, Table C-115 presents the cleanup goals to be used as the criteria for the proposed remediation activities. Values in Table C-115 represent the $DCGL_W$ and $DCGL_{EMC}$ values for surface soil and sediment (considering the combined dose), as well as cleanup goals for subsurface soil (which are 50% of the $DCGL_W$ and $DCGL_{EMC}$ values adjusted to provide a margin of confidence/safety factor for excavation success for each radionuclide (also presented in Table 5-12).

Evaluation of Institutional Control Period

After Phase 1 proposed remediation there is assumed to be a 30 year period of institutional controls (associated with storage of the HLW canisters until 2041), prior to site access by the critical receptors. During this period, radionuclide inventories will be subject to decay and leaching, which will result in site concentrations at the time of exposure that are reduced from the initial concentrations left at the time of proposed remediation. With the exception of Sr-90 and Cs-137, DCGLs were developed neglecting the effects of decay and leaching from the source during the 30 year institutional control period. The ratio of the initial concentrations in soil to the RESRAD generated soil concentration after a 30 year simulation was used to provide an evaluation of uncertainty associated with the assumption of neglecting decay/leaching. A RESRAD simulation was run using the surface soil base case without irrigation, well pumping, or plant/animal/human uptake from soil (see RESRAD input file "WV SURFACE – 10k – LCH_DCAY.RAD" and output file "WV SURFACE – 10k – LCH_DCAY_sum.txt". The RESRAD concentration output summary file (see page 8 of the file "WV SURFACE – 10k – LCH_DCAY_conc.txt") provides the soil concentration at year 30, which is then related to the initial soil concentration to quantify the effects of leaching/decay (see Excel file "WV Institutional Control.xls" Table C-116).

Evaluation of Potential Dose Drivers and Sensitivity Parameters

The impact of specific sensitivity parameters is dependent on the radionuclides that contribute the majority of the dose to the receptor. Due to limited site data, a full evaluation cannot be performed until additional site characterization data is available. In the interim, Table C-117 presented below identifies the primary dose pathways for each radionuclide and indicates which of the sensitivity parameters have significant impact on the dose. This evaluation would be refined as additional site data are collected.

Table C-117 Summary of Primary Dose Pathways

Nuclide	Primary Pathway for Dose	Key Parameters(1)	Year of Peak Dose
Surface Soil			
Am-241	Water independent (plant uptake)	plant transfer factors, source thickness	0.00E+00
C-14	Water independent (plant uptake)	source thickness	0.00E+00
Cm-243	External Exposure, Water independent (plant uptake)	plant transfer factors, source thickness	0.00E+00

Table C-117 Summary of Primary Dose Pathways

Nuclide	Primary Pathway for Dose	Key Parameters[1]	Year of Peak Dose
Cm-244	Water independent (plant uptake)	plant transfer factors, source thickness	0.00E+00
Cs-137	External Exposure	outdoor fraction, plant transfer factors	0.00E+00
I-129	Water dependent (water ingestion, plant and milk uptake)	K, Kd, runoff/evap coefficients, well intake depth, groundwater model	9.21E+00
Np-237	Water dependent (water ingestion, plant uptake)	hydraulic conductivity, Kd, runoff/evap coefficients, well intake depth, groundwater model	2.01E+01
Pu-238	Water independent (plant uptake)	Kd, plant transfer factors	0.00E+00
Pu-239	Water independent (plant uptake)	Kd, plant transfer factors	0.00E+00
Pu-240	Water independent (plant uptake)	Kd, plant transfer factors	0.00E+00
Pu-241	Water independent (plant uptake)	Kd, plant transfer factors	5.52E+01
Sr-90	Water independent (plant uptake)	source thickness, plant transfer factors, Kd, groundwater model	0.00E+00
Tc-99	Water dependent (water ingestion, plant uptake), independent (plant uptake)	source thickness, well intake depth, plant transfer factors, length parallel to flow, Kd, K, groundwater model	1.54E+00
U-232	External Exposure	outdoor fraction, plant transfer factors	8.17E+00
U-233	Water dependent (water ingestion, plant uptake)	irrigation/pump rate, Kd, runoff/evap coefficients, groundwater model	2.96E+02
U-234	Water dependent (water ingestion, plant uptake)	irrigation/pump rate, Kd, runoff/evap coefficients, groundwater model	2.96E+02
U-235	Water dependent (water ingestion, plant uptake)	irrigation/pump rate, Kd, runoff/evap coefficients, groundwater model	2.96E+02
U-238	Water dependent (water ingestion, plant uptake)	irrigation/pump rate, Kd, runoff/evap coefficients, groundwater model	2.96E+02
Subsurface Soil			
Am-241	External Exposure, Water independent (plant uptake)	source thickness, plant transfer factors	0.00E+00
C-14	Water independent (plant uptake)	source thickness	0.00E+00
Cm-243	External Exposure	outdoor fraction, source thickness	0.00E+00
Cm-244	Water independent (plant uptake)	source thickness, plant transfer factors	0.00E+00
Cs-137	External Exposure	outdoor fraction, source thickness	0.00E+00
I-129	Water dependent (water ingestion)	source thickness, irrigation/pump rate, Kd, runoff/evap coefficients	6.32E+00
Np-237	Water independent (soil ingestion, plant uptake)	source thickness, Kd, runoff/evap coefficients	1.37E+01
Pu-238	Water independent (plant uptake, soil ingestion and inhalation)	source thickness, Kd, plant transfer factors	0.00E+00
Pu-239	Water independent (plant uptake, soil	source thickness, Kd, plant transfer factors	0.00E+00

Table C-117 Summary of Primary Dose Pathways

Nuclide	Primary Pathway for Dose	Key Parameters(1)	Year of Peak Dose
	ingestion and inhalation)		
Pu-240	Water independent (plant uptake, soil ingestion and inhalation)	source thickness, Kd, plant transfer factors	0.00E+00
Pu-241	Water independent (plant uptake)	source thickness, Kd, plant transfer factors	6.14E+01
Sr-90	Water independent (plant uptake)	source thickness, Kd, plant transfer factors	0.00E+00
Tc-99	Water dependent (plant uptake)	source thickness, plant transfer factors	0.00E+00
U-232	External Exposure	outdoor fraction, source thickness	4.60E+00
U-233	Water dependent (water ingestion)	Kd, runoff/evap coefficients	1.97E+02
U-234	Water dependent (water ingestion)	Kd, runoff/evap coefficients	1.97E+02
U-235	External Exposure	outdoor fraction, source thickness, Kd	0.00E+00
U-238	Water dependent (water ingestion)	source thickness, irrigation/pump rate, Kd, runoff/evap coefficients, groundwater model	1.98E+02
Sediment			
Am-241	External Exposure, Soil ingestion, Water independent (meat uptake)	outdoor fraction	0.00E+00
C-14	Water independent (meat uptake), Water dependent (fish uptake)	source thickness, unsaturated thickness, Kd	0.00E+00
Cm-243	External Exposure	outdoor fraction	0.00E+00
Cm-244	Soil ingestion	outdoor fraction	0.00E+00
Cs-137	External Exposure	outdoor fraction	0.00E+00
I-129	Water independent (meat uptake), Water dependent (fish uptake)	unsaturated thickness, Kd, fish transfer factors	0.00E+00
Np-237	External Exposure, Water independent (meat uptake), Water dependent (fish uptake)	unsaturated thickness, Kd, fish transfer factors	0.00E+00
Pu-238	Water independent (meat uptake), Soil ingestion	outdoor fraction, Kd	0.00E+00
Pu-239	Water independent (meat uptake), Soil ingestion	outdoor fraction, Kd	2.82E-01
Pu-240	Water independent (meat uptake), Soil ingestion	outdoor fraction, Kd	1.18E-01
Pu-241	External Exposure, Water independent (meat uptake), Soil ingestion	outdoor fraction, Kd	5.78E+01
Sr-90	Water independent (meat uptake)	plant and fish transfer factors	0.00E+00
Tc-99	Water independent (meat uptake)	Kd, plant and fish transfer factors	0.00E+00
U-232	External Exposure	outdoor fraction, Kd	7.72E+00
U-233	External Exposure, Water independent (meat uptake), Water dependent (fish uptake)	outdoor fraction, unsaturated thickness, Kd, plant and fish transfer factors	1.56E-01

Table C-117 Summary of Primary Dose Pathways

Nuclide	Primary Pathway for Dose	Key Parameters(1)	Year of Peak Dose
U-234	Water independent (meat uptake), Water dependent (fish uptake)	outdoor fraction, unsaturated thickness, Kd, fish transfer factors	1.81E-01
U-235	External Exposure	outdoor fraction	0.00E+00
U-238	External Exposure	outdoor fraction, fish transfer factors	0.00E+00

NOTE: (1) Key parameters identified in sensitivity runs. As additional site characterization data becomes available, the radionuclides driving dose and parameters most critical to calculating dose can be used to refine the sensitivity analysis.

3.0 References

Beyeler, et al. 1999, *Residual Radioactivity from Decommissioning, Parameter Analysis*, NUREG/CR-5512, Vol 3, Draft Report for Comment. Beyeler, W. E., W. A. Hareland, F. A. Duran, T. J. Brown, E. Kalinina, D. P. Gallegos, and P. A. Davis, Sandia National Laboratories, Albuquerque, New Mexico, October 1999.

Dames and Moore, 1995a, *Testing and Characterization of Glacial Deposits: Geochemical and Radionuclide Adsorption Data*, Project 10805-953-8251. Dames and Moore, Orchard Park, New York, June 26, 1995.

Dames and Moore, 1995b, *Investigation of Strontium Behavior in the Surficial Sand and Gravel-Groundwater System*, Project 10805-953-8251. Dames and Moore, Orchard Park, New York, June 9, 1995.

EPA 1997, *Exposure Factors Handbook*. National Center for Environmental Assessment, Office of Research and Development, U. S. Environmental Protection Agency, Washington, D.C., 1997.

NRC 1997, *Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities; Final Policy Statement*. NUREG-1496, Vol. 1. U.S. Nuclear Regulatory Commission, Office of Regulatory Research, Division of Regulatory Applications, Washington, D.C., July 1997.

Sheppard and Thibault 1990, "Default Soil Solid/Liquid Partition Coefficients, Kds, for Four Major Soil Types: A Compendium," Sheppard, M.I., and D.H. Thibault, *Health Physics*, 59:471-482, 1990.

Sheppard, et. al., 2006, "Revision and meta-analysis of selected biosphere parameter values for chlorine, iodine, neptunium, radium, radon, and uranium", Journal of Environmental Radioactivity, 89:115-137, 2006.

Yu, et al. 1993, *Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil*. Yu, C., et al., Environmental Assessment and Information Sciences Division, Argonne National Laboratory, Argonne, Illinois, April 1993.

Yu, et al. 2000, *Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes*, NUREG/CR-6697, ANL/EAD/TM-98. Yu, C., et al., Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois, November 2000.

Yu, et al. 2001, *User's Manual for RESRAD Version 6*, ANL/EAD-4. Yu, C., et al., Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois, July 2001.

WVNSCO 1993a, *Environmental Information Document, Volume I, Geology,* WVDP-EIS-004, Rev. 0. West Valley Nuclear Services Company, West Valley, New York, 1993.

WVNSCO 1993b, *Environmental Information Document, Volume III, Hydrology: Part 4, Groundwater Hydrology and Geochemistry*, WVDP-EIS-009, Rev. 0. West Valley Nuclear Services Company, West Valley, New York, 1993.

WVNSCO 1993c, *Environmental Information Document, Volume III, Hydrology: Part 5, Vadose Zone Hydrology*, WVDP-EIS-009, Rev. 0. West Valley Nuclear Services Company, West Valley, New York, 1993.

WVNSCO 1993d, *Environmental Information Document, Volume VIII, Air Resources: Part 2, Meteorology*, WVDP-EIS-014, Rev. 0. West Valley Nuclear Services Company, West Valley, New York, 1993.

Attachments

1. Electronic Files Described in Section 2 (provided separately)
2. Electronic File Described in Section 1 (provided separately)

RAI 5C13 (18)

Subject: *streambed sediment source geometry*

RAI: The assumed distribution of contamination for development of the streambed sediment DCGLs should be compared to observed contamination. (Section 5.2.1, Page 5-31)

Basis: The contaminated zone of interest is located on the stream bed and is assumed to be three meters (10 feet) wide and 333 meters (1093 feet) long, with a total area of 1000 square meters (approximately ¼ acre). Figure 2-7 on page 2-38 shows how natural redistribution processes can result in contamination over a much broader area than would be expected based solely on the geometry of the stream channels. For remediation of onsite streams, a technical basis should be provided to support the assumption that the assumed extent of contamination is consistent with or more limiting than expected to result from observed redistribution processes.

NRC Path Forward: Provide a comparison of the assumed size of the contaminated zone to the observed contamination of streambed sediment.

****

DOE Response: Available data on contamination associated with the sediment in Erdman Brook and the portion of Frank's Creek on the project premises and on the banks of those streams are limited as explained in Section 4.2 of the DP. Consequently, the comparison requested cannot be made at this time.

The Characterization Sample and Analysis Plan will provide for gamma walkover surveys of the banks of the streams and biased sampling of sediment in the streambeds and on the banks of the streams. These characterization data will be compared to the contamination zone geometry specified in the conceptual model for streambed sediment DCGLs and the model refined accordingly.

Changes to the Plan: None. Refining the source geometry in the conceptual models based on characterization data is required by the text and footnote on page 5-18.

RAI5C14 (19)

Subject: source for game ingestion transfer factors

RAI: The data sources for transfer factors used for the game ingestion pathway were not provided. (Section 5.2.1, Page 5-29; Appendix C, Section 1.0, Table C-1)

Basis: It is not clear what values were used or the data source for transfer factors for uptake of radionuclides to venison in the streambed sediment DCGL development.

NRC Path Forward: Provide the transfer factors for venison and the associated data sources in Table C-1.

****

DOE Response: The transfer factors used are the RESRAD defaults for meat/livestock. It was noted that the transfer factor for milk was also omitted from the table.

Changes to the Plan: The following entries will be added to Table C-1:

RESRAD Parameter (Units)	Default	Value	Medium	Comment/Reference
Meat transfer factor	Varies	Chemical specific	All	Default values assumed, including for venison.
Milk Transfer factor	Varies	Chemical specific	SS, SB	Default values assumed.

RAI 5C18 (23)

Subject: Pumping, irrigation rate conservatism

RAI: DOE did not provide sufficient support that the selection of parameter values in the deterministic analysis is sufficiently conservative to demonstrate compliance with LTR criteria. This specific comment is related to DOE's selection of pumping and irrigation rates. (Section 5.2.4; Appendix C, Table C-1)

Basis: Irrigation and pumping rates can have a significant impact on the expected risk associated with residual contamination remaining at the site following remediation. While higher pumping and irrigation rates would be more conservative for some radionuclides in certain situations, the assumed pumping and irrigation rates may not be conservative for other radionuclides. Therefore, the conservatism of the set of parameter values selected for the DCGL calculations becomes a function of the scenario and radionuclide being evaluated making it difficult to select a global parameter set that is demonstrably conservative for the entire site.

The pumping and irrigation rates selected by DOE are based on the support of various groundwater-dependent pathways including drinking water ingestion and animal and plant product ingestion (see Table C-1). As the subsurface DCGLs assume a contaminated area of 100 m^2 the impact of plant and animal pathways is substantially reduced given the much smaller contaminated area that is not expected to fully support these pathways (e.g., 1000 to 2000 m^2 is generally needed to support the large plant ingestion rates and 20,000 m^2 to support animal product ingestion rates). The drinking water ingestion rates may be the same for a family of four; however, the amount of irrigation water needed for a 100 m^2 garden could be substantially reduced. Thus, the pumping requirements for the subsurface DCGLs are expected to be much lower then those assumed for the surface DCGLs. Additionally, a resident scenario may be more limiting then a resident farmer scenario due to decreased water usage in the surface soil DCGL calculations. Lower pumping rates can lead to an increase in dose due to lower dilution factors (all other factors being equal) and in certain circumstances where water-dependent pathways dominate the dose, the DCGLs may be significantly reduced. DOE should also attempt to use site-specific irrigation rates or provide support for the value selected.

Evapotranspiration and runoff coefficients were selected to achieve an infiltration rate of 0.42 m/y or 25% of the applied water according to Table C-1. No basis is provided for the targeted infiltration rate. Infiltration rates can significantly affect DCGL calculations.

Path Forward: DOE should demonstrate that its selection of parameters does not significantly underestimate the potential risk from residual radioactivity remaining at the site considering the potential uncertainty in the dose predictions. In the absence of sufficient characterization data to demonstrate that the DCGLs calculated err on the side of conservatism considering the actual mix of radionuclides expected to remain at the site following remediation, DOE should consider using a radionuclide-specific parameter set that considers the most important parameter values for individual radionuclides (e.g., pumping and irrigation rates for 1-129) and select parameter values that tend to overestimate— rather than under — estimate the potential dose. DOE should justify its selection of pumping and irrigation rates for the surface and subsurface soil DCGL calculations and evaluate whether a resident scenario would be more limiting then a resident farmer scenario. DOE should justify its selection of parameter values to achieve the targeted infiltration rate of 0.42 m/y and provide support that this infiltration rate does not lead to a significant under-estimate of risk for key radionuclides.

****

DOE Response: DOE evaluated the values used in the deterministic analysis for pumping and irrigation rates and determined that it was appropriate to retain the original values, a pumping rate of 5720 cubic meters per year and an irrigation rate of 0.47 meter per year. DOE did not change these values in the base-case models because they are considered to be reasonable and appropriate. However, a lower pumping rate was used in a residential gardener analysis as discussed below.

Tables 5-9 and 5-10 of the DP include the results of sensitivity analysis performed for the combined irrigation and pumping rates. These analyses showed that for the surface soil model a 57 percent decrease in the combined irrigation/pumping rate generally resulted in higher DCGLs. A 70 percent increase resulted in lower DCGLs for many radionuclides, with the I-129 DCGL being the most sensitive to changes in the irrigation and pumping rates. With the subsurface soil model, the DCGLs dropped up to 36 percent with the 57 percent decrease in the combined irrigation and pumping rates due to the resulting lower dilution factor. Increasing the irrigation and pumping rate by 70 percent resulted in increases up to 159 percent in the DCGLs.

The pumping and irrigation rates were among the parameters included in the probabilistic uncertainty analysis described in the response to RAI 5C15.

DOE has modeled a residential gardener scenario for both the surface soil and subsurface soil cases to determine whether it would be more limiting than the resident farmer scenario for any of the 18 radionuclides of interest. The results, which are described below, indicated that it is more limiting for some radionuclides in the subsurface soil case.

Residential Gardener Scenario – Surface Soil

Key features of this model included:

- The same contaminated zone area (10,000 m^2) and thickness (1 m) as the resident farmer model, but with a smaller area (2,000 m^2) being used;
- A lower well pumping rate (1140 m^3/y compared to 5720 m^3/y for the resident farmer model);
- The same 0.2 dilution factor with the non-dispersion model;
- A lower outdoor time fraction (0.12 compared to 0.25 with the resident farmer model); and
- Assuming no consumption of milk or meat, unlike the resident farmer model.

Table 5C18-1 shows the results of the analysis.

Table 5C18-1. Residential Gardener Results Compared to Base Case (Surface Soil DCGLs)

Nuclide	Base-Case Resident Farmer DCGL (pCi/g)(1)	Residential Gardener DCGL (pCi/g)	Limiting Scenario
Am-241	4.3E+01	4.5E+01	Resident Farmer
C-14	2.0E+01	4.1E+01	Resident Farmer
Cm-243	4.1E+01	4.7E+01	Resident Farmer
Cm-244	8.2E+01	8.5E+01	Resident Farmer
Cs-137	2.4E+01(2)	4.1E+01	Resident Farmer
I-129	3.5E-01	7.3E-01	Resident Farmer

Table 5C18-1. Residential Gardener Results Compared to Base Case (Surface Soil DCGLs)

Nuclide	Base-Case Resident Farmer DCGL (pCi/g)(1)	Residential Gardener DCGL (pCi/g)	Limiting Scenario
Np-237	9.4E-02	9.5E-02	Resident Farmer
Pu-238	5.0E+01	5.3E+01	Resident Farmer
Pu-239	4.5E+01	4.8E+01	Resident Farmer
Pu-240	4.5E+01	4.8E+01	Resident Farmer
Pu-241	1.4E+03	1.5E+03	Resident Farmer
Sr-90	6.2E+00(2)	8.4E+00	Resident Farmer
Tc-99	2.4E+01	2.6E+01	Resident Farmer
U-232	5.8E+00	8.2E+00	Resident Farmer
U-233	1.9E+01	2.0E+01	Resident Farmer
U-234	2.0E+01	2.1E+01	Resident Farmer
U-235	1.9E+01	2.0E+01	Resident Farmer
U-238	2.1E+01	2.2E+01	Resident Farmer

NOTE: (1) Revised deterministic $DCGL_W$ values calculated using revised parameters described in the response to RAI 5C12.

(2) With 30-year decay period.

As can be seen in the table, the base-case resident farmer scenario produces lower DCGLs for all radionuclides of interest.

Residential Gardener Scenario – Subsurface Soil

These model runs made use of three combinations of contamination zone areas and thicknesses using the mass balance model. Key features of this model are shown in Table 5C18-2.

Table 5C18-2. Key Input Parameters for Resident Farmer and Residential Gardener Subsurface DCGL Evaluation

Parameters	Resident Farmer Model			Residential Gardener Model		
Model	1	2	3	1	2	3
CZ Area (m^2)	100	300	50	100	300	50
CZ Thickness (m)	0.3	0.1	0.6	0.3	0.1	0.6
Well pump rate (m^3/y)	5720	5720	5720	1140	1140	1140
Dilution Factor (MB model)	0.004	0.013	0.002	0.023	0.068	0.011
Outdoor time fraction	0.25	0.25	0.25	0.12	0.12	0.12
Dust loading factor (g/m^3)	1.50E-05	1.50E-05	1.50E-05	4.50E-06	4.50E-06	4.50E-06
Contaminated Fraction - Plant	0.05	0.15	0.025	0.05	0.15	0.025
Contaminated Fraction - Milk	0.01	0.03	0.0005	NA	NA	NA
Contaminated Fraction - Meat	0.01	0.03	0.0005	NA	NA	NA

LEGEND: NA = Residential gardener model does not include milk and meat consumption exposure pathways

Table 5C18-3 shows the results of the analyses.

Table 5C18-3. Subsurface Soil DCGLs (pCi/g) Derived from the Resident Farmer and Residential Gardener Scenarios

Nuclide	Resident Farmer					Residential Gardener						Limiting Value	Receptor/Contam. Zone Area
	Model 1[(1)]	Model 2		Model 3		Model 1		Model 2		Model 3			
Am-241	7.2E+03	**7.1E+03**	*	8.3E+03		9.8E+03		8.0E+03		1.1E+04		7.1E+03	Farmer – 300 m^2
C-14	5.6E+05	1.0E+06		**3.7E+05**	*	7.2E+05		4.5E+05	*	4.6E+05	*	3.7E+05	Farmer – 50 m^2
Cm-243	**1.2E+03**	1.2E+03		1.3E+03		1.6E+03		1.7E+03		1.8E+03		1.2E+03	Farmer – 100 m^2
Cm-244	2.4E+04	2.4E+04		2.9E+04		3.1E+04		**2.3E+04**	*	3.8E+04		2.3E+04	Gardener – 300 m^2
Cs-137[(2)]	**4.4E+02**	5.0E+02		4.8E+02		6.2E+02		7.1E+02		6.8E+02		4.4E+02	Farmer – 100 m^2
I-129	6.5E+02	2.7E+02	*	1.2E+03		1.3E+02	*	**5.2E+01**	*	2.5E+02	*	5.2E+01	Gardener – 300 m^2
Np-237	5.8E+01	2.3E+01	*	1.1E+02		1.2E+01	*	**4.3E+00**	*	2.2E+01	*	4.3E+00	Gardener – 300 m^2
Pu-238	1.5E+04	1.5E+04		1.8E+04		1.9E+04		**1.5E+04**	*	2.4E+04		1.5E+04	Gardener – 300 m^2
Pu-239	1.3E+04	1.4E+04		1.6E+04		1.7E+04		**1.3E+04**	*	2.1E+04		1.3E+04	Gardener – 300 m^2
Pu-240	1.3E+04	1.4E+04		1.6E+04		1.8E+04		**1.3E+04**	*	2.2E+04		1.3E+04	Gardener – 300 m^2
Pu-241	**2.4E+05**	**2.4E+05**		2.8E+05		3.3E+05		2.7E+05		3.8E+05		2.4E+05	Farmer - 100 & 300 m^2
Sr-90[(2)]	4.4E+03	1.2E+04		4.4E+03		4.8E+03		**3.2E+03**	*	4.8E+03		3.2E+03	Gardener – 300 m^2
Tc-99	1.6E+04	4.8E+04		1.5E+04	*	1.4E+04	*	**1.1E+04**	*	1.5E+04	*	1.1E+04	Gardener – 300 m^2
U-232	1.1E+02	1.8E+02		**1.0E+02**	*	1.5E+02		2.6E+02		1.5E+02		1.0E+02	Farmer – 50 m^2
U-233	2.7E+03	9.7E+02	*	5.2E+03		5.5E+02	*	**1.9E+02**	*	1.1E+03	*	1.9E+02	Gardener – 300 m^2
U-234	2.8E+03	9.9E+02	*	5.6E+03		5.6E+02	*	**2.0E+02**	*	1.1E+03	*	2.0E+02	Gardener – 300 m^2
U-235	9.4E+02	1.0E+03		1.0E+03		5.9E+02	*	**2.1E+02**	*	1.2E+03		2.1E+02	Gardener – 300 m^2
U-238	2.9E+03	1.0E+03	*	5.0E+03		5.9E+02	*	**2.1E+02**	*	1.2E+03	*	2.1E+02	Gardener – 300 m^2

LEGEND: * = smaller, more limiting value than the base case.

NOTES: (1) This is the base-case deterministic model $DCGL_W$ values calculated using revised parameters described in the response to RAI 5C12.

(2) With 30-year decay period.

The results in the Limiting Value column of Table 5C18-3 are being taken into account in revising the cleanup goals for subsurface soil in the deep excavations. This matter is addressed in the response to RAI 5C15, which describes the probabilistic uncertainty analysis undertaken to evaluate degree of conservatism in conceptual model input parameters.

Note that the use of the mass balance model results in more conservative DCGLs than would use of the non-dispersion model. The mass balance model is used because it is recommended in the RESRAD guidance manual for sites less than 1,000 m^2 in area.

Basis for Hydraulic Parameters

The following information is provided on the basis for the targeted infiltration rate. The coefficient was selected to be appropriate for relatively flat, cultivated, clay/loam soil. From the RESRAD Data Collection Manual (Yu et. al., 2001; p.E-7), the coefficient for relatively flat land (0.3 to 0.9 m/mi slope) is 0.3, the coefficient for cultivated land is 0.1, the runoff coefficient for sandy/clayey/loam is taken to be 0.3. The coefficient total (0.6) is subtracted from 1 to provide the runoff coefficient.

From the RESRAD Data Collection Manual (Yu et. al., 1993; p.77) the evapotranspiration rate is 24 in/y for the Buffalo area (Figure 12). Utilizing the irrigation rate equations found in this manual for the site-specific precipitation rate, runoff coefficient, evapotranspiration rate, and assumed irrigation efficiency of 51.5%, the irrigation rate is ~0.47 m/y.

The calculation package for the residential gardener scenario modeling and the associated electronic files will be provided to NRC with the second group of RAI responses to be submitted in September 2009.

Changes to the Plan:

Add the following information on page 23 before the unnumbered subsection heading Subsurface Soil Conceptual Model:

Residential Gardener Model

Another alternative exposure scenario was evaluated to confirm that the base-case resident farmer scenario is bounding for development of surface soil DCGLs. This alternative scenario involved a residential gardener scenario.

The receptor in the residential gardener scenario is a hypothetical person who resides in the area and grows a vegetable garden. This scenario differs from the resident farmer scenario in that the person of interest does not consume meat or milk produced on the property and spends less time outdoors in the hypothetical garden. The well pumping rate used in this scenario was lower than that used in the resident farmer model (1140 cubic meters per year compared to 5720 meters per year) to reflect the smaller area being used and the lower well water usage.

This alternative exposure scenario produced DCGLs that were slightly higher than those produced by the base-case resident farmer model for all 18 radionuclides. Consequently, the base-case model is bounding for surface soil DCGL development when compared to the resident gardener scenario.

Add the following information on page 5-28 before the unnumbered subsection heading Streambed Sediment Conceptual Model:

Residential Gardener Model

Another alternative exposure scenario was evaluated to determine whether the base-case resident farmer-cistern installation scenario is bounding for development of subsurface soil DCGLs. This alternative scenario involved a residential gardener scenario.

The receptor in the residential gardener scenario is a hypothetical person who resides in the area and grows a vegetable garden. This scenario differs from the resident farmer scenario in that the person of interest does not consume meat or milk produced on the property and spends less time outdoors in the hypothetical garden. The well pumping rate used in this scenario was lower than the rate used in the resident farmer model (1140 cubic meters per year compared to 5720 meters per year) to reflect the smaller area being used and the lower well water usage.

This analysis was performed using three models which differed with respect to the area of the contamination zone and its thickness:

- Model 1 used a 100 square meter area and 0.3 meter depth, the base-case values in the resident farmer deterministic analysis;
- Model 2 used a 300 square meter area and 0.1 meter depth; and
- Model 3 used a 50 square meter area and 0.6 meter depth;

This alternative exposure scenario produced DCGLs for some radionuclides that were lower than those produced by the base-case resident farmer model. In most cases, Model 2 with the largest contamination zone area produced the lowest DCGLs. The results appear in Section 5.4.1 and were taken into account in establishing revised cleanup goals.

The results of the analysis are to be included in the response to RAI 5C15, which addresses the probabilistic uncertainty analysis and the revisions to the cleanup goals considering the results of that analysis and other evaluations performed to determine whether the base-case deterministic DCGLs are limiting.

RAI 5C19 (24)

Subject: Contaminated plant fraction

RAI: DOE should justify use of a contaminated plant fraction of -1 in RESRAD. (Section 5.2.1; Appendix C, Table C-1)

Basis: Use of a contaminated plant fraction of -1 effectively reduces the ingestion rates by one-half. Coupled with use of a contaminated area of 100 m^2, the ingestion rates are effectively reduced to 1/20th of their reported values. For many radionuclides dominated by the plant pathway, the DCGLs would be significantly reduced if a contaminated plant fraction of 1 and larger area of contamination is assumed.

Path Forward: DOE should use a contaminated plant fraction of 1 and adjust the plant ingestion rates, if necessary, to reflect the expected yield from a smaller area of contamination to ensure that the plant ingestion rates are not arbitrarily reduced by one-half or provide support for the reduced plant ingestion rates. DOE is encouraged to use regional-specific plant ingestion rates, which may be significantly lower than the default values in RESRAD.

****

DOE Response: A contaminated plant fraction of 1 will be used for both the surface soil and subsurface soil DCGL models and the plant ingestion rates adjusted appropriately, as suggested. Rather than performing a probabilistic evaluation of contaminated zone area in the subsurface DCGL model in the probabilistic uncertainty analysis, the contaminated zone area will be fixed, as suggested by NRC during the June 15, 2009 public meeting. A sensitivity analysis of the contaminated zone area is being performed as discussed in the response to RAI 5C10.

Changes to the Plan: Table C-1 will be changed as follows:

Table C-1. RESRAD Input Parameters

RESRAD Parameter (Units)	Default	Value	Medium	Comment/Reference
Fruits, vegetables and grain consumption (kg/y)	1.60E+02	1.12E+02	SS, SB	Beyeler, et al. 1999.
Leafy vegetable consumption (kg/y)	1.40E+01	2.10E+01	SS, SB	Beyeler, et al. 1999.
Contamination fraction of plant food	-1	1.0	SS, SB	Fraction based on the source area.

Note that a complete copy of the revised Table C-1 is provided with the response to RAI 5C12.

RAI 5C20 (25)

Subject: Considering barriers in hydraulic parameters

RAI: The impact of hydraulic barriers should be considered when selecting hydrologic parameters for use in RESRAD when deriving DCGLs. (Section 5.2.1; Appendix C, Table C-1)

Basis: Table C-1 in the DP indicates that the saturated hydraulic gradient is based on historical information. Appendix D modeling shows a flattening of the water table surface downgradient from the WMA slurry wall, which will lead to a lower hydraulic gradient across most of the North Plateau. Decreased flow could have a significant impact on the results of the DCGL calculations.

Path Forward: DOE should consider the impact of hydraulic barriers on the flow field when selecting parameter values for use in RESRAD or show how its selection of parameter values is reasonable or conservative.

****

DOE Response: DOE considers the hydraulic parameter values used in the conceptual models, which are based on site-specific data, to be reasonable with respect to predicted flow changes associated with the hydraulic barriers. The primary hydraulic parameter of interest is the hydraulic gradient.

Section 3.7.1 on page 3-68 of the DP states that the overall hydraulic gradient across the north plateau has been calculated at 0.031, with gradients up to 0.049 and as little as 0.026 existing in localized areas. As indicated in Table C-1, a value of 0.03 is used in the deterministic analysis, compared to the RESRAD default value of 0.02.

The site specific value used in the analyses is considered to be appropriate for the following reasons:

(1) Flow field changes associated with the hydraulic barriers are not factors in the development of DCGLs to support unrestricted release of the site, that is, in support of the site-wide removal alternative; and

(2) Flow field changes associated with the hydraulic barriers would not be significant factors in the case of a restricted release, such as the site-wide close-in-place alternative.

If Phase 2 of the decommissioning were to entail unrestricted release, the hydraulic barriers installed during Phase 1 would not be necessary and would be removed to restore natural groundwater flow on the north plateau. Consequently, flow field changes related to the presence of the barriers would not apply in this case.

If Phase 2 of the decommissioning were to entail a restricted release, DCGLs to support unrestricted release would not be relevant because there would be no unrestricted release of the project premises. Moreover, the presence of the large Phase 2 sources would overshadow the affects of reduced hydraulic gradients on the DCGLs and cleanup goals.

Tables in Section 4 of the DP show estimates for the main Phase 2 sources, the underground waste tanks (Table 4-9) and the NDA (Table 4-10), which as of 2011 total approximately 345,000 curies and 180,000 curies, respectively. The maximum amounts of residual radioactivity that could be associated with subsurface soil in the remediated large excavations at the end of Phase 1 would be many orders of magnitude less. And, as indicated by available data summarized in Table 5-1 of the DP, the actual amounts of residual radioactivity at the bottom of the large excavations are expected to be well below the cleanup goals.

Considering the relative amounts of residual radioactivity, potential future doses from residual radioactivity in the Waste Tank Farm and NDA would be orders of magnitude greater than potential doses from residual radioactivity that could be associated with the remediated large excavations. Likewise, potential future doses from surface soil and streambed sediment remediated to their respective cleanup goals developed using the site-specific hydraulic gradient value would be much less than those associated with the Phase 2 sources for the same reason.

Changes to the Plan: None.

RAI 5C21 (26)

Subject: I-129 sensitivity to hydraulic conductivity

RAI: The sensitivity analysis of the surface soil model indicated that decreasing the hydraulic conductivity increased the DCGL for I-129 due to increasing the travel time to the well. It is not clear why this result was obtained (see bullet on page 5-37). (Section 5.2.4, Page 5-37)

Basis: I-129 is very long-lived, and therefore the travel time to the well should have little impact on the estimated DCGL instead of resulting in a 1873% change.

Path Forward: Provide additional technical basis that the observed change in I-129 DCGL is a result of travel time to the well, or clarify the underlying reason for the change.

****

DOE Response: The RESRAD non-dispersion model calculation of dilution factors is a primary basis for the parameter uncertainty. The model utilizes four different equations for the calculation of dilution factors, based on parameters such as well depth, contaminated area, area parallel to aquifer flow, infiltration rate, etc., which may lead to counterintuitive results for deterministic evaluations.

In the specific case of I-129, the dilution factor is reduced from 0.2 to 0.026 when reducing the hydraulic conductivity from 140 m/y to 1 m/y. For the high conductivity case, the dilution factor is calculated based on the depth of contamination in the aquifer relative to the depth of well intake. For the low conductivity case, the dilution factor is calculated as a ratio of infiltrating recharge to aquifer pumping rate.

After discussion with NRC, it was determined that utilizing a site-specific groundwater dilution factor (based on available site data and DEIS groundwater modeling results) would eliminate such anomalies in the results. In order to achieve a deterministic dilution factor in RESRAD several hydrogeologic parameters must be assigned deterministic values. The parameters for the surface soil model (utilizing the RESRAD non-dispersion groundwater model) and for the subsurface soil and sediment models (utilizing the RESRAD mass balance groundwater model) and the resulting dilution factors are discussed below.

The basis for establishing a site-specific dilution factor was the three dimensional groundwater model used in the DEIS. Review of available three dimensional modeling results indicated a groundwater dilution factor of approximately 0.14 in the vicinity of the process building, when utilizing the simplified RESRAD box model calculation, and also suggested that the conditions discussed below were most representative of the site.

- For the surface soil model, the non-dispersion groundwater model was used with the following assumptions:
  - The groundwater well has an effective pumping width that is less than the width of the contaminated zone (well is laterally capturing only contaminated water), and
  - The groundwater well has a screened depth that exceeds the depth of contamination in the aquifer (some vertical dilution of groundwater in the well).
- For the subsurface soil model, the mass balance groundwater model was used with the following assumptions:

- The groundwater well has an effective pumping width that is larger than the width of the contaminated zone (some lateral dilution of groundwater in the well), and
- The groundwater well has a screened depth that exceeds the depth of contamination in the aquifer (some vertical dilution of groundwater in the well).

Surface Soil Model – Groundwater Dilution Factor

In the non-dispersion groundwater model used for surface soil calculations, several parameters were assigned fixed values to correspond with the detailed groundwater model as discussed below and presented in Table 5C21.

Precipitation rate – assigned a site-specific value based on historical records;

Runoff coefficient – based on site-specific area slope and land use to reflect clay/loam over a relatively flat area of cultivated land;

Evapotranspiration coefficient – assigned a value to achieve site-specific infiltration rate of 26 cm/y used in DEIS modeling. Assumed to be reflective of non-irrigation and irrigation conditions where the additional water input balances the evapotranspiration rate;

Irrigation rate – determined from site-specific climatological water demand and assumed irrigation efficiency;

Contamination zone (CZ) length parallel to aquifer flow – assigned a value to achieve site-specific groundwater dilution factor observed in DEIS modeling;

Saturated zone (SZ) saturated hydraulic conductivity – average value for sand and gravel thick bedded unit from Table 3-19 of the DP;

Hydraulic gradient – site-specific value selected in consideration of the presence of the hydraulic barrier walls as described in Appendix D of the DP (see Figure D-2);

Well pumping rate – site specific value based on required irrigation rate, assumed crop area and number of livestock, and household water use; and

Depth of well intake below water table – site specific value adjusted to achieve site-specific groundwater dilution factor observed in DEIS modeling.

As indicated above, the hydraulic gradient was assigned a site-specific value of 0.03 when defining other parameters to achieve the groundwater dilution factor of 0.14. In order to provide conservative results, the dilution factor was adjusted to a value of 0.2 by adjusting the length of the contamination zone parallel to aquifer flow. The selected hydraulic gradient considered the presence of the hydraulic barriers as follows;

- Potential flattening of the hydraulic gradient downgradient of the barriers does not impact DCGLs as there will be no remediation of this portion of WMA 2
- Changes to the hydraulic gradient within the remediated portion of WMA 2, downgradient of the barriers are insignificant based on current three dimensional modeling (see DEIS)
- Changes to the hydraulic gradient within WMA 1, upgradient of the barriers are insignificant as installation of the French drain in conjunction to the barrier walls will minimize changes to the flow field.

Subsurface Soil – Groundwater Dilution Factor

In the mass balance model, used in subsurface soil calculations, the following parameters were used to establish the site-specific dilution factor, as discussed below and presented in Table 5C21.

Precipitation rate – assigned a site-specific value based on historical records;

Runoff coefficient – based on site-specific area slope and land use to reflect clay/loam over a relatively flat area of cultivated land;

Evapotranspiration coefficient – assigned a value to achieve site-specific infiltration rate of 26 cm/y used in DEIS modeling assumed to be reflective of non-irrigation and irrigation conditions where the additional water input balances the evapotranspiration rate;;

Irrigation rate – determined from site-specific climatological water demand and assumed irrigation efficiency; and

Well pumping rate – site-specific value based on required irrigation rate, assumed crop area/number of livestock, and household water use.

The parameter values for the subsurface soil model were consistent with those used for surface soil where applicable. As with the surface soil model, the subsurface soil model used a hydraulic gradient that considers the presence of the hydraulic barriers.

Changes to the plan: Changes to the plan are being made in the following areas:

- Revising deterministic surface soil and subsurface soil DCGLs based on the parameters and dilution factors in Table 5C21-1;
- For the surface soil model (non-dispersion groundwater model) probabilistic uncertainty analysis, varying values of parameters from Table 5C21-1, to provide a range of dilution factors for the site-specific conditions described above (undiluted lateral flow to well, diluted vertical flow within well);
- For the subsurface soil model (mass balance groundwater model), varying applicable parameters from Table 5C21-1, similar to surface soil model; and
- Including a deterministic residential groundwater ingestion scenario based on parameters presented in Table 5C21-1.

More details on these changes will be provided after completion of the related modeling.

Table 5C21-1. West Valley - Summary of RESRAD Parameters for Dilution Calculation

Parameter	Units	Surface Soil - Resident Farmer (Non-dispersion Model)	Surface Soil - Residential Gardener (Non-dispersion Model)	Subsurface/ Sediment - Resident Farmer - 100 m^2 CZ (Mass Balance Model)	Subsurface/ Sediment - Resident Farmer - 1000m^2 CZ (Mass Balance Model)	Subsurface/ Sediment - Residential Gardener - 100 m^2 CZ (Mass Balance Model)	Subsurface/ Sediment - Residential Gardener - 1000m^2 CZ (Mass Balance Model)
Input							
Precipitation rate	m/y	1.16	1.16	1.16	1.16	1.16	1.16
Irrigation rate[1]	m/y	0.47	0.47	0.47	0.47	0.47	0.47
Runoff coefficient	unitless	0.40	0.40	0.40	0.40	0.40	0.40
Evapotranspiration coefficient	unitless	0.78	0.78	0.78	0.78	0.78	0.78
Infiltration rate	m/y	0.26	0.26	0.26	0.26	0.26	0.26
CZ Length parallel to aquifer[2]	m/y	165	165	na	na	na	na
SZ Saturated hydraulic conductivity[3]	m/y	1400	1400	na	na	na	na
Hydraulic gradient[4]	m/m	0.03	0.03	na	na	na	na
Well pumping rate[5]	m^3/y	5720	1140	5720	5720	1140	1140
Depth of well intake below water table	m	5	5	na	na	na	na
CZ area[6]	m^2	10000	10000	100	1000	100	1000
Calculated Values							
Darcy velocity	m/y	42	42	na	na	na	na
Contaminant depth in aquifer	m	1.01	0.20	na	na	na	na
Effective pump width	m	27.24	5.43	na	na	na	na
CZ width	m	61	313	na	na	na	na
Groundwater Dilution Factor	**unitless**	**0.202**	**0.039**	**0.004**	**0.045**	**0.023**	**0.225**

LEGEND: CZ = contamination zone, na = not applicable to mass balance calculation. (Mass balance dilution factor based on total infiltration volume/total pumped volume.)
SZ = saturated zone

NOTES: (1) Infiltration rate of 26 cm/y for irrigation scenario is based on DEIS groundwater model.

(2) Contaminated zone (CZ) length parallel to aquifer is adjusted to achieve desired dilution factor of 0.14 for a gradient of 0.03. Final dilution factor adjusted to a conservative value of 0.2

(3) Saturated zone (SZ) hydraulic conductivity from Table 3-19 of DP for average value in the thick bedded unit (4.4E-3 cm/s).

(4) Hydraulic gradient of 0.03 from DEIS used to assign other values and achieve 0.14 dilution factor. Final dilution factor adjusted to a conservative value of 0.2.

(5) Well pumping rate; assumed for resident farmer with five cattle, five milk cows, irrigating at 0.47 m/y.

(6) The contamination zone area is 10,000 m^2 for both the resident farmer and the residential gardener. However, the resident farmer uses all 10,000 m^2 to grow produce to support his family and livestock, whereas the residential gardener is assumed to use 2,000 m^2 to cultivate a garden to partially support his family.

RAI 6C1 (27)

Subject: Good-practice efforts that promote ALARA (as low as reasonably achievable)

RAI: Provide additional discussion of planned good-practice efforts for ALARA. (Section 6.2, Page 6-3)

Basis: The NRC staff believes that ALARA analyses for decommissioning should involve two aspects. One is that all licensees should use typical good practice or good housekeeping efforts, such as floor and wall washing (for buildings that will remain) and removal of readily removable radioactivity in both buildings and soil areas. The second aspect is that in some cases, cost-benefit (quantitative) ALARA analyses should be performed. DOE has focused its ALARA analyses on the latter, and very little discussion is provided to address good practice efforts. In Section 6.2 of the DP, there is brief mention of broad concepts that somewhat relate to such good practices. But, information on actual practices that might be employed as part of the cleanup work has not been provided.

Both aspects are discussed in the NRC staff's guidance in Section 6 and Appendix N of NUREG-1757, Vol. 2 (NRC, 2006).

NRC Path Forward: Provide a discussion of the good practice efforts for ALARA that DOE plans as part of its cleanup activities.

****

DOE Response: Additional information on planned good-practice efforts for ALARA is being incorporated into Section 6.

Changes to the Plan: A new subsection on good practices that promote ALARA is being included as follows:

- "Essentially all radioactive material that would remain after the Phase 1 activities have been completed would be located underground, primarily in the underground waste tanks and in the NDA. Controlled access to the WVDP would continue during the Phase 1 institutional control period, which would prevent access to this underground radioactivity.

6.2.2 Good Practices that Promote ALARA

The DOE radiological controls requirements identified in Section 1.7 and the supplemental technical standards associated with those requirements will be followed during the decommissioning activities as specified in Section 7. DOE Policy 441.1, *Department of Energy Radiological Health and Safety Policy*, and the associated implementation guidance, DOE Guide 441.1-2, *Occupational ALARA Program Guide* include provisions for good practices that promote ALARA. Among these good practices will be:

- The use of spray fixatives or fog sprays during building demolition to reduce the potential spread of airborne contamination;
- The use of engineered surface water run-off controls during building demolition to reduce the potential spread of contamination by precipitation;
- The use of radiological containment to avoid spreading radioactive material during equipment removal, such as removal of piping in the HLW transfer trench and

cutting and capping contaminated lines that remain when infrastructure such as the concrete floor slab of the LLW2 Building is removed;

- The use of airborne contamination controls to ensure that doses to workers will be below federally allowed limits;
- The use of personal protective equipment, such as respirators and anti-contamination clothing, in contaminated areas;
- Removal of all demolition debris that may fall within the footprints of removed infrastructure, such as the two-foot deep excavation made to remove the Equipment Shelter;
- Removal of debris remaining in the HLW transfer trench after contaminated piping removal and removal of any radioactive contamination spread to the trench during this work to the extent practicable[1];
- Requiring that the large excavations in WMA 1 and WMA 2 extend at least one foot into the unweathered Lavery till, a geologic unit that is relatively impervious to radionuclide migration;
- Removing easily removable contaminated soil in the large WMA 1 and WMA 2 excavations; and
- Installation of infiltration and surface water run-off controls such as liners, drainage collection systems, and berms below and around excavated soil laydown areas to prevent migration of contaminants into underlying groundwater and nearby surface waters.

6.2.3 Conservatism in DCGL Development

- The process for developing DCGLs for Phase 1 of the proposed decommissioning as described in Section 5 was conservative in several respects. Section 5 provides examples of this conservatism.

6.2.4 Conservatism from the Decontamination and Final Status Survey Processes"

DOE Policy 441.1 and DOE Guide 441.1-2 will be added to the Section 6 reference list.

[1] The HLW transfer trench is the only facility within the scope of the Phase 1 of the WVDP decommissioning that will remain in place. It is not expected to be radioactively contaminated when the piping removal begins. Even though radiological containment will be used in removal of the piping, spills during this work are possible.

RAI 6C2 (28)

Subject: ALARA analysis intergenerational concerns

RAI: Calculations of costs and benefits for ALARA analyses: Provide either an evaluation using zero discount rate or a sensitivity analysis of the discount rate for the present worth calculations for the value of future dose averted. (Section 6.3, Page 6-5):

Basis: In Section 6.3 of the DP, DOE provides the cost-benefit ALARA analyses. In these analyses, DOE calculates the cost of the future doses averted over 1000 years, and applies a discount rate of three percent to calculate the present worth of the future doses. Based on the length of the compliance period (1000 years), the benefits and costs could span across population generations. Thus, the NRC staff is concerned that use of this discount rate essentially eliminates any value in doses averted in the later years of the compliance period.

The NRC staff guidance on use of discount rates is provided in NUREG-1757, Vol. 2, Section N.5 (NRC, 2006). That guidance refers to NUREG/BR-0058, Rev. 2, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission." However, the most recent version of NUREG/BR-0058 is Rev. 4, dated September 2004. Section 4.3.5 of NUREG/BR-0058 (NRC, 2004) indicates that for certain regulatory actions, such as those involving decommissioning and waste disposal, special considerations arise when considering benefits and costs across generations. That section indicates that the analysis should be supplemented with an explicit discussion of intergenerational concerns. This could be done by performing the analysis based on costs and impacts at the time they are incurred, with no present worth conversion, or by performing a sensitivity analysis using lower discount rates.

NRC Path Forward: If the cost-benefit ALARA analyses are retained, DOE should include some method for analyzing the intergenerational concerns, by including an analysis with no discounting or with a sensitivity analysis of the discount rate.

****

DOE Response: A new Subsection 6.3.6 will be added to address intergenerational concerns, with the results of a preliminary ALARA analysis using no discounting. Information will be added to Section 6.4 also to address intergenerational concerns.

Changes to the Plan: Add new Subsection 6.3.6 as follows:

6.3.6 Addressing Intergenerational Concerns

The consequences (i.e., doses) of the remediation that will take place during Phase 1 of the decommissioning could occur over a lengthy period, especially if Phase 2 of the decommissioning were to involve a site-wide removal approach resulting in unrestricted release of the property. (In a Phase 2 site-wide close-in-place approach, the potential future doses from the remediated Phase 1 areas would be small compared to those from the Phase 2 source areas.) The impact of intergenerational doses on the cost-benefit analysis can be evaluated by considering the impact of lower discount rates.[1]

[1] Based on Office of Management and Budget guidance, present worth calculations are normally performed using both three and seven percent real discount rates. These discount rates are used to calculate the present worth of adverted health effects regardless of when these effects are adverted. The three percent rate (as used in Section 6.3.3) approximates the real rate of return on long-term government debt, which serves as proxy for the real rate of return on savings. (NRC 2004)

Figure 6-1 shows the unit cost of remediation (C_{TU}) as a function of the discount rate. It shows that with a discount rate of zero, the cost of remediation would be approximately \$20/m^2. Because this unit cost is less than the \$36.38/m^2 disposal component of the total remediation cost in the preliminary analysis (Section 6.3.3), the DCGLs result in intergenerational doses that are ALARA and further remediation would not be necessary.

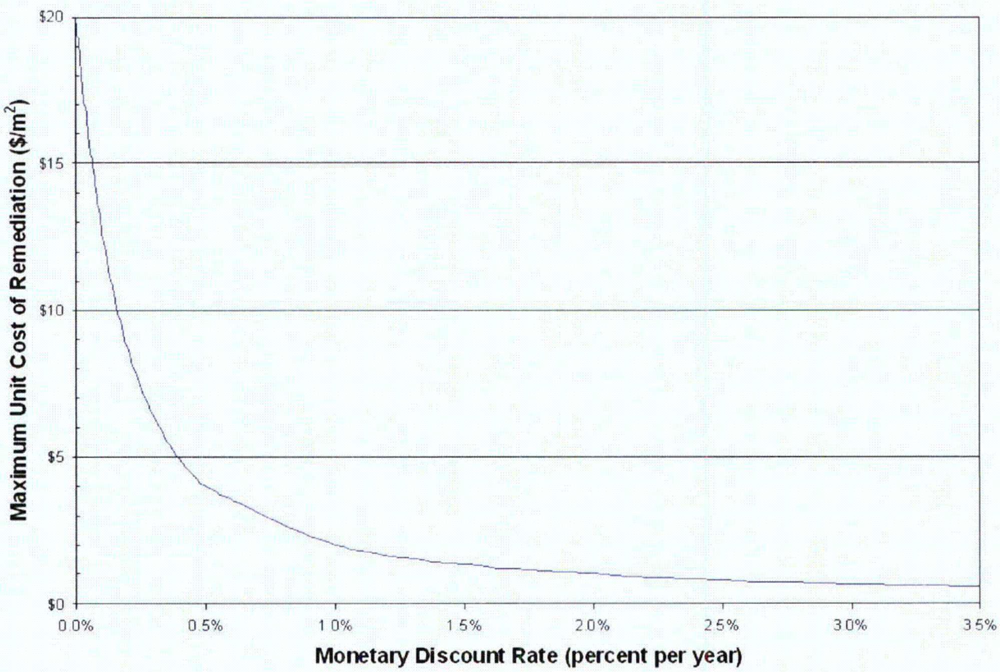


Figure 6-1. Unit Remediation Costs vs. Monetary Discount Rate

Add to Section 6.4:

6.4 Additional Analyses

Additional ALARA analyses would be performed in connection with remediation of the WMA 1 and WMA 2 excavations. These analyses would make use of updated values for parameters such as LLW disposal costs, as well as in-process survey results for radioactivity in soil at the base of the excavation during soil removal activities.

Factors not included in the simple preliminary analyses such as other societal and socioeconomic considerations, the costs related to occupational risks, and transportation of additional waste would be taken into account in the additional ALARA analyses. Consideration would also be given in these analyses as to whether remediation of the WMA 1 and WMA 2 excavations to DCGLs (actually to the cleanup goals) for surface soil, rather than for subsurface soil, would be cost-effective. Consideration will be given as well to the effects of using lower discount rates on the estimated cost of remediation so that intergenerational concerns are taken into account.

RAI 6C3 (29)

Subject: reasons for a simple preliminary ALARA analysis and a later detailed ALARA analysis

RAI: Provide reasons for why DOE has presented a simple, preliminary ALARA analysis in the DP and proposes an additional, complete ALARA analysis during Phase 1. (Section 6.2, Page 6-4; and Section 6.4, Page 6-10)

Basis: In Section 6 of the DP, DOE has presented a simple, preliminary ALARA analysis and proposes an additional, complete ALARA analysis during Phase 1. The discussion does not indicate that this two-step approach is consistent with NRC's guidance (2006). While the NRC believes that the two-step approach is consistent with NRC's guidance (2006), the text in the DP does not discuss this for the benefit of other readers of the DP.

NRC Path Forward: Add a discussion that explains why the two-step approach is consistent with NRC's guidance (2006) and why it is a reasonable approach for the nature of Phase 1 decommissioning at this site. Also explain why a preliminary analysis is reasonable for the DP.

****

DOE Response: Add discussion as requested.

Changes to the Plan:

The following note will be added to Section 6.3 just before the existing Subsection 6.3.2:

NOTE

DOE has performed a preliminary ALARA analysis and provided for a later, more detailed ALARA analysis that will be performed during the remediation work. This approach is appropriate for Phase 1 of the decommissioning since information used in the analyses may change between the time of Decommissioning Plan issue and the time when remediation of the large excavations – the activity for which the analyses are most important – takes place. For example, waste disposal costs could increase significantly and possibly change the outcome of the analyses.

The results of the preliminary analysis provide useful information for planning purposes, even though it is possible that the later, more detailed analysis will produce different results. This two-step approach is consistent with guidance in Appendix N of NUREG-1757, Volume 2 (NRC 2006)

RAI 7C1 (30)

Subject: Excavated groundwater management

RAI: Section 7.4.3 states that before soil excavation takes place groundwater extraction wells will be installed and placed in operation to dewater the excavation. Details of the dewatering design were not provided in the DP. It is also not clear in Section 7.4.3 how the planned hydraulic barriers will prevent infiltration of upgradient groundwater into the WMA 2 excavation or how excess water will be managed. (Section 7.3.8, Page 7-25; Section 7.4.3, Page 7-32)

Basis: The total depth of the planned excavation for WMA 1 is approximately 13.5 m (45 ft), with more than half of the excavation below the water table. Groundwater will continue entering the excavation from below the sheet pile in the upgradient direction. Information on the amount of water to be pumped will help determine the number of wells and need of potential water treatment equipment/facility.

Additional details are also needed regarding the sequencing (e.g., Figure 7-15) of WMA 1 and 2 hydraulic barrier construction and excavations to ensure that contaminated groundwater does not infiltrate the WMA 2 excavation and that infiltrating groundwater is appropriately managed.

Path Forward: Based on the site-specific aquifer hydraulic data, planned excavation, and hydraulic barrier design details; provide an estimate or design of the proposed dewatering system, such as number of wells, and pumping capacity as well as an explanation on how the planned hydraulic barriers will prevent infiltration of upgradient groundwater into the WMA 2 excavation or how excess water will be managed.

****

DOE Response: The final design for the dewatering system will be prepared by the site decommissioning contractor should the phased decision-making alternative be selected by DOE in the Record of Decision for the Decommissioning EIS. Details of the dewatering system design will be developed when the excavation detailed designs are developed, which will follow collection of additional subsurface soil data at the planned boundaries of the two large excavations. DOE will provide the dewatering system design details to NRC to give NRC staff the opportunity to review and comment on this design.

DOE expects that groundwater in the two large excavations can be effectively managed using conventional methods. Photographs taken during excavation and construction of subgrade cells in the Process Building and the waste tank farm excavation, some of which did not use sheet piling, suggest that this will be the case. See Figure 7C1-1. Also see Figures DC1-1 and DC1-2 with the response to RAI DC1.

DOE will change the conceptual schedule in Figure 7-15 to provide for installation of the WMA 1 hydraulic barrier before starting the WMA 2 large excavation. This sequence will reduce infiltration of groundwater into the WMA 2 large excavation.

Changes to the Plan:

Add the following information to Section 1.6 before the existing first complete paragraph on 1-10. Note that these changes also include those discussed in the DOE responses to RAIs DC2, DC7, and DC9.

> Detailed engineering designs for the decommissioning will be developed based on the conceptual designs outlined in this plan. Detailed design information on the following engineered features will be provided to NRC to provide an opportunity for NRC to review

and comment on the safety aspects of the designs: The designs for the large excavations in WMA 1 and WMA 2, including the hydraulic barriers, the French drain, the groundwater control provisions, and the groundwater monitoring system as discussed in Section 7 and Appendix D.

Change the Figure 7-15 conceptual schedule as follows:

Add the following new activity after existing activity 11: "12. Install WMA 2 hydraulic barrier," showing this activity starting after completion of activity 10 (Remove source area of north plateau plume).

Move existing activity 12 (Remove WMA 2 lagoons, other facilities – renumbered 13) to follow the new activity 12.

Move existing activity 13 (Perform WMA 2 final surveys, fill excavations renumbered to 14) to follow existing activity 12.

Figure 7C1-1. Excavation for Fuel Receiving and Storage Fuel Pools

RAI 7C2 (31)

Subject: Excavated soil management

RAI: It is not clear how excavated soil will be managed and if soil with residual radioactivity or clean soil will be returned to the excavation. Section 7.3.8, page 7-27, states that uncontaminated soil from similar offsite geologic deposits will be used as backfill. (Section 7.3.8, page 7-25 and 7-26)

Basis: This section discusses the use of cleanup goals for determining when sufficient soil has been removed from the excavation and that contaminated soil concentrations below cleanup goals will be removed where practical. It is not clear how soil removed from the excavations will be managed to ensure that fugitive dust emissions and airborne concentrations are maintained ALARA, and how the contaminated soil will be managed to prevent contamination of other land.

NRC Path Forward: Provide a detailed plan on the management of excavated soils including the location of interim storage areas and environmental controls, and the radiological and associated quality programs for measuring the radioactivity in the soils for segregating non-contaminated soil and contaminated soil. If soil with residual radioactivity is to be returned to the excavation, assess the impact on the dose modeling and the final status survey design.

****

DOE Response: A detailed plan for management of excavated soil and the associated radiological and environmental controls was not included in the DP because such details were considered to be inconsistent with the agreement between NRC and DOE to manage health and safety, environmental monitoring and control, and radioactive waste in accordance with DOE procedures (NRC 2008). Section 7.2.2 on page 7-6 provides for mitigative measures related to management of excavated soil, including using covering material under and over the soil. These provisions address the only NUREG-1757 DP checklist topic on health and safety, environmental monitoring and control, and radioactive waste management that applies to Phase 1 of the WVDP decommissioning.

The terms "uncontaminated earthen backfill" and "clean backfill" are repeatedly used in Section 7 to indicate that excavated soil will not be used to backfill the excavations. However, Section 7 does not specifically state that excavated material will not be used for backfill. This matter will be clarified using words like those that appear on page 5-25:

> ". . . the uncontaminated backfill as shown in the figure would be soil obtained from outside the Center from an area that has not been impacted by site radioactivity. No soil removed during the excavation work would be used in filling the excavation, even if that soil were determined to be uncontaminated."

Note that Section 9 on page 9-11 states that the Characterization Sample and Analysis Plan would address characterization of materials and states that the decommissioning contractor would provide a DOE-approved procedure for characterizing materials for waste management purposes. Since these provisions in Section 9 were written, it has been decided that these matters will not be covered in the Characterization Sample and Analysis Plan, but rather in Section 9 of the DP.

After consideration of the matters addressed in this RAI, DOE plans to take the following actions:

- A project Waste Management Plan will be issued. Section 1 will be revised to provide for this plan, which will cover basic requirements related to excavated soil management and will be provided to NRC for information. This plan will make it clear that all decommissioning waste, including excavated soil, will be disposed of offsite.

- Section 7 will be revised as explained above to make it clear that only soil from outside the Center from an area that has not been impacted by site radioactivity will be used in backfilling the excavations.
- Section 7 will be revised to provide additional information on mitigative measures related to managing excavated soil.
- Section 7 will be revised to change the information on characterization based on changes to the content of the Characterization Sample and Analysis Plan, which will address soil and sediment but not facilities.
- Section 7 will be changed to provide for Phase 1 final status surveys in excavated soil laydown areas.

DOE prefers not to identify the excavated soil laydown areas in the DP or in the Waste Management Plan. It is considered better to leave this matter to the discretion of the decommissioning contractor since more than one location for the laydown areas would be acceptable.

Also, there are disadvantages in being unnecessarily prescriptive in contracts on methods of work performance, such as extra costs and delays associated with contract change orders, and reduced efficiency can result. The new provisions to include the laydown areas in the Phase 1 final status surveys will eliminate potential issues with these areas being contaminated during Phase 1 decommissioning activities even though they will be protected with covering material.

Changes to the Plan:

Add the following provision to Section 1.6 on page 1-10:

- A Quality Assurance Project Plan, which is described in Section 8;
- A Characterization Sample and Analysis Plan, which is described in Section 9;
- A Waste Management Plan to implement requirements outlined in Section 1.9; and
- A Final Status Survey Plan, which is also described in Section 9.

Make the following changes to Section 7.2.2:

Mitigative Measures

Actions will be taken as necessary to eliminate or reduce potential impacts to human health and the environment during the proposed decommissioning work and to prevent recontamination of remediated areas. For example, fixatives and water spray will be used as necessary to minimize airborne radioactivity during demolition of contaminated structures and equipment.

The large excavations for WMA 1 and WMA 2 and the shallow excavations for removal of infrastructure will be planned to minimize the impacts associated with handling of removed contaminated soil. Control measures will include:

- Protecting laydown areas with a suitable covering material,
- Establishing earthen berms around the laydown areas to control surface water runoff equipped with runoff collection capability,

- Making provisions for removal, appropriate treatment, and disposal of water collected inside the berms,
- Arranging excavated soil in the laydown areas to facilitate radiological surveys and sampling of the soil for waste characterization purposes,
- Using water spray to reduce fugitive emissions in cases where the excavated soil is dry; and
- Placing suitable covering material over removed contaminated soil to prevent the spread of contamination by precipitation.

Waste Management

All waste generated during Phase 1 of the decommissioning will be disposed of offsite. The Waste Management Plan implements DOE procedures identified in Section 1.9 and provides requirements and guidance for management of all types of waste.

In accordance with the Waste Management Plan, radioactive waste generated during proposed decommissioning activities will be characterized and disposed of offsite at appropriate government-owned or commercial disposal facilities. Hazardous and toxic waste will be managed and disposed of offsite in accordance with applicable requirements. Non-radioactive equipment and demolition debris will be disposed of offsite at a construction and demolition debris landfill.

Soil laydown areas will be located following guidance in the Waste Management Plan. Mitigative measures will be implemented for these areas as discussed previously. After the soil and ground covering material have been removed from these areas, they will be considered to have been impacted by radioactivity, even if there were no known spills. Phase 1 final status surveys will be performed in these areas as specified in Section 9 and the Final Status Survey Plan.[1]

Add a new unnumbered subsection in section 7.2.2 following the unnumbered subsection on Waste Management as follows:

Backfill Soil

Soil used as backfill in deep and shallow excavations associated with Phase 1 decommissioning activities will be obtained from outside the Center from an area that has not been impacted by site radioactivity. The properties of soil to be used as backfill in the deep excavations in WMA 1 and WMA 2 – especially the texture, hydraulic conductivity, and distribution coefficients – will be similar to those of the sand and gravel layer on the project premises as described in Section 3.

No soil removed during the excavation work will be used in filling an excavation, even if that soil were determined to be uncontaminated.

Revise the Characterization subsection in Section 7.2.2 as follows:

[1] Contamination found in excess of surface soil cleanup goals will be remediated as specified in Section 9.6. DOE may approve an exception to this requirement if the laydown area is located in a part of the project premises known to have subsurface radioactivity, or if surface soil contamination in excess of the cleanup goals was known to be present prior to establishing the laydown area.

Characterization

As indicated in Section 4, the WVDP facilities and areas had not been completely characterized for radioactivity as of 2008. Additional characterization will be performed as necessary as explained in Section 9.

The Characterization Sample and Analysis Plan will provide for characterizing soil and sediment. This characterization program will include the banks and streambeds of the portions of the Erdman Brook and Franks Creek located on the project premises[2].

Characterization of subsurface soil in the area of the large WMA 1 and WMA 2 excavations will include collecting samples in the top portion of the Lavery till. Samples of subsurface soil will also be collected along the upgradient and cross-gradient edges of the excavation footprint in WMA 1 and on the edges of the WMA 2 excavation footprint. Analytical data from these samples (1) will help determine the best location for the excavation boundaries, (2) may be useful in refining the conceptual model used in developing subsurface soil DCGLs as described in Section 5, and (3) will support planning Phase 1 final status surveys to be performed on the sides of the excavations.

Characterization measurements will include those necessary for waste management purposes. The decommissioning contractor will provide a procedure for characterizing materials for waste management purposes and obtain DOE approval of this procedure. This procedure will be consistent with applicable DOE requirements and guidance, as well as any applicable State-specified waste acceptance criteria for radioactivity in the offsite landfill(s) where uncontaminated material may be disposed of. This procedure will apply to, among other materials, surface and subsurface soil not known to have been impacted by radioactivity.

Note that the specific proposed decommissioning activities described below are based on assumptions about conditions that will be encountered during the course of the work. If characterization were to disclose unexpected conditions, the proposed decommissioning activities will be changed as necessary to ensure that conditions at the conclusion of the Phase 1 proposed decommissioning activities meet the DCGLs (i.e., the cleanup goals). This plan will be revised as appropriate under these circumstances with NRC involvement as described in Section 1.13.

References:

NRC 2008, *Summary of a Meeting Between NRC and DOE on the WVDP Phase 1 Decommissioning Plan*, May 19, 2008.

[2] It is not intended that the characterization extend outside of the project premises, even in cases where environmental media contamination has been previously identified outside of the project premises, i.e., in the cesium prong area to the northwest of the project premises and in stream sediment in Franks Creek downstream of the project premises.

RAI 9C1 (32)

Subject: Characterization surveys

RAI 9C1: The plans, methodologies, and Data Quality Objectives (DQOs) to be used for characterization surveys are not completely defined. (Section 9.4, Page 9-8)

Basis: A "Characterization Sample and Analysis Plan" is anticipated, but it has not yet been provided for NRC review. Chapter 9.0 of the DP indicates that. "[w]hile this section addresses all applicable requirements for facility radiation surveys, it does so in general terms because two supplemental documents would later be developed to provide additional details: a Characterization Sample and Analysis Plan and a Phase 1 Final Status Survey Plan (or multiple Phase 1 Final Status Survey Plans)." The Characterization Sample and Analysis Plan is referred to numerous times throughout the WVDP Phase 1 DP, and it appears that this plan will become an integral part of the characterization of site radiological conditions including current soil and sediment conditions in preparation for site excavation (Chapters 7.0 and 9.0). Additionally, DP Section 9.4.1 states that, "[a] key objective of [The Characterization Sample and Analysis Plan] would be to produce data for the Phase 1 final status survey of sufficient quality and quantity to serve final status survey purposes when practicable."

Path Forward: Considering the emphasis that has been placed on the Characterization Sample Analysis Plan and its usage as a basis for in-process and final status surveys, it is requested that this plan be submitted to the NRC in order to supplement the technical review of the WVDP Phase 1 Decommissioning Plan.

NUREG-1757, Vol. 2, Sections 2.3 and 4.2 (NRC, 2006) states that there is no requirement that the final status survey be performed at the end of the decommissioning process, but in order to use other surveys the data must be of sufficient quality and detail to meet the expectations for final status survey data. It is also important to ensure that non-impacted areas of the site have not been adversely affected by decommissioning activities.

Characterization DQOs are briefly outlined in the DP Section 9.4, but not applied, and it is noted that they will be detailed later in the Characterization and Sample and Analysis Plan. Further elaborate on how the quality control of measurements and samples will be maintained during characterization surveys. Describe the plans to ensure non-impacted and excavated areas will not be adversely affected during the decommissioning process. Provide the details of site characterization DQOs that will be consistent with those for final status surveys. NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, (NRC, 2000) and NUREG-1757, Vol. 2, Sections 4.2 and 4.4, and Appendix D and E (NRC, 2006) may provide additional guidance on the planning required for characterization and final status surveys.

****

DOE Response: Input on the objectives of the Characterization Sample and Analysis Plan will be informally solicited from NRC, NYSERDA, and NYSDEC as the plan is being prepared to make sure that the plan is comprehensive, and the draft final plan will be submitted to NRC for review and comment, as requested. The plan will cover both pre-remediation and remedial support data collection needs. This plan will include provisions for ensuring that the quality of the data collected during characterization will meet expectations for final status surveys as appropriate.

Regarding maintaining quality control of measurements and samples during characterization surveys, Section 8.3.2 of the DP provides requirements to ensure quality in characterization measurements. Section 9.4.3 of the DP describes the provisions to be included in the

Characterization Sample and Analysis Plan to this end. This subsection addresses the primary concerns in these areas, which will be addressed in greater detail in the Characterization Sample and Analysis Plan. A new Section 9.4.4 is being added to provide an example of how the characterization DQOs will be applied to a particular area of interest.

Section 7.2.2 of the DP will be revised to address mitigative measures to avoid impacting non-impacted portions of the project premises during Phase 1 decommissioning activities and to avoid impacts to areas remediated during Phase 1, such as the backfilled WMA 1 excavation. Section 7 of the DP will be revised to provide for Phase 1 final status surveys in excavated soil laydown areas after the soil has been removed. (These sections will also be revised to provide for Phase 1 final status surveys in selected impacted areas with no subsurface contamination that can be released for unrestricted use during Phase 1 of the decommissioning.)

The characterization DQOs will be expanded to address objectives related to final status surveys. This information will be included in the Characterization Sample and Analysis Plan.

Changes to the Plan:

The Mitigative Measures subsection in Section 7.2.2 will be revised as follows:

Mitigative Measures

"Actions will be taken as necessary to eliminate or reduce potential impacts to human health and the environment during the Phase 1 decommissioning work and to prevent contamination of non-impacted areas of the project premises and recontamination of remediated areas.

The excavations for WMA 1 and WMA 2 will be planned to minimize the impacts associated with handling of removed contaminated soil. Methods such as the following will be used to mitigate potential impacts from excavated contaminated soil:

- Protecting laydown areas with a suitable covering material;
- Using water spray to minimize airborne radioactivity from piles of dry excavated contaminated soil;
- Placing suitable covering material over the removed soil;
- Establishing earthen berms around the laydown areas equipped with runoff collection capability;
- Collecting samples of water from precipitation that collects within the berms and analyzing them for radioactivity; and
- Treating the water found to be contaminated as necessary to remove radioactivity and releasing it through a permitted outfall.

Such measures will also be used as practical in managing contaminated soil excavated during infrastructure removal, such as during the removal of foundations and floor slabs.

Fixatives and water spray will be used as necessary to minimize airborne radioactivity during demolition of contaminated structures and equipment. Suitable covering material will be placed over radioactive waste stored outdoors to help prevent the spread of contamination.

Confinement structures also will be used or other radiological control measures taken to minimize the release of airborne radioactivity associated with removal of soil containing significant concentrations of radioactivity. Appropriate dust suppression measures will be used also during demolition of noncontaminated concrete and steel and during transportation of waste generated in such work.

Mitigative measures will include as low as reasonably achievable (ALARA) considerations, such as removal of contaminated soil to concentrations below the cleanup goals in cases where this would be practical.

Special emphasis will be placed on measures to ensure that areas remediated during Phase 1 are not re-contaminated during subsequent Phase 1 decommissioning activities and that those areas not impacted by radioactivity are not inadvertently contaminated. Such measures would typically include use of suitable barriers, such as temporary fences, and warning signs

Details will be provided in the Decommissioning Work Plan(s) or in a separate Mitigative Measures Plan."

The Final Status Surveys and Confirmatory Surveys subsection in Section 7.2.2 will be revised as follows:

"The Phase 1 final status surveys focus primarily on areas to be made inaccessible by proposed decommissioning activities. Phase 1 final status surveys would be performed and confirmatory surveys coordinated with NRC or its contractor before these areas are made inaccessible. An example of such an area would be the lagoon excavation in WMA 2, which would be filled with radiologically uncontaminated earth imported from offsite only after the Phase 1 final status surveys and confirmatory surveys have been accomplished and the resulting data reviewed and accepted.

Phase 1 final status surveys will also be performed in two other types of areas: excavated soil laydown areas and impacted areas with no subsurface contamination that meet criteria for unrestricted release during Phase 1 of the decommissioning.

For an excavated soil laydown area, Phase 1 final status surveys will be performed after the excavated soil and the ground covering is removed. The purpose of such surveys is generally to verify that the surface soil meets the cleanup goals. However, if the laydown area is known to have subsurface soil contamination, then the purpose of the surveys is to document the surface soil radiological conditions because such an area could not meet criteria for unrestricted release based only on surface soil contamination criteria.

Impacted areas that could be released for unrestricted use based on meeting surface soil cleanup goals will be identified during the characterization program. DOE will notify NRC at least 60 days before performing Phase 1 final status surveys to demonstrate that a particular area meets criteria for unrestricted release.

Surveys of excavations to remove infrastructure will be performed in accordance with the Characterization Sample and Analysis Plan, not the Final Status Survey Plan. An example of such a survey would be the shallow excavation made to remove the LLW2 Building floor slab and foundation."

A new Section 9.4.4 will be added as follows:

9.4.4 Applying DQOs for Characterization Surveys

The following example illustrates how DQOs will be applied to characterize a particular area of interest in a manner supportive of final status survey information needs.

The example is the footprint of the old hardstand, which was located on the west side of the Lag Storage Additions 3 and 4. The old hardstand footprint has the potential for radioactive contamination below the surface due to the major spill described in Table 2-17. The footprint of the old hardstand will undergo characterization as part of the planned Characterization Sample and Analysis Plan activities.

The Characterization Sample and Analysis Plan includes a set of characterization objectives that form the basis for DQO planning process. Of this set, the following are pertinent to the old hardstand area:

- Evaluate appropriateness of the current list of radionuclides of interest,
- Verify absence of additional radionuclides of interest,
- Identify the presence/absence of buried contamination,
- Determine extent of surface contamination,
- Identify soil waste stream characteristics, and
- Obtain data to support Phase 2 planning.

Data collection requirements specific to the old hardstand for each of these objectives will be developed as part of the DQO evaluation contained in the Characterization Sample and Analysis Plan. Characterization Sample and Analysis Plan decision-making (and consequently, Characterization Sample and Analysis Plan data collection activities) will be sequential with respect to these objectives. For example, data collection to verify the absence of additional radionuclide of interest may result in changes to the list of analytes for the balance of sampling work conducted for the old hardstand. As another example, if sampling identifies contamination likely to require remediation (either as a discretionary Phase 1 activity or during Phase 2), analyses would be conducted to determine waste stream characteristics.

Characterization Sample and Analysis Plan data collection will support final status survey requirements in a number of ways. The first two Characterization Sample and Analysis Plan objectives listed above will determine the list of radionuclides that final status survey activities will need to address. If contamination is encountered deeper than one meter (third objective), then the old hardstand area will not be a candidate for Phase 1 final status data collection, and instead data collection will focus on identifying the nature and extent of surface and subsurface contamination that is present. Alternatively, if contamination is present above Phase 1 DCGL requirements but not at depths greater than one meter, DOE may defer remediation until Phase 2.

If initial Characterization Sample and Analysis Plan data collection indicates the old hardstand area is a candidate for Phase 1 final status survey closure (i.e., there is no evidence of contamination exceeding DCGL requirements in surface soils and no evidence of contamination deeper than one meter), then the balance of soil sampling from the former hardstand area would be conducted in a manner consistent with final status survey DQO requirements. Final status survey sampling requirements are described in detail in the Phase 1 Final Status Survey Plan. In general, these would include biased surface soil samples (representative of a 0 to 15 cm depth and representative of a 0 to 1 m depth) that targeted specific locations of concern (e.g., historical locations where contamination was present, gamma walkover survey anomalies, etc.) to determine $DCGL_{EMC}$ compliance, and systematic surface soil sampling (representative of a 0 to 15 cm depth and representative of a 0 to 1 m depth) to determine $DCGL_W$ compliance.

RAI 9C2 (33)

Subject: Field Detection Limits

RAI: It is not clear that the survey methodologies and instrumentation to be used in the in-process and remediation action support surveys are adequate to detect contamination sufficiently below the DCGLs under site specific conditions.

Basis: NUREG-1757, Vol. 1, Appendix D, Section XIV.c. (NRC, 2006) on in-process surveys requires, "[a] demonstration that field screening should be capable of detecting residual radioactivity at the DCGL." NUREG-1575 (NRC 2000) specifies in Chapter 6 that "Scanning and direct measurement techniques should be capable of measuring levels below the established DCGLs – detection limits of 10-50% of the DCGL should be the target." NUREG1575 (NRC, 2000) guidance also cautions that the sensitivities of detection limits given by service providers and instrument manufacturers are usually based on "ideal or optimistic situations and may not be achievable under site-specific measurement conditions." NUREG1575 (NRC, 2000) additionally notes that cost, time, best available technology, or other constraints may create situations where the above stated sensitivities are deemed impractical. If it is anticipated that certain site conditions will not allow for detection sensitivities at 10-50% of the DCGL, then justification for the use of higher detection sensitivity should be provided in each situation.

Path Forward: Provide a demonstration that methodologies proposed are capable of detecting residual radioactivity sufficiently below the proposed DCGLs in the WVDP DP. This demonstration should be performed for each of the ten (10) major survey areas based on characterization data currently available with the goal of demonstrating the ability to accurately measure DCGLs under site-specific measurement conditions. The focus of the demonstration should be on determining the appropriate field instrumentation and detectors and survey methods. The demonstration and justification for the survey methods chosen should be based on the minimum detectable count and scanning rates, the use of surrogate nuclides for hard-todetect nuclides, and how backgrounds will be determined and applied in the field. If laboratory soil analysis is required, report Lower Limits of Detection in the same units as the DCGLs. Provide the procedure, discussion, and justification for the survey methodology for determining how it will be demonstrated that sufficient soil has been removed and that there is no residual radioactivity at depth. NUREG-1757, Vol. 2, Section 4.3 and Appendix E (NRC, 2006) provide additional guidance on remediation action support surveys and in-process surveys.

****

DOE Response: The DOE has provided a detection capability demonstration for Cs-137, will revise the DP after completion of soil characterization as necessary to refine this information, and will provide laboratory minimum detectible concentrations for soil samples in pCi/g.

It is not practicable to demonstrate detection capabilities for the 10 different WMAs because data on radioactive contamination and radionuclide distributions are not sufficient for this purpose. DOE provides a demonstration of the calculation below. It is not meaningful to demonstrate scanning instrument detection capability for radionuclides other than Cs-137 because the ubiquitous presence of Cs-137 may mask the presence of other gamma-emitting radionuclides such as Am-241 in measurements with the field instruments to be used. It will be necessary to make extensive use of sample analytical data because Sr-90, which is expected to be the dominant radionuclide at the bottom of the deep excavations, is not a gamma emitter.

Demonstration of Scanning Minimum Detectable Count Rate and Concentration

A discussion of the calculation of scanning minimum detectable concentration (MDC) and the scanning minimum detectable count rate (MDCR) is provided in the *MARSSIM*. More detail on signal detection theory and instrument response is provided in NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC 1997), from which the following discussion is drawn. Data correlating count rate to Cs-137 soil concentration is from the Brookhaven National Laboratory, Bldg 811 Waste Concentration Facility Remediation project (BNL 2001).

Minimum Detectable Count Rate and Surveyor Efficiency

The framework for determining the scan sensitivity is based on the premise that there are two stages of scanning. That is, surveyors do not make decisions on the basis of a single indication, rather, upon noting an increased number of counts, they pause briefly and then decide whether to move on or take further measurements. Thus, scanning consists of two components: continuous monitoring and stationary sampling.

In the first component, characterized by continuous movement of the probe, the surveyor has only a brief "look" at potential sources, determined by the scan speed. The surveyor's willingness to decide that a signal is present at this stage is likely to be liberal, in that the surveyor should respond positively on scant evidence, since the only "cost" of a false positive is a little time.

The second component occurs only after a positive response was made at the first stage. This response is marked by the surveyor interrupting his scanning and holding the probe stationary for a period of time, while comparing the instrument output signal during that time to the background counting rate. Owing to the longer observation interval, sensitivity is relatively high. For this decision, the criterion should be more strict, since the cost of a "yes" decision is to spend considerably more time taking a static measurement or a sample.

Since scanning can be divided into two stages, it is necessary to consider the survey's scan sensitivity for each of the stages. Typically, the MDCR associated with the first scanning stage will be greater due to the brief observation intervals of continuous monitoring, provided that the length of the pause during the second stage is significantly longer. Typically, observation intervals during the first stage are on the order of one or two seconds, while the second stage pause may be several seconds long. The greater value of MDCR from each of the scan stages is used to determine the scan sensitivity for the surveyor.

The minimum detectable number of net source counts in the interval is denoted by s_i. Therefore, for an ideal observer, the number of source counts required for a specified level of performance can be arrived at by multiplying the square root of the number of background counts by the detectability value associated with the desired performance (as reflected in d') as shown in the following equation:

$$s_i = d'(b_i)^{1/2} \quad \text{[Equation 6-8, MARSSIM]}$$

where the value of d' is selected from MARSSIM Table 6.5 based on the required true positive and false positive rates and b_i is the number of background counts in the interval.

The minimum detectable source count rate (*MDCR*), in cpm, detectable during the observation interval *i*, in seconds by an "ideal" surveyor may be calculated by the following equation:

$MDCR = s_i \times (60 / i)$ [Equation 6-9, MARSSIM]

For the case of real surveyors who are not equivalent to the "ideal" construct, the MARSSIM recommends assuming an efficiency value at the lower end of the observed range of 0.75 – 0.50 (*i.e.*, p = 0.5) when making MDCR estimates. Thus, the required number of net source counts for the surveyor ($MDCR_{surveyor}$) is determined by dividing the MDCR by the square root of p.

Consider the calculation of the MDCR for the case of a two-inch by two-inch NaI(Tl) scintillation detector used in a typical walkover scan. The observed background level is 8,000 cpm. The desired level of performance, 95 percent correct detections and 60 percent false positive rate, results in a *d'* of 1.38 [Table 6-5, MARSSIM]. The scan rate of 0.5 m/s at an observation interval of 1.0 second, results in a diameter of about 50 cm for the area of activity observed. The $MDCR_{surveyor}$ may be calculated assuming a surveyor efficiency (p) of 0.5 as follows:

(1) b_i = (8,000 cpm) × (1 sec) × (1 min/60 sec) = 133 counts

(2) MDCR = (1.38) × $(133)^{1/2}$ / (1 sec) × (60 sec/1 min) = 956 cpm

(3) $MDCR_{surveyor}$ = 956 / $(0.5)^{1/2}$ = 1,352 cpm net above background

The minimum number of source counts required to support a given level of performance for the final detection decision (second scan stage) can be estimated using the same method. As explained earlier, the performance goal at this stage will be more demanding. The required rate of true positives remains high (e.g., 95 percent), but fewer false positives (e.g., 20 percent) can be tolerated, such that *d'* (from Table 6.5 of the MARSSIM) is now 2.48. For this second stage of the scan survey, the surveyor typically stops the probe over a suspect location for about four seconds before making a decision,

(1) b_i = (8,000 cpm) × (4 sec) × (1 min/60 sec) = 533 counts

(2) MDCR = (2.48) × $(533)^{1/2}$ / (4 sec) × (60 sec/1 min) = 859 cpm

(3) $MDCR_{surveyor}$ = 859 / $(0.5)^{1/2}$ = 1,215 cpm net above background

The greater of the calculated $MDCR_{surveyor}$ values is 1,352 cpm above background or approximately 9,350 cpm gross. This is the value chosen for the $MDCR_{surveyor}$.

Scanning Minimum Detectable Concentration

Having determined an estimate of the minimum instrument count rate detected by a real observer in the field, the count rate must be translated to the units corresponding to those of the DCGL (pCi/g). The greater of the $MDCR_{surveyor}$ values calculated in the previous section is 1,352 cpm above background or approximately 9,350 cpm gross. From data correlating count rate to soil concentration it was seen that an instrument response of 9,350 cpm corresponds to a surface soil concentration of approximately 7 pCi/g Cs-137. This is then the scanning minimum detectable concentration that corresponds to the $MDCR_{surveyor}$.

These procedures will be followed to obtain appropriate scan MDCs for the specific instruments to be used at the WVDP site. These calculations will take into account site-specific factors such as soil properties, the expected distribution of radionuclides in soil, and the scanning speed. This information will be developed as part of future planning activities for the project.

DOE has developed a summary table of scanning instrument sensitivities for the 18 radionuclides of interest. This information will be provided in the DP by revising Section 9.5 (see additional text for Section 9.5 discussed below).

Available analytical data in WMA 1 suggest that Sr-90 will dominate contamination at the bottom of the deep excavations. These data – which are taken from Table 5-1 and Table C-4 of the Decommissioning Plan, with the sample 76-08 results amended to reflect a reanalysis with lower detection limits – are summarized below. These data show the maximum detected and non-detected concentrations of each of the 18 radionuclides of interest in the unweathered Lavery till.

Nuclide	Max pCi/g	Nuclide	Max pCi/g	Nuclide	Max pCi/g
Am-241	<0.13	Np-237	<0.021	Tc-99	<0.55
C-14	0.11	Pu-238	<0.023	U-232	0.041
Cm-243	<0.023*	Pu-239	<0.064**	U-233	2.3***
Cm-244	<0.023*	Pu-240	<0.064**	U-234	2.3***
Cs-137	3.9	Pu-241	<0.57	U-235	<0.14
I-129	<0.29	Sr-90	59	U-238	1.4

*Cm-243/244 results, **Pu-239/240 results, ***U-233/234 results

These data are from 21 samples analyzed for Sr-90 and 12 samples analyzed for Cs-137, including seven sample analyzed for Cs-137 that were taken partly in the sand and gravel unit. Eleven of the samples analyzed for Cs-137 showed only the minimum detectable concentration.

It is probable that results obtained by implementation of the Characterization Sample and Analysis Plan will show that some of the 18 radionuclides of interest will not be present or will be present at such low concentrations that they can be considered to be insignificant and removed from the list. NRC guidance in Section 3 of NUREG-1757, Volume 2 (NRC 2006) considers radionuclides and exposure pathways that contribute no greater than 10 percent of the dose criteria to be insignificant contributors. Once it is demonstrated that radionuclides or exposure pathways are insignificant, then (a) the dose from the insignificant radionuclides and pathways must be accounted for in demonstrating compliance, but (b) the insignificant radionuclides and pathways may be eliminated from further detailed evaluations. For this reason, DOE will demonstrate scanning instrument sensitivity for Cs-137 for use in the deep excavations of WMA 1 and WMA 2, rather than demonstrating for all 18 radionuclides of interest.

Changes to the plan:

The following changes will be made to Section 9.4, by adding text and a new table following existing Table 9-4:

> Samples may be analyzed onsite or shipped to an offsite contract laboratory for analysis. Laboratory methods, instruments and sensitivities will be in accordance with New York State protocols for environmental analysis. Any laboratory used for environmental sample analysis will have appropriate New York State Department of Health Environmental Laboratory Approval Program certification, or equivalent. Table 9-5 indicates the target minimum detectable concentrations for radionuclides in laboratory analyses of soil samples. Minimum detectable concentration requirements are set to whichever is lower: (1) approximately 10 percent of the most restrictive radionuclide-specific cleanup goal identified in Table 5-14, (2) 25 percent of background for naturally occurring radionuclides;

or (3) standard laboratory minimum detectable concentrations.

Table 9-5. Radionuclide Target Sensitivity for Laboratory Sample Analysis

Nuclide	Instrument/Method	Target Sensitivity pCi/g[(1)]
Am-241	Alpha and/or gamma spectrometry	1[(4)]
C-14	Sample oxidizer and liquid scintillation	2[(4)]
Cm-234/244	Alpha and/or gamma spectrometry	1[(4)]
Cs-137	Gamma spectrometry	0.1[(4)]
I-129	Gamma spectrometry	0.06[(2)]
Np-237	Alpha and/or gamma spec	0.01[(2)]
Pu-238	Alpha spectrometry	1[3]
Pu-239/240	Alpha spectrometry	1[3]
Pu-241	Liquid scintillation	15[3]
Sr-90	Liquid scintillation	0.9[(2)]
Tc-99	Gas flow proportional counting	3[(2)]
U-232	Alpha spectrometry	0.5[(2)]
U-233/234	Alpha spectrometry	0.2[(3)]
U-235 (-236)	Alpha spectrometry	0.1[(3)]
U-238	Alpha spectrometry	0.2[(3)]

NOTES: (1) Dependent on sample size, counting time, etc.
(2) Approximately 10 % of the most restrictive radionuclide-specific cleanup goal identified in Table 5-14
(3) 25% of background for naturally occurring radionuclides
(4) Standard laboratory minimum detectable concentrations.

The following subsection heading will be included between the first and second paragraphs of Section 9.5:

9.5.1 Measurements Methods and Instrumentation

The following text and new Table 9-6 will be added to Section 9.5, following the existing second paragraph:

9.5.2 Scan Surveys and Direct Measurements

Investigation levels for scanning surveys to identify areas of elevated activity will be determined in implementation of the Characterization and Sampling Plan. Scanning surveys will be performed to locate radiation anomalies indicating residual gross activity that may require further investigation or action. Areas of elevated activity typically represent a small portion of the site or survey unit. Thus, random or systematic direct measurements or sampling on a grid spacing may have a low probability of identifying these areas, so that scanning surveys are typically performed before direct measurements or sampling. Because of the inability to detect certain radionuclides of interest in scanning surveys as discussed below, collection and analysis of soil samples will be necessary using protocols specified in the Characterization Sample and Analysis Plan and the Final Status Survey Plan.

Scan Minimum Detectable Concentrations

Procedures are provided in the MARSSIM for calculating scan MDCs for particular survey instruments. More detail on signal detection theory and instrument response is provided in NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*. These procedures will be followed to obtain appropriate scan minimum detectable concentrations (MDCs) for the specific instruments to be used at the site. These calculations will take into account site-specific factors such as soil properties, the expected distribution of radionuclides in soil, and the scanning speed. This information will be developed as part of future planning activities for the project, and can be provided to NRC upon request.

To assist with current planning activities, estimated scanning MDCs in soil for the radionuclides of interest were obtained by reviewing available information, and these values are shown in Table 9-6. Information is only provided for 14 of the 18 radionuclides, as four have no or minimal photon (gamma ray and X-ray) emissions making them impractical to detect with field scanning instruments. Field survey instruments for soil contamination are generally limited to those that can detect photons, given the uneven terrain and conditions encountered in the field. This is in contrast to survey instruments that can be used for buildings, many of which allow for the detection of alpha and beta contamination as well as gamma emissions.

Table 9-6. Estimated Scanning Minimum Detectable Concentrations (MDCs) of Radionuclides in Soil

Radionuclide	Type of detector	Scan MDC (pCi/g)
Am-241	FIDLER	30
C-14	NA(1)	-
Cm-243	2" by 2" NaI	50
Cm-244	FIDLER	300
Cs-137	2" by 2" NaI	7(2)
I-129	FIDLER	60
Np-237	FIDLER	30
Pu-238	FIDLER	100(3)
Pu-239	FIDLER	200(3)
Pu-240	FIDLER	100
Pu-241	NA(1)	-
Sr-90	NA(1)	-
Tc-99	NA(1)	-
U-232	FIDLER	60
U-233	FIDLER	500

Table 9-6. Estimated Scanning Minimum Detectable Concentrations (MDCs) of Radionuclides in Soil

Radionuclide	Type of detector	Scan MDC (pCi/g)
U-234	FIDLER	60
U-235	FIDLER	30
U-238	FIDLER	60

NOTES: (1) NA means not applicable; either there are no photons associated with the radionuclide or the photon yield is too low to allow for detection by field scanning instruments.

(2) A specific calculation of scanning minimum detectable count rate for Cs-137 in soil performed in connection with preparation of the Phase 1 Decommissioning Plan yielded a value equivalent to 7 pCi/g Cs-137. A comparable value of 6.4 pCi/g is given in Table 6.7 of the MARSSIM when units are given in pCi/g.

(3) While scan MDCs of 10 and 20 pCi/g are reported for Pu-238 and Pu-239, respectively, in Appendix H of MARSSIM, much larger values were reported elsewhere. The values given here are those expected to be reasonably achievable under field conditions.

The scanning MDCs given in Table 9-6 are representative of those that reasonably can be expected to be obtained with currently available instruments under conditions encountered in the field. These values were obtained from reported values and scanning experience at other radioactively contaminated sites.[1]

Experience for the Shallow Land Disposal Area site in Pennsylvania indicated that the calculated values were much lower than was actually obtainable under field conditions, which is reflected in the values given in Table 9-6. For some radionuclides (such as Pu-238 and Pu-239), a wide range of values was reported. In this case, a midpoint value is given in the table.

Information for scan MDCs was not available for about half of the radionuclides. In these cases, the energy spectrum and yields of the gamma rays and X-rays were reviewed along with the relative detector response (by photon energy). This allowed for an estimate to be made of the scan MDCs for those radionuclides having no published information.

The scan MDCs for some radionuclides exceed the expected values for surface soil $DCGL_W$ values (cleanup goals) given in Table 5-14 of this plan. Also, the general approach used to calculate scan MDCs assumes flat terrain and does not account for situations where scans may be occurring on the walls of excavations. Experience has shown that it is difficult to obtain scan MDCs at the levels calculated using conditions that are more ideal than generally occur at the site. The values given in Table 9-6 account for expected field conditions.

Because there may be multiple radionuclides present at many locations, it will be necessary to achieve soil concentrations at some relatively small fraction of the DCGLs to arrive at definitive conclusions as to the need to conduct further remedial action. This typically cannot be done using scanning instruments. Rather, scanning techniques are

[1] Calculations of scan MDCs are provided in a number of gamma walkover plans including the *Site Radiological Survey Plan* for the CWM Chemical Services site in Model City, New York (CWM 2006) and the *Final Gamma Walkover Survey Sampling and Analysis Plan* for the Shallow Land Disposal Area FUSRAP site in Pennsylvania (USACE 2003). Additional information reviewed included the article *Detection of Depleted Uranium in Soil Using Portable Hand-Held Instruments* (Coleman and Murray 1999) and *Ask an Expert Question and Answer Page on Survey Instruments (conventional)* (ORAU 2009). These sources provided a range of scan MDCs for several different detectors.

generally used to indicate the presence of elevated radioactivity (above background) and the radionuclides that may have elevated concentrations. Definitive conclusions as to the presence or absence of contamination above radionuclide-specific DCGLs will be made by making direct static measurements or by collecting samples for analysis.

Direct Measurements

Direct measurements may be collected at random locations in the excavation area. Alternatively, direct measurements may be collected at systematic locations and supplement scanning surveys for the identification of small areas of elevated activity. Direct measurements may also be collected at locations identified by scanning surveys as part of an investigation to determine the source of the elevated instrument response. Professional judgment may also be used to identify locations for direct measurements to further define the areal extent of residual radioactivity and to determine maximum radiation levels within an area, although these types of direct measurements are usually associated with preliminary surveys (i.e., scoping, characterization, remedial action support). All direct measurement locations and results shall be documented.

For those radionuclides that cannot be effectively measured directly in the field, samples of the soil in the area under investigation will be collected and then analyzed with a laboratory-based procedure including gamma spectrometry, beta analysis using liquid scintillation counting, or alpha spectrometry following separation chemistry.

New references added to Section 9.9:

BNL 2001, Brookhaven National Laboratory, Bldg 811 Waste Concentration Facility Remediation. Brookhaven National Laboratory, Upton, New York, 2001.

Coleman and Murray 1999, "Detection of Depleted Uranium in Soil Using Portable Hand-Held Instruments," IAEA-SM-359/P-5. Coleman, R.L. and M.E. Murray, Proceedings of the IAEA Annual Conference, Washington, D,C., November 1999.

CWM 2006, *Site Radiological Survey Plan, Model City, NY,* prepared by CWM Chemical Services, LLC., with assistance from Shaw Environmental, Inc. and URS Corporation, November 2006.

ORAU 2009, *Ask an Expert Question and Answer Page on Survey Instruments (conventional),* at http://www.orau.gov/ddsc/expert/answers/instruments.htm, accessed on July 23, 2009.

NRC 1997, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, NUREG-1507. U.S. Nuclear Regulatory Commission, Washington, D.C., December 1997.

USACE 2003, *Final Gamma Walkover Survey Sampling and Analysis Plan, Part 1 – Field Sampling Plan,* prepared for the U.S. Army Corps of Engineers, Buffalo District, by URS Corporation, April 21. 2003.

References (other):

NRC 2000, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, NUREG-1575, Revision 1. NRC, Washington, DC, August, 2000. (Also EPA 4-2-R-97-016, Revision 1, U.S. Environmental Protection Agency and DOE-EH-0624, Revision 1, DOE)

RAI 9C3 (34)

Subject: Application of Background Data

RAI: Provide a description and technical justification for how the soil background data will be applied to characterization, in-process and remediation action support surveys and final status surveys. (Section 9.3, Page 9-8)

Basis: 10 CFR 20.1402, "Radiological Criteria for Unrestricted Use" states a site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year. Chapter 4 of the DP provides background concentrations for various environmental media and Chapter 9 discusses NRC guidance that may be followed.

Path Forward: Provide a technical justification for the application of the background radiation in the decommissioning survey process. The justification must address application to defining non-impacted and impacted areas and how background activity is used in survey measurements. NUREG-1757, Vol. 2, Appendix A (NRC, 2006), and NUREG-1575 (NRC, 2000) Sections 8.3 and 8.4 provide guidance on determining background, application in radiological surveys, and the statistical tests.

****

DOE Response:

The discussion in Section 9.3 will be expanded to address the definition and application of background data in surveys to be performed in support of Phase I of the WVDP decommissioning should DOE decide in the Record of Decision to choose the phased decision-making closure alternative. The discussion in Section 9.5 will be expanded to address the DQOs and the application of background data in in-process surveys. More detailed information on in-process surveys will be included in Section 9.5 and Section 9.7.

As indicated in the NRC RAI basis, Section 4 provides background radioactivity concentrations for various environmental media. These data cover most of the 18 radionuclides of interest. The Characterization Sample and Analysis Plan will provide for collecting data on background concentrations in soil and sediment for other radionuclides of interest from locations not impacted by site operations. Section 4 also describes impacted and non-impacted facilities and areas of the project premises based on available data.

Changes to the plan: The following changes will be made to Section 9:

9.3 Background Surveys

Some information on background radiation and radioactivity in non-impacted areas is available, such as that contained in annual site environmental reports (WVES and URS 2008) and that described in Section 4. Table 4-11 shows background concentrations in various environmental media for most radionuclides of interest.

Additional background measurements will be taken in connection with characterization surveys outlined in Section 9.4. The characterization surveys will be described in a separate Characterization Sample and Analysis Plan to be developed and submitted for NRC review. The additional measurements will include exposure rates and samples from non-impacted soil, sediments and building materials in suitable non-impacted (background) reference areas. These additional samples will be subjected to appropriate radionuclide–specific analyses to address all 18 radionuclides of interest.

Applicable guidance for background surveys in the MARSSIM (NRC 2000) and in NUREG-1505 (Gogolak, et al. 1997) will be incorporated. Guidance provided in NUREG-1757, Vol. 2, (NRC, 2006) will be considered to ensure that quality objectives and survey execution, controls and results are consistent with those of the characterization and Phase1 final status surveys.

The surveys and sampling in non-impacted on-site and offsite areas to establish a basis for background radioactivity levels will be described in detail in the Characterization Sample and Analysis Plan. The application of the background data during assessment and use of the data obtained in the characterization and Phase 1 final status surveys will be based on guidance in Chapter 8 of the MARSSIM (NRC 2000) and will be described in each of the respective plans.

Because the Sign test will be used in the Phase 1 final status survey to show $DCGL_W$ compliance, application of a background reference area will not be necessary. (If the DCGLs were to be revised in a manner that results in lower values for naturally occurring radionuclides, the Wilcoxon Rank Sum test would be required instead, and a background reference area would become necessary.)

9.5 In-Process Surveys

In-process or remedial action support surveys will be performed while remediation is in progress. The purposes of these surveys are to guide decontamination and determine when remediation to the cleanup goals specified in Section 5 has been attained. In-process surveys also support radiation protection.

Measurement methods and instruments used will be identical to those utilized during the characterization performed in accordance with the Characterization Sample and Analysis Plan and the Phase 1 final status surveys. Survey quality objectives during in-process survey activities will be aligned with the quality objectives of the Phase 1 final status surveys, to ensure that decisions and interpretations of data have the same confidence as those based on the Phase 1 final status survey results. Data quality objectives and quality control parameters will be consistent with those identified for the Characterization Sample and Analysis Plan, Section 9.4, above. Media-specific and instrument/method-specific background levels developed by measurements and sampling in the Characterization Sample and Analysis Plan will be applied during the remediation, usually through subtraction from onsite analysis of samples.

The Characterization Sample and Analysis Plan will specify the sampling, instruments and data objectives for surveys in the area around the Process Building foundation pilings, an area that will not be readily accessible until late in the excavation in WMA 1 when overlaying structures are removed. In-process surveys in this area will be used to guide remediation and to identify locations for biased sampling.

Because surveys performed in the deep excavations are expected to be dominated by Sr-90, nuclide-specific measurements by onsite sample analysis will be used to guide the excavation. Where practicable, correlations between gamma exposure rates and soil radioactivity concentrations will be used to help determine when removal of target soil has been completed and to demonstrate that the instrument scan and direct measurement sensitivities are sufficient for the purpose of the in-process survey.

Data reports and documents will be archived and maintained to comply with the Project Quality Assurance Program described in Section 8.

The following changes will be made to Section 9.7.1 on page 9-25:

In-Process Surveys of Other WMA 1 Facilities

In-process surveys would be performed during remediation as described in Section 9.5. However, the scope of such surveys would be minimal because of the relative low potential for contamination, except in some areas of the 01-14 Building which may contain significant contamination.

In-Process Surveys in the WMA 1 Excavation

In-process surveys will be performed as described in Section 9.5 in connection with completing the large excavation. These surveys will focus primarily on the floor of the excavation after the underground structures have been removed and soil has been removed at least one foot into the unweathered Lavery till as specified in Section 7.3.8. They will be coordinated with surveys performed around Process Building foundation pilings that are specified in the Characterization Sample and Analysis Plan. The in-process surveys will include the following activities:

- Laying out the survey units as specified in the Phase 1 Final Status Survey Plan to facilitate use of the in-process survey data for final status survey purposes in cases where this may be practicable;
- Performing gamma scan surveys of the entire excavation floor to locate areas of elevated activity;
- Collecting biased samples within each survey unit from the top six inches of soil, with emphasis on areas of elevated activity;
- Analyzing these samples in the onsite laboratory to determine the concentrations of gamma-emitting radionuclides and Sr-90;
- Evaluating the resulting analytical data with respect to the cleanup goals to determine if additional remediation is necessary; and
- Removing additional soil in areas where the cleanup goals have not been achieved and then performing additional surveys and sampling in those areas to confirm that the cleanup goals have been achieved.

This same process will be followed for survey units on the walls of the excavation that are hydraulically downgradient, that is, those survey units on the east side and north side at the hydraulic barrier wall. In these cases, the depth of any necessary remediation will be limited as specified in Section 7 to avoid reducing the effectiveness of the hydraulic barriers.

Phase 1 Final Status Surveys in Other WMA 1 Facilities

As all facilities within the Process Building excavation would be removed, the Phase 1 final status surveys would be surveys of the excavation surface in accordance with the Phase 1 Final Status Survey Plan.

The following changes will be made to Section 9.7.2 on page 9-27:

In-Process Surveys of WMA 2 Area

In-process surveys would be performed during remediation as described in Section 9.5. These surveys would include the surface of the soil in excavations made during removal of the interceptors, the Neutralization Pit, and the associated valve pits.

In-Process Surveys in the WMA 2 Excavation

In-process surveys of the completed large excavation will be performed in a manner similar to those for the WMA 1 large excavation described in Section 9.7.1, except that there are no foundation pilings involved and the excavation walls where surveys will be performed will be those on the northeast and northwest sides at the hydraulic barrier wall.

RAI 9C4 (35)

Subject: Final status survey plan details

RAI: Provide details for the Final Status Survey Design as required by the NUREG-1757, Vol. 1, Appendix D, Section XIV.d (NRC, 2006) checklist using the data determined in RAI 9C1-9C3 above. (Section 9.6, Page 9-15)

Basis: NRC guidance in NUREG-1757, Vols. 1 and 2 (NRC, 2006) requires the development of a Final Status Survey Design.

Path Forward: Given the characterization data collected to date and the development of the Characterization Plan, In-process/Remediation Action Support Survey information demonstration, and determination how background concentrations will be applied, provide the details for the Final Status Survey Design for Phase 1 areas. NUREG-1757, Vol.2, Section 4.4 and Appendix E (NRC, 2006) and NUREG-1575 (NRC, 2000) provide additional guidance for Final Status Survey Design.

****

DOE Response:

DOE has had Argonne National Laboratory develop a conceptual design framework for the Phase 1 Final Status Survey Plan. The Plan will be based on this framework, which will be included in Revision 2 to the DP as a new appendix. A copy of this appendix is attached.

APPENDIX G

PHASE 1 FINAL STATUS SURVEY CONCEPTUAL FRAMEWORK

PURPOSE OF THIS APPENDIX

The purpose of this appendix is to describe the conceptual basis for the Phase 1 Final Status Survey Plan.

INFORMATION IN THIS APPENDIX

This appendix describes the design basis for the Phase 1 Final Status Survey Plan, including the key assumptions, and then outlines the final status survey approach. It closes with a discussion of documentation requirements. Logic diagrams are provided to illustrate the processes involved.

RELATIONSHIP TO OTHER PARTS OF THE PLAN

The information in this appendix supplements the requirements for the Phase 1 Final Status Survey Plan described in Section 9.

1.0 Introduction

The purpose of this conceptual framework is to describe the design basis and general approach for the WVDP Phase 1 Final Status Survey Plan, thus augmenting the requirements outlined in Section 9 of this plan.

Section 7.2.2 of this plan provides for Phase 1 final status surveys in three types of areas:

(1) The major areas to be made inaccessible during Phase 1 decommissioning activities, that is, the bottom and sides of excavations for removal of key WVDP facilities and contaminated subsurface soil (i.e., the WMA 1 and WMA 2 large excavations);

(2) Excavated soil laydown areas after the soil and ground covering are removed; and

(3) Potentially impacted areas with no subsurface soil contamination that meet the unrestricted release criteria during Phase 1 of the decommissioning.

The primary objective of these surveys is to confirm that cleanup goals specified in Section 5 of this plan have been achieved. However, if an excavated soil laydown area is known to have subsurface contamination, then the objective of the survey of that area would be to determine the radiological status of the surface soil.

Note that the Characterization Sample and Analysis Plan, rather than the Phase 1 Final Status Survey Plan, will provide for radiological status surveys of:

(1) Soil in the footprints of structures, concrete slabs, asphalt pavement, and gravel pads outside of the WMA 1 and WMA 2 large excavations to be removed during Phase 1 decommissioning activities; and

(2) The interior of the HLW transfer trench following removal of piping and equipment in the trench and the associated pump pits and diversion pit.

If DOE chooses to demonstrate that soil in the footprints of selected structures, concrete slabs, asphalt pavement, or gravel pads outside of the WMA 1 and WMA 2 large excavations removed during Phase 1 decommissioning activities meets the unrestricted release criteria, then Phase 1 final status surveys will also be performed in those areas if the characterization data are not sufficient for final status survey purposes.

2.0 Final Status Survey Design Basis

As required by Section 9 of this plan, the Phase 1 Final Status Survey Plan will be consistent, to the extent possible, with the MARSSIM (NRC 2000). There are aspects of the WVDP project premises (e.g., buried subsurface soil contamination, sediments, etc.) that are beyond MARSSIM's scope. In those instances, the proposed protocols will be consistent with the intent of MARSSIM.

2.1 Project Premises and Proposed Phase I Activities

As explained in Section 3 of this plan, the project premises comprise 156.4 acres. The major features of the project premises include existing facilities and associated above-ground and buried infrastructure, disposal areas, wastewater lagoons, roads, hardstands, paved parking lots, a railway spur, streams that drain the parcel, and open land. The project premises were used for spent-fuel reprocessing in the 1960s and early 1970s.

Reprocessing activities resulted in environmental releases of radionuclides to surrounding soils, surface water, and groundwater as discussed in Section 2 of this plan.

To address known historical releases whose residual environmental contamination pose significant dose concerns, Phase 1 activities include the following planned environmental remediation activities:

(1) A deep (30 – 45 feet), extensive (three acre) excavation of contaminated soils adjacent to and beneath the Main Plant Process Building (WMA);

(2) A deep (up to 14 feet), extensive (four acre) excavation of contaminated soils adjacent to and beneath facilities and lagoons associated with the Low-Level Waste Treatment Facility (WMA 2); and

(3) Excavation of contaminated and uncontaminated near-surface soils (approximately 2 feet below grade) associated with selective building and infrastructure removal in WMA 3, WMA 5, WMA 6, WMA 7, WMA 9, and WMA 10.

In addition to these planned excavations, DOE may also choose to remove additional contaminated soils and/or sediments as part of Phase 1 decommissioning work. Any residual contamination within the project premises that still poses a dose concern would be addressed by Phase 2 decommissioning activities.

2.2 Cleanup Criteria

As indicated in Section 5 of this plan, there are 18 radionuclides of interest for the project premises. The DCGL values for each radionuclide are based on a 25 mrem/y dose requirement (incremental to background) assuming a goal of unrestricted release.

The DCGL requirements include a $DCGL_W$ value to be applied as an area-averaged goal to final status survey units and a $DCGL_{EMC}$ value applicable to 1-square meter (m^2) areas. Different DCGL values are provided for surface soils (defined as soils to a depth of 1 m), for subsurface soils (defined as soils at significant depth that would be temporarily exposed by proposed Phase 1 excavation activities in WMA 1 and WMA 2), and for streambed sediments. These DCGL values were further refined to reflect cumulative dose concerns, resulting in a final set of cleanup goals reflected in Table 5-14 of this plan[1].

2.3 Key Assumptions

This conceptual framework includes several key assumptions:

- ***Decommissioning Plan Changes.*** This conceptual framework is based on DCGLs in Revision 2 to the plan. Any changes in DCGL values or definitions may require changes to this framework.
- *DCGL Definitions.* The surface soil DCGLs apply to a vertical interval (contamination zone thickness) of one meter. The planned characterization work may identify project premises characteristics that are inconsistent with the conceptual site model used for DCGL derivation (e.g., surface contamination restricted to the top few inches of soil surface, subsurface contamination covered

[1] Section 5 of this plan explains the difference between the DCGLs developed to correspond to 25 mrem per year for individual areas and the cleanup goals to be used in remediation activities. As in Section 9 of this plan, the term *DCGL* as used in this appendix from this point on is understood to mean *cleanup goal.*

by a few inches of clean soil, or contaminated soils extending to a depth greater than one meter). To address this potential issue:

(1) Surface soil DCGL standards will only be applied when contamination impacts are less than one meter in depth;

(2) Surface soil DCGL standards will be applied separately to the top 15 cm (six inches) of soil and to the top one meter soil interval as part of the final status survey process; and

(3) The presence of thin, highly elevated zones overlain by clean surface soils will be evaluated by Characterization Sampling and Analysis Plan data collection. If near surface contaminated layers are encountered during this data collection effort that result in potential dose concerns but that would not have been identified by the proposed Final Status Survey Plan data collection approach, the Final Status Survey Plan process will be modified to meet the specific needs of those areas.

- ***LBGR.*** MARSSIM's Lower Bound on the Grey Region (LBGR) corresponds to the average residual activity concentration that will be present when final status survey data collection activities begin. For areas that do not require remediation, the LBGR is the existing average level of contamination present. For areas requiring remediation, the LBGR is the cleanup level targeted by the remediation program. In combination with the Type II error rate and expected sample variability, the LBGR is an important determinant of the number of systematic samples required to demonstrate compliance with the $DCGL_W$ values.
- ***Data Gaps.*** There are key data gaps that will be addressed as part of the pre-design characterization work discussed in Section 9 of this plan. One example of these is the presence and spatial prevalence of the 18 radionuclides of interest. A second example is the presence and importance of radionuclides other than the 18 identified in this plan. While unlikely, the Final Status Survey Plan framework may need to be revisited if Phase 1 conditions encountered during characterization work are determined to be significantly different from the assumptions and conceptual site model in this plan.
- ***Chemical Contamination.*** Chemical contamination may exist for portions of the facility. Chemical contamination concerns will be addressed in compliance with RCRA requirements, and are not directly within the scope of the Final Status Survey Plan. Samples collected as part of the Final Status Survey Plan process may also be analyzed for chemical constituents as necessary for waste stream characterization needs, and/or to fulfill RCRA requirements.
- ***Scope of Phase 1 Final Status Survey Plan Data Collection.*** As part of Phase 1 decommissioning activities, data will be collected to demonstrate that the floors and the sides (at depths greater than three feet) of the WMA 1 and 2 excavations meet the appropriate DCGL requirements. In addition, DOE may also choose to collect data to demonstrate that surface soils for other portions of the WVDP project premises also meet the Phase 1 cleanup goals for those situations where contamination is not present at depths greater than one meter. Examples of these areas include: (1) soils exposed by hardstand, pad, or foundation removal that are believed to be below DCGL requirements; (2) soils with surface contamination

above DCGL goals that DOE chooses to remediate; and/or (3) other soils where there is no evidence of contamination above DCGL requirements. The Final Status Survey Plan framework as described applies to soils and sediments and does not apply to surface water or groundwater.

- ***Sign Test Applicability.*** Because all 18 radionuclides identified in the decommissioning plan are either not naturally occurring or have $DCGL_W$ requirements an order of magnitude or more above background levels, the Sign test is considered appropriate for demonstrating compliance with wide-area DCGL ($DCGL_W$) requirements. In the event that DCGL values are lowered it may be necessary to establish a background reference area and use the Wilcoxon Rank Sum (WRS) test instead to demonstrate compliance with the $DCGL_W$ requirements.

- ***$DCGL_{EMC}$ Applicability.*** The $DCGL_{EMC}$ radionuclide-specific and applies to 1-m^2 areas. Gross gamma surveys will be used for demonstrating compliance with the $DCGL_{EMC}$ criteria where appropriate. In addition, appropriate $DCGL_{EMC}$ values will be calculated that correspond to the area represented by systematic samples collected to demonstrate $DCGL_W$ compliance using area factors provided in Tables 9-1 and 9-2 of Section 9 of this plan. The latter approach is intended to address the radionuclides of interest that are not detectable by gamma scans and that may exist in isolation for specific portions of the project premises (e.g., the floor of the WMA 1 dig where Sr-90 may be the principal radionuclide of interest).

- ***Radionuclides of Interest List.*** Because processes and contaminant release scenarios vary from location to location across the project premises, not all 18 radionuclides of interest may be pertinent to specific areas. The assumption is that Characterization Sample and Analysis Plan data collection may be used to determine which of the 18 radionuclides of interest are pertinent to specific areas and that final status survey sampling for those areas may be limited to the smaller set of the pertinent radionuclides of interest.

- ***Use of Sum-of-Ratios Calculations***. Because of the many radionuclides of interest, all final status survey determinations will be based on sample sum-of-ratios calculations. The sum-of-ratios calculation for any particular sample will be based on the radionuclides pertinent to the final status survey unit that was the source of the sample.

- ***Subsurface Soil Contamination.*** The Phase 1 Final Status Survey Plan is not applicable to areas outside the WMA 1 and 2 excavations where subsurface contamination exists at depths greater than one meter.

- ***Null Hypothesis and Acceptable Error Rates.*** For the Sign test, the null hypothesis will be that final status survey units are contaminated above $DCGL_W$ levels based on sample sum-of-ratios values. In this context, the acceptable Type I error rate (i.e., rejecting the null hypothesis when it should have been accepted) will be 0.05. The Type II error rate (i.e., accepting the null hypothesis when it should have been rejected) will be set based on an engineering cost analysis that weighs the potential for false contaminated conclusions with the costs of final status survey data collection. The Type I error rate establishes the minimum number of systematic samples required for Sign test implementation. In the case of an error rate of 0.05, the minimum number is five samples per survey unit; final status survey units, however, will likely require more systematic samples than this minimum number to meet Type II error rate needs.

- ***Role of Composite Sampling.*** While not discussed in MARSSIM, the use of composite samples is one means for attaining desired Type II error rates while controlling analytical costs when performing $DCGL_W$ evaluations. Composite sampling can also significantly increase the likelihood that $DCGL_{EMC}$ exceedances are identified for radionuclides that are not detectable by gross activity scans. Composite sampling combines soil increments systematically distributed across a portion of a final status survey unit into homogenized composite samples before analysis. The minimum number of composites per survey unit is determined by the desired Type I error rate. The minimum number of soil increments contributing to each composite sample is a function of the desired Type II error rate, the degree of heterogeneity expected within survey units, and the expected average residual activity concentration. Composite sampling will be used when appropriate during the final status survey process to improve overall decision-making performance.
- ***Analytical Methods.*** Some of the radionuclides of interest have relatively low $DCGL_W$ values. The 18 radionuclides span a range of required analytical techniques, including gamma spectroscopy, alpha spectroscopy, liquid scintillation, and gas proportional counting. The Final Status Survey Plan will specify the analytical performance requirements expected for each radionuclide (Table 9-5 of this plan identifies target detection limits). In some cases (e.g., gamma spectroscopy and liquid scintillation), a field-based laboratory may prove advantageous, particularly for those radionuclides that will likely be the primary decision drivers (e.g., Cs-137 and Sr-90). Whether data from field deployable techniques can be used for final status survey compliance demonstration purposes will depend on whether data quality standards can be achieved and documented. There may be cases where a particular field-deployable technique may not have sufficient data quality for final status survey purposes, but where the technique still serves an important and useful role as a screening tool for elevated area concerns, or as part of pre-final status survey/remedial support data collection to determine that an area is ready for final status survey data collection.
- ***Use of Pre-Design Investigation Data for Final Status Survey Purposes.*** The final status survey logic and Final Status Survey Plan were developed in tandem with the Characterization Sample and Analysis Plan for pre-design data collection. The intent is that pre-design data, if collected consistent with Final Status Survey Plan protocols and data quality standards, can potentially be used for final status survey purposes if contamination levels requiring remediation are not identified.

2.4 Role of Pre-Design Data Collection

The Characterization Sample and Analysis Plan will address key data gaps pertinent to decommissioning work. Some of those data gaps are also important from the perspective of designing and implementing the final status survey process for the project premises. These include:

- Determining whether the list of the 18 radionuclides of interest as identified by the DP is complete. An additional 12 radionuclides have been identified as possibly (but unlikely) present at the site. In addition, the presence of progeny not in equilibrium with the 18 radionuclides of interest has also been identified as a possible concern. Both issues have the potential for requiring changes to the radionuclides of interest list. The Characterization Sample and Analysis Plan will determine whether this is necessary.

- Addressing the prevalence, spatial distribution, and potential collocation of the 18 radionuclides of interest. There are several potential outcomes from this data collection. If particular radionuclides of interest are either not present to any significant degree or are always dominated from a sum-of-ratios perspective by other radionuclides, the analytical list for systematic samples may be reduced to those that are pertinent. The list of "pertinent" radionuclides of interest might vary with location. Alternatively, if a few readily measurable radionuclides of interest (e.g., Cs137) are ubiquitous and at relatively stable ratios to other radionuclides of interest, a surrogate approach might be adopted for DCGL analysis.

- Determining the presence/absence and prevalence of near-surface subsurface soils (e.g., soils that are at depths just below one meter) that exceed DCGL standards. The Phase 1 surface soil DCGL requirements are only applicable to areas where contamination is not present below a depth of one meter. The Characterization Sample and Analysis Plan will delineate where near-surface subsurface soil contamination is a concern.

- Identifying whether thin layers of buried contamination exist within the top one meter of soils that might pose dose concerns if exposed but would be missed by the currently proposed Final Status Survey Plan sampling logic. The Characterization Sample and Analysis Plan will determine if this is the case, and if so, identify the areas where this would be a concern. If such areas exist, then the Final Status Survey Plan logic will be adjusted to address those concerns.

- Supporting layout of final status survey unit areas for the site. The MARSSIM defines three different classifications of final status survey units that may potentially be applied to one or more areas of a site. The selection of the appropriate final status survey unit classification for a particular area depends on its expected contamination status relative to the DCGLs. The Characterization Sample and Analysis Plan will provide the data necessary for the correct classification and delineation of MARSSIM final status survey units.

- Estimating likely residual radionuclide activity concentrations to be encountered after Phase 1 activities are complete. Expected average residual activity concentrations, in conjunction with expected heterogeneity and Type II error requirements, will affect final status survey sample numbers.

3.0 Final Status Survey Approach

Final status survey data collection will take place for soils and sediments within the project premises. Final Status Survey Plan protocols will vary depending on whether they are applied to soils or stream sediments. In the case of soils and sediments, if the final status survey data collection conclusions are that DCGL standards have not been attained, DOE may remediate the area and collect additional final status survey data to demonstrate compliance with DCGL requirements.

For the deep excavated surfaces within WMA 1 and WMA 2, additional remediation will take place if subsurface DCGL requirements are not met. For areas outside the WMA 1 and WMA 2 deep excavations, if a final status unit fails the final status survey process, DOE may choose to remediate the affected area until DCGL requirements are met or to postpone remediation until Phase 2.

If DOE chooses to remediate soils exceeding DCGL standards and the original unit was a Class 1 unit, final status survey data collection will be repeated after additional remediation is complete. If the original unit was an unexcavated Class 2 or Class 3 unit, the affected area will be remediated, reclassified as one or more Class 1 units, and final status survey data collection repeated. DOE may defer remediating areas that are not currently identified as requiring excavation by the DP until Phase 2.

3.1 Surface Soils

A complete logged gamma walkover survey of accessible areas within the project premises using an appropriate detector (e.g., Field Instrument for Detecting Low Energy Radiation (FIDLER)) will be performed as part of Characterization Sample and Analysis Plan data collection activities. This walkover survey, in conjunction with biased surface soil sampling and intrusive GeoProbe® data collection, will be used to identify areas likely requiring remediation or impacted at levels approaching soil DCGL levels but not planned for remediation (Class 1 areas), areas impacted but with no evidence of soil DCGL exceedances (Class 2 areas), and areas within the WVDP project premises' boundary that either show no evidence of impacts, or are minimally impacted at very low levels compared to soil DCGL standards (Class 3 areas). Based on data available to date, it is expected that the majority of the project premises will be classified as either Class 1 or Class 2 final status survey units.

As part of Characterization Sample and Analysis Plan data collection, a background reference area will be identified that can be used to assess the background response of the detector used and that can serve as a source of background samples if a WRS test is required to demonstrate $DCGL_W$ compliance. One outcome of reference area gross gamma data collection will be the identification of appropriate field investigation levels to be applied to gross gamma data during routine use of detectors for pre-design characterization, remediation support, and final status survey data collection.

An example of a field investigation level would be a detector response that is not statistically consistent with background readings (e.g., above the 95 percent upper tolerance limit for background data sets). Biased sampling, in conjunction with gamma walkover survey data and associated field investigation levels, will be used during pre-design data collection work in contaminated areas to develop additional field investigation levels that could potentially be used to reliably identify gross activity responses that might be indicative of soil DCGL exceedance concerns.

For areas that are excavated, the final exposed dig face (walls and floors) will be scanned using one or more logged detectors to evaluate the potential presence of either general contamination above soil $DCGL_W$ standards, or very localized contamination potentially associated with soil $DCGL_{EMC}$ concerns. Biased sampling will be used to further evaluate evidence of contamination potentially above soil DCGL standards if encountered by the detector. Detector data will be collected with the goal of complete spatial coverage at a density of one logged measurement per square meter, on average.

Prior to the initiation of final status survey sample collection, the layout of final status survey units will be finalized for surface soils that are considered ready for final status survey data collection. Areas that are candidates for Phase 1 final status survey data collection are areas where there is no evidence or concern about contamination deeper than one meter, and where Characterization Sample and Analysis Plan data indicate that residual contamination levels likely meet surface soil DCGL requirements. Soil Class 1 survey units will not exceed 2,000 m^2 in size. Soil Class 2 survey units will not exceed 10,000 m^2 in size. There is no size constraint for Class 3 survey units.

For each survey unit the pertinent radionuclides of interest subset will be defined based on historical information, Characterization Sample and Analysis Plan sampling results for that area, and remedial support data in the case of excavated area Class 1 units.

In all cases of sample collection and analysis (systematic and biased), the sum-of-ratios values calculated for samples will be used to test compliance with DCGL standards. *Sum-of-ratios values will be calculated based on soil $DCGL_{EMC}$ requirements and based on* soil $DCGL_W$ requirements. As part of the sum-of-ratios calculation, background will not be subtracted for those radionuclides that occur naturally. The radionuclides of interest subset used for sum-of-ratios calculation purposes may vary from survey unit to survey unit, depending on which radionuclides of interest have been determined to be pertinent to the area of interest.

The primary determinant of soil $DCGL_{EMC}$ compliance for each survey unit will be scanning results combined with associated biased sampling for radionuclides of interest that lend themselves to scanning, and systematic soil samples for radionuclides of interest that are not detectable via scans. All survey units (Class 1, Class 2, and Class 3) will have complete scanning coverage. Scanning data sets will be logged to allow for post-data collection mapping, analysis, presentation, and data preservation. Biased samples collected in response to scan results, or for any other reason, will be compared to 1-m^2 soil $DCGL_{EMC}$ requirements.

If biased soil samples are collected, two samples will be collected and analyzed for each biased sampling location: one that is representative of the top 15 cm of exposed soils, and one that is representative of a 1 m soil depth. Sample results (biased or systematic) that exceed soil $DCGL_{EMC}$ requirements indicate soil conditions requiring further remediation. In addition, appropriate $DCGL_{EMC}$ values will be calculated based on the areas represented by systematic samples collected for $DCGL_W$ purposes using area factors provided by the DP; systematic sample results will also be compared to these additional $DCGL_{EMC}$ values.

The primary determinant of soil $DCGL_W$ compliance will be systematic sample results. Systematic samples will be collected on a random start triangular grid. Systematic samples will be composite samples formed from soil increments distributed across the immediate area the systematic sample represents. Two composite samples will be formed from each grid node, one representative of soils to a depth of 15 cm and one representative of soils to a depth of one meter. The minimum number of systematic soil sample grid locations per survey unit will be five (consistent with achieving a Type I error rate of 0.05). In the case of each composite, sufficient soil mass will be collected to allow analysis for all 18 radionuclides of interest, if necessary.

Figure G-1 contains a decision logic flow diagram for surface soil final status survey units. Sum-of-ratios values for systematic sample results will first be calculated based on soil $DCGL_{EMC}$ requirements. There are two applicable $DCGL_{EMC}$ values of interest. The first is the 1-m^2 $DCGL_{EMC}$ value explicitly defined in this plan. This standard will be applied to biased soil sample results. The second is a $DCGL_{EMC}$ value determined from the $DCGL_W$ using area factors (provided in Section 9 of the plan) that are appropriate for the area the systematic sample represents. This approach will be applied to systematic soil sample results.

If there are no soil $DCGL_{EMC}$ concerns, sum-of-ratios values corresponding to soil $DCGL_W$ requirements will be calculated. Samples results representing depths of 15 cm will be evaluated separately from sample results representing a depth of one meter. In each case, if the average of the results is less than unity, the Sign test will be applied assuming a Type I error rate of 0.05. If the null hypothesis is rejected for both depth intervals, the unit will be considered compliant with all relevant soil DCGL standards.

If the radionuclides of interest subset for a particular survey unit does not include all 18 radionuclides, then one composite sample for the unit will be formed from sub-samples from each of the systematic surface soil samples representing the one meter depth interval, the composite homogenized, and submitted for analysis of all 18 radionuclides. If the resulting soil $DCGL_W$ sum-of-ratios value exceeds unity, then the unit will require additional remediation. If the sum-of-ratios score is significantly influenced by radionuclides that were originally not considered pertinent to that final status survey unit, the remaining systematic sample composite soil masses will be analyzed for the balance of the 18 radionuclides not already analyzed, $DCGL_W$ sum-of-ratios values recalculated, and compliance with $DCGL_W$ standards re-evaluated.

3.2 Subsurface Soils

In the case of the final exposed soil surface for the WMA 1 and 2 deep excavations, the general final status survey process will mirror what has already been described in Section 3.1 utilizing the appropriate subsurface DCGL standards.

The primary differences in the case of WMA 1 are the foundation pilings that will remain in place after excavation is complete. There are some 476 pilings and there are concerns that they may have provided vertical preferential flow pathways for contaminated groundwater into the Lavery Till, resulting in soil contamination at levels of potential concern within the till. This issue will be addressed both by remedial support data collection described in the Characterization Sample and Analysis Plan, and by data collection as part of the final status survey process for final status survey units that include foundation pilings.

If foundation piles did serve as preferential pathways for contamination entry into the Lavery Till, the following conditions would be expected:

- Contamination would have occurred between the piling and surrounding soil,
- Contamination that penetrated into the till would have left evidence at the till/sand and gravel unit interface (i.e., soil contamination at that interface), and
- The possibility for till contamination to occur would have been greatest where groundwater contamination was the greatest – beneath the original release point and immediately down gradient.

Based on these assumptions, the final status survey process for demonstrating that there is no significant till contamination concerns associated with pilings would have the following components:

- Excavation work will identify the exact locations of pilings and remedial action support surveys will determine where contaminated soil at levels of concern existed immediately above the Lavery Till.
- Pilings will be considered in two groups: pilings that fell within the greater-than-DCGL footprint of contaminated soils immediately above the Lavery Till, and pilings that did not – final status survey data collection will target those pilings falling within the greater-than-DCGL footprint.
- In this set of pilings, sampling would be a combination of biased and systematic data collection:
  - Ten piling locations would be selected for biased sampling to look for $DCGL_{EMC}$ exceedances. This selection would target those pilings most likely to exhibit till contamination, if it existed. The selection would be based on a combination of factors, including proximity to the original release event, level of soil contamination as identified by remedial support sampling immediately above the till, visual evidence of "spaces" between the till and pilings that might have provided preferential flow pathways, etc.
  - A minimum of five of the pilings in the footprint would be selected for each final status survey unit, at random, for $DCGL_W$ sampling. In the event that this random selection process identifies a piling already selected for biased sampling, the sample collected from that piling will be used for both $DCGL_{EMC}$ and $DCGL_W$ compliance demonstration purposes.

For those pilings selected for sampling (either biased or systematic) sampling would focus on obtaining a soil sample from immediately along the piling at a depth of one meter below the excavation surface.

If any individual soil sample identifies contamination above $DCGL_{EMC}$ requirements, additional excavation will occur to identify the extent of contamination and remove it. Additional samples will be collected from the final exposed dig face to demonstrate that no further $DCGL_{EMC}$ exceedances exist.

For each final status survey unit that includes pilings falling within the greater-than-DCGL overburden footprint, the systematic sample results from pilings will be evaluated using the Sign test. If the pilings satisfy the Sign test and there are no biased piling samples with $DCGL_{EMC}$ exceedances, till contamination associated with pilings will not be considered an issue. If fewer than five systematic piling samples are available, rather than the Sign test all systematic piling samples will be compared to the $DCGL_W$ requirement. If none are above the $DCGL_W$ values, then till contamination associated with pilings will not be considered an issue.

Figure G-2 shows the decision flow logic for final status survey data collection from the deep excavations in WMA 1 and WMA 2 floors.

3.2 Sediments

For the purposes of this conceptual framework, sediments are defined as soil or sediment-like materials associated with the bed and banks of Erdman Brook and Franks Creek within the project premises.

Historical data have demonstrated that stream sediments in Erdman Brook and Franks Creek contained within the WVDP fence line are impacted by Phase 1 radionuclides. The Characterization Sample and Analysis Plan pre-design data collection will include stream sediment and stream bank sampling to determine if remediation may be required for portions of the stream within the WVDP fence line. Currently there is no remediation planned for sediments as part of the Phase 1 decommissioning activities. Because of the integrating nature of project premises drainage features, final status survey data collection for stream features will likely be one of the final activities to avoid the possibility of re-contamination occurring post-final status survey data collection due to soil erosion and deposition within drainage features.

However, to support overall final status survey planning, the delineation of final status survey unit areas for stream and drainage features within the WVDP fence line will occur as part of Phase 1 activities. All stream features will be classified as Class 1 areas. Consistent with the sediment DCGL derivation contained in the decommissioning plan, the definition of a stream final status survey unit includes sediments within the streambed itself and three m of bank on either side of the streambed. Each unit will be at most 333 m long, comprising an area of at most 2,000 m^2. Subsurface contamination deeper than the 1-m definition of sediments is not considered a plausible scenario for a stream setting; consequently final status survey data collection will focus on surface sediments and adjacent bank soils. This assumption will be tested by Characterization Sample and Analysis Plan data collection.

The decision logic for sediment survey units is identical to surface soils (Figure G-1). As with surface soils across the site, a complete gamma walkover of exposed sediments and associated banks will be performed using an appropriate detector. Biased samples will be collected to clarify scan results that might be indicative of DCGL excedances. For locations where biased samples are collected, two samples will be collected, one representative of a depth of 15 cm, and one representative of a depth of 1 m.

Biased samples collected in response to scan results or for any other reason from within sediment final status survey units will be compared to sediment 1-m^2 $DCGL_{EMC}$ requirements. In addition, appropriate $DCGL_{EMC}$ values will be calculated based on the areas represented by systematic samples collected for $DCGL_W$ purposes using area factors provided in Section 9 of this plan; systematic sample results will also be compared to these additional $DCGL_{EMC}$ values. Sample results (biased or systematic) that exceed sediment $DCGL_{EMC}$ requirements indicate conditions requiring remediation.

Sediment $DCGL_W$ compliance will be demonstrated through the use of systematic sediment samples. A minimum of five systematic composite samples will be collected and submitted for laboratory analysis. For each location where a composite sample is obtained, two samples will be formed, one representative of a depth of 15 cm and one representative of a depth of 1 m. The radionuclides of interest subset for the analyses will be determined based on historical data and Characterization Sample and Analysis Plan data collection results.

The systematic sediment sample locations will conform to a linear grid down the length of the survey unit with a fixed grid node separation distance but random start. At each grid node, the sample collected will be formed from three increments, one from the stream centerline, and two collected from randomly selected distances up the bank from the bank's edge. In the case of each composite, sufficient soil/sediment mass will be collected to allow analysis for all 18 radionuclides of interest, if necessary.

Systematic sediment samples will be submitted for analysis based on the radionuclides of interest subset pertinent to that final status survey unit. Sum-of-ratios values for systematic sample results will first be calculated based on sediment $DCGL_W$ requirements corrected by appropriate area factors contained in Section 9 of this plan and evaluated for $DCGL_{EMC}$ exceedances. If there are no sediment $DCGL_{EMC}$ exceedances, sum-of-ratios values corresponding to sediment $DCGL_W$ requirements will be calculated. If the average of these is less than unity, the Sign test will be applied assuming a Type I error rate of 0.05. This will be done for both depth intervals. If the null hypothesis is rejected in both cases, the unit will be considered compliant with all relevant soil DCGL standards.

In the event that the radionuclides of interest subset does not include all 18 radionuclides, one composite sample per survey unit will be formed by sub-sampling all individual systematic composite samples (after homogenization) representative of a depth of one meter from a survey unit and submitted for a complete analysis of all 18 radionuclides. If the resulting sediment $DCGL_W$ sum-of-ratios value exceeds unity, then the unit will require additional remediation. If the sum-of-ratios value is significantly influenced by radionuclides that were originally not considered pertinent to that final status survey unit, the remaining composite soil mass for each radionuclide will be analyzed for the balance of the 18 radionuclides not already analyzed, $DCGL_W$ sum-of-ratios values recalculated, and compliance with $DCGL_W$ standards re-evaluated.

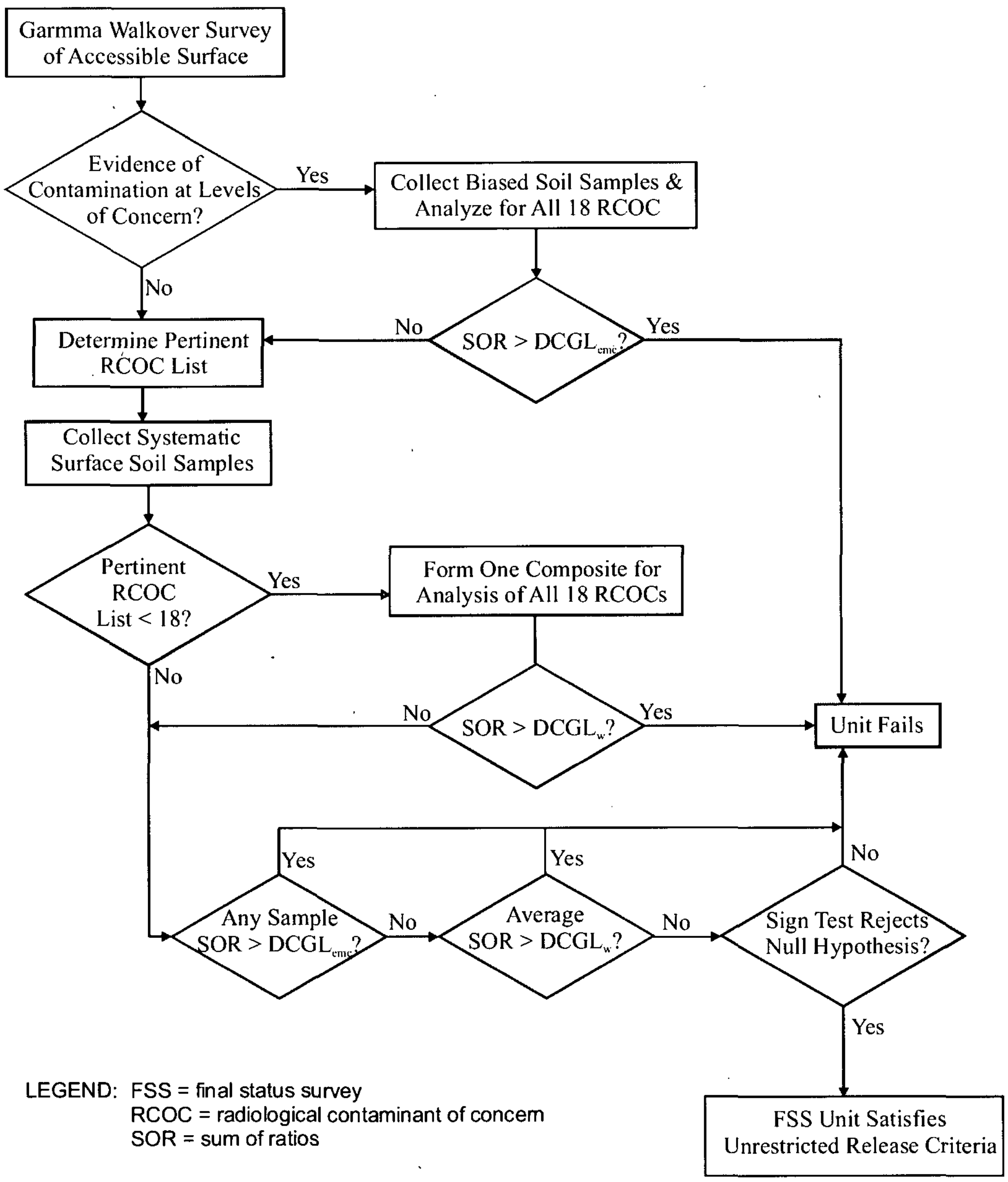
4.0 Documentation Requirements

Due to the complexity and time span of the Phase 1 decommissioning activities, it is expected that multiple Final Status Survey Reports will be prepared in accordance with Section 9.8 of this plan. Such reports, for example, may address a group of related survey units, such as those associated with the WMA 1 excavation, or a particular excavated soil laydown area. The use of multiple Final Status Survey Reports will facilitate independent confirmatory surveys and support periodic progress reports to interested stakeholders as the Phase 1 decommissioning activities take place.

Technical data packages will be prepared for individual survey units. Each Final Status Survey Report together with the related technical data packages will contain the information specified in Section 9.8 of this plan, including:

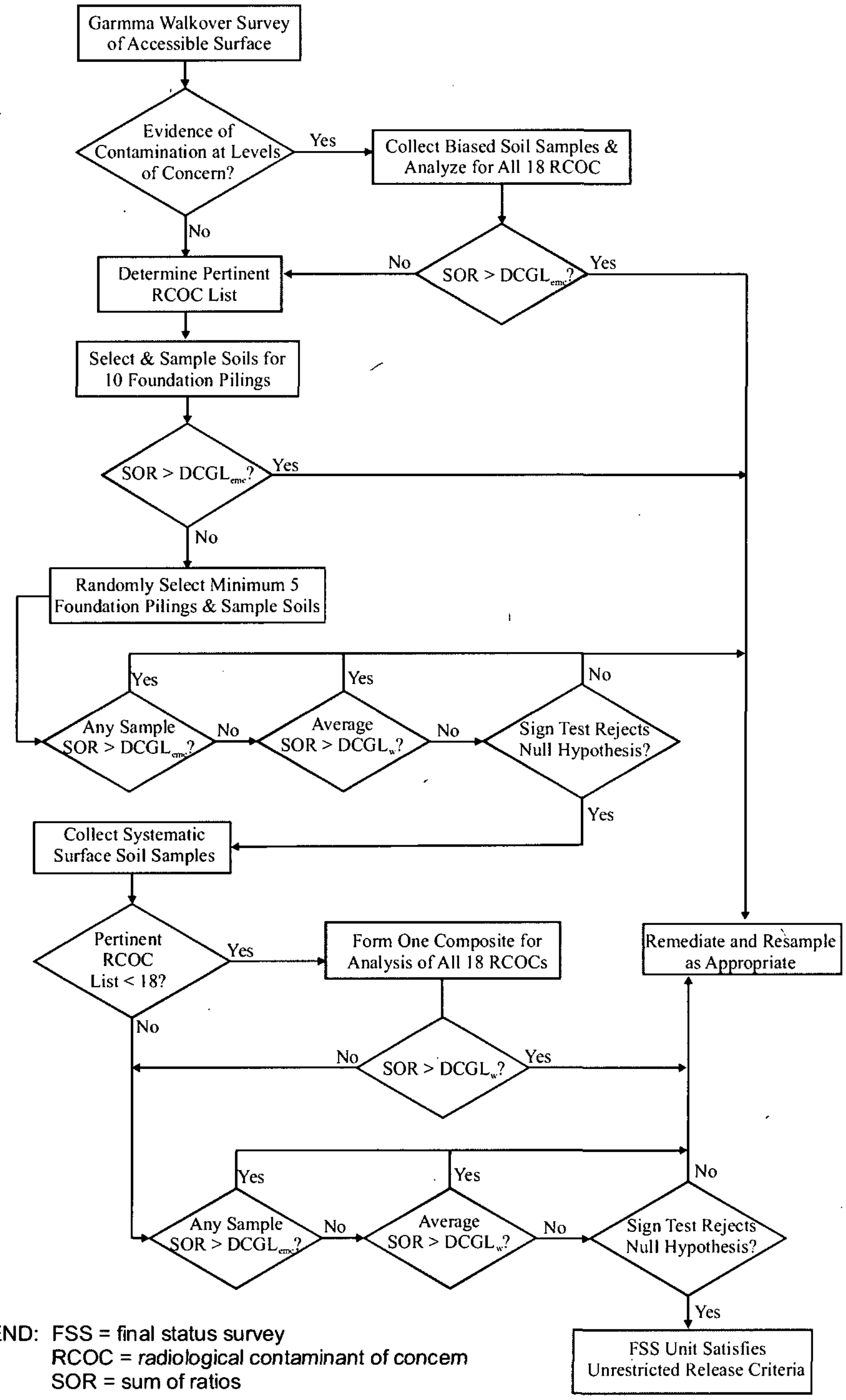
- An overview of the final status survey results;
- A description of the final status survey units comprising the area being evaluated, including any changes from what had been originally proposed;
- A summary of the pertinent radionuclides of interest subset and the appropriate $DCGL_W$ and $DCGL_{EMC}$ standards;
- A description of the basis for sample numbers and the analyses used to support sample number determinations for each survey unit;

- A presentation of the gamma scan data for each survey unit, including a map showing the extent of coverage and discussion of the scan data;
- A presentation of the data collected for each survey unit, including a map or drawing of the survey units illustrating the random start systematic sample locations and the location of other samples (i.e., judgmental, biased, and miscellaneous sample data sets which will be reported separately from those samples collected for performing the statistical evaluation);
- A review of quality control parameters associated with data sets;
- A statistical analysis of the data sets with respect to the $DCGL_W$ values in the context of MARSSIM final status survey guidance;
- An evaluation of survey and sampling data to address $DCGL_{EMC}$ standards;
- A conclusion about whether $DCGL_W$ and $DCGL_{EMC}$ requirements have been met;
- A description of how ALARA practices were employed to achieve final activity levels; and
- If a unit fails to meet DCGL requirements, the reason for the failure, the implications for other final status survey units, the actions taken to correct the failure, and/or the implications for Phase II activities



LEGEND: FSS = final status survey
RCOC = radiological contaminant of concern
SOR = sum of ratios

Figure G-1. Decision Logic for Surface Soil and Sediment Survey Units



LEGEND: FSS = final status survey
RCOC = radiological contaminant of concem
SOR = sum of ratios

Figure G-2. Decision Logic for WMA 1 and WMA 2 Subsurface Soils

RAI DC1 (36)

Subject: Phase 1 excavation water flow patterns and sheet piling experience

RAI: Additional explanation is needed for the footnote regarding recontamination potential on page D-2 and to summarize the experience at West Valley with temporary interlocking sheet piling. (Section 1.1, Page D-2)

Basis: The footnote on page D-2 indicates that the recontamination potential for the WMA-1 excavation would be limited since groundwater flows northeast away from WMA-1. However, if the media is removed it will locally alter the water table prior to backfilling. The DP should also describe the experience with temporary interlocking sheet piling to provide confidence that the barriers can be effectively implemented to prevent recontamination.

NRC Path Forward: Provide a more detailed discussion of the impact of the excavations on water flow patterns and summarize the experience with interlocking sheet piling.

****

DOE Response: The conceptual design for the proposed deep excavation of WMA 1 involves the use of temporary interlocking sheet piling and a permanent soil-cement-bentonite barrier wall to prevent groundwater intrusion into the excavation. If the phased decision-making alternative is selected in the Record of Decision for the Decommissioning EIS, the final design for the WMA 1 barrier walls and French drain will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities start in 2011 and will be provided to the NRC for technical review.

The temporary interlocking sheet piling will be driven into uncontaminated soils on the upgradient and cross-gradient sides of the excavation and the permanent soil-cement-bentonite barrier wall will be installed on the downgradient side of the excavation to prevent intrusion of groundwater into the excavation during its excavation, final status survey, and backfilling with clean fill imported from offsite sources. The final design and location of the sheet piling and barrier wall will be constrained by the collection and evaluation of groundwater monitoring and subsurface soil geotechnical data and groundwater modeling performed by the site decommissioning contractor.

After the temporary sheet piling and permanent hydraulic barrier wall has been installed the excavation area will be dewatered using dewatering wells screened within the sand and gravel unit. The number of wells required and their location will be dependent on the final size of the excavation which will be determined after the final design has been completed. The final dewatering system design will be provided to the NRC for technical review. Groundwater pumped from the WMA 1 excavation will be transferred and treated at either the existing Low-Level Waste Treatment Facility or another radioactive wastewater treatment system if the Low-Level Waste Treatment Facility is no longer In operation.

Soil within the WMA 1 excavation area will be removed down to a depth of at least one foot into the Lavery till which underlies the sand and gravel unit. All excavated soil will be disposed of at offsite disposal facilities. Once soil excavation is completed in WMA 1, a final status survey and regulatory confirmatory surveys will be performed along the bottom and sides of the excavation to document that the clean-up criteria has been achieved and to provide data to estimate potential dose from any remaining residual subsurface contamination.

The WMA 1 excavation will be backfilled with clean fill obtained from offsite sources after receipt of regulatory approval. The French drain will be installed and the temporary sheet piling removed from the upgradient and cross-gradient side of the WMA 1 excavation to allow groundwater flow into the backfilled WMA 1 excavation.

Interlocking sheet piling was used during the construction of the Nuclear Fuel Services (NFS) fuel reprocessing facility in the early 1960's and by the WVDP during the installation of the pilot-scale permeable treatment wall in 1999. Photographs taken during the construction of the NFS Fuel Receiving and Storage show that interlocking sheet piling was used to support the excavation and construction of the Fuel Receiving and Storage Fuel Storage Pool (Figure DC1-1) and Cask Unloading Pool (Figure DC1-2), The sheet piling was used to support the excavation of the sand and gravel unit to a depth of 30 feet for the Fuel Storage Pool, and to a depth of 50 feet for the Cask Unloading Pool which extends into the Lavery till, an impermeable clay-rich glacial till which underlies the sand and gravel unit. The lack of water in the bottom of the Fuel Receiving and Storage excavations suggests the sheet piling was effective in preventing groundwater infiltration into the excavations.

Temporary interlocking sheet piling was also used by the WVDP in 1999 to support the excavation of the sand and gravel unit during the installation of the Pilot-Scale Permeable Treatment Wall. The Pilot-Scale Permeable Treatment Wall is a 30.5 foot long, seven foot wide, and 26 foot deep permeable reactive barrier containing the natural zeolite clinoptilolite, which was designed to treat Sr-90 contaminated groundwater in the east lobe of the north plateau groundwater plume by ion-exchange processes. Forty foot long sheet piles were driven through the sand and gravel unit and seated 10 feet into the underlying Lavery till to form a cofferdam (Figure DC1-3). Groundwater extraction wells were installed within the sheet piled cofferdam (Figure DC1-4) and residual groundwater was extracted and treated in the WVDP Low-level Waste Treatment Facility. Once the dewatering was complete the sand and gravel unit within the sheet piled cofferdam was excavated down to the unweathered Lavery till (Figure DC1-5), the cofferdam backfilled with pea gravel and clinoptilolite, and the sheet piling removed to allow groundwater flow through the Pilot-Scale Permeable Treatment Wall. The lack of water in the bottom of the cofferdam excavation (Figure DC1-5) suggests the sheet piling was effective in limiting groundwater infiltration into the Pilot-Scale Permeable Treatment Wall excavation.

However, sheet piling was not used to support the excavations needed for the construction of other prominent NFS sub-grade facilities such as Tanks 8D-1 and 8D-2 in WMA 3 and the General Purpose Cell and its associated operating aisle and crane rooms in the Main Plant Process Building. Photographs of the construction of Tanks 8D-1 and 8D-2 show a large deep excavation through the sand and gravel unit into the unweathered Lavery till with sloping cutback walls extending some distance away from the bottom of the excavation (See Figures DC1-6 and DC1-7). There is no indication that sheet piling was used to support the excavation. Infiltration of groundwater does not appear to have been a problem during their construction as the floor of the vault excavations appear to be dry. A portable pump may have been present at the bottom of the excavation with discharge hoses leading out of the excavation towards Quarry Creek (Figure DC1-7).

A photograph showing the driving of foundation piles in the General Purpose Cell excavation (Figure DC1-8) does not indicate that sheet piling was used to support this excavation which was approximately 35 feet deep. Infiltration of groundwater does not appear to have been a problem as the bottom of the excavation surrounding the pile driving crane appears dry.

Changes to the plan: Information will be added to Section 1.6 to specify providing detailed design information to NRC as indicated in the response to RAI 7C1.

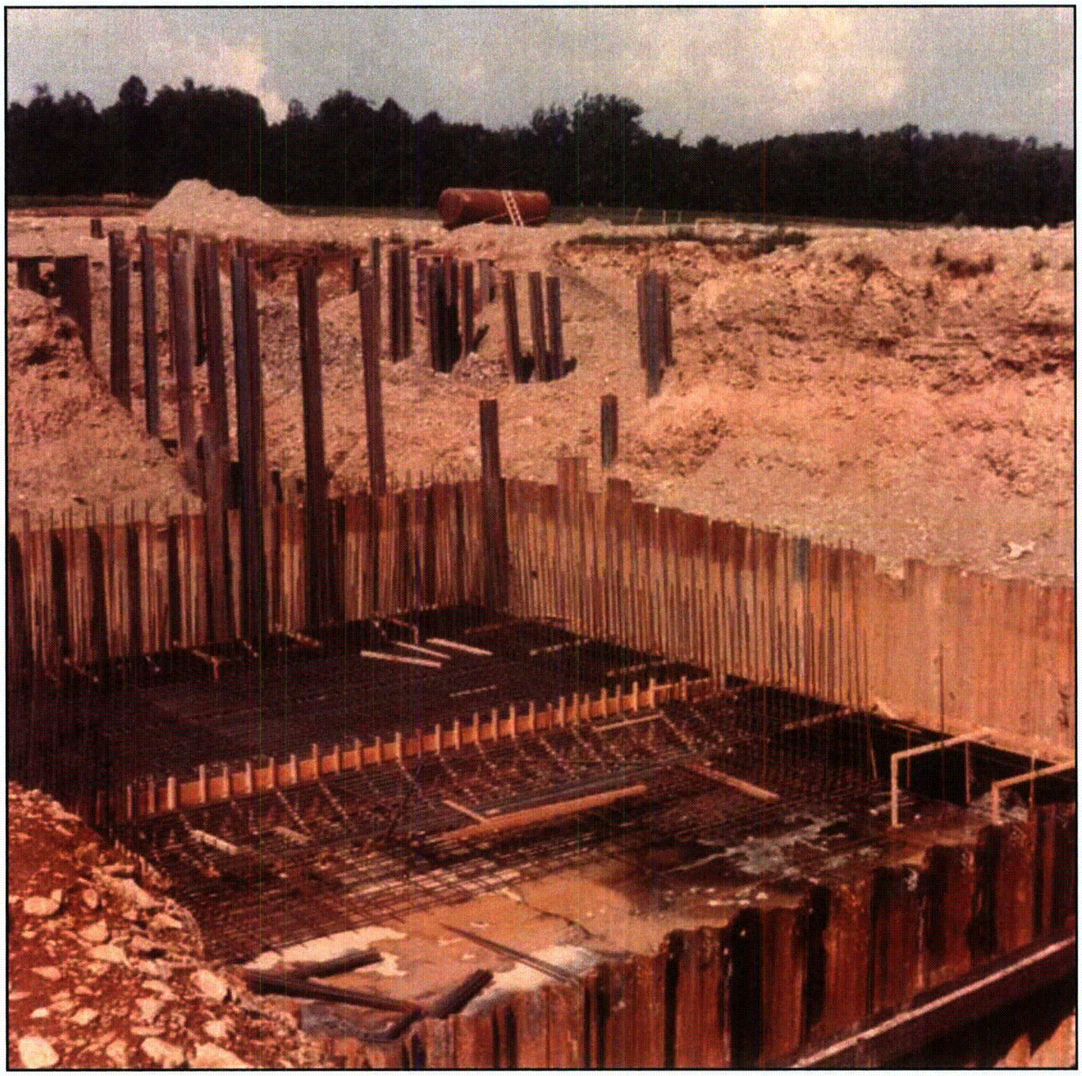


Figure DC1-1. Sheet Piling Supporting the Fuel Storage Pool Excavation Looking to the West

Figure DC1-2. Sheet Piling Supporting the Fuel Storage Pool and Cask Unloading Pool Excavation Looking to the East

Figure DC1-3. Installation of Sheet Piling to Support the Excavation of the Pilot-Scale Permeable Treatment Wall

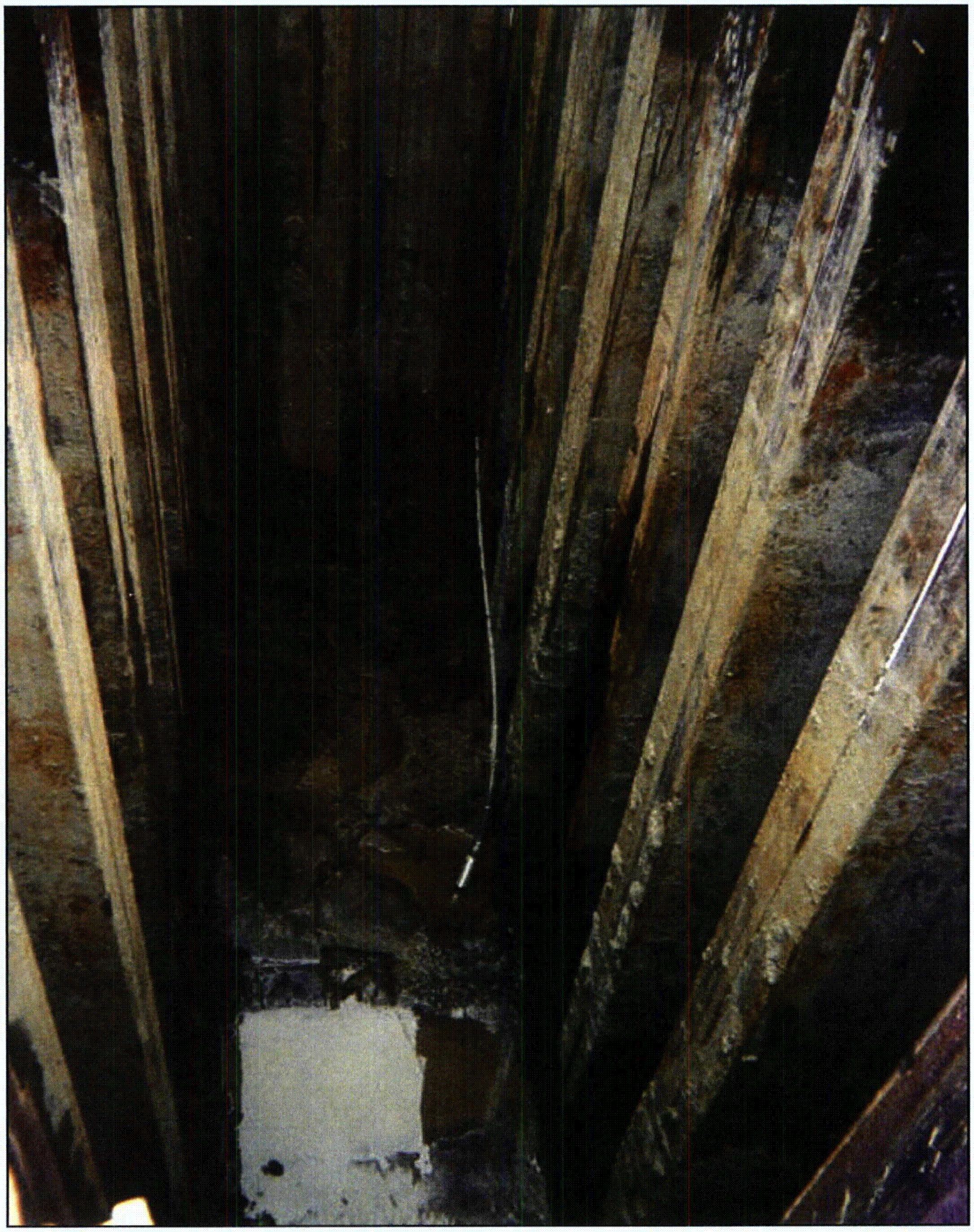


Figure DC1-4. Excavated Permeable Treatment Wall Before Backfilling with Clinoptilolite Showing Sheet Piling Supporting the Excavation

Figure DC1-5. Permeable Treatment Wall Backfilled with Clinoptilolite Showing Sheet Piling

Figure DC1-6. Photograph of the Tank 8D-1/8D-2 Excavation and Construction of Tank 8D-2 Vault Floor Looking to the North

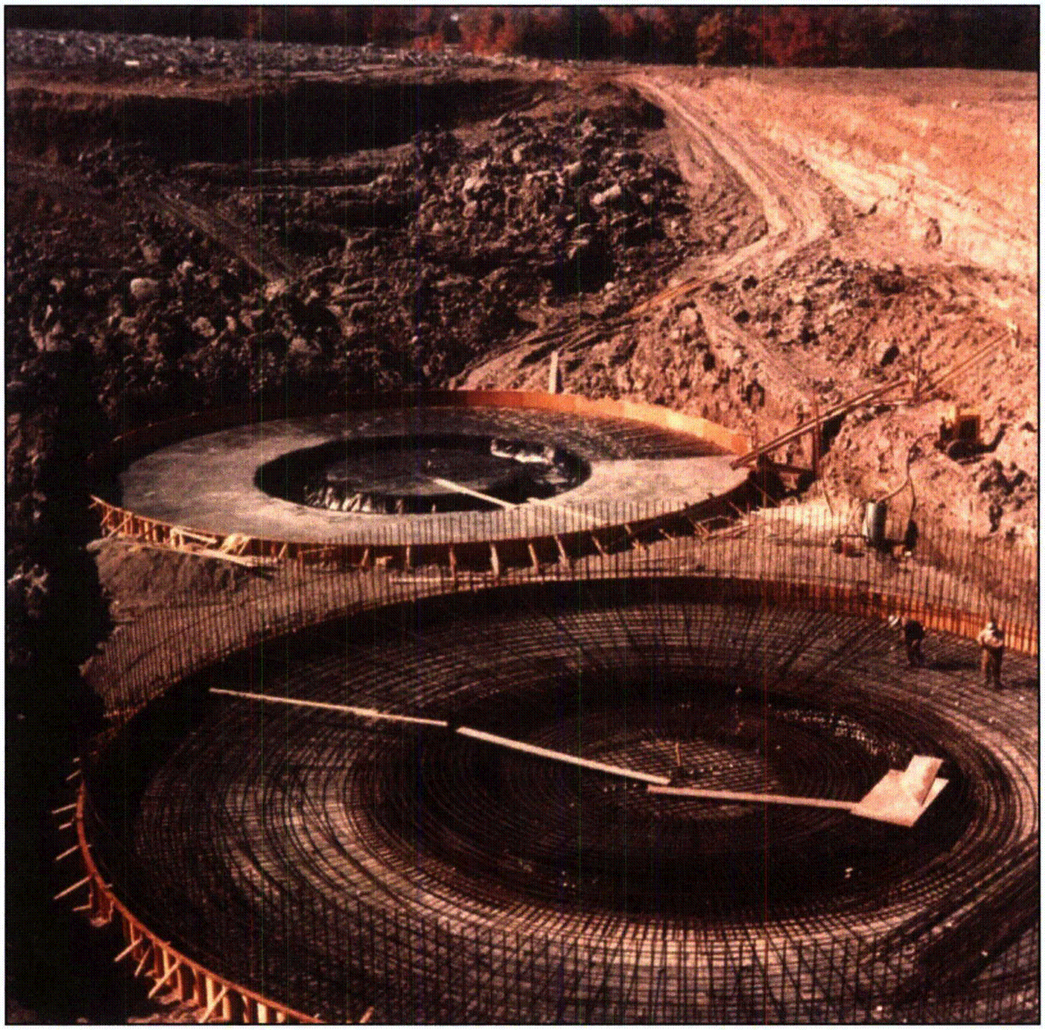


Figure DC1-7. Photograph of the Tank 8D-1/8D-2 Excavation and Construction of the Tank 8D-1 and 8D-2 Vault Floors Looking to the Northwest

Figure DC1-8. Photograph Showing the General Purpose Cell Excavation and Foundation Pile Driving Looking to the North

RAI DC2 (37)

Subject: Phase 1 excavation water flow patterns and sheet piling experience (Appendix D).

RAI: One of the stated objectives of the two phase decommissioning process is to not limit potential Phase 2 decisions. The installation of hydraulic barriers for the WMA 1 excavation may impact future decisions.

Basis: Installation of hydraulic barriers will alter groundwater flow the North Plateau. It appears that groundwater flow would be increased to the HLW tanks and decreased on the downgradient side of the engineered barriers. Increased groundwater flow to the HLW tanks may make it more difficult to close them in place, if that option were evaluated in Phase 2. Decreased flow in the non-source area of the Sr-90 plume may increase potential exposure concentrations as a result of decreased dilution (in future exposure evaluations) or reduce the effectiveness of remedial; activities implemented as part of the interim action to reduce the risk from the site (e.g., permeable reactive wall).

NRC Path Forward: Provide an assessment of the Phase 1 alteration of the hydrologic system on potential Phase 2 decisions, or provide a description of how those impacts could be mitigated.

****

DOE Response: The proposed WMA 1 and WMA 2 hydraulic barrier walls and French drain described in the DP are conceptual designs that were developed to constrain the Decommissioning EIS analysis for the phased decision-making closure alternative. If the Record of Decision issued by DOE selects this alternative, the final design for the barrier walls and French drain will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities start in 2011.

The groundwater modeling described in Appendix D of the DP evaluated groundwater elevations, hydraulic gradients, and flow patterns in the sand and gravel unit associated with the conceptual design for the WMA 1 and WMA 2 hydraulic barrier walls and the WMA 1 French drain. The modeling demonstrated that this conceptual barrier wall and French drain design could achieve groundwater levels and associated hydraulic gradients within the backfilled WMA 1 and WMA 2 excavations that would result in groundwater flow outward from both WMA 1 and WMA 2 to downgradient areas. Such a flow field would limit the potential for recontamination of the backfilled WMA 1 and WMA 2 excavations by Sr-90 contaminated groundwater from the non-source area of the north plateau plume or from a potential release from the Waste Tank Farm in WMA 3.

The final design of the barrier walls and French drain will be supported by the collection and evaluation of additional groundwater data and subsurface soil geotechnical data, and by groundwater modeling to evaluate the potential impacts these proposed hydraulic barriers have on groundwater flow patterns in the immediate and surrounding areas. These structures will be designed to result in minimal changes to groundwater flow patterns and water levels in WMA 3.

The Phase 1 hydraulic barrier walls will not limit potential Phase 2 decisions on the north plateau. The final design of the WMA 1 hydraulic barrier wall and French drain will incorporate criteria that will minimize any potential negative impacts to the HLW tanks. If a Phase 2 close-in-place option is selected for the tanks it will most likely include the following engineered barriers to keep them dry:

- A circumferential hydraulic barrier wall and an upgradient barrier wall to divert groundwater flow away from the tanks, and
- A multi-layer closure cap to prevent infiltration of precipitation into the tanks.

The Phase 2 Waste Tank Farm barrier walls for the close-in-place alternative could be tied into the proposed Phase 1 WMA 1 barrier wall if necessary. If an unrestricted release scenario were to be selected the barrier walls would be removed along with the Waste Tank Farm and non-source area of the plume.

Removal of the source area of the north plateau plume will remove a significant amount of Sr-90 loading to the non-source area of the plume which would reduce concerns about increased potential exposure concentrations from decreased dilution especially after the 30 year Phase 1 period.

The Permeable Treatment Wall is currently being designed and is scheduled to be installed in 2010 in an area south of the Construction and Demolition Debris Landfill. The contractor responsible for the Permeable Treatment Wall design is modeling the potential effects that the proposed WMA 1 and WMA 2 hydraulic barrier walls and French drain may have on groundwater flow directions, gradients, and velocities in the non-source area of the north plateau plume. The final design of the Permeable Treatment Wall will consider the potential changes to groundwater flow resulting from the installation of the proposed Phase 1 hydraulic barriers and French drain to ensure that the Permeable Treatment Wall meets its overall performance goals of reducing Sr-90 concentrations in the north plateau plume.

The final designs of the WMA 1 and WMA 2 hydraulic barrier walls and French drain will be provided to the NRC for technical review and comment before their installation. Text will be added to the WVDP Phase 1 Decommissioning Plan to clarify this issue.

Changes to the Plan: The following text will be added to Section 1.0 of Appendix D. Note that the change to Section 1.6 to provide for NRC review of the final design details of the hydraulic barriers and French drain is described in the response to RAI 7C1.

1.0 Description of Engineered Barriers

This section presents a detailed description of the conceptual designs for the engineered barriers to be installed during Phase 1 of the proposed decommissioning, supplementing the physical descriptions previously presented in Section 7. Engineered barriers would be installed at the WMA 1 and WMA 2 excavations to facilitate the removal of sub-grade structures, excavate contaminated soil to meet unrestricted release criteria, and to prevent the recontamination of the WMA 1 and WMA 2 excavated areas by the non-source area of the North Plateau Plume. The final design of the barrier walls and French drain will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities start in 2011. The final design details of the hydraulic barriers and French drain will be provided to the NRC for technical review before their installation, as indicated in Section 1.6.

The development of the WMA 1 and WMA 2 hydraulic barrier walls and French drain designs will be supported by the collection of subsurface soil geotechnical data, the installation of groundwater monitoring wells to provide groundwater elevation monitoring data, and groundwater modeling to evaluate the potential impacts these proposed structures have on groundwater flow patterns in WMA 1 and WMA 2 and in surrounding areas such as WMA 3.

RAI DC3 (38)

Subject: Phase 1 excavation water flow patterns and sheet piling experience.

RAI: Additional information is needed to support the assumption that the performance goals (e.g., hydraulic conductivity, mechanical strength or durability) of the slurry wall trenching technology and other engineered barriers are likely to be achieved. (Appendix D)

Basis: The slurry wall technology is stated as having a long history of successful usage, however this usage is not summarized. An initial maximum design hydraulic conductivity of 6E-06 cm/s is provided, which is approximately 200 cm/y. It is not clear at a moderately high conductivity for a hydraulic engineered barrier that the objectives of the barrier will be achieved. The DP states that the upper three feet of the barrier wall would be clean backfill to allow vehicular traffic over the wall without damaging it, however no basis is provided for this statement. The French drain system will contain perforated pipe and the trench will be backfilled with permeable granular materials. The DP states the French drain trench backfill will be designed to minimize silting, but no technical basis is provided on how it will be designed. In addition, the DP states the French drain will be monitored but includes no description of how the monitoring will be completed and what performance metrics will be used.

The durability of the engineered barriers projected to be used is discussed briefly on page D-8; however, a comparison of the required performance period to the experience base is not provided. The DP states that sodium bentonite would be added at a rate to achieve 1E-8 to 1E6 cm/s hydraulic conductivity, but no information is provided as to how it will be determined that those hydraulic conductivity values have been achieved.

NRC Path Forward: Provide additional technical basis to justify that the performance goals of the engineered barrier systems are likely to be achieved, including but not limited to: a summary of slurry wall technology usage including problems, a demonstration that a hydraulic conductivity of 6E-6 cm/s will achieve the design goals, an evaluation of barrier performance with three feet of backfill subject to vehicle loading, a description of the design and monitoring of the French drain system to minimize silting, a comparison of the required performance period to the experience base for the engineered barriers, and a description of how it will be determined that the design goal hydraulic conductivities and mechanical strength have been achieved in the field.

****

DOE Response: The proposed WMA 1 and WMA 2 hydraulic barrier walls and French drain described in the DP are conceptual designs that were developed to constrain the EIS analysis for the phased decision-making alternative. If the phased decision-making alternative is selected in the Record of Decision for the Decommissioning EIS, the final design for the barrier walls, French drain, and their monitoring program will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities start in 2011. It is premature to present final performance goals in this revision of the DP as the final design of these hydraulic barriers has not been prepared. Presenting overly prescriptive performance goals in the DP would limit the ability of the decommissioning contractor to develop an optimal final design based on the collection and evaluation of subsurface soil geotechnical data, groundwater monitoring data, and groundwater modeling to evaluate the effect the barriers have on groundwater flow in the north plateau. The final design details, performance goals, and supporting technical basis for the hydraulic barriers and French drain will be provided to the NRC for technical review before their installation.

Changes to the plan: Information will be added to Section 1.6 to specify providing detailed design information to NRC as indicated in the response to RAI 7C1.

The following information will be added to Section 7.2.2 before the last paragraph to address protection of the in-place hydraulic barriers. This change will be made in conjunction with other changes to this subsection described in the response to RAI 7C2:

> "Mitigative measures will be taken to minimize impacts to areas where slurry will be mixed in connection with installing the hydraulic barriers as described in Section 7. Measures will also be taken to avoid damage to the hydraulic barriers after they are installed from subsequent Phase 1 decommissioning activities. These measures will include protecting the barriers from impacts associated with the movement of heavy equipment, such as by the use of temporary load-distributing or bridging spans at the ground surface in the locations where such equipment will cross the barriers."

RAI DC4 (39)

Subject: Phase 1 engineered barrier corrective action program (Appendix D).

RAI: Additional information is needed for the corrective action implementation program to address observed defects or irregularities in the engineered barrier systems.

Basis: Page D-11 indicates that corrective action would be implemented to correct observed defects and irregularities, without defining what conditions would constitute a defect or irregularity. Without an effective monitoring and maintenance program or robust designs, the engineered barriers may not be able to meet their performance requirements. Section 2.1.1 states that routine inspections would be performed of the subsurface barrier walls and French drain but does not state how these buried systems will be evaluated.

NRC Path Forward: Provide the conditions that lead to corrective actions of the engineered barriers and detail how evaluations of buried systems will be performed.
****

DOE Response: The proposed WMA 1 and WMA 2 hydraulic barrier walls and French drain described in the DP are conceptual designs that were developed to constrain the EIS analysis for the phased decision-making closure alternative. If the phased decision-making alternative is selected in the Record of Decision for the Decommissioning EIS, the final design for the barrier walls, French drain, and their corrective action implementation program will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities start in 2011.

The proposed WMA 1 and WMA 2 barrier walls would be designed to be robust enough to allow for excavation up to the barriers and to prevent recontamination of the excavations during excavation and after they have been backfilled with clean imported fill. The final barrier wall designs would be based on an integrated hydrological and subsurface soil geotechnical investigation that would be performed early in Phase 1 by the site decommissioning contractor to support the design effort.

As discussed in Section 2.1.1, after the WMA 1 and WMA 2 excavations have been backfilled, a groundwater monitoring network will be installed along the WMA 1 and WMA 2 hydraulic barrier walls and the WMA 1 French drain to monitor their performance and to identify the need for future corrective actions. This monitoring network and its monitoring schedule would be designed by the site decommissioning contractor.

The monitoring system could involve a series of nested piezometers screened at different depth intervals that would be installed at regular intervals upgradient and downgradient of the barrier walls and French drain to monitor their performance. As discussed in Section 2.1.1, groundwater levels in the piezometers would be routinely monitored to identify any changes in water levels that may indicate the development of defects within the barrier walls or French drain that require corrective action. Groundwater samples would also be routinely collected and analyzed for selected radiological indicator parameters such as gross alpha, gross beta, tritium, and Sr-90. Changes in radiological indicator parameter concentrations in groundwater may identify defects associated with the barrier walls that require corrective action to limit potential recontamination of the backfilled WMA 1 and WMA 2 excavations.

Text will be added to Section 2.1.1 in Appendix D to identify the type of routine monitoring that will be implemented for the WMA 1 and WMA 2 hydraulic barrier walls and French drain, and to identify the types of conditions that may result in potential corrective actions of these structures.

Changes to the Plan: The following text will be added to Section 2.1.1 of Appendix D:

2.1.1 North Plateau Subsurface Barrier Walls and French Drain

The monitoring and maintenance program would monitor the performance and condition of the subsurface hydraulic barriers installed at WMA 1 and WMA 2, and the French drain at WMA 1. This program would include routine inspections of these systems for signs of degradation or loss of performance.

Hydraulic Barrier Walls

A series of nested piezometers screened at different depth intervals would be installed at regular intervals upgradient and downgradient of the permanent hydraulic barrier walls installed downgradient of the WMA 1 and northwest of the WMA 2 excavations (Figure D-10) to monitor their performance. These piezometers would be spaced at intervals at least equal to the maximum lateral spacing recommended by the U.S. Environmental Protection Agency (EPA 1998). Water levels in these piezometers would be routinely monitored to identify any changes in water levels that may indicate the development of defects within the barrier walls that require corrective action. Groundwater would be routinely sampled and analyzed for radiological indicator parameters (gross alpha, gross beta, tritium) and for Sr-90 to evaluate the effectiveness of the barrier walls in preventing recontamination of WMA 1 and WMA 2. Changes in groundwater concentrations of these radiological indicator parameters may identify defects associated with the barrier walls that require corrective action to limit the potential recontamination of the backfilled WMA 1 and WMA 2 excavations.

If groundwater monitoring suggests repairs to the walls are required, these repairs would be accomplished through grouting, consistent with past industry experience and practice (e.g., EPA 1998).

French Drain

Monitoring and maintenance activities associated with the French drain installed upgradient of the WMA 1 hydraulic barrier wall would include monitoring of groundwater levels in piezometers installed on the upgradient and downgradient sides of the French drain following installation.

The need for and extent of repairs to the French drain, if any, would be determined based on analysis of the groundwater level data, which would be evaluated to identify evidence for any localized defect(s) in the French drain.

References:

EPA 1998, *Evaluation of Subsurface Engineered Barriers at Waste Sites*, EPA 542-R-98-005. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., August 1998.

RAI DC5 (40)

Subject: Missing text

RAI: There appears to be missing text on page D-19. Also, there are two sections numbered 2.1.4. (Section 2.1.4, Page D-19)

Basis: Not applicable.

Path Forward: Provide the missing text.

****

DOE Response: The missing text is "1." That is, the sentence should end ". . . throughout Phase 1." The duplicate section number will be corrected.

Changes to the Plan: The corrections to be made to the plan are as follows:

On page D-19:

2.1.4 NRC-licensed Disposal Area Engineered Barriers

The geomembrane cover and the hydraulic barrier wall installed at the NDA during work to establish the interim end state would be routinely monitored and maintained throughout Phase 1.

On page D-21:

2.1.5 Security Features

The features important to security on the project premises and to security of the new Canister Interim Storage Facility during the period before Phase 2 of the decommissioning would be periodically inspected and maintained in good repair. These features include the security fences, signs, and security lighting described in Section 3.2 of this appendix.

RAI DC6 (41)

Subject: Proposed engineered barriers effect on groundwater flow in WMA 3 (Appendix D).

RAI: The proposed groundwater monitoring system should include sufficient monitoring points to observe significant changes to hydrologic conditions in the vicinity of WMA 3 and the permanent hydraulic barrier wall. A specific monitoring schedule of water level was not provided for the piezometers located upgradient and downgradient of the permanent hydraulic barrier wall.

Basis: The proposed groundwater monitoring system in Figure D-10 on page D-20 does not provide for monitoring points extending from the western most point of the WMA 1 barrier wall. As indicated in a previous comment, changes to the hydrologic system from Phase 1 actions could impact or limit Phase 2 decisions. Groundwater monitoring is needed both pre-and post-installation of the barrier system at the end of the WMA1 barrier wall to ensure that the Phase 1 actions are not significantly impacting the HLW tanks. Increased water flow or a rising water table could also reduce or eliminate the effectiveness of the tank/vault drying, which could impact the ability to maintain it in a stable configuration until Phase 2 decisions and actions are completed. Measurement of water levels with adequate frequency from the upgradient and downgradient piezometers is essential to ensure the integrity of the hydraulic barrier.

NRC Path Forward: Provide additional monitoring locations at the western end of the WMA 1 barrier wall both pre-and post-installation of the barrier, and specified monitoring schedules for the monitoring wells and piezometers.

****

DOE Response: The proposed groundwater monitoring system depicted in Figure D-10 is a conceptual design of a groundwater monitoring system that would be installed to monitor groundwater levels in WMA 3 and along the WMA 1 barrier wall and French drain and was not intended as a final design. If the phased decision-making alternative is selected in the Record of Decision for the Decommissioning EIS, the final designs of the WMA 1 hydraulic barrier wall, French drain, and the post-installation groundwater monitoring system will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities begin in 2011.

DOE understands the need for additional groundwater monitoring capability for the sand and gravel unit at WMA 3 beyond the westernmost point of the WMA 1 barrier wall both before and after the installation of the hydraulic barrier wall and the French drain. The development of the WMA 1 barrier wall and French drain designs will be supported by the collection of additional groundwater data and by groundwater modeling to evaluate the potential impacts these proposed structures have on groundwater flow patterns in the immediate and surrounding areas. The WMA 1 barrier wall and French drain will be designed to result in minimal changes to groundwater flow patterns and water levels in WMA 3.

The design of the WMA 1 barrier wall and French drain will also consider its potential affect on the performance of the Tank and Vault Drying System which is currently being designed and will become operational in 2010. The final design of the WMA 1 hydraulic barrier wall, French drain, and the groundwater monitoring system will be provided to the NRC for technical review and comment before their installation. Additional text will be added to Appendix D to document this design review.

Text will be added to Appendix D that identifies the need for additional upgradient and downgradient groundwater monitoring in the vicinity of WMA 3 to collect data to evaluate pre-installation groundwater flow patterns which will guide the design of the WMA 1 hydraulic barrier wall and French drain. Additional conceptual upgradient and downgradient groundwater monitoring locations for the sand and gravel unit will be added to Figure D-10. This monitoring capability will remain after the installation of the WMA 1 hydraulic barrier wall and French drain to monitor the affect these engineered barriers have on groundwater flow in WMA 3. The site decommissioning contractor will be responsible for establishing a specified monitoring schedule for the monitoring wells and piezometers as part of the final design for the groundwater monitoring program for WMA 3 and the WMA 1 hydraulic barrier and French drain.

Changes to the Plan: The following text will be added to Sections 1.0 and 2.2.1 of Appendix D:

1.0 Description of Engineered Barriers

This section presents a detailed description of the conceptual designs for the engineered barriers to be installed during Phase 1 of the proposed decommissioning, supplementing the physical descriptions previously presented in Section 7. Engineered barriers would be installed at the WMA 1 and WMA 2 excavations to facilitate the removal of sub-grade structures, excavate contaminated soil to meet unrestricted release criteria, and to prevent the recontamination of the WMA 1 and WMA 2 excavated areas by the non-source area of the North Plateau Plume. The final design of the barrier walls and French drain will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities start in 2011. The final design details of the hydraulic barriers and French drain will be provided to the NRC for technical review before their installation.

The development of the WMA 1 and WMA 2 hydraulic barrier walls and French drain designs will be supported by the collection of subsurface soil geotechnical data, the installation of groundwater monitoring wells to provide groundwater elevation monitoring data, and groundwater modeling to evaluate the potential impacts these proposed structures have on groundwater flow patterns in WMA 1 and WMA 2 and in surrounding areas such as WMA 3.

1.1 Waste Management Area 1

Phase 1 of the WVDP proposed decommissioning would include the removal of all above grade and sub-grade structures of WMA 1 and the removal of the underlying soils associated with the source area of the north plateau groundwater plume to a maximum depth of approximately 50 feet. The removal of the sub-grade structures and the soils of the source area of the plume would require the installation of temporary and permanent subsurface hydraulic barrier walls prior to excavation as described in Section 7. A French drain system would be installed in the backfilled excavation to prevent mounding of groundwater against the permanent barrier wall as described in Section 7. The WMA 1 barrier walls and French drain will be designed to result in minimal changes to groundwater flow patterns and water levels in WMA 3. These barrier walls and the French drain system are described in greater detail below.

2.2.1 Groundwater Monitoring Within the Project Premises

Groundwater within the project premises would be monitored during the Phase 1 institutional control period in accordance with the DOE WVDP Groundwater Monitoring Plan in effect at the time. Offsite groundwater monitoring would not be performed as this monitoring program was discontinued in 2007. The onsite groundwater monitoring program for the project premises is described below and shown on Figure D-4. A total of 40 groundwater wells would be routinely monitored along with 59 piezometers.

WMA 1 - Process Building and Vitrification Facility Area

Groundwater in the sand and gravel unit in the backfilled WMA 1 excavation would be monitored using the network of piezometers installed to monitor the effectiveness of the hydraulic barrier wall and French drain described in Section 2.1.1 of this Appendix. A monitoring well screened in the sand and gravel unit would also be installed in the upgradient portion of the WMA 1 excavation to provide information on groundwater quality flowing into the backfilled excavation.

An additional monitoring well screened in the Kent Recessional Sequence would be installed immediately upgradient of the WMA 1 hydraulic barrier wall to monitor groundwater in this unit and to evaluate potential migration of groundwater from the source area of the north plateau groundwater plume that was removed during Phase 1 of the proposed decommissioning.

Groundwater from these piezometers and monitoring wells would be sampled semiannually for radiological indicator parameters (gross alpha, gross beta, and tritium) and for Sr-90 during the Phase 1 institutional control period.

WMA 2 - Low-Level Waste Treatment Facility Area

Groundwater in the sand and gravel unit in the backfilled WMA 2 excavation would be monitored using the network of piezometers installed to monitor the effectiveness of the hydraulic barrier wall and French drain described in Section 2.1.1 of this Appendix. Three monitoring wells screened in the sand and gravel unit would also be installed on the southeastern boundary of the WMA 2 excavation to provide information on groundwater flow and quality in this area.

Groundwater from these piezometers and monitoring wells would be sampled semiannually for radiological indicator parameters (gross alpha, gross beta, and tritium) and for Sr-90 during the Phase 1 institutional control period.

WMA 3 - Waste Tank Farm Area

Groundwater in the sand and gravel unit and the Kent Recessional Sequence would be routinely monitored at WMA 3 during the Phase 1 institutional control period. Four wells would be screened in the sand and gravel unit with three wells upgradient and five wells downgradient of the Waste Tank Farm. Two wells screened in the Kent Recessional Sequence would be installed downgradient of the Waste Tank Farm.

Groundwater from these wells would be sampled semiannually for radiological indicator parameters (gross alpha, gross beta, and tritium) and for Sr-90 during the Phase 1 institutional control period.

RAI DC7 (42)

Subject: Hydraulic barrier wall design details (Section 1.3, Page D-8).

RAI: The DP does not provide adequate details with respect to the stability of the hydraulic barrier walls.

Basis: The DP does not provide adequate details to verify that the permanent hydraulic barrier wall will be sufficiently wide to provide the stability necessary to permit excavation close to the edge of the excavation, as stated in the DP. Stability of the barrier wall is needed to prevent recontamination of the excavation, and to ensure protection of workers during remediation.

NRC Path Forward: Provide the design details and analysis to demonstrate that the hydraulic barrier walls will be stable during excavations prior to backfilling under reasonably foreseeable loadings and scenarios.

****

DOE Response: The proposed WMA 1 and WMA 2 hydraulic barrier walls and French drain described in the DP are conceptual designs that were developed to constrain the EIS analysis for the phased decision-making closure alternative. If the Record of Decision issued by DOE selects this alternative for the WVDP and WNYNSC, the final design for the barrier walls and French drain will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities start in 2011.

The decommissioning contractor responsible for the final design of the WMA 1 and WMA 2 hydraulic barrier walls will ensure that these walls are designed with sufficient stability to allow excavation up to the walls, permit the completion of final status and verification surveys, and will prevent the recontamination of the backfilled WMA 1 and WMA 2 excavations. The design of these barriers will require additional groundwater investigation and subsurface soil sampling to evaluate the hydrologic and geotechnical properties of the soils surrounding and underlying the proposed barriers. The final design of the WMA 1 and WMA 2 barrier walls will incorporate the results of the groundwater and soil geotechnical investigations. The final design details of the WMA 1 and WMA 2 hydraulic barriers will be provided to the NRC for technical review. Text will be added to the DP to clarify this point.

Changes to the Plan: The following text will be added to Section 1.0 of Appendix D. Note that the change to Section 1.6 to provide for NRC review of the final design details of the hydraulic barriers and French drain is described in the response to RAI 7C1.

1.0 Description of Engineered Barriers

This section presents a detailed description of the conceptual designs for the engineered barriers to be installed during Phase 1 of the proposed decommissioning, supplementing the physical descriptions previously presented in Section 7. Engineered barriers would be installed at the WMA 1 and WMA 2 excavations to facilitate the removal of sub-grade structures, excavate contaminated soil to meet unrestricted release criteria, and to prevent the recontamination of the WMA 1 and WMA 2 excavated areas by the non-source area of the North Plateau Plume. The final design of the barrier walls and French drain will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities start in 2011. The final design details of the hydraulic barriers and French drain will be provided to the NRC for technical review before their installation, as specified in Section 1.6 of this plan.

The development of the WMA 1 and WMA 2 hydraulic barrier walls and French drain designs will be supported by the collection of subsurface soil geotechnical data, the installation of groundwater monitoring wells to provide groundwater elevation monitoring data, and groundwater modeling to evaluate the potential impacts these proposed structures have on groundwater flow patterns in WMA 1 and WMA 2 and in surrounding areas such as WMA 3.

RAI DC8 (43)

Subject: Phase 1 excavation water flow patterns and sheet piling experience (Appendix D).

RAI: The proposed hydraulic barrier walls in WMA 1 and WMA 2 may potentially impact the effectiveness of the two north plateau plume control measures, Ditch Permeable Reactive Barrier and a full-scale Permeable Treatment Wall (e.g., shown in Figure 5-4 on Page 5-11 and Figure D-10 on Page D-20).

Basis: As part of the Phase I DP two hydraulic barrier walls, along with a French drain, will be installed to prevent the remediated sources area from recontamination by the downgradient contaminated groundwater. These reactive barriers are supposed to be installed before Phase I of the proposed decommissioning begins. The diversion of groundwater through the French drain will potentially reduce groundwater flow, and then slow down the migration of Sr-90 plume in the north plateau. The hydraulic barriers also potentially result in slower groundwater flow into the permeable reactive barriers, and the amount of dissolved radionuclides as well.

NRC Path Forward: The design of these permeable reactive barriers/walls should balance the overall objective of preventing recontamination with the hydraulic barriers and remediation with the downgradient permeable reactive barriers, by taking into account the potentially lower groundwater flow rate as a result of installation of two upgradient hydraulic barrier walls. Perform a quantitative analysis to optimize the designs.

****

DOE Response: The proposed WMA 1 and WMA 2 hydraulic barrier walls and French drain described in the DP are conceptual designs that were developed to constrain the EIS analysis for the phased decision-making closure alternative. If the Record of Decision issued by DOE selects this alternative, the final design for the barrier walls and French drain will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities start in 2011.

The DOE is no longer considering the installation of the Permeable Reactive Barrier in the area of the Swamp Ditch as detailed hydrogeological analyses have questioned its effectiveness in reducing the offsite migration of Sr-90. The DP will be revised to reflect this change by deleting reference of the Permeable Reactive Barrier in the text and figures.

The Permeable Treatment Wall is currently being designed and is scheduled to be installed in 2010 in an area south of the Construction and Demolition Debris Landfill. The contractor responsible for the Permeable Treatment Wall design is modeling the potential effects that the proposed WMA 1 and WMA 2 hydraulic barrier walls and French drain may have on groundwater flow directions, gradients, and velocities in the non-source area of the North Plateau Plume. The final design of the Permeable Treatment Wall will consider the potential changes to groundwater flow resulting from the installation of the proposed Phase 1 hydraulic barriers and French drain to ensure that the Permeable Treatment Wall meets its overall performance goals of reducing Sr-90 concentrations in the North Plateau Groundwater Plume. The final design details of the Permeable Treatment Wall will be provided to the NRC and other Core Team agencies for information and review.

Changes to the Plan: References to the Permeable Reactive Barrier will be removed from the DP figures or text on the following pages: 1-17, 3-12, 4-6, 5-10, 5-11, and 7-4.

RAI DC9 (44)

Subject: Proposed engineered barriers effect on groundwater flow in WMA 3 (Appendix D).

RAI: The proposed construction of hydraulic barriers at WMA 1 and WMA 2 may result in an increase of groundwater flow from WMA 1 into the Waste Tank Farm area (WMA 3), which could impact the current dewatering system.

Basis: As discussed in Section 1.4, "Engineered Barriers and Groundwater Flow" (page D-8), groundwater modeling indicates a higher flow from the source area toward the waste tank farm even with a French drain. In the Waste Tank Farm a dewatering system is currently operating to minimize in-leakage of groundwater into the tank vaults. Depending on the initial design, the dewatering system may or may not have the capacity to handle an increase in the amount of groundwater infiltrating the tanks/vaults.

NRC Path Forward: Conduct an analysis to evaluate the potential implications of increased groundwater flow towards the waste tank farm and ability of the tank and vault drying system to maintain the waste tanks/vaults in a safe configuration during the ongoing assessment period.

****

DOE Response: The requested analysis cannot be performed at this time as the proposed Tank and Vault Drying System is currently being designed by the WVDP site operations contractor and is not expected to be completed and in operation until 2010.

The groundwater modeling described in Appendix D of the DP evaluated groundwater elevations, hydraulic gradients, and flow patterns in the sand and gravel unit associated with the conceptual design for the WMA 1 and WMA 2 hydraulic barrier walls and the WMA 1 French drain. The modeling assumed the barrier walls were one meter thick with a hydraulic conductivity of 1.0E-06 cm/s and the assumed French drain was one meter wide, three meters deep, with a hydraulic conductivity of 10 cm/s. The modeling demonstrated that this conceptual barrier wall and French drain design could achieve groundwater levels and associated hydraulic gradients within the backfilled WMA 1 and WMA 2 excavations that would result in groundwater flow from the backfilled WMA 1 and WMA 2 outward to downgradient areas. Such a flow field would severely limit the potential for recontamination of the backfilled WMA 1 and WMA 2 excavations by Sr-90 contaminated groundwater from the non-source area of the north plateau plume or from potential releases from the Waste Tank Farm in WMA 3.

The proposed WMA 1 and WMA 2 hydraulic barrier walls and WMA 1 French drain described in the DP are a conceptual design and were not intended to represent a final design. The final design of these hydraulic barrier walls, French drain, and their post-installation groundwater monitoring system will be prepared in the future by the site decommissioning contractor that will implement the Phase 1 closure activities that are scheduled to begin in 2011 should DOE select this alternative in the Record of Decision. The final design of the barrier walls and French drain will be supported by the collection and evaluation of additional groundwater data and by additional groundwater modeling to evaluate the potential impacts these proposed hydraulic barriers would have on groundwater flow patterns in the immediate and surrounding areas. These structures will be designed to result in minimal changes to groundwater flow patterns and water levels in WMA 3.

The final design of the WMA 1 barrier wall and French drain will also consider its potential impact on the Waste Tank Farm groundwater dewatering system and the performance of the Tank and Vault Drying System which is currently being designed. The current Waste Tank Farm groundwater dewatering system consists of a single two-foot diameter dewatering well located between Tanks 8D-1 and 8D-2. This groundwater dewatering system has been operated to maintain set Waste Tank Farm operational groundwater elevations around the tanks to (1) reduce the upward hydrostatic pressure on Tanks 8D-1 and 8D-2 and (2) maintain a hydraulic gradient towards both tanks to prevent any potential leaks from the tanks from migrating out of the tank vaults into adjacent groundwater

The Waste Tank Farm operational groundwater levels maintained by the dewatering system have changed over time depending on the volume of liquid contained in Tanks 8D-1 and 8D-2. Groundwater levels are currently maintained at an elevation between 1371.3 and 1377.3 feet above mean sea level, which corresponds to a level of 4.6 to 10.6 feet above the bottom of the vaults of Tanks 8D-1 and 8D-2.

Groundwater is pumped from the dewatering well approximately four times a month to maintain the current Waste Tank Farm operational groundwater levels, with pumped volumes ranging from 500 to 3500 gallons per pumping event. Based on its current operations, the dewatering well is expected to be able to manage slight increases in groundwater volumes in the Waste Tank Farm area. However, the WMA 1 hydraulic barrier wall and French drain will be designed both to minimize additional groundwater flow into the Waste Tank Farm area and to achieve groundwater levels and hydraulic gradients within the backfilled WMA 1 excavation that would result in outward groundwater flow to downgradient areas limiting potential recontamination.

The final designs of the WMA 1 and WMA 2 hydraulic barrier walls and French drain will be provided to the NRC for technical review and comment before their installation. Text will be added to the DP to clarify this issue. Note that the change to Section 1.6 to provide for NRC review of the final design details of the hydraulic barriers and French drain is described in the response to RAI 7C1.

Changes to the Plan: The following text will be added to Section 1.0 of Appendix D:

1.0 Description of Engineered Barriers

This section presents a detailed description of the conceptual designs for the engineered barriers to be installed during Phase 1 of the proposed decommissioning, supplementing the physical descriptions previously presented in Section 7. Engineered barriers would be installed at the WMA 1 and WMA 2 excavations to facilitate the removal of sub-grade structures, excavate contaminated soil to meet unrestricted release criteria, and to prevent the recontamination of the WMA 1 and WMA 2 excavated areas by the non-source area of the North Plateau Plume. The final design of the barrier walls and French drain will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities start in 2011. The final design details of the hydraulic barriers and French drain will be provided to the NRC for technical review before their installation as indicated in Section 1.6 of this plan.

The development of the WMA 1 and WMA 2 hydraulic barrier walls and French drain designs will be supported by the collection of subsurface soil geotechnical data, the installation of groundwater monitoring wells to provide groundwater elevation monitoring data, and groundwater modeling to evaluate the potential impacts these proposed structures have on groundwater flow patterns in WMA 1 and WMA 2 and in surrounding areas such as WMA 3.