West Valley Demonstration Project

Phase 1 Decommissioning Plan

DOSE MODELING

A Follow-up Briefing for the U.S. Nuclear Regulatory Commission

U.S. Department of Energy • October 21, 2008

Note on presentation

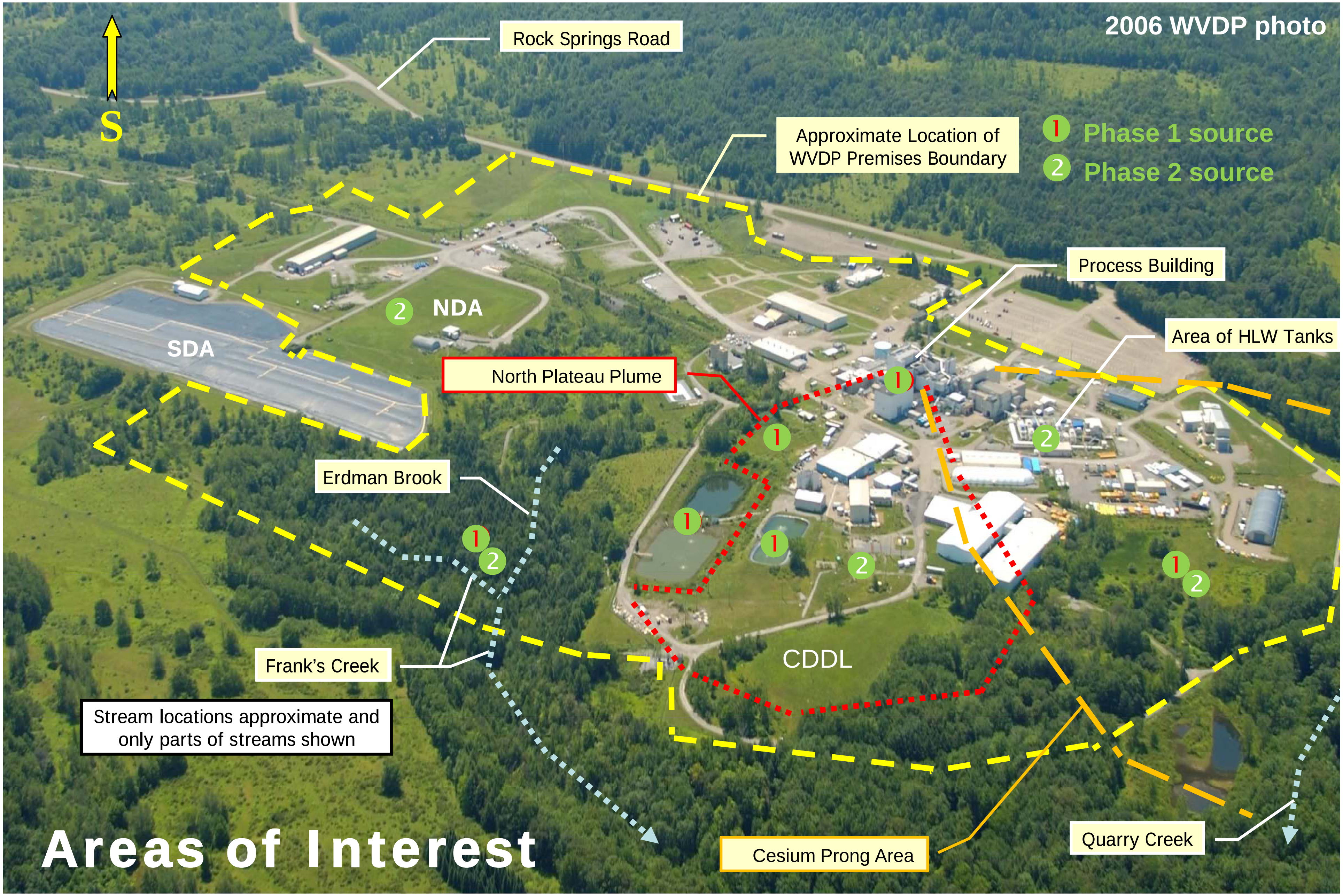
The information in this presentation is based upon data and analysis associated with the presumptive Preferred Alternative in the Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center, which is still under development.

To the extent the presumptive Preferred Alternative is either modified or changed during the course of the NEPA process, the approach described in this presentation may correspondingly change.

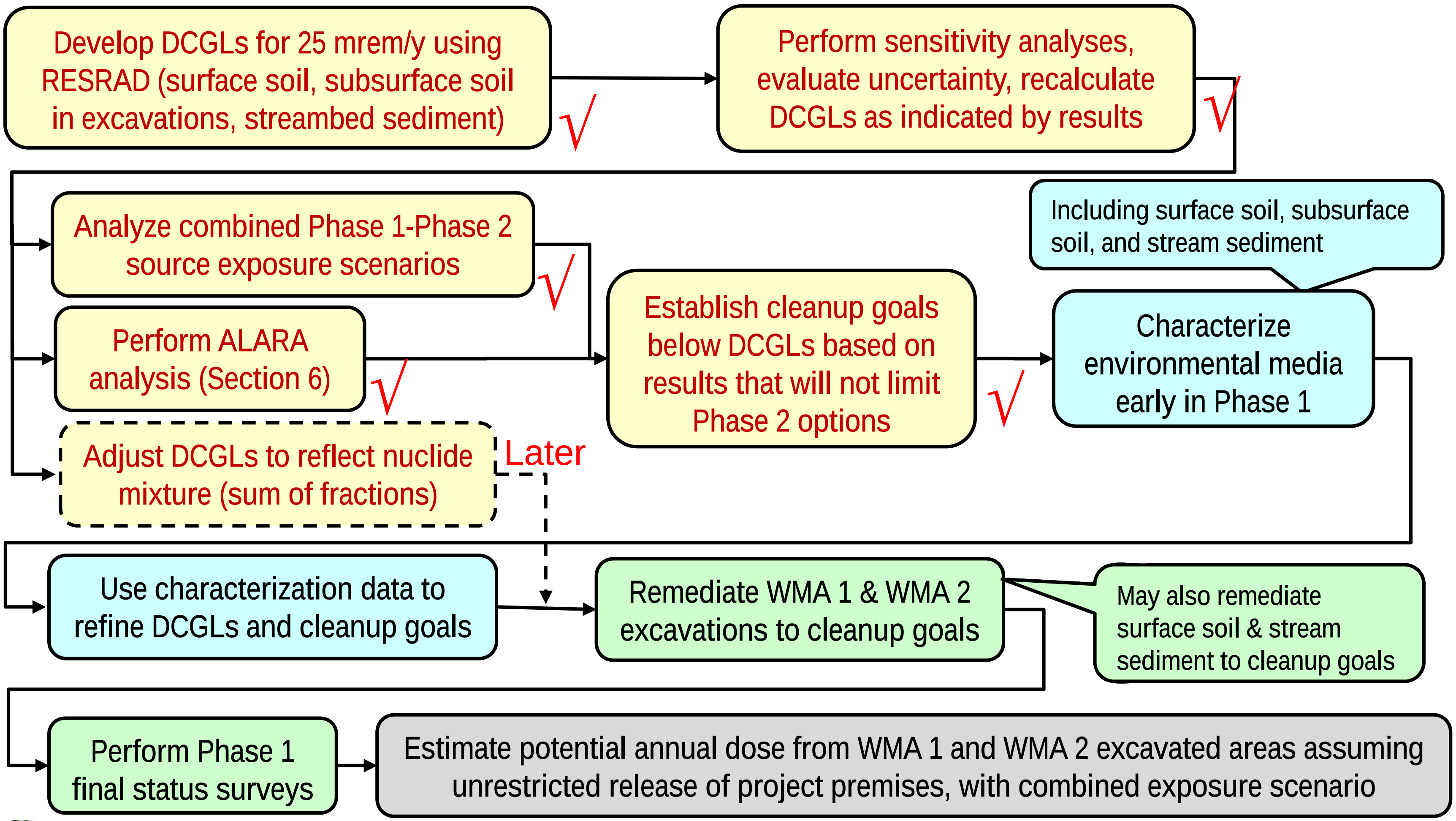
Note also that the preliminary modeling results provided herein (DCGLs and cleanup goals) are subject to change in connection with an ongoing peer review.

Objective and agenda

- Objective:
  - To provide more information on dose modeling for the WVDP Phase 1 DP to afford an opportunity for additional NRC input
- Agenda (generally following preliminary DP Section 5):
  1) Background, including July meeting discussions and NRC expectations expressed in the meeting summary
  2) Section 5.1, introduction to establish context
  3) Section 5.2, DCGL development, including preliminary results
  4) Section 5.3, limited site-wide dose assessment, including ALARA analysis and preliminary results
  5) Section 5.4, preliminary cleanup goals and additional analyses
  6) Summary of dose modeling


2006 WVDP photo
S
Rock Springs Road
Approximate Location of WVDP Premises Boundary
1 Phase 1 source
2 Phase 2 source
Process Building
NDA
SDA
Area of HLW Tanks
North Plateau Plume
Erdman Brook
CDDL
Frank's Creek
Stream locations approximate and only parts of streams shown
Areas of Interest
Cesium Prong Area
Quarry Creek

Basic approach planned and taken



Addressing NRC expectations – 1 of 2

Stated expectations from the 7/24/08 meeting summary	Slides
1. Demonstrate understanding of how Phase 1 and 2 sources contribute to the peak dose.	16, 24, 25
2. Evaluate erosion of Phase 1 sources for the entire compliance period.	18-22
3. Develop realistic scenarios and evaluate less likely, but plausible exposure scenarios.	28, following
4. Justify models to derive DCGLs, use conservative assumptions when uncertainty is great.	31, following
5. Use DEIS information on groundwater analysis and modeling to estimate flow directions and timing from Phase 1 source areas and potential overlap of Phase 1 and 2 sources.	23-26
6. Model subsurface contamination in the saturated zone at the bottom of the excavations.	42, 43
7. Consider erosion that would deplete the cover materials, gully intrusion into the lagoons .	18-22

Addressing NRC expectations – 2 of 2

Stated expectations from the 7/24/08 meeting summary	Slides
8. Use dose to source factors to account for sediment as a continuing source to groundwater.	42, 43
9. Model the engineered barrier performance to ensure that there are no unintended impacts, consider how barrier performance and degradation would affect the flow field, and justify any assumptions.	23-26
10. Evaluate the sensitivity of model results to parameter values and alternative conceptual models.	35-37, 44, 45, 50, 51
11. Develop site-specific parameter values for those parameters with the most impact on dose or use conservative assumptions.	29, 34, 41, 49
12. As additional data are collected to reduce uncertainty in the source concentrations, revise DCGLs as necessary, and after remediation is complete, use actual data to estimate the potential dose from Phase 1 sources.	66
13. Provide information regarding development of site-specific K_ds for Sr-90 and other constituents.	34, 41, 49

Section 5 – Content

5.1 Introduction

5.2 DCGL Development

5.3 Limited Site-Wide Dose Assessment

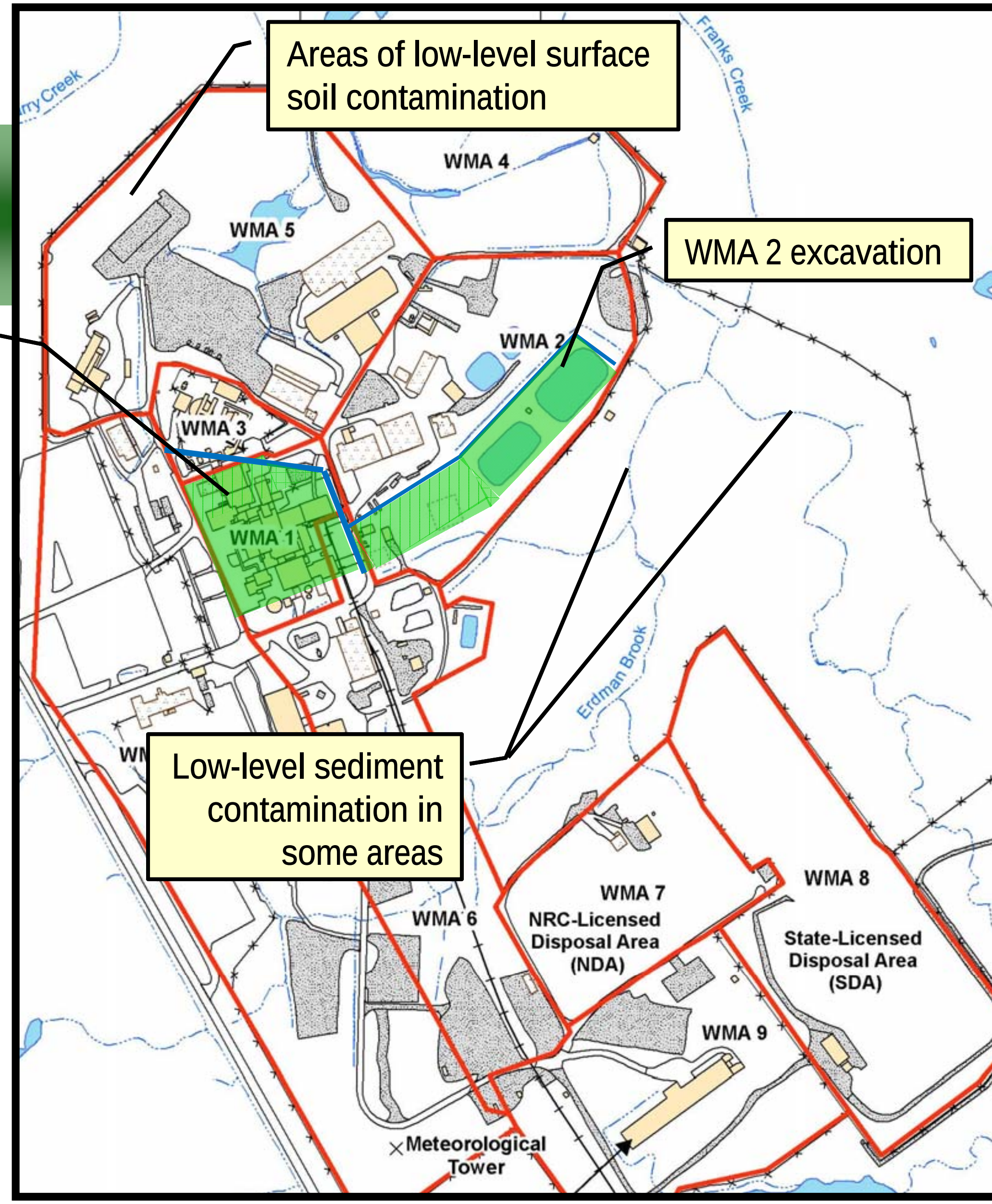
5.4 Cleanup Goals and Additional Analyses

Appendix C provides supplemental details

Section 5.1.1, requirements and guidance

- Primary requirements: LTR, 10 CFR 20.1402
  - <25 mrem/y and ALARA
- Primary guidance: NUREG-1757, vol. 2
  - Dose modeling approach
  - DCGL and final status survey approach
  - Appendix J, assessment strategies for buried radioactive material

Section 5.1.2, context for DCGLs

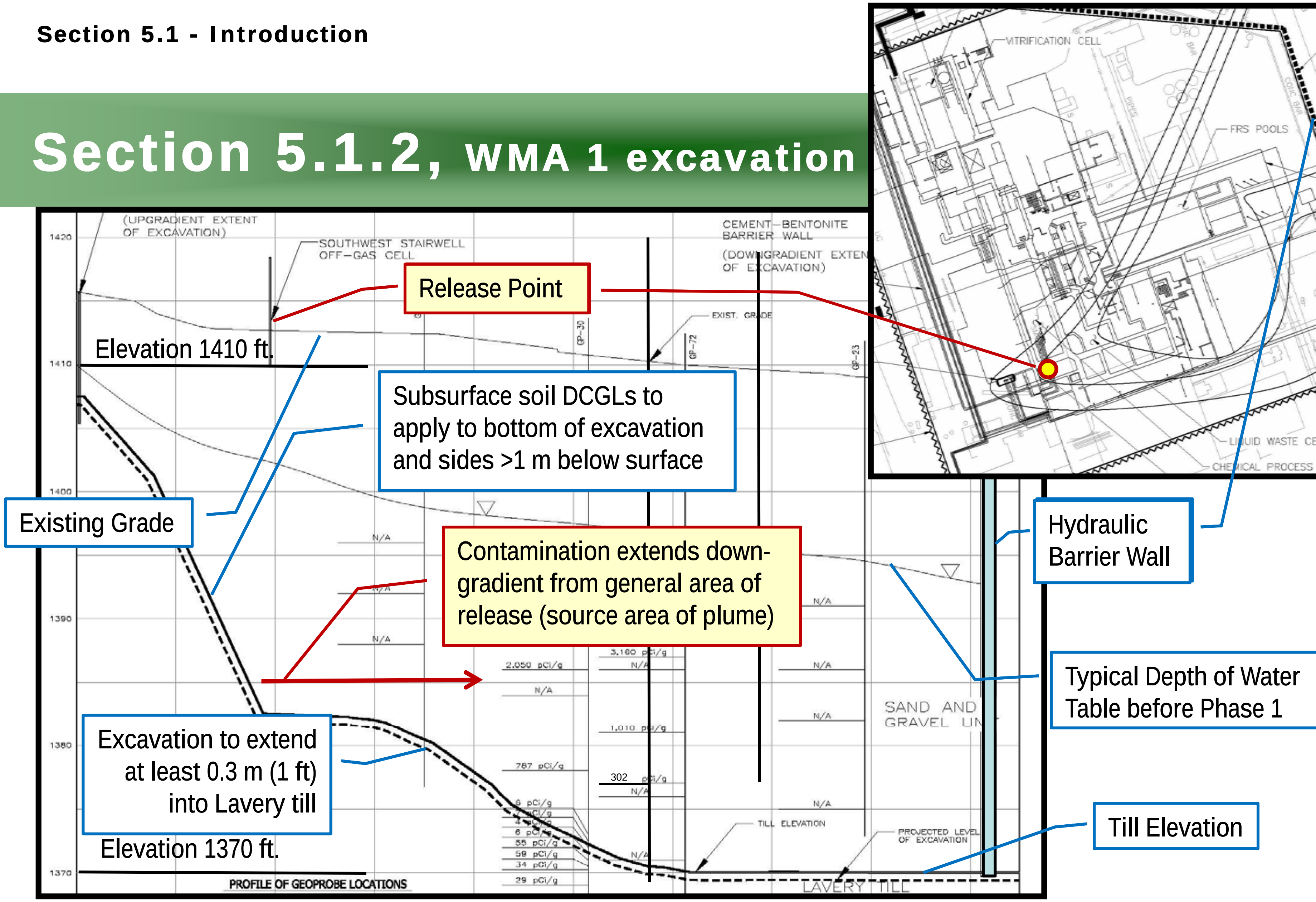


- Surface soil may be remediated to surface soil DCGLs in Phase 1
- Subsurface soil DCGLs are intended for deep soil at the bottom and lower sides of the WMA 1 and 2 excavations
- Sediment in Erdman Brook and Franks Creek may be remediated to streambed sediment DCGLs in Phase 1

Section 5.1.2, context for DCGLs

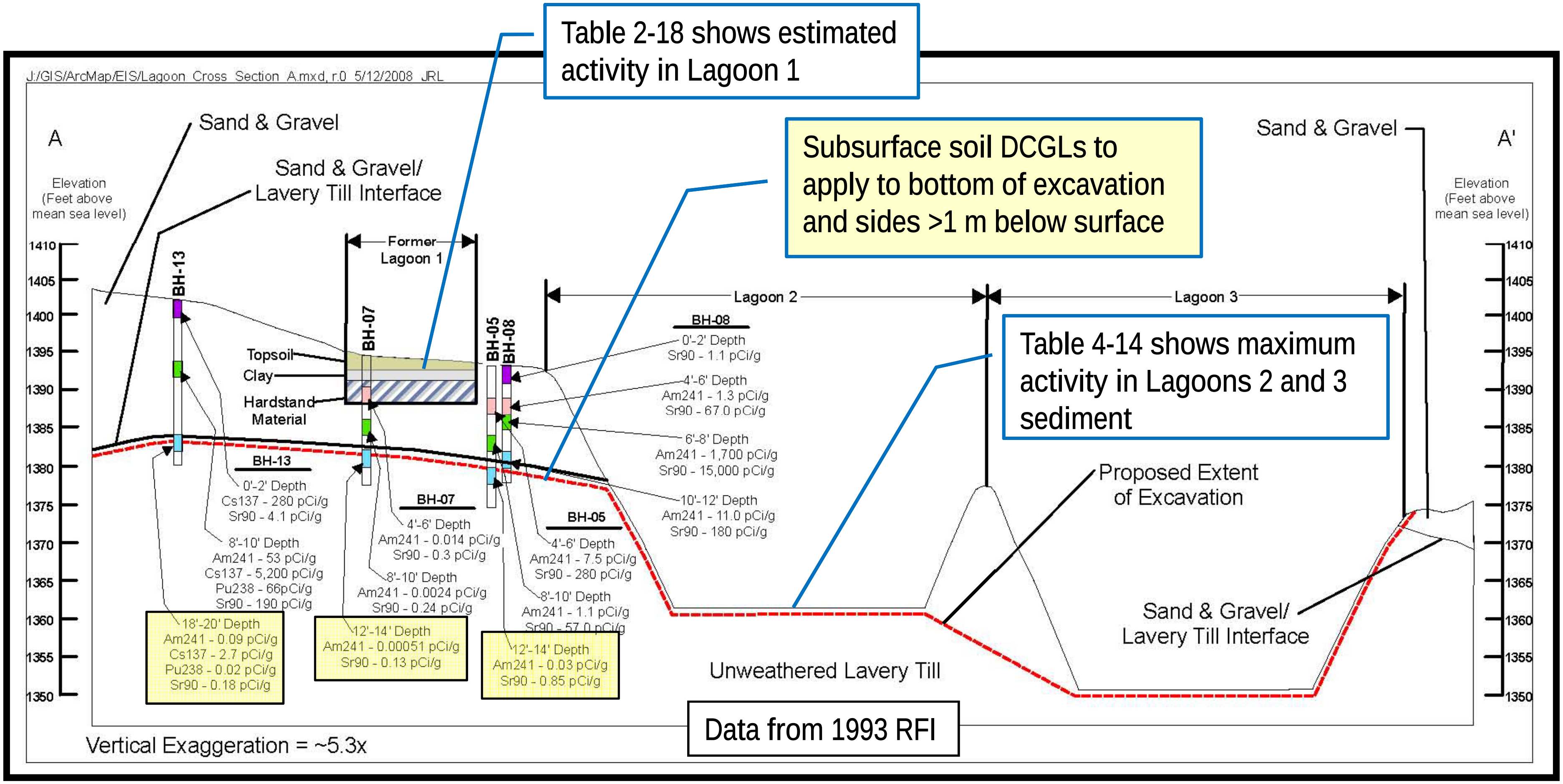
- Summaries of available data on nature and extent of contamination
  - Surface soil
  - Subsurface soil
  - Streambed sediment
- Additional characterization
  - 2008 plume investigation (18 locations, 5 in Process Building area, analyses for 17 radionuclides, report in spring 2009)
  - Additional soil and sediment characterization early in Phase 1

Section 5.1.2, WMA 1 excavation



Data from 1998 Geoprobe Investigation

Section 5.1.2, WMA 2 excavation



Soil DCGL transition point

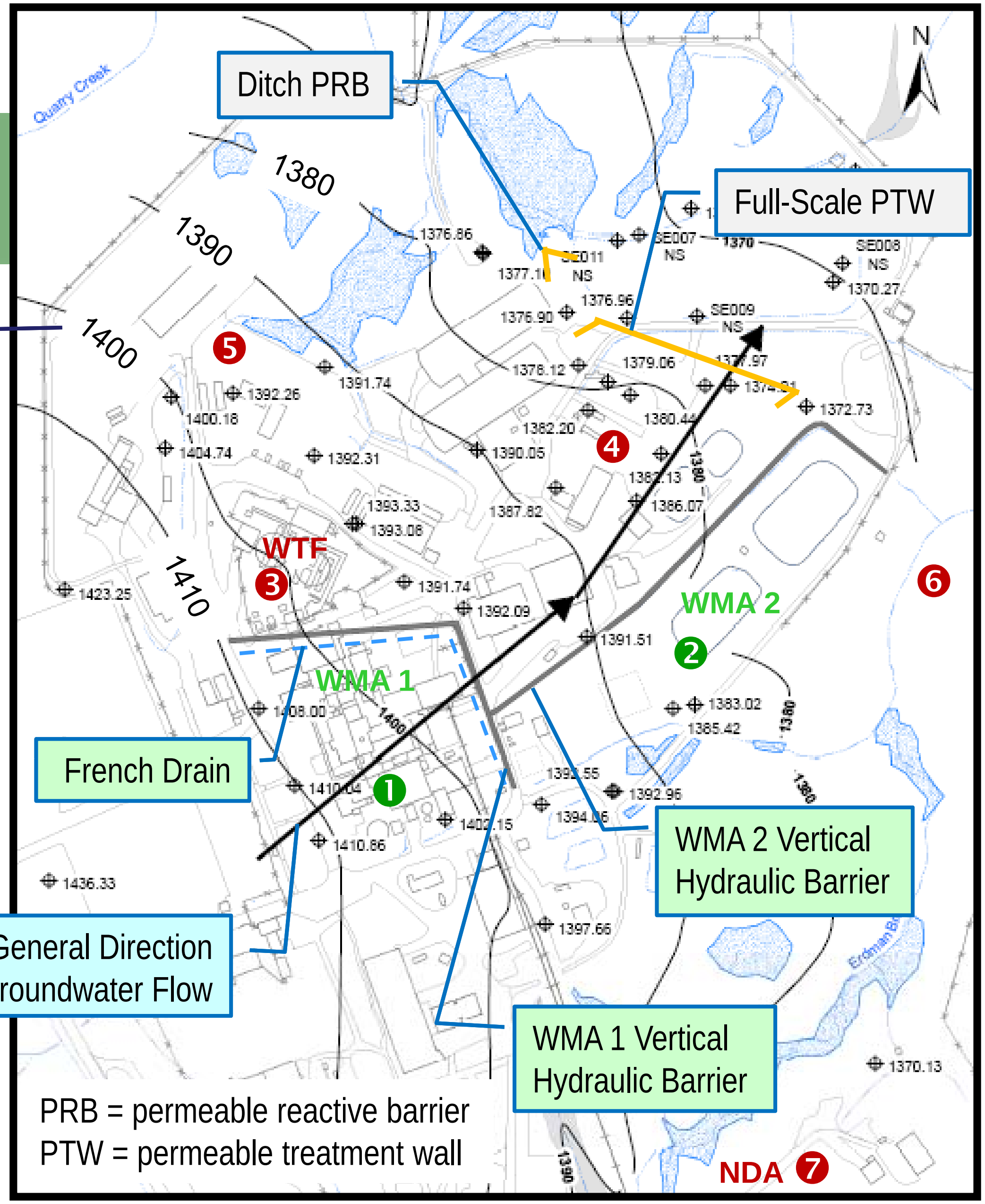
- Transition point between application of surface soil DCGLs and subsurface soil DCGLs (i.e., cleanup goals) established at 1 m below the surface for WMA 1 excavation considering
  - The 1 m modeled contamination zone thickness for surface soil (more conservative than closer to surface)
  - NRC definition of surface soil (0-15 cm or 0-6 in deep) and deep or subsurface soil (>15 cm or 6 in below the surface)
- The upgradient and cross-gradient sides of the WMA 1 excavation are not expected to be contaminated, based on
  - Pre-excavation groundwater flow patterns
  - Available subsurface soil contamination data

Section 5.1.3, context for limited dose assessment

- 3 sets of DCGLs for particular areas of interest
  - Surface soil DCGLs, for surface soil, sediment in drainage ditches (not in Erdman Brook and Franks Creek), and WMA 1 and WMA 2 excavation sides from ground to 1 m below surface
  - Subsurface soil DCGLs, intended for WMA 1 and WMA 2 excavation bottoms and sides >1 m below surface
  - Streambed sediment DCGLs, for Erdman Brook and Franks Creek only
- DCGLs developed as if the area of interest would be the only area to which a future resident or recreationist might be exposed

Section 5.1.3

- Phase 1 and Phase 2 sources
  1. Remediated WMA 1 excavation
  2. Remediated WMA 2 excavation
  3. Waste Tank Farm
  4. North Plateau plume
  5. Surface soil
  6. Streambeds
  7. NDA



Section 5.1.3

- This subsection also addresses
  - Potential conditions at the end of Phase 2
    - Site-wide close in place alternative
    - Site-wide removal alternative
  - Addresses compatibility of Phase 1 end conditions with these different final end conditions
  - Discussed resident farmer on remediated project premises spending time hiking and fishing at Erdman Brook and Franks Creek
    - Concludes that this is a reasonable set of circumstances to evaluate (as was discussed in previous meeting)

Section 5.1.4, potential erosion impacts

- Subsection 3.5.3 of Section 3 (Facility Description) will address geomorphology
  - Table 3-13 will summarize measured soil loss rates from sheet and rill erosion, stream downcutting and rim widening
- Unmitigated erosion estimates are discussed based on studies described in EIS Appendix F
  - Early site studies
  - SIBERIA modeling
  - CHILD modeling

Section 5.1.4, conclusions about erosion

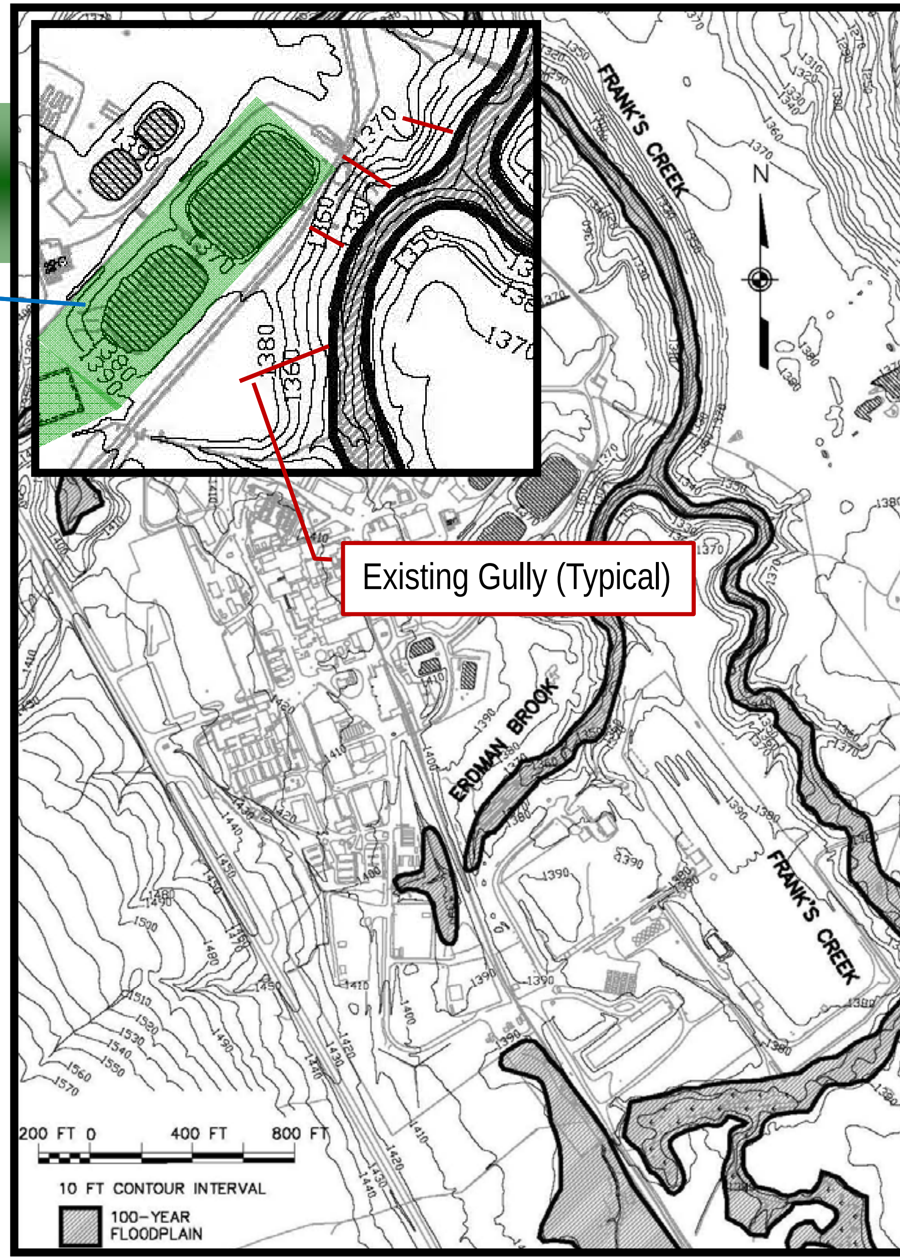
- Central part of north plateau generally stable over 1000 years
- WMA 2 area, being nearer the Erdman Brook stream valley, is more susceptible to erosion than WMA 1 area
- Gullies will propagate, becoming deeper and longer, if erosion proceeds unchecked, and more gullies may form
- Rim widening and channel downcutting will occur in Erdman Brook and Franks Creek (and also Quarry Creek)

Modeling long-term erosion at this site is difficult and there is uncertainty in the quantitative predictions of the models.

Erosion in WMA 2

WMA 2 Remediated Area

- With unmitigated erosion, gullies could eventually extend into the areas of Lagoons 1, 2, and 3
- Without mitigating measures, rim widening and downcutting of Erdman Brook could impact the eastern edge of the Lagoon 3 area, and possibly the Lagoons 1 and 2 areas, over 1000-year period



Potential impacts of erosion in WMA 2 (1)

- Conditions at the conclusion of Phase 1
  - Lagoon 3 bottom (surface where cleanup goals applied after removal of all sediment and approximately 1 ft of underlying Lavery till) will be covered by ~25 ft of clean earthen backfill
  - Lagoon 2 bottom (same surface) will be covered by ~18 ft of clean earthen backfill

To uncover a portion of the remediated WMA 2 excavated area, erosion would have to cut about 25 feet deep into the Lagoon 3 area and about 18 feet into the Lagoon 2 area.

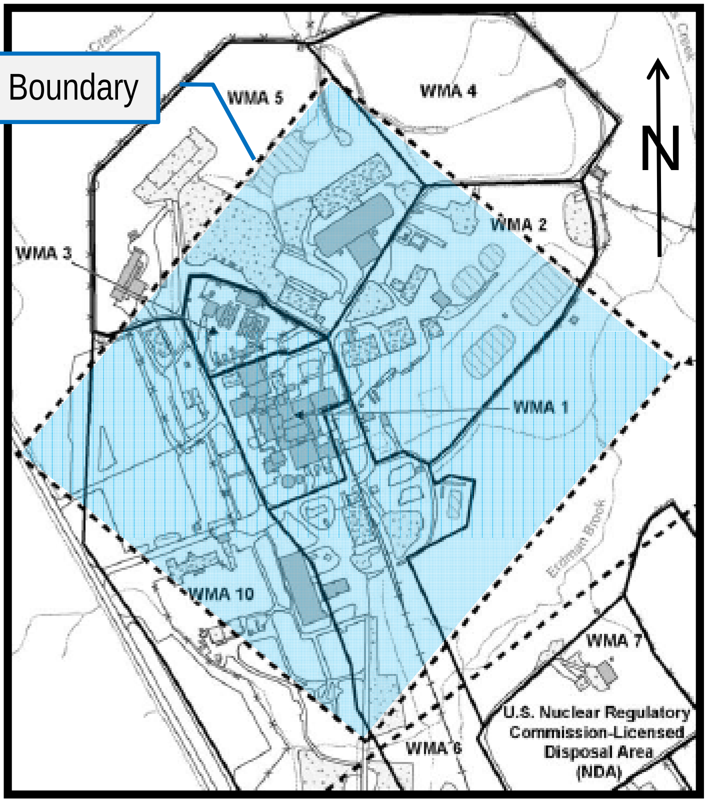
Potential impacts of erosion in WMA 2 (2)

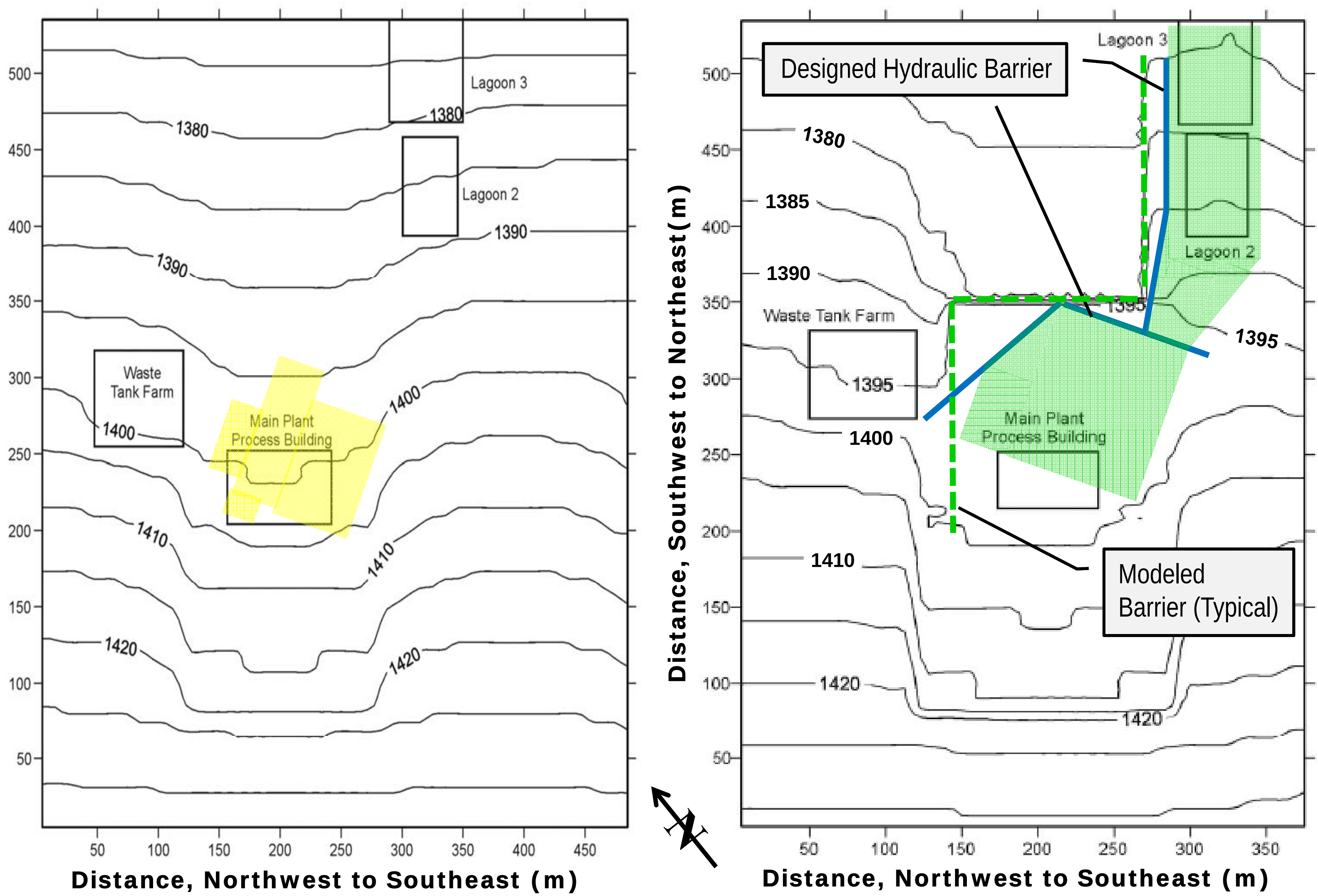
- Available data suggest deep erosion in Lagoon 3 area would be unlikely to have a significant dose impact
  - Lagoon 3 sediment data show low concentrations of long-lived radionuclides, with maximum values as follows:

    Am-241 5.1 pCi/g U-238 8.8 pCi/g Pu-239/240 1.4 pCi/g
  - All sediment will be removed, along with at least 1 foot of underlying till, and radionuclide concentrations in the Lavery till should be much lower
  - Gullies would make area unsuitable for farming, as in the conceptual model used for surface soil DCGLs
- Contamination in Lavery till under Lagoon 1 also very low

Section 5.1.5, groundwater flow fields

- Evaluation makes use of model described in DEIS Appendix E
  - 3D near-field model
  - Uses rectangular grid blocks
  - Barriers simulated parallel and perpendicular to model blocks
  - Block thickness varies with geologic unit
  - Implemented by STOMP (sub-surface transport over multiple phases) code developed by PNNL
- Next slide shows key results



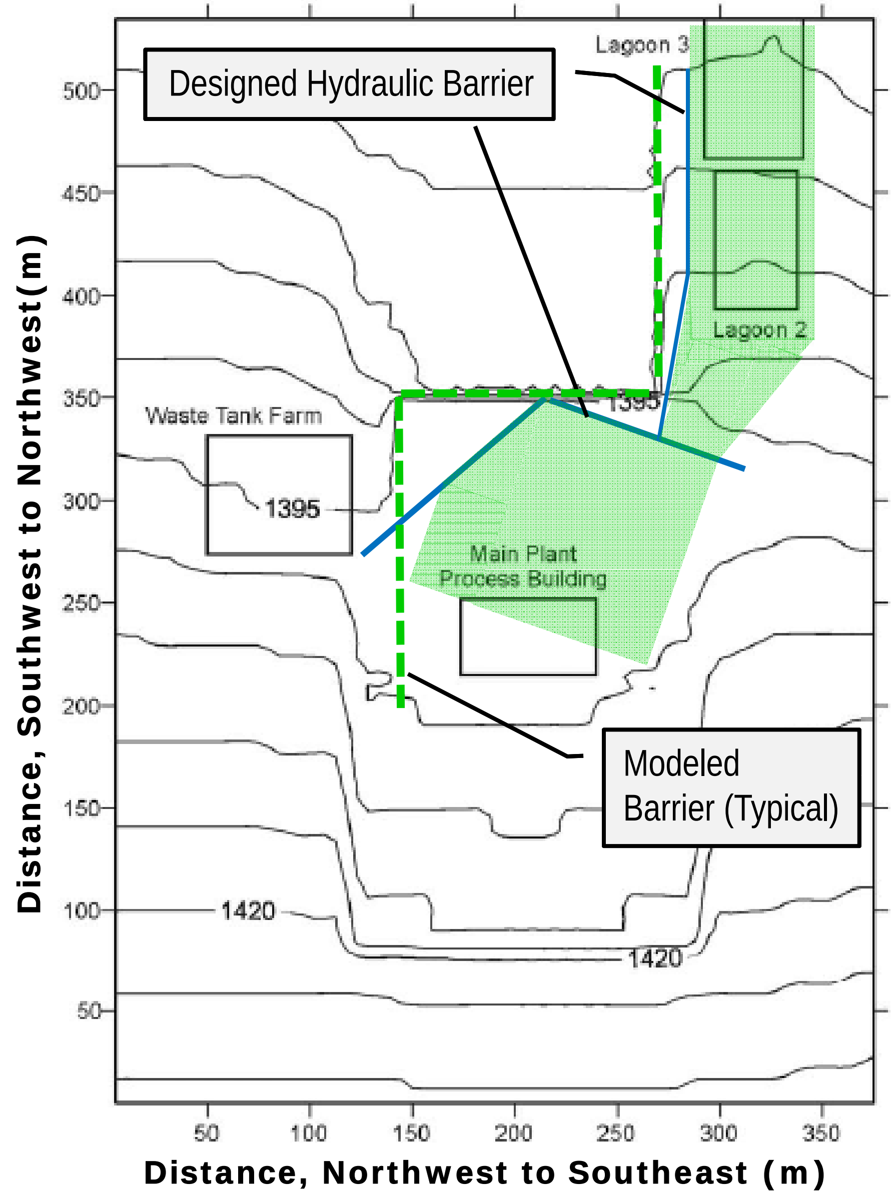


CURRENT CONDITION

AFTER PHASE 1

Conclusions

- Model suggests low potential for recontamination of remediated Phase 1 areas
  - Water table elevations up to 15 ft higher on WMA 1 and WMA 2 sides of the hydraulic barrier
- French drain will control groundwater upgradient of the WMA 1 hydraulic barrier, maintain steep NE hydraulic gradient across the WMA 1 barrier wall



AFTER PHASE 1

Hydraulic barrier degradation

- Hydraulic barrier degradation has not been modeled for the Phase 1 DP because
  - Conventional slurry walls used, with extra thick WMA 1 wall
  - No significant degradation is expected before Phase 2 begins based on performance data in technical literature
  - The long-term significance of the hydraulic barriers depends upon the Phase 2 approach (they may not be necessary)
  - Modeling of potential degradation – which is inherently difficult – would be performed as part of the Phase 2 planning if the hydraulic barriers were determined to be important in the long term, such as for the close-in-place alternative

Section 5.1.6, dose modeling process

- This subsection explains the process discussed at the last meeting, for example
  - Develop 3 sets of DCGLs
  - Perform sensitivity analysis, refine models as appropriate, recalculate DCGLs
  - Analyze combined exposure scenario
  - Perform preliminary ALARA analysis
  - Establish cleanup goals that will not limit Phase 2 options

Section 5.2 – Content

5.2.1 Conceptual models for DCGL development

5.2.2 Mathematical model

5.2.3 Summary of results

5.2.4 Discussion of sensitivity and uncertainty

Parameter selection

- Followed planned parameter selection hierarchy
  1) Site-specific values where available, e.g. groundwater and vadose zone parameters
  2) Semi site-specific literature values, e.g. physical values based on soil type from NUREG/CR-6697 and behavioral factors based on regional data in the EPA Exposure Factors Handbook
  3) Scenario-specific values using conservative industry defaults, e.g., from Exposure Factors Handbook, RESRAD Data Collection Handbook, NUREG/CR-6697
  4) The most likely values among default RESRAD parameters defined by a distribution, when available, otherwise mean values from NUREG/CR-6697
- Also used some parameters from NUREG/CR-5512, Volume 3 as in DEIS dose modeling

1)

DCGLs for 18 radionuclides of interest

- Radionuclides of interest

Am-241	Cs-137	Pu-239	Tc-99	U-235
C-14	I-129	Pu-240	U-232	U-238
Cm-243	Np-237	Pu-241	U-233	
Cm-244	Pu-238	Sr-90	U-234	

- These 18 radionuclides were evaluated in the Facility Characterization Project
- Site modeling has shown all to be important to the outcome of the long-term PA
  - Sr-90 and Cs-137 are important in intruder scenarios

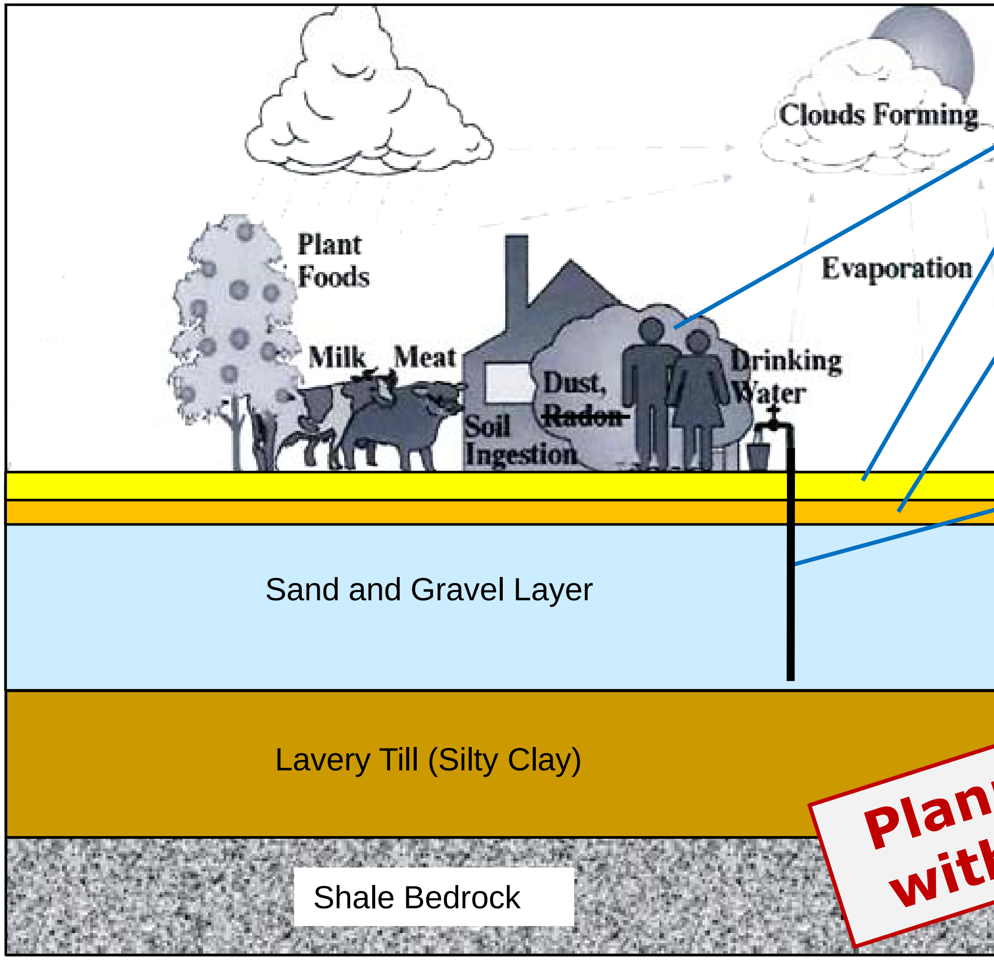
Surface soil scenarios considered

- Considered various exposure scenarios
  - Resident farmer
  - Hunter
  - Fisherman
  - Hiker
- Selected resident farmer to evaluate

  Recreationist at Erdman Brook and Franks Creek evaluated separately (hiking, fishing, deer hunting) to develop streambed sediment DCGLs and later combined with resident farmer scenario.

- Developed DCGLs for the 18 radionuclides of interest

Conceptual Model – surface soil DCGLs



Resident Farmer (member of critical group)

Contaminated Zone (assumed 3 ft thick)

Unsaturated Zone (assumed 6 ft (2m) thick, actually 0-16' thick on north plateau)

Well screened in sand and gravel layer 16 ft (5 m) deep

Planned model used with minor changes

Pathways for resident farmer Surface soils DCGLs

Pathway	Active	Remarks
External gamma radiation	Yes	
Inhalation of dust	Yes	
Radon inhalation	No	
Ingestion of plant foods	Yes	
Ingestion of meat	Yes	
Ingestion of milk	Yes	
Ingestion of fish	No	Streams analyzed separately
Ingestion of soil	Yes	
Ingestion of water	Yes	Groundwater from well and through indirect pathways (irrigation, livestock)

Planned pathways used

Key input parameters

Made indicated parameter changes

Parameter	Value	Basis
Contaminated zone area	10,000 m^2	[was to evaluate 1-10,000 range]
Contaminated zone thickness	1 m	Conservative estimate (likely <0.3 m)
Cover thickness	0	Contamination expected to be at the surface
Contaminated zone erosion rate	0	Assuming no erosion is conservative
Unsaturated zone thickness	2 m	[was 0.6 m, 2 m more representative and realistic]
Well pumping rate	5720 m^3/y	Estimated water use [was 2400, 5720 more conservative]
Sr soil K_d	6.16 mL/g	Site-specific value (Table 3-20) [was 5]
Cs soil K_d	150 mL/g	Site-Specific value (Table 3-20) [was 447]
Am soil K_d	1000 mL/g	Site-Specific value (Table 3-20) [was 1450]

Appendix C identifies all parameters and their bases.

Addressing sensitivities and uncertainty

- Planned to evaluate selected input parameters, e.g.,
  - Contaminated layer geometry √ [area evaluated in area factor calcs]
  - Unsaturated zone thickness √
  - Aquifer pump rate √
  - Plant transfer factors [decided not to perform – not useful]
  - Root depth [decided not to perform – not useful]
  - Also evaluated K_d values, hydraulic conductivity, well intake depth, runoff/evapotranspiration coefficient, and groundwater model (mass balance/non-dispersion)
- Made no adjustment in the conceptual model based on analysis results

Results of sensitivity analyses (1)

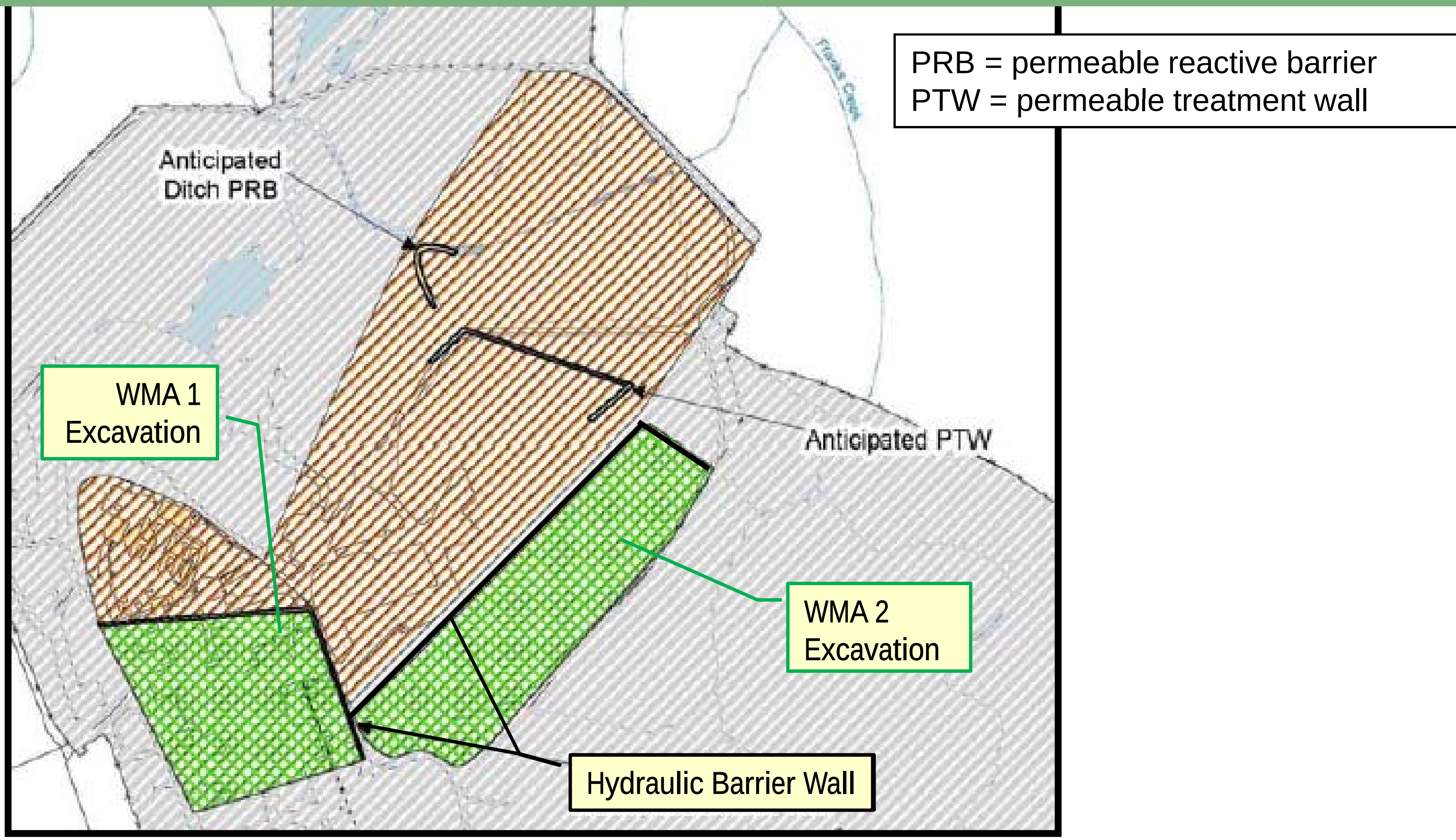
Parameter (units)	Base Case	Change	Range of $DCGL_W$ Changes
Indoor/outdoor time fraction	0.66/0.25	0.45/0.45	-21%(Cs-137) to 0% (Sr-90, others)
Indoor/outdoor time fraction	0.66/0.25	0.80/0.10	0% (Sr-90, others) to +26% (Cs-137)
Contaminated layer thickness (m)	1	0.5	+2% (most U) to +239% (C-14)
Contaminated layer thickness (m)	1	3	-58% (C-14) to 0% (Cs-137, others)
Contaminated layer area (m^2)	10,000	various	DCGLs increase as area decreases
Unsaturated zone thickness (m)	2	1	-26% (Sr-90) to 0% (Cs-137, most others)
Unsaturated zone thickness (m)	2	5	0% (Cs-137, others) to +188% (Sr-90)
Irrigation/well pump rate (m/y, m^3/y)	0.5/5720	0.2/2720	-1% (C-14, Tc-99) to +29% (Sr-90)
Irrigation/well pump rate (m/y, m^3/y)	0.5/5720	0.8/8720	-20% (Sr-90) to +1% (Tc-99)
Lower K_d values (mL/g)	various	lower	-86% (Sr-90) to +2% (C-14)
Higher K_d values (mL/g)	various	higher	-4% (C-14) to +1622% (U-232)

Results of sensitivity analyses (2)

Parameter (units)	Base Case	Change	Range of $DCGL_W$ Changes
Hydraulic conductivity (m/y)	1400	500	-0% (all)
Hydraulic conductivity (m/y)	1400	3500	-0% (all)
Well intake depth (m)	5	3	-0% (all)
Well intake depth (m)	5	10	-0% (all)
Runoff/evapotransp. coefficient	0.2/0.5	0.1/0.25	-16% (Sr-90) to +6% (I-129, Np-237)
Runoff/evapotransp. coefficient	0.2/0.5	0.4/0.78	-3% (C-14, Tc-99) to +283% (U-232)
Groundwater model	MB	ND	0% (Cs-137, others) to +549% (U-232)*

*Sr-90 +188%

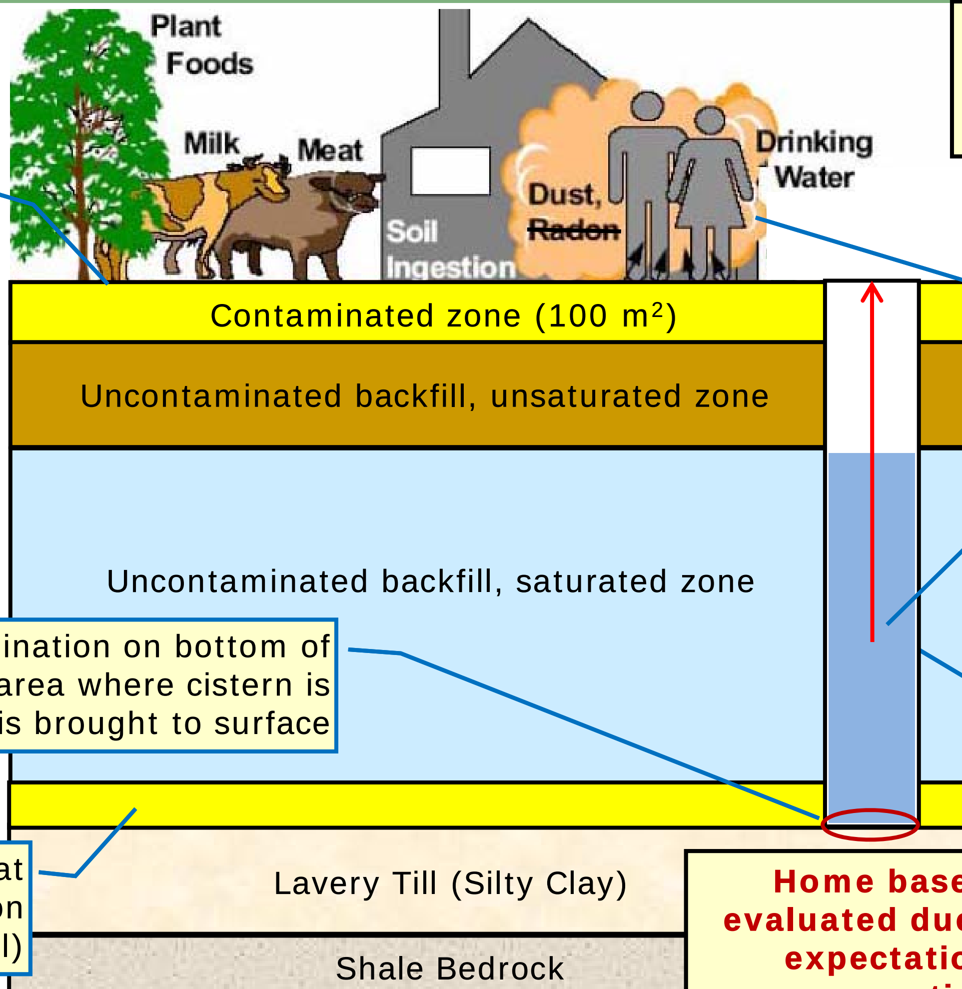
Subsurface soil DCGL areas of interest



Subsurface soil conceptual model

Model applies to both WMA 1 and WMA 2 excavations

Contaminated zone is garden soil in 100 m² area 0.3 m thick contaminated by radioactivity from the excavation bottom brought to surface and mixed with other clean excavated backfill.



A resident farmer is the average member of the critical group.

Well (cistern) intake depth 5 m below water table

Contamination on bottom of excavation in area where cistern is installed is brought to surface

Hypothetical cistern (2 m diameter well, 10 m deep)

Residual Radioactivity at Bottom of Excavation (Lavery Till)

Home basement construction not evaluated due to contamination depth, expectation that sloped sides of excavation not contaminated.

Pathways for resident farmer, subsurface soils DCGLs

Pathway	Active	Remarks
External gamma radiation	Yes	From contamination in drill cuttings
Inhalation of dust	Yes	Contaminated by drill cuttings
Radon inhalation	No	Ra predominately naturally occurring
Ingestion of plant foods	Yes	Grown in soil contaminated by cuttings
Ingestion of meat	Yes	Contamination from drill cuttings
Ingestion of milk	Yes	Contamination from drill cuttings
Ingestion of fish	No	Streams analyzed separately
Ingestion of soil	Yes	Contaminated by drill cuttings
Ingestion of water	Yes	Groundwater from well and through indirect pathways (irrigation, livestock)

Planned pathways used

Key model input parameters

Parameter	Planned WMA 1	Planned WMA 2	Modeled	Remarks
Contaminated zone area (m^2)	1-12,000*	1-17,000*	100	100 m^2 area on surface.
Contaminated zone thickness (m)	-	-	0.3**	Excavated from Lavery till
Depth to Lavery till contam. (m)	9 (30 ft)	4.3 (14 ft)	10	Representative value.
Residual contamination (m)	0.6 (2 ft)	0.6 (2 ft)	1.0	Thickness in Lavery till.
Unsaturated zone thickness (m)	3.5	2.0	2.0	
Contaminated zone erosion rate	0	0	0	
Aquifer productivity (m^3/y)	330-1520	330-1520	5720	Value used conservative.
Well diameter (m)	0.2 -1.4	0.2 -1.4	2.0	Value used conservative.
Sr soil K_d (mL/g)	5	5	6.16	Site-specific value used.$^+$
Cs soil K_d (mL/g)	447	447	150	Site-specific value used.$^+$
Am soil K_d (mL/g)	1450	1450	1000	Value used conservative.$^+$

*Was for bottom of excavation **More plausible than 1 m $^+$Table 3-20 provides basis.

Continuing contribution from Lavery till (1)

- Evaluation of leaching of buried radionuclides to groundwater using dose to source factors or another method found not to be necessary
  - Model has well screened in uncontaminated backfill (slide 39) where sufficient water for resident farmer would be available
  - Well screened entirely in Lavery till could not produce enough groundwater for the resident farmer scenario
  - Contaminant migration upward from the Lavery till to the backfill where the well is screened would be unlikely due to the vertical downward groundwater gradient
  - Diffusive movement from the Lavery till to the uncontaminated backfill is unlikely due to the very low diffusion coefficients for radionuclides

Continuing contribution from Lavery till (2)

- Other reasons why evaluation of leaching of buried radionuclides to groundwater using dose to source factors or another method found not to be necessary
  - Residual contamination levels in the Lavery till are expected to be very low (not more than 10s of pCi/g)
  - Radionuclide K_d values for the Lavery till are high, limiting partitioning to the uncontaminated backfill
  - Small amounts of contaminants that might be released from the Lavery till would be diluted with groundwater in the uncontaminated backfill

Addressing sensitivities and uncertainty

- Planned to perform analyses as with development of surface soil DCGLs
  - Surface soil sensitivity analyses results considered to be representative of subsurface soil
  - Also analyzed sensitivity of well diameter
- Results were to be evaluated and any appropriate adjustments to the conceptual model made
  - Considered results and made no changes

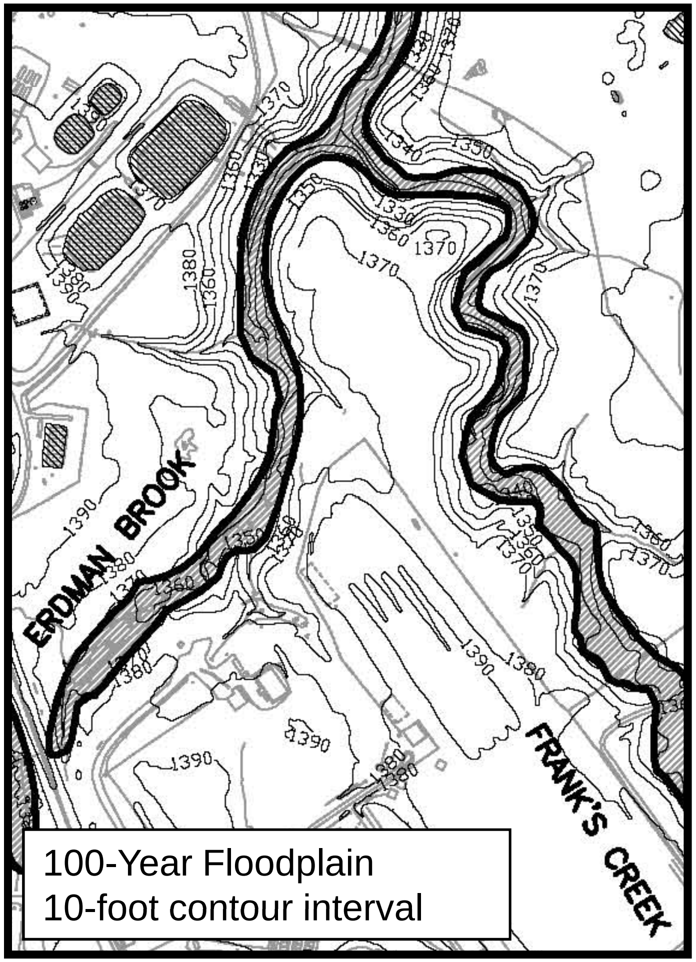
Results of sensitivity analysis

Parameter (units)	Base Case	Change	Range of $DCGL_W$ Changes
Well diameter (m)	2	0.02	+613% (Am-241) to +10,164% (I-129)

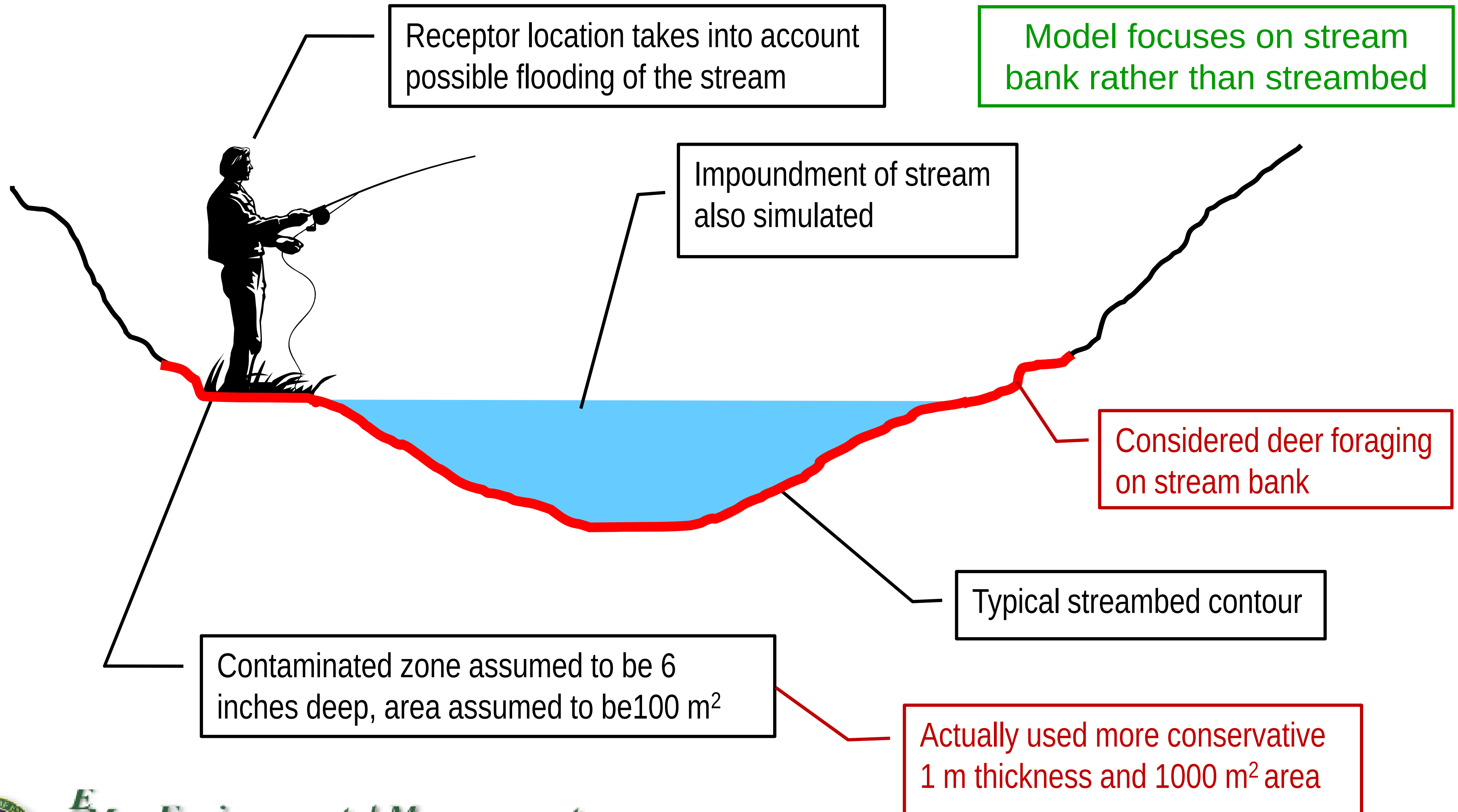
- The 20 cm (8 in) well diameter is typical for a well
  - However, amount of soil brought to the surface with such a small well diameter would be too small for a practical garden
- Sensitivity to depth to Lavery till contaminated zone also considered
  - Depth less than 10 m would result in a smaller total volume of removed soil with higher radioactivity concentrations due to mixing
  - Depth greater than 10 m would result in opposite affect
  - No significant impact would result

Streambed conceptual model

- Member of critical group – recreationist
  - Exposed to contamination in streambed, water, and fish (and venison)
  - Exposure duration assumed to be 104 hrs/y
- Impoundment scenario was also to be considered
  - Modeled by assuming 100% of ingested fish and water contaminated (exposed within the local watershed, i.e, fish are captive in contaminated stream water)



Streambed geometry model



Pathways for streambed sediment DCGLs

Planned pathways used, with 2 changes

Pathway	Active	Remarks
External gamma radiation	Yes	From streambed sediment during recreation
Inhalation of dust	No	Moisture prevents airborne dust
Radon inhalation	No	Radon predominantly naturally occurring
Ingestion of plant foods	No	No farming on steep banks
Ingestion of meat (beef)	No	No farming on steep banks
Ingestion of meat (venison)	Yes	Evaluated hunting
Ingestion of milk	No	No farming on steep banks
Ingestion of fish	Yes	Potential impoundment of stream
Ingestion of sediment	Yes	Incidental during recreation
Ingestion of water	Yes	Only incidental drinking water

Key input parameters

Parameter	Value	Basis
Stream geometry	Slide 47	Concept as planned
Contamination thickness (m)	1	Planned 0.2 m (6 in)
Source area (m^2)	1000	Planned 100 m^2
Unsaturated zone thickness	0	Assumed 0 due to stream bank location
Sr K_d (mL/g)	200	Planned 5, site-specific value used.*
Cs K_d (mL/g)	30,000	Planned 447, site-specific value used.*
Am K_d (mL/g)	1000	Planned 1450, site-specific value used.*

Changes to planned parameters as indicated

*Table 3-20 provides values and their basis.

Addressing sensitivities and uncertainty

- Analyses planned to be performed as with development of soil DCGLs, focusing on
  - Contaminant source geometry √ [area evaluated in area factor calculations]
  - Use of surface soil K_d values for sediment √
  - Fish bioaccumulation factors [determined not to be useful]
- Results were evaluated, but no adjustments to the conceptual model were needed

Results of sensitivity analyses

Parameter (units)	Base Case	Change	Range of $DCGL_W$ Changes
Outdoor time fraction	0.012	0.006	0% (C-14) to +97% (Cm-243, U-232)
Outdoor time fraction	0.012	0.024	-50% (Cm-243, U-232) to 0% (C-14)
Contaminated layer thickness (m)	1	0.5	0% (Am-241, Cm, Pu) to +124% (C-14)
Contaminated layer thickness (m)	1	3	-57% (C-14) to 0% (Cs-137, Sr-90, others)
Contaminated layer area (m^2)	1000	various	DCGLs increase as area decreases
Unsaturated zone thickness (m)	0	1	0% (Cs-137) to +74% (C-14)
Unsaturated zone thickness (m)	0	3	0% (Cs-137) to +90% (I-129)
Lower K_d values (mL/g)	various	Lower*	-63% (Tc-99) to +1% (U-232)
Higher K_d values (mL/g)	various	higher	-11% (U-232) to +117% (C-14)
Runoff/evapotransp. coefficient	0.2/0.5	0.1/0.25	0% (Sr-90, others) to +8% (U-232)
Runoff/evapotransp. coefficient	0.2/0.5	0.4/0.78	-9% (U-232) to 0% (Sr-90, Cs-137)

*Included use of site-specific surface soil K_d values for Cs, Np, Pu, and Sr.

Mathematical model

- RESRAD used because
  - Extensive use by DOE and NRC licensees
  - Evaluates multiple exposure pathways for direct contact with radioactivity, indirect contact, and food intake – the conditions being evaluated at the WVDP
- RESRAD used with conceptual models to calculate unit dose factors (mrem per pCi/g)
  - Mass balance model used for conservatism (with sensitivity analysis for use of the non-dispersion model)
- Microsoft Excel used to scale unit dose factors to 25 mrem/y

Preliminary $DCGL_W$ values in pCi/g

Nuclide	Surface Soil	Subsurface Soil	Streambed Sediment	NRC Surface Soil Screening DCGL
Sr-90*	3.4	3500	10,000	1.7
Cs-137*	30	440	1300	11
Pu-238	64	12,000	20,000	2.5
Pu-239	58	11,000	18,000	2.3
U-238	1.1	1100	13,000	14
Am-241	54	6400	15,000	2.1

**Sr-90 and Cs-137 DCGLs for 25 mrem/y as of year 2041.*

DCGLs also calculated for the 12 other radionuclides.

Preliminary $DCGL_{EMC}$ values in pCi/g

Nuclide	Surface Soil		Subsurface		Streambed Sediment	
	$DCGL_W$	$DCGL_{EMC}$	$DCGL_W$	$DCGL_{EMC}$	$DCGL_W$	$DCGL_{EMC}$
Sr-90*	3.4	9000	3500	220,000	10,000	1,500,000
Cs-137*	30	340	440	3700	1300	12,000
Pu-238	64	8500	12,000	92,000	20,000	17,000,000
Pu-239	58	7700	11,000	83,000	18,000	14,000,000
U-238	1.1	3300	1100	38,000	13,000	130,000
Am-241	54	4400	6400	46,000	15,000	370,000

*DCGLs for 25 mrem/y as of year 2041 and later

$DCGL_{EMC}$ estimates developed for 1 m^2 area using each RESRAD model with an area of 1 m^2 for the contaminated zone. They are also provided for the 12 other radionuclides.

Conservatism in DCGL development – 1

- Surface soil DCGLs
  - Typical thickness of contaminated zone is likely much less than 1 m value used in model
  - Crop and forage yields likely less than those assumed because of short regional growing season
  - Leachate assumed for all water uses (mass-balance model feature), although less use is more plausible

Conservatism in DCGL development – 2

- Subsurface soil DCGLs
  - The hypothetical large diameter well (cistern) results in 100 times more radioactivity being brought to the surface to cause exposure than a typical 0.2 m (8 in) diameter well
  - Crop and forage yields likely less than those assumed because of short regional growing season
  - Leachate assumed for all water uses, although less use is more plausible

Conservatism in DCGL development – 3

- Streambed sediment soil DCGLs
  - Typical contamination zone thickness is likely less that 1 m
  - Most sediment contamination is expected to be in streambeds, not on incised banks as modeled
  - Rates used for incidental sediment ingestion (50 mg/d) likely high
  - Assumptions that all fish and venison eaten are impacted by the streambed source are likely conservative
  - Assumption about fish population very conservative compared to present conditions in the streams
  - Leachate assumed for all water uses, although less use is more plausible

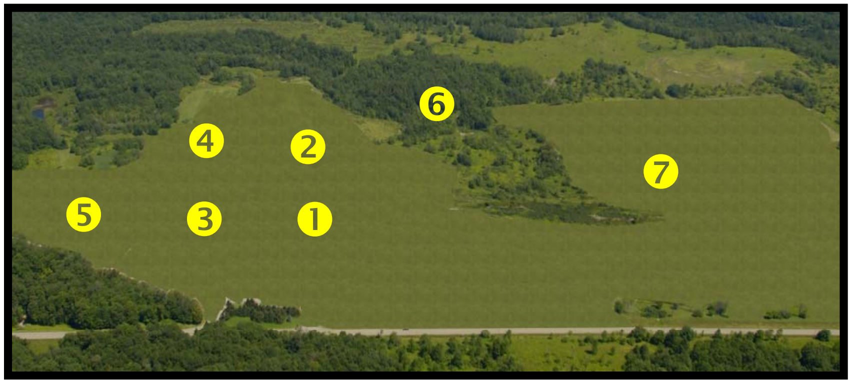
Limited site-wide dose assessment

- Used the planned approach
  - Resident farmer in the remediated WMA 1 area who spends time in the area of the streams hiking and fishing
- Also analyzed a second combined exposure
  - Resident farmer in area where surface soil had been remediated who spends time in the area of the streams hiking and fishing
- In both scenarios, a hypothetical individual is treated as a member of two critical groups
  - With appropriate dose apportionment

Site-wide removal alternative (Phase 2)

1) WMA 1 excavation remediation below subsurface soil DCGLs
2) WMA 2 excavation remediation below subsurface soil DCGLs
3) Underground waste tanks removed, soil remediated to DCGLs
4) Non-source area of plume removed, soil remediated to DCGLs
5) Surface soil remediated to DCGLs
6) Stream sediment remediated to DCGLs
7) Waste in NDA exhumed, shipped off site, area remediated to DCGLs

All DCGLs would be based on <25 mrem/y, ALARA for unrestricted release.



Assessment approach

- Partitioned acceptable doses
  - 0.9/0.1 ratio
  - 22.5 mrem/y to resident farmer activities
  - 2.5 mrem/y to recreational activities
- Based on judgment from risk-management standpoint
  - Partitioning based only on 104 hours per year at streams would have greatly reduced streambed sediment DCGLs with minimal impact on soil DCGLs
- Approach analogous to using sum-of-fractions rule for mixtures of radionuclides
- Assessment performed using the base-case analysis results for the resident farmer and the recreationist

Preliminary assessment results in pCi/g

Nuclide	Surface or Subsurface Soil $DCGL_W$			Streambed Sediment $DCGL_W$		
	Base Case	Run 1	Run 2	Base Case	Run 1	Run 2
Sr-90*	3.4	3100	3.1	10,000	1000	1000
Cs-137*	30	390	27	1300	130	130
Pu-238	64	11,000	58	20,000	2000	2000
Pu-239	58	10,000	52	18,000	1800	1800
U-238	1.1	1000	0.94	13,000	1300	1300
Am-241	54	5800	49	15,000	1500	1500

Run 1 = resident farmer in remediated WMA 1 area who spends time at streams

Run 2 = resident farmer in area of remediated surface soil who spends time at streams

*DCGLs for 25 mrem/y as of year 2041 and later

Results for the 12 other radionuclides as well

Cleanup goal approach

- Cleanup goals appropriately below the DCGLs have been established to be used in the remediation work, based on
  - The results of the combined assessment
  - The ALARA analysis being described in Section 6
  - Consideration of potential erosion in WMA 2
- The Section 6 ALARA analysis
  - Evaluates cost-benefits of remediation to residual radioactivity concentrations below the DCGLs, considering the costs of incremental removal of additional soil or sediment
  - Follows the methodology of Appendix N to NUREG-1757, vol. 2
  - Provides for a two-stage analysis: before remediation (with the results in the DP) and during the remediation process when more data about residual radioactivity become available

Preliminary ALARA analysis

- Preliminary analysis methodology considers
  - The cost of additional contaminated soil disposal at $6.76 per cubic foot
  - The benefits of reduced dose at $2000 per person-rem
- Results suggest costs would outweigh benefits
- Final analysis
  - Will be performed during the Phase 1 decommissioning, will use updated information, and will take additional factors into account

Preliminary cleanup goals in pCi/g

Nuclide	Surface Soil		Subsurface		Streambed Sediment	
	CG_W	CG_{EMC}	CG_W	CG_{EMC}	CG_W	CG_{EMC}
Sr-90	3.1	8100	1600	100,000	1000	150,000
Cs-137	27	300	200	1700	130	1200
Pu-238	58	7700	5500	41,000	2000	1,600,000
Pu-239	52	7000	5000	38,000	1800	1,400,000
U-238	1.0	3000	500	17,000	1300	13,000
Am-241	49	4000	2900	21,000	1500	37,000

Cleanup goals consistent with dose limits shown on the next slide, with Sr-90 and Cs-137 cleanup goals consistent with these dose limits as of year 2041

$DCGL_{EMC}$ estimates for 1 m^2 area.

Results for the 12 other radionuclides as well

Basis for cleanup goals

- Surface soil
  - Uses the assessment DCGLs, which are slightly lower than the DCGLs developed separately for surface soil, equivalent to 22.5 mrem/y
  - Considered conservatism in DCGL development
- Subsurface soil in WMA 1 and WMA 2 excavations
  - Set at 50% of the assessment DCGLs, equivalent to 11.25 mrem/y, considered to be conservative and achievable
- Streambed sediment
  - Uses the assessment DCGLs, which are much lower than the DCGLs developed separately for the streambeds, effectively based on 2.5 mrem/y dose limit

Additional analyses

- Refining DCGLs and cleanup goals
  - Will use additional characterization data on soil and sediment collected early in Phase 1 to refine DCGLs and cleanup goals
  - These data may, for example, lead to more realistic source geometry (thickness and area)
- Use of surrogate radionuclide DCGLs
  - If additional characterization data make it practical, surrogate radionuclide DCGLs will be developed for use
- Final dose assessment
  - As discussed previously, a dose assessment for the WMA 1 and WMA 2 excavated areas using actual final survey status data will be required

Appendix C, Supporting Details

- Table C-1 – complete list of input parameters and their basis
- Table C-2 – K_d values and their basis
- Table C-3 – list of exposure pathways evaluated
- Detailed description of Attachment 1 contents
- Attachment 1 contains
  - Excel spreadsheets with model input parameters
  - RESRAD input files
  - RESRAD output files
  - Excel files with (1) RESRAD outputs, (2) data summaries, (3) $DCGL_W$ calculations, (4) calculations for area factors, and (5) summaries of sensitivity analysis results.

DOE plans to provide Attachment 1 electronically (on CD) only and wants to make sure that will be acceptable to NRC.

In summary

- DOE has developed DCGLs for unrestricted release for surface soil, subsurface soil in the WMA 1 and WMA 2 excavations, and streambed sediment using appropriate conceptual models and RESRAD
- A preliminary ALARA analysis has evaluated remediation below DCGLs
- The relationships between the Phase 1 removal actions and the potential decommissioning approaches for Phase 2 have been addressed by two assessments that combined exposure scenarios for the site-wide removal approach
- Cleanup goals to be used in the Phase 1 decommissioning work have been established based on the results of the combined exposure assessments to ensure that the Phase 1 end state does not limit Phase 2 decommissioning options and that the cleanup criteria are fully protective of human health
- The DP will require an analysis to be performed after the Phase 1 work is completed that will use actual data to estimate the potential doses from the residual radioactivity from the areas remediated in Phase 1