

## **Appendix G**

### **Summary of PCB RAL Evaluation for Floodplain Soil**

Source: *Area 1 Alternatives Screening Technical Memorandum* (ARCADIS 2012b)

A range of RALs was considered to compare incremental risk reduction to the current post-TCRA conditions. Candidate PCB RALs of 0.5, 5, 10, 15, 20, and 25 mg/kg were evaluated for floodplain soil within the formerly-inundated area in the former Plainwell Impoundment and Plainwell No. 2 Dam Area (evaluation areas). The evaluation of each RAL began with identification of areas where surface (0-6 inch depth interval) soil PCB concentrations are currently greater than the specified RAL. The identification of areas was based on the spatially interpolated surface (natural neighbor interpolation) soil PCB concentration map developed for the Area 1 TBERA (ARCADIS 2012d) for post-removal action conditions in the former Plainwell Impoundment and the Plainwell No. 2 Dam Area. Discontinuous areas smaller than ¼ acre were not included in the footprint identified for each RAL. A sensitivity analysis was conducted to determine if this quarter acre size-cut off had a significant impact on the estimation of area, and it was found to have little impact. Further detail is presented in Attachment 1 of this Appendix.

The distribution of available soil PCB concentrations in the natural floodplain outside of the two TCRA areas was evaluated and compared to the PRG. A detailed RAL analysis was not conducted for those areas due to the small data set and the generally lower soil PCB concentrations observed. Only one out of 68 samples exhibited PCB concentrations above the selected 11 mg/kg PRG. These data along with a 95% UCL exposure concentration (2.55 – 6.28 mg/kg) are presented in Section 6.0.

The RAL analysis was performed by identifying areas greater than a quarter acre with soil concentrations exceeding each RAL within the evaluation area. Sample locations within the identified areas that were greater than each RAL were then replaced with a post-excavation PCB concentration of 0.078 mg/kg, which represents the assumed PCB concentration of clean backfill placed after excavation. A circular-shaped moving window of 1, 2, and 11 acres centered on grid points spaced in 1-foot increments was then run over the evaluation area with the replacement value data to calculate post-remediation EPCs. A moving window of 1 acre represents the home range for the shrew. A 2-acre moving window represents the home range for the American robin and house wren, and an 11-acre moving window represents the home range for the American woodcock.

An array of 1-acre home ranges placed in non-overlapping adjacent circles across the former Plainwell Impoundment produces 57, 1-acre home ranges in this area. The array of 1-acre overlapping home ranges centered on the 1-foot grid produces over 2.5 million possible EPCs. The latter approach was used to estimate exposure area boundaries exceeding each RAL (i.e., with a one-foot resolution) to prevent underestimation of EPCs as a result of arbitrary placement of home range boundaries. Analysis of the EPCs generated for all three home range sizes indicated that the use of 1- and 2- acre moving windows results in higher EPC estimates than using an 11-acre moving window (Figure G-1). Therefore, this evaluation focused on the 1- and 2-

acre estimates because they are considered protective of the American woodcock. Further details on this process are included in Attachment 1.

Implementation of an RAL of 0.5 mg/kg would result in removal of the vast majority of the unremediated portions of the floodplain soil in both the former Plainwell Impoundment (Figure G-2) and Plainwell No. 2 Dam Area (Figure G-3), as well as large areas of the natural floodplain in other parts of Area 1. The resulting EPCs based on 1- and 2-acre moving windows would fall below 0.5 mg/kg. As such, the 0.5 mg/kg RAL scenario would be protective of 100% of the home ranges of the receptors (i.e., soil PCB concentrations would be below the RBC for the most sensitive receptor, see below). Thus, a formal moving window home range analysis was not necessary for this scenario. The remainder of the RAL evaluation focuses on the RALs of 5, 10, 15, 20 and 25 mg/kg.

Figure G-4 shows the distribution of EPCs for the evaluation area, based on the 1-acre and 2-acre moving windows for pre-TCRA conditions, current (post-TCRA) conditions, and each RAL scenario. As shown on this graph, the completed TCRA actions in the former Plainwell Impoundment and the Plainwell No. 2 Dam Area resulted in a significant reduction in EPCs, reducing the 75<sup>th</sup> percentile EPC from approximately 10 mg/kg to 4 mg/kg under current conditions for the 1-acre scenario. A similar reduction is observed for the 2-acre moving window EPCs.

Figure G-5 shows cumulative frequency plots of the EPCs based on the 1- and 2-acre moving windows for the former Plainwell Impoundment and the Plainwell No. 2 Dam Area. Figure G-6 provides a summary of the performance of each candidate RAL based on percent of possible home ranges within a given area that are below the RBC values for the various ecological receptors.

To provide risk managers with an understanding of the relationships among the candidate RALs and the full range of ecological receptor RBCs (independent of relative uncertainty considerations among RBC values), the results are also presented in comparison to a series of concentration intervals that are not based on the Area 1 TBERA results, but span the range of RBCs for the types of receptors found to potentially be at risk, if present in these areas. The 1- and 2-acre moving window results for the two evaluation areas are shown on Figures G-7 through G-9.

### **Area and Volume Estimates**

The areas and volumes associated with each of the candidate RAL scenarios are summarized in Table G-1 for two removal scenarios. The volumes shown in Table G-1 may vary from those used to estimate costs in Section 5 and Appendix H, because the latter volumes were increased by a factor to account for additional excavation needed to reach a given location and adjustments that may be made in the field.

The first scenario is based on an assumed uniform soil removal thickness of 1 foot, presuming that one foot of clean backfill would be placed over the excavation area to provide at least 6 inches of new soil habitat to reduce ecological exposure risk. The second scenario provides

approximate removal volumes associated with achieving a cleanup goal of 5 mg/kg. The second scenario volumes were calculated using a natural neighbor interpolation between sample data within the former impoundment area to estimate the excavation depths that would be needed to remove PCB concentrations greater than 5 mg/kg within the area of remediation. Figure G-10 illustrates the interpolation performed to identify the depth required to capture PCB concentrations greater than 5 mg/kg for the former Plainwell Impoundment.

**Table G-1. Surface Areas and Volumes within the former Plainwell Impoundment and the Plainwell No. 2 Dam Area Associated with 5, 10, 15, 20, and 25 mg/kg Candidate RAL Scenarios**

RAL (mg/kg)	Area of Remediation (acres)	Volume to 1 foot depth (cubic yards)	Volume to < 5 mg/kg (cubic yards)
<b>Former Plainwell Impoundment</b>			
5	26	43,000	42,000
10	17	28,000	31,000
15	12	19,000	24,000
20	7	11,000	15,000
25	4	6,600	9,000
<b>Plainwell No. 2 Dam Area</b>			
5	12	19,000	8,800
10	3	5,000	3,100

The areas and volumes associated with the RAL of 0.5 mg/kg are summarized in Table G-2. The volumes in Table G-2 are based on an assumed uniform soil removal depth of 1 foot (see rationale for Table G-1 scenario 1 above).

**Table G-2. Areas and Volumes Associated with the 0.5 mg/kg RAL Scenario**

Area	Area of Remediation (acres)	Volume (cubic yards)
Former Plainwell Impoundment	39	63,000
Plainwell No. 2 Dam Area	75	120,000
Natural floodplain upstream of Plainwell No. 2 Dam Area	660	1,100,000
Natural floodplain between the former Plainwell impoundment and Plainwell No. 2 Dam Area	75	120,000
<b>Total:</b>	<b>850</b>	<b>1,400,000</b>

## Assessment of RALs and Receptor RBCs

The evaluation of each RAL is based on the protectiveness to potential receptors and the scale of the possible remedy. Table G-3 summarizes the area, volumes, and protectiveness of each RAL scenario for the various ecological receptors for which possible risk was identified in the Area 1 TBERA (ARCADIS, 2012d). Under current (i.e., post-TCRA) conditions, no unacceptable risk was identified for carnivorous birds and mammals and mid-range sensitivity birds. There is also no unacceptable risk identified for vermivorous mammals and high sensitivity birds under current conditions in the Plainwell No. 2 Dam area. Below is a summary listing changes in home ranges protected following the former Plainwell Impoundment and Plainwell No. 2 Dam area TCRAs.

Former Plainwell Impoundment (see Attachment 1 Figure A-39)

- 48% of home ranges were protective for vermivorous mammals pre-TCRA
- 82% of home ranges were protective for vermivorous mammals in current conditions
- 59% of home ranges were protective for high sensitivity birds pre-TCRA
- 96% of home ranges were protective for high sensitivity birds in current conditions

Plainwell No. 2 Dam Area (see Attachment 1 Figure A-40)

- 97% of home ranges were protective for vermivorous mammals pre-TCRA
- 100% of home ranges were protective for vermivorous mammals in current conditions
- 98% of home ranges were protective for high sensitivity birds pre-TCRA
- 100% of home ranges were protective for high sensitivity birds in current conditions

In addition to the RBCs from the Area 1 TBERA, the original RBC for the American robin (site-specific NOAEL-based RBC = 6.5 mg/kg; site-specific LOAEL-based RBC = 8.1 mg/kg; geometric mean RBC = 7.2 mg/kg) from the Site-Wide BERA (CDM 2003) is also included in this evaluation. For highly exposed, high sensitivity species with a predominantly vermivorous diet (i.e., greater than 40% terrestrial invertebrates), the RBC from the Site-wide BERA (CDM 2003a) was updated in the Area 1 TBERA by revising dietary inputs at the direction of USEPA. The robin-based RBCs from the Area 1 TBERA that were calculated with specific input from USEPA to reduce uncertainty in the model used in the Site-Wide BERA (site-specific NOAEL-based RBC = 13 mg/kg; site-specific LOAEL-based RBC = 16 mg/kg; geometric mean RBC = 14 mg/kg) are included as a means of considering additional uncertainty that may exist with the exposure models. The protectiveness percentages shown in Table G-3 are based on the geometric mean of NOAEL and LOAEL-based RBCs to facilitate comparison between RALs. The NOAEL, LOAEL, and geometric mean values considered for each approach for each receptor are listed in Table G-4.

## RAL Analysis Summary

The current conditions and the associated incremental risk reduction for each RAL scenario are summarized below based on the home range analyses performed for the former Plainwell Impoundment and Plainwell No. 2 Dam Area. The RAL analysis is based on residual (post-TCRA)

soil PCB concentrations in these areas. Home range analysis for each of the candidate RALs from 5 to 25 mg/kg was performed for the former Plainwell Impoundment. Home range analysis for the Plainwell No. 2 Dam Area was performed only for RALs of 5 mg/kg and 10 mg/kg because residual (post-TCRA) soil PCB concentrations are already below 15 mg/kg in this area. Only the RAL of 0.5 mg/kg was considered for all of Area 1 (including both TCRA areas), though a formal home range analysis was not performed for this RAL as it would result in residual PCB concentrations throughout Area 1 that are below the RBCs for the highest sensitivity receptors.

**Current Conditions:** As shown in Table G-3, current conditions are protective of a high percentage of possible home ranges evaluated based on the range of RBCs for dietary exposure calculated in the TBERA (i.e., 82% for vermivorous mammals to 99% for insectivorous birds for the former Plainwell Impoundment and 100% for all receptors for the Plainwell No. 2 Dam Area); while the percentages of home ranges protected for egg-based approaches are very low (2% to 5% for the former Plainwell Impoundment and 1% to 9% for the Plainwell No. 2 Dam Area). As discussed in Attachment 1, there is lower confidence in the RBCs for egg-based approaches due to the relatively high uncertainty associated with exposure and effect inputs. RBCs for the American robin from the Site-Wide BERA have also been considered. However, there is lower confidence in these RBCs relative to those calculated in the TBERA. By comparison, updated RBCs for the American robin (i.e., vermivorous birds) calculated in the TBERA, which have higher confidence, are protective of 96% of home ranges for the former Plainwell Impoundment and 100% of home ranges for the Plainwell No. 2 Dam Area under current conditions. Both of these vermivorous bird RBC values are based on the assumption that highly exposed, high sensitivity vermivores are present in Area 1, when none have been observed or documented. Current conditions are also protective of carnivorous birds and mammals. Local populations are not likely adversely affected by PCBs in soil under current conditions because of the conservative nature of the risk estimates and the fact that the actual habitat area, that would support a local bird population, is much larger than the two TCRA areas evaluated herein.

**RAL 25 mg/kg:** This RAL was evaluated only for the former Plainwell Impoundment because residual (post-TCRA) soil PCB concentrations were already below 25 mg/kg in the Plainwell No. 2 Dam Area.

Remediating residual soil in the former Plainwell Impoundment with PCB concentrations greater than 25 mg/kg results in:

- 89% of home ranges for vermivorous mammals being protected based on the dietary RBC from the Area 1 TBERA
- 100% of home ranges for insectivorous/vermivorous birds being protected based on the dietary RBC from the Area 1 TBERA.

- 75% of possible home ranges being protected based on the original RBC from the Site-Wide BERA (CDM 2003a), which has higher uncertainty<sup>1</sup>
- 3% to 6% of possible home ranges being protected based on the egg-based approaches, which have a higher degree of uncertainty than the dietary approaches<sup>2</sup>

The potential remediation area and volume for this scenario are approximately 4 acres and 9,000 cy of soil, respectively.

**RAL 20 mg/kg:** This RAL was evaluated only for the former Plainwell Impoundment because residual (post-TCRA) soil PCB concentrations were already below 20 mg/kg in the Plainwell No. 2 Dam Area.

Remediating residual soil with PCB concentrations greater than 20 mg/kg in the former Plainwell Impoundment results in:

- 95% of home ranges for vermivorous mammals being protected based on the dietary RBCs from the Area 1 TBERA
- 100% of home ranges for insectivorous/vermivorous birds being protected based on the dietary RBCs from the Area 1 TBERA.
- 83% of possible home ranges being protected based on the original RBC from the original Site-Wide BERA (CDM 2003a), which has higher uncertainty<sup>1</sup>
- 4% to 9% of possible home ranges protected based on the egg-based approaches, which have a higher degree of uncertainty than the dietary approaches<sup>2</sup>

The potential remediation area and volume for this scenario are approximately 7 acres in area and 15,000 cy of floodplain soil, respectively. The additional 3 acres and associated incremental volume of floodplain soil removal compared to the RAL of 25 mg/kg scenario are accompanied by an approximate 6% decrease in risk based on vermivorous mammals for the former Plainwell Impoundment area.

**RAL 15 mg/kg:** This RAL was evaluated only for the former Plainwell Impoundment because all residual (post-TCRA) soil PCB concentrations were already below 15 mg/kg in the Plainwell No. 2 Dam Area.

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<sup>1</sup> The RBC for highly exposed, high sensitivity species with a predominantly vermivorous diet (i.e. greater than 40% terrestrial invertebrates) from the Site-wide BERA (CDM 2003a) was later updated in the Area 1 TBERA by revising dietary inputs at the direction of USEPA.

<sup>2</sup> Uncertainty in the egg injection studies arises from the unnatural process of injection in the laboratory which is not a natural bioaccumulation process, and among other limitations imparts relatively greater uncertainty than dietary based estimates supported by site-specific data.

Remediating residual soil with PCB concentrations greater than 15 mg/kg in the former Plainwell Impoundment results in:

- 100% of home ranges being protected for all receptors based on the dietary RBC from the Area 1 TBERA
- 99% of possible home ranges being protected based on the original RBC from the Site-Wide BERA (CDM 2003a), which has higher uncertainty<sup>1</sup>
- 4% to 10% of possible home ranges being protected based on the egg-based approaches, which have a higher degree of uncertainty than the dietary approaches<sup>2</sup>

The potential remediation area and volume for this scenario are approximately 12 acres in area and approximately 24,000 cy of floodplain soil, respectively. These quantities are almost double that of the 20 mg/kg RAL while the relative risk reduction achieved by this lower RAL is approximately 5% in the former Plainwell Impoundment based on vermivorous mammals. Little additional risk reduction is achieved at a substantial increase in the area and volume of soils that would potentially be remediated.

**RAL 10 mg/kg:** This RAL was evaluated in both the former Plainwell Impoundment and the Plainwell No. 2 Dam Area.

Remediating residual soil with PCB concentrations greater than 10 mg/kg in the Plainwell No. 2 Dam Area results in:

- 100% of home ranges for all birds and mammals being protected based on the dietary RBCs from the Area 1 TBERA and the original Site-Wide BERA
- 1% to 10% of possible home ranges being protected based on the egg-based approaches, which have a higher degree of uncertainty than the dietary approaches<sup>2</sup>

Remediating residual soil with PCB concentrations greater than 10 mg/kg in the former Plainwell Impoundment results in:

- 100% of home ranges for all birds and mammals being protected based on the dietary RBCs from the Area 1 TBERA and the original Site-Wide BERA
- 14% to 26% of possible home ranges protected based on the egg-based approaches, which have a higher degree of uncertainty than the dietary approaches<sup>2</sup>

The potential remediation area and volume for this scenario are approximately 17 acres and approximately 31,000 cy of floodplain soil for the former Plainwell Impoundment and approximately 3 acres and approximately 3,100 cy of floodplain soil for the Plainwell No. 2 Dam Area, respectively. The increase in potential remediation effort to implement an RAL of 10 mg/kg

almost triples the area as compared to the 20 mg/kg RAL, while the risk reduction achieved by this lower RAL is approximately 5% in the former Plainwell Impoundment based on vermivorous mammals.

**RAL 5 mg/kg:** This RAL was evaluated in both the former Plainwell Impoundment and the Plainwell No. 2 Dam Area.

Remediating residual soil with PCB concentrations greater than 5 mg/kg in the Plainwell No. 2 Dam Area results in:

- 100% of home ranges for all birds and mammals being protected based on the dietary RBCs from the Area 1 TBERA and the original Site-Wide BERA
- 2% to 13% of possible home ranges being protected based on the egg-based approaches, which have a higher degree of uncertainty than the dietary approaches<sup>2</sup>

Remediating residual soil with PCB concentrations greater than 5 mg/kg in the former Plainwell Impoundment results in:

- 100% of home ranges for all birds and mammals being protected based on the dietary RBCs from the Area 1 TBERA and the original Site-Wide BERA
- 27% to 50% of possible home ranges being protected based on the egg-based approaches, which have a higher degree of uncertainty than the dietary approaches<sup>2</sup>

The potential remediation area and volume for this scenario are approximately 26 acres and approximately 42,000 cy of floodplain soil for the former Plainwell Impoundment and approximately 12 acres and approximately 8,800 cy of floodplain soil for the Plainwell No. 2 Dam Area, respectively. These quantities are over three times that of the 20 mg/kg RAL while the relative risk reduction achieved by this lower RAL is approximately 5% in the former Plainwell Impoundment based on vermivorous mammals.

**RAL 0.5 mg/kg:** A home range analysis was not necessary for an RAL of 0.5 mg/kg because the majority of soils in both the former Plainwell Impoundment and the Plainwell No. 2 Dam Area contain PCB concentrations above this value, as do large areas of the natural floodplains upstream of the formerly impounded areas. Remediation concentrations greater than 0.5 mg/kg would encompass large areas of the floodplains and potentially involve large volumes of soil. Remediation to this level would result in essentially 100% of home ranges for birds and mammals being protected based on all RBCs, including the most conservative values, regardless of the uncertainty in their application. The remediation area and volume for this scenario in the former Plainwell Impoundment and the Plainwell No. 2 Dam Area would be approximately 39 acres and involve approximately 63,000 cy of floodplain soil and approximately 75 acres and approximately 120,000 cy of floodplain soil, respectively. Applied to all of Area 1, the potential remediation area is estimated to exceed 850 acres and involve more than 1,400,000 cy of floodplain soil. This RAL

offers only a 5% improvement in risk reduction in the former Plainwell Impoundment area for vermivorous mammals as compared to the 20 mg/kg RAL scenario. Greater improvement would be achieved for avian protection under the egg-based models; however, as described in Attachment 1, there is considerable uncertainty and a lower confidence associated with the egg-based approaches.

### **Selection of RALs for Alternatives Development**

The Area 1-wide RAL of 0.5 mg/kg was evaluated to provide an upper bound on potential remedial actions. A soil PCB RAL of 20 mg/kg is recommended; USEPA, MDEQ and GP have agreed that 20 mg/kg is an appropriate RAL value for constructing a range of alternatives for soils to be evaluated in the FS. An RAL of 20 mg/kg is recommended based on assessment of the incremental risk reduction, protecting 95% to 100% of the receptors (shrew, wren, and robin under the dietary model) and the incremental area and soil volume associated with each value.

Following the TCRAs in the former Plainwell Impoundment and Plainwell No. 2 Dam Area, 82% and 100% of possible 1-acre vermivorous mammal home range EPCs are less than the selected floodplain surface soil PRG of 11 mg/kg, respectively in these two areas (see Table G-3). Implementing a floodplain soil RAL of 20 mg/kg results in 95% of the possible 1-acre vermivorous mammal home ranges in the former Plainwell Impoundment having soil PCB concentrations below the selected floodplain surface soil PRG of 11 mg/kg. The PRG of 11 mg/kg PCBs is also assumed to be protective of avian receptors as it represents a balance between risk and uncertainty associated with the various methodologies and assumptions used in the TBERA to calculate risk to avian receptors (see Section 2.4.7). Development and evaluation of floodplain soil remedial alternatives using RALs of 0.5 and 20 mg/kg PCBs are provided in Sections 3.0 and 5.0, respectively.

**Table G-3**  
**Summary of RAL Scenarios for Floodplain Soil (Vermivorous Mammals and High Sensitivity Vermivorous/Insectivorous Birds)**  
**Area 1, OU-5 Kalamazoo River**

Assessment Endpoint	Representative Receptor	Exposure Model	Geomean of RBCs <sup>2</sup>	Source of RBC values	Percent of Home Ranges Protected for each Candidate Remedial Action Level (RAL) (mg/kg) <sup>1</sup>										
					Former Plainwell Impoundment						Plainwell No. 2 Dam Area				
					RAL 0.5	RAL 5	RAL 10	RAL 15	RAL 20	RAL 25	Current Conditions <sup>3</sup>	RAL 0.5	RAL 5	RAL 10	Current Conditions <sup>3</sup>
Vermivorous Mammals	Shrew	Dietary	11	Area 1 TBERA	100%	100%	100%	100%	95%	89%	82%	100%	100%	100%	100%
HS Insectivorous Birds	Wren	Dietary	17	Area 1 TBERA	100%	100%	100%	100%	100%	100%	99%	100%	100%	100%	100%
HS Vermivorous Birds	Robin <sup>4</sup>	Dietary <sup>4</sup>	14	Area 1 TBERA	100%	100%	100%	100%	100%	100%	96%	100%	100%	100%	100%
HS Vermivorous Birds	Robin <sup>4,5</sup>	Dietary <sup>4,5</sup>	7.2	Site-Wide BERA	100%	100%	100%	99%	83%	75%	5%	100%	100%	100%	100%
HS Vermivorous or Insectivorous Birds	Avian Species	Egg-Based	0.6	Area 1 TBERA	100%	50%	26%	10%	9%	6%	5%	100%	13%	10%	9%
HS Vermivorous Birds	Robin <sup>4</sup>	Combination <sup>4,6</sup>	0.3	Area 1 TBERA	100%	27%	14%	4%	4%	3%	2%	100%	2%	1%	1%
<b>Area of Potential Remediation (acres):</b>					39	26	17	12	7	4		75	12	3	
<b>Volume to depth &lt; 5 mg/kg Clean Up Goal for Removal Areas (cy):</b>					63,000 <sup>7</sup>	42,000	31,000	24,000	15,000	9,000		120,000 <sup>7</sup>	8,800	3,100	

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**Notes:**

No species of this sensitivity category have been documented to be present at the Site

HS = High Sensitivity

Area 1 TBERA = Area 1 Terrestrial Baseline Ecological Risk Assessment (ARCADIS 2012b Appendix B)

Site-Wide BERA = Final (Revised) Site-Wide Baseline Ecological Risk Assessment (CDM 2003a)

LOAEL – Lowest Observed Adverse Effect Level

NOAEL – No Observed Adverse Effect Level

<sup>1</sup> The extent of habitat area supporting local populations of receptors has not been quantified, but is known to be larger than the limits of the former Plainwell Impoundment and Plainwell No. 2 Dam Areas.

<sup>2</sup> LOAEL and NOAEL RBC values are presented in Table G-4. RBC value for the shrew is between the geometric mean and the arithmetic mean of the NOAEL- and LOAEL-based RBCs.

<sup>3</sup> Current Conditions following completion of TCRAs.

<sup>4</sup> Robins have been shown to be moderately sensitive to dioxin-like effects of PCBs. No highly-sensitive species with a predominantly vermivorous diet (i.e. greater than 40% worms) have been documented at the Site

<sup>5</sup> The Site-wide BERA completed by CDM (2003a) used the robin as a representative receptor, assuming high sensitivity to PCBs. The robin RBC values from CDM 2003a have been updated in the TBERA with

<sup>6</sup> Combination of egg and dietary composition exposure models.

<sup>7</sup> Estimated based on assumed excavation depth of 1 foot where surface soil PCB concentrations are greater than 0.5 mg/kg. Actual removal volumes would be higher if removal depths in the formerly impounded

**Table G-4**  
**RBC Evaluation Summary for the Former Plainwell Impoundment and Plainwell No. 2 Dam Area Combined**  
**Area 1, OU-5 Kalamazoo River**

Category <sup>1</sup>	Receptor	Applicable Moving Window	Exposure Estimate	TRV	Endpoint	RBC	Maximum EPC Current Conditions	Protectiveness <sup>2</sup> Under Current Conditions	Comments
1	Vermivorous Mammal (shrew)	1 acre	Dietary Exposure	tPCB	LOAEL	18	24	100%	Dietary tPCB approach found to have lower uncertainty than TEQ-based approach because TEQs were extrapolated from tPCB concentrations based on an assumption of a site-specific relationship between tPCB and TEQ. Range carried forward.
					Geomean	11		94%	
					NOAEL	6		84%	
2	Vermivorous Mammal (shrew)	1 acre	Dietary Exposure	TEQ	LOAEL	27	24	100%	Because the tPCB NOAEL is well below the lowest LOAEL, that value is an appropriate lower bound. Current conditions are protective at the LOAEL and the geomean is encompassed by the tPCB range. Thus values not carried forward.
					Geomean	9		90%	
					NOAEL	3		59%	
1	Vermivorous Bird (Robin)	2 acre	Dietary Exposure	Mid-Range tPCB	LOAEL	56	20	100%	Dietary approach found to have lower uncertainty than egg-based approaches. Values not carried forward because current conditions are protective.
					Geomean	33		100%	
					NOAEL	19		100%	
3	Vermivorous Bird (Robin)	2 acre	Dietary Exposure	High Sensitivity tPCB	LOAEL	16	20	100%	While dietary exposure approach has lower relative uncertainty than egg-based approaches, these values are considered to have high uncertainty because no high sensitivity vermivorous birds (i.e., species with greater than 40% worms in diet) have been observed at the site in over 30 years of survey data.
					Geomean	14		99%	
					NOAEL	13		98%	
2	Vermivorous Bird (Robin)	2 acre	Approach 3 - Dietary/Egg-based	Mid-Range TEQ	LOAEL	35	20	100%	Approach 3 found to have moderate uncertainty relative to Approaches 1 and 2. Values not carried forward because current conditions are protective.
					Geomean	25		100%	
					NOAEL	17		100%	
3	Vermivorous Bird (Robin)	2 acre	Approach 3 - Dietary/Egg-based	High Sensitivity TEQ	LOAEL	0.5	20	5%	These values are considered to have high uncertainty because no high sensitivity vermivorous birds (i.e., species with greater than 40% worms in diet) have been observed at the site in over 30 years of survey data. Specific values not carried forward, but range is evaluated in the RAL of 0.5 mg/kg scenario
					Geomean	0.3		1%	
					NOAEL	0.2		0%	

**Table G-4**  
**RBC Evaluation Summary for the Former Plainwell Impoundment and Plainwell No. 2 Dam Area Combined**  
**Area 1, OU-5 Kalamazoo River**

Category <sup>1</sup>	Receptor	Applicable Moving Window	Exposure Estimate	TRV	Endpoint	RBC	Maximum EPC Current Conditions	Protectiveness <sup>2</sup> Under Current Conditions	Comments		
3	Vermivorous Bird (Robin)	2 acre	Approach 2 egg-based	Mid-Range tPCB	LOAEL	62	17	100%	Approach 2 considered to have highest uncertainty of the approaches because of the lack of spatial and species specificity in the exposure model. Values not carried forward because current conditions are protective.		
					Geomean	51		100%			
					NOAEL	43		100%			
					Mid-Range TEQ	LOAEL		65		100%	
						Geomean		46		100%	
						NOAEL		32		100%	
				High Sensitivity tPCB	LOAEL	2	20	48%		Approach 2 considered to have highest uncertainty of the approaches because of the lack of spatial and species specificity in the exposure model. Specific values not carried forward but the range of values is evaluated by the 0.5 mg/kg RAL scenario.	
					Geomean	1.4		30%			
					NOAEL	1		17%			
					High Sensitivity TEQ	LOAEL		1			17%
						Geomean		0.6			7%
						NOAEL		0.3			2%
1	Vermivorous Bird (woodcock)	11 acre	Dietary Exposure	Mid-Range tPCB	LOAEL	20	9	100%	Dietary approach found to have lower uncertainty than egg-based approaches.		
					Geomean	11		100%			
					NOAEL	7		97%			
3	Vermivorous Bird (woodcock)	11 acre	Dietary Exposure	High Sensitivity tPCB	LOAEL	5.5	9	95%	While dietary exposure approach has lower relative uncertainty than egg-based approaches, these values are considered to have high uncertainty because no high sensitivity vermivorous birds have been observed at the site in 30+ years of survey.		
					Geomean	4.9		91%			
					NOAEL	4.4		86%			
1	Insectivorous Bird (wren)	2 acre	Dietary Exposure	High Sensitivity tPCB	LOAEL	20	19.9	100%	Dietary approach found to have lower uncertainty than egg-based approaches. High Sensitivity Insectivores identified at the site (catbird and starling)		
					Geomean	17		100%			
					NOAEL	16		100%			
				Mid-Range tPCB	LOAEL	70	20	100%	These values not carried forward current conditions are protective		
					Geomean	41		100%			
					NOAEL	23		100%			

**Table G-4**  
**RBC Evaluation Summary for the Former Plainwell Impoundment and Plainwell No. 2 Dam Area Combined**  
**Area 1, OU-5 Kalamazoo River**

Category <sup>1</sup>	Receptor	Applicable Moving Window	Exposure Estimate	TRV	Endpoint	RBC	Maximum EPC Current Conditions	Protectiveness <sup>2</sup> Under Current Conditions	Comments		
3	Insectivorous Bird (wren)	2 acre	Approach 2 egg-based	Mid-Range tPCB	LOAEL	62	17	100%	Approach 2 considered to have highest uncertainty of the approaches because of the lack of spatial and species specificity in the exposure model. Values not carried forward because current conditions are protective		
					Geomean	51		100%			
					NOAEL	43		100%			
					Mid-Range TEQ	LOAEL		65		100%	
						Geomean		46		100%	
						NOAEL		32		100%	
				High Sensitivity tPCB	LOAEL	2	20	48%		Approach 2 considered to have highest uncertainty of the approaches because of the lack of spatial and species specificity in the exposure model. Specific values not carried forward but the range of values is evaluated by the 0.5 mg/kg RAL scenario.	
					Geomean	1.4		30%			
					NOAEL	1		17%			
					High Sensitivity TEQ	LOAEL		1			17%
						Geomean		0.6			7%
						NOAEL		0.3			2%
1	Red-Tailed Hawk	site-wide	Dietary Exposure	Mid-Range tPCB	LOAEL	133	8	100%	These values not carried forward as PRGs because current conditions are protective		
					Geomean	77		100%			
					NOAEL	44		100%			
	Fox	site-wide	Dietary Exposure	Mid-Range tPCB	LOAEL	51	8	100%			
					Geomean	30		100%			
					NOAEL	17		100%			

**Notes:**

<sup>1</sup> Category based on detailed uncertainty analysis provided and approved in the Area 1 TBERA

3 - highest uncertainty	2 - moderate uncertainty	1 - least uncertainty
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<sup>2</sup> Protectiveness expressed as a percent of possible home ranges below respective RBC.

EPC = exposure point concentration

Geomean = geometric mean of the NOAEL and LOAEL RBCs

LOAEL = lowest observed adverse effects level

NOAEL = no observed adverse effects level

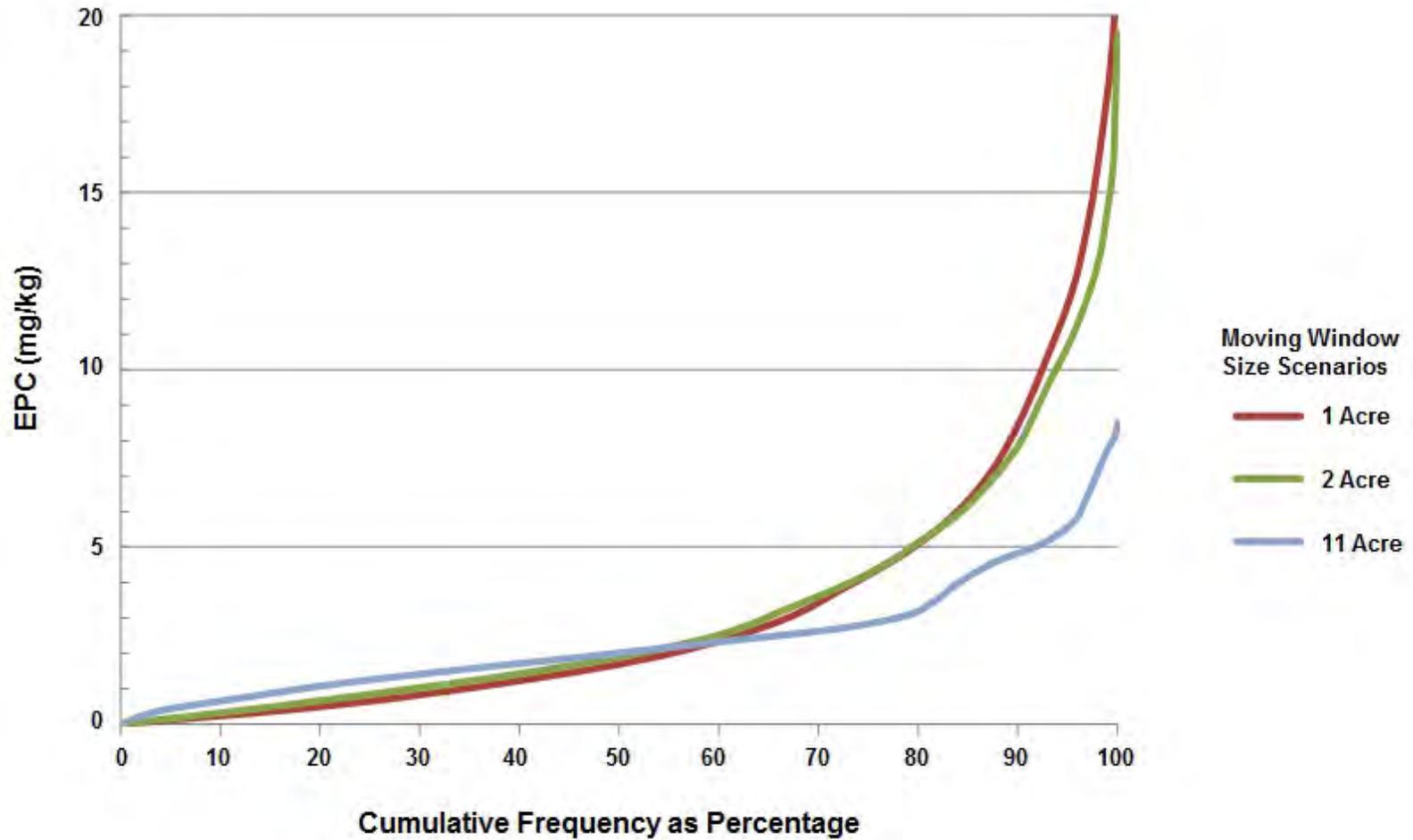
RBC = risk based concentration

TEQs = toxicity equivalents

tPCB = total polychlorinated biphenyls

Source: ARCADIS 2012b





**Note:**  
EPC = Exposure point concentration for total PCBs based on 1, 2, and 11 acre moving windows

**DRAFT**

Source: Area 1 Alternatives Screening Technical Memorandum (ARCADIS 2012b)

GEORGIA-PACIFIC LLC ALLIED PAPER, INC./PORTAGE CREEK/ KALAMAZOO RIVER SUPERFUND SITE AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM	
<b>CUMULATIVE FREQUENCY DISTRIBUTIONS OF EPCS (1 ACRE, 2 ACRE, AND 11 ACRE MOVING WINDOWS) FORMER PLAINWELL IMPOUNDMENT AND PLAINWELL NO. 2 DAM AREA COMBINED</b>	
	FIGURE G-1

## **Appendix G, Attachment 1**

**Originally Appendix A  
to  
Area 1 Alternatives Screening Technical Memorandum  
(ARCADIS 2012b)**



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**Allied Paper, Inc./Portage Creek/  
Kalamazoo River Superfund Site**

**Area 1 Alternatives Screening  
Technical Memorandum – Morrow  
Dam to Former Plainwell Dam**

**Appendix A – Development of  
Floodplain Soils Preliminary  
Remedial Goals and Remedial  
Action Levels**

Georgia-Pacific LLC

Date: October 2012



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## Acronyms and Abbreviations

### Acronyms and Abbreviations

Area 1 ASTM	Area 1 Alternatives Screening Technical Memorandum
Area 1 TBERA	Terrestrial Baseline Ecological Risk Assessment for Area 1
BAF	bioaccumulation factor
BERA	Baseline Ecological Risk Assessment
EPCs	exposure point concentrations
FS	Feasibility Study
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
NOAEL	no observable adverse effect level
PCB	polychlorinated biphenyl
PRGs	Preliminary Remedial Goals
RALs	Remedial Action Levels
Site or Superfund Site	Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
TCRA	Time-Critical Removal Action
TEQ	toxicity equivalent
TRVs	Toxicity Reference Values
USEPA	U.S. Environmental Protection Agency



## **1. Approach**

To further evaluate the range of potential Preliminary Remedial Goals (PRGs) for floodplain soils in Area 1, a range of candidate Remedial Action Level (RAL) values was evaluated on the basis of percent of home ranges protected within the formerly inundated areas of the former Plainwell Impoundment and the Plainwell No. 2 Dam. Consideration of a range of RALs facilitates the assessment of incremental risk reduction that might be achieved with selection of a particular RAL. For floodplain soil, candidate polychlorinated biphenyl (PCB) RALs of 5, 10, 15, 20 and 25 milligrams per kilogram (mg/kg) were evaluated in the former Plainwell Impoundment and Plainwell No. 2 Dam Area. An RAL of 0.5 mg/kg was also included at the request of the U.S. Environmental Protection Agency (USEPA). The analysis was not conducted for natural floodplain areas outside of the former impoundments due to the low soil PCB concentrations. The evaluation of each RAL started with identification of areas where surface (0-6 inch depth interval) soil PCB concentrations are currently greater than the given RAL. Identification of areas was based on the spatially interpolated surface (natural neighbor interpolation) soil PCB concentration map developed for the Terrestrial Baseline Ecological Risk Assessment for Area 1 (Area 1 TBERA, presented as Appendix B to the Area 1 Supplemental Remedial Investigation Report [ARCADIS 2012])<sup>1</sup>. Areas less than a quarter acre in size were excluded from the remedial footprint as described in Section 1.1.1.

The evaluation of candidate RALs was conducted using a “hill-topping” approach. Hill topping is a term of art used to describe the process of representing remediation of all PCB concentrations above a chosen action level. The sequence of steps in the hill topping analysis is described here. Once all of the areas greater than a quarter acre with soil concentrations exceeding each RAL were delineated, the PCB concentration in each polygon from the natural neighbor surface greater than a given RAL was replaced with the assumed backfill concentration of 0.078 mg/kg<sup>2</sup> to simulate remediation. The moving windows of 1 or 2 acres<sup>3</sup> were then run over this altered surface to calculate post-remediation exposure point concentrations (EPCs) across the area (See section 5.2.1 of the *Area 1 Alternatives Screening Technical*

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<sup>1</sup> It is noted that the final remedial footprint for any selected option will be further developed during feasibility study and design efforts.

<sup>2</sup> A series of samples from backfill soils were analyzed for PCB and the highest reporting limit was 0.078 mg/kg.

<sup>3</sup> The 11 acre moving window results in lower EPCs than the 1 and 2 acre moving windows, therefore this evaluation focuses on the 1 and 2 acre results.



*Memorandum* [Area 1 ASTM] document for additional description of the methods for calculating EPCs to evaluate receptor home ranges), which are then compared to the range of PRG values. Based on this comparison, the performance of each candidate RAL value is assessed based on percentage of home ranges protected at the various PRG values compared to the existing post-time critical removal action (TCRA) exposures, both for the 1 acre and 2 acre home range results. The hill-topping analysis was performed for both the former Plainwell Impoundment and the Plainwell No. 2 Dam Area. Each area has already been the focus of completed removal actions. The hill topping analysis was not conducted for natural floodplain areas outside of the former impoundments due to the low soil PCB concentrations. Natural floodplain surface soil PCB concentrations upstream of the Plainwell No. 2 Dam Area averaged 0.76 mg/kg and only 2 samples had PCB concentrations greater than 5 mg/kg (the lowest of the RAL values for which hill topping analysis was performed). See Section 5.2 of the Area 1 ASTM for a description of soil alternatives that address natural floodplain soils above 0.5 mg/kg.

## **1.1 Former Plainwell Impoundment**

Figure A-01 presents the former Plainwell Impoundment post-TCRA (i.e., current conditions) spatially interpolated surface concentration map and Figures A-02 through A-05 show the pre- and post-TCRA 1 acre and 2 acre moving window average data. The potential areas of remediation associated with each candidate RAL (except 0.5 mg/kg) are shown for the former Plainwell Impoundment on Figures A-06 through A-11. The figure showing RAL areas greater than 0.5 mg/kg is included in the ASTM (Figure 5-15). Figures A-12 through A-21 show the 1 and 2 acre moving window results for each candidate RAL scenario, except 0.5 mg/kg. The moving window was not employed for the 0.5 mg/kg RAL because almost the entirety (greater than 99 percent including the areas already remediated and those covered under the 0.5 mg/kg RAL scenario) of both areas (the former Plainwell Impoundment and Plainwell No. 2 Dam Area) would be within the remedial footprint under this scenario and the resulting mean values for each home range would all be the same (i.e., the concentration assumed for backfill of 0.078 mg/kg).

### **1.1.1 Sensitivity to Quarter Acre Exclusion**

Areas less than a quarter acre in size were excluded from the remedial footprint evaluated in the hill-topping analysis under the assumption that possible future remedial project design considerations would not address small discontinuous areas due to practical issues and a lower cost: benefit associated with accessing such



areas for remediation. This was done so as not to overstate the benefit of a given RAL if in the end, the entire area would not be addressed in a remedial action.

In order to evaluate the sensitivity of the overall footprint to exclusion of contiguous areas less than a quarter acre in size, an analysis was conducted on the former Plainwell Impoundment data using a range of size restrictions, including a quarter acre minimum, a tenth of an acre minimum, and no size restriction. The footprint based on each of these size restrictions was identified (Figure A-22) and then the 1 and 2 acre moving window was used to estimate EPCs for each scenario (Figures A-23 and A-24). As shown in figures A-22 through A-24, exclusion of small areas results did not have a large effect on the resulting EPCs for the area. For example, at an RAL of 20 mg/kg, 1 total acre of small discontinuous areas less than one quarter acre in size were excluded, and 0.8 acres were excluded when a size threshold of one tenth acre was used. A quarter acre size limit for contiguous areas was applied for each RAL hill-topping scenario evaluated herein. Development of boundaries of areas to be included in alternatives evaluated in the Feasibility Study (FS) Report may use other considerations in addition to a size threshold for identifying what areas are included in the alternative. For example, small areas, even if less than a quarter acre may be included if they are in close proximity to larger areas – thereby allowing access without appreciable loss of cost: benefit. Final remediation area boundaries will be evaluated during the FS in consultation with the Agencies.

## **1.2 Plainwell No. 2 Dam Area**

Figure A-25 presents the Plainwell No. 2 Dam Area post-TCRA (i.e., current conditions) spatially interpolated surface concentration map and Figures A-26 through A-29 show the pre- and post-TCRA 1 acre and 2 acre moving window average data. The potential areas of remediation associated with each candidate RAL and the resulting 1 and 2 acre moving windows for the Plainwell No. 2 Dam Area are illustrated in Figures A-30 through A-36. The area greater than the 0.5 mg/kg RAL is shown in Figure 5-16 in the ASTM. As described above for the former Plainwell Impoundment, moving windows for this scenario were not evaluated. For the Plainwell No. 2 Dam Area, the candidate RALs of 15, 20 and 25 mg/kg were not



evaluated because no surface soil PCB concentrations are currently greater than 15 mg/kg within a contiguous area greater than a quarter acre<sup>4</sup>.

### **1.3 RAL Evaluation “Hill topping” Results**

Figures A-37 and A-38 present the protectiveness of each of the RBCs for high-sensitivity birds and vermivorous mammals under current conditions in the former Plainwell Impoundment and the Plainwell No. 2 Dam Area, respectively.

Figures A-39 and A-40 provide a summary of the performance of each candidate RAL based on percent of possible home ranges within a given area that are below the various PRG values, along with the same information for the pre-TCRA and current (post-TCRA) conditions for the 1 and 2 acre moving windows. These figures show the results for the former Plainwell Impoundment (Figure A-39) and the Plainwell No. 2 Dam Area (Figure A-40). A combined-area figure is provided in Section 5 of the Area 1 ASTM (Figure 5-19).

Figures A-41 and A-42 show the cumulative frequency distributions of possible EPCs within the former Plainwell Impoundment, and the Plainwell No. 2 Dam Area, respectively for the 1, 2, and 11 acre-based EPCs

Figures A-43 and A-44 present a summary of the EPCs for the former Plainwell Impoundment and the Plainwell No. 2 Dam Area, respectively based on the 1 acre and 2 acre moving windows for pre-TCRA, current conditions, and each RAL scenario. As shown on these graphs, the completed TCRA actions in the former Plainwell Impoundment and the Plainwell No. 2 Dam Area resulted in a significant reduction in EPCs, reducing the median EPC from approximately 12 mg/kg to 4 mg/kg under current conditions for the 1 acre scenario in the former Plainwell Impoundment. A similar reduction is observed in the former Plainwell Impoundment based on the 2 acre moving window EPCs.

Figures A-45 and A-46 show cumulative frequency plots of the EPCs based on the 1 and 2 acre moving windows for the former Plainwell Impoundment and the Plainwell No. 2 Dam Area, respectively.

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<sup>4</sup> Remaining areas above 15 mg/kg but less than a quarter acre are located primarily along the edges of areas that have already been remediated, and range in size up to 0.15 acres



## 2. Uncertainty in Identified PRG Concentration Ranges

The concentration ranges shown on all of the moving window figures and graphics that depict protectiveness are based on the potential PRGs identified in Table 5-5 of the Area 1 ASTM. These values are based on the Risk-Based Concentrations (RBCs) calculated in the Area 1 TBERA (ARCADIS 2012). However, there is some degree of uncertainty associated with each of these concentration ranges. Lower uncertainty is present in applying certain values, while higher uncertainty is present in applying other values – as explained in the summary of the risk assessment in the Area 1 TBERA (ARCADIS 2012). The Area 1 TBERA was conducted to reduce uncertainty in conclusions regarding risks, as well as the associated RBCs from the Site-Wide BERA (CDM 2003). In addition, even within the TBERA, there are greater levels of uncertainty associated with RBCs based on some approaches compared to others. The RBCs from the Site-Wide BERA and their associated uncertainty and the uncertainties associated with the RBCs from the Area 1 TBERA are discussed in Sections 2.1 and 2.2, below. The recommended PRGs are selected from the RBCs as explained in Section 5.2.3 of the Area 1 ASTM.

### 2.1 RBCs and Uncertainty from the Site-Wide BERA

RBCs<sup>5</sup> were calculated in the Site-Wide BERA (CDM 2003) for the receptors evaluated as part of that assessment. For terrestrial species, this included the white-footed mouse, the red fox, and the American robin.

The resulting RBCs from the Site-Wide BERA are:

Receptor	NOAEL RBC (mg/kg)	LOAEL RBC (mg/kg)
White-Footed Mouse	21	63
Red Fox	5.9	29
American Robin	6.5	8.1

<sup>5</sup> The back-calculated protective soil concentrations in the Site-Wide BERA were called PRGs in that document. They are referred to as RBCs in this Area 1 ASTM for consistency in comparing values with the RBCs in the TBERA. The general method for calculating both sets of values is the same.



Uncertainties associated with the evaluations of these receptors are as follows:

- The primary uncertainty associated with the mouse values is that the mouse may not represent the high end of the exposure for other small mammals. The shrew was added to the Area 1 TBERA to address this uncertainty.
- For the red fox, the primary uncertainty was associated with modeling the bird prey tissue component of the diet. This uncertainty was addressed in the Area 1 TBERA by using measured adult bird tissue for house wrens as the basis for this estimate, rather than a literature-based model.
- For the American robin, the two primary uncertainties identified were the ingestion rate and the dietary composition used in the calculation. Revisions to these two parameters in the Area 1 TBERA were made at the request of the agencies by using specific analysis provided by USEPA during the development of the *Area 1 Work Plan Supplement: Baseline Ecological Risk Assessment Work Plan* (Area 1 BERA Work Plan; ARCADIS 2010).

One additional uncertainty that affects all three receptors is associated with the bioaccumulation factors (BAFs) used to estimate prey tissue concentrations in the food web models. The BAFs used in the Site-Wide BERA were based on data for soil and biota data available at the time. Since the completion of that report, additional data collected in the former Trowbridge Impoundment were subjected to a formal peer review. Based on the recommendations of the peer review panel (Dickson et al. 2008), these data were included along with the data used in the Site-Wide BERA to develop BAFs for use in the Area 1 TBERA. The inclusion of a broader dataset is expected to reduce uncertainty associated with the BAFs.

## **2.2 Uncertainties Associated with the TBERA RBCs**

Because the Area 1 TBERA includes significant updates to address the specific uncertainties in the Site-wide BERA (CDM 2003) described above, the RBCs from the Site-Wide BERA are considered to have a comparatively higher degree of uncertainty. However, it is recognized that any modeled concentration will have some degree of inherent uncertainty. The following discussion provides a detailed analysis of uncertainty recognized in the evaluation of the relative confidence in each approach. The relative confidence in each approach is summarized Table 5-4 of the Area 1 ASTM.



### 2.2.1 Mammalian Receptors

For mammalian receptors, dietary exposure was evaluated based on the shrew. The shrew was selected because it has a relatively high ingestion rate and a high percent of worms in its diet compared to other small mammals. Thus, this receptor represents the high end of exposure for small mammals. The specific exposure parameters selected (e.g., the ingestion rate, dietary composition, and home range) were selected and agreed upon in the USEPA-approved Area 1 BERA Work Plan (ARCADIS 2010) to minimize the possibility of underestimating exposure. In addition, the toxicity reference values (TRVs) selected for the shrew were half of those selected for use in the Site-Wide BERA (CDM 2003). As a result, the exposure and effects elements of the RBC calculation for the shrew developed for the Area 1 TBERA are conservative and have lower uncertainty than the mammal values presented in the Site-Wide BERA.

For shrews, RBCs were calculated based on both total PCB and toxicity equivalents (TEQs). Because the RBCs for TEQs include an additional modeling step over the total PCB values, the TEQ RBCs are considered more uncertain than the total PCB-based values.

### 2.2.2 Avian Receptors

For avian receptors, three different approaches were used to calculate RBCs in the Area 1 TBERA. These included a dietary foodweb model (Approach 1), an egg-based exposure model (Approach 2), and an approach that combined certain dietary assumptions with an egg-based model (Approach 3). For each approach, there are a number of elements of uncertainty associated with both the exposure and effects estimates. The key uncertainties that differ among approaches for avian receptors are summarized below, and the relative confidence associated with the key elements of each approach is summarized in Table 5-4 of the Area 1 ASTM.

For the exposure estimates, key uncertainties that differ between approaches include exposure parameters used in each model and the tissue EPC calculations based on BAFs. For the dietary exposure, exposure factors are considered to have a similar level of uncertainty across species. In most cases, parameters were selected from a range of available values presented in species-specific field studies. Comparing dietary exposure estimates (Approach 1) to the Approach 2 egg-based exposure estimates, the egg-based exposure estimates are considered relatively more uncertain. One of the primary uncertainties associated with the Approach 2 egg



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## Appendix A – Development of Soil Preliminary Remedial Goals and Remedial Action Levels

concentration estimates is the lack of species-specific inputs to the model. As a result, exposure estimates for all species would be identical. Many factors can affect PCB accumulation, including differential accumulation of specific congeners through the foodweb (Blankenship et al. 2005). This is evident from the variable PCB concentrations observed in bird eggs from the former Trowbridge Impoundment for house wrens and blue birds (Blankenship et al. 2005). In addition to the lack of species-specific inputs, the Approach 2 model is also considered uncertain because the BAFs, which are the primary input to the exposure estimate, are based on data that are not specifically spatially related (i.e., the BAF is based on an impoundment-wide soil EPC compared to a mean egg tissue concentration for all house wren eggs collected). Thus, while these BAFs provide a general, broad scale estimate of egg concentrations, the application of these BAFs on the scale of the moving window employed in the Area 1 TBERA (i.e., 2 acre moving windows spaced in 1-foot increments) introduces uncertainty. As such, the Approach 2 model is considered less certain than the Approach 1 model.

EPCs for prey tissue and egg tissue were estimated by applying BAFs to the floodplain soil EPCs. Uncertainty with floodplain soil EPCs is low because over 2.5 million mean EPCs are calculated – as a result, the chance that the actual population mean has not been captured is very low. This parameter is same across all approaches. The uncertainty associated with BAFs used to estimate prey tissue concentrations is a differentiating factor among approaches. The BAFs used to estimate prey tissue for the dietary exposure model (Approach 1) are considered more certain than the BAFs used to estimate egg tissue concentrations for Approach 2. The prey tissue BAFs are estimated from soil and tissue data that are more spatially related, because prey tissue and soil were either co-located or collected from a discrete grid. The egg BAF used for Approach 2 is based on an impoundment-wide mean floodplain soil concentration relative to house wren egg tissue concentrations measured in the former Trowbridge Impoundment. Thus, the prey tissue EPCs for Approach 1 are considered more certain than egg tissue EPCs for Approach 2.

In comparison, Approach 3 employs two modeling steps. The first uses prey-tissue BAFs to estimate a PCB concentration in diet. The second applies a diet to egg biomagnification factor (BMF) to the dietary estimate to derive an egg concentration. This model relies on the assumption that uptake from diet to eggs is both constant and the same for all species. Specifically, it is based on the assumption that the BMF, defined by the ratio of mean non-worm terrestrial invertebrates and mean house wren eggs from the former Trowbridge Impoundment, is predictive for the



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## Appendix A – Development of Soil Preliminary Remedial Goals and Remedial Action Levels

American robin, which eats plants, worms, and other terrestrial invertebrates. Due to the added uncertainty associated with the BMF, the uncertainties associated with Approach 3 EPCs are considered similar to Approach 2, and both are higher than the uncertainty for Approach 1.

In addition to the specific uncertainties associated with BAFs used to estimate tissue concentrations in each approach, egg EPCs were estimated based on both total PCBs and TEQs. Because TEQ concentrations are estimated from the modeled total PCB estimates for egg tissue, this additional modeling step adds uncertainty to the TEQ exposure estimates for Approaches 2 and 3. Given these uncertainties, TEQ exposure estimates are considered to have higher uncertainty than total PCB exposure estimates.

Each TRV used in the hazard quotient (HQ) calculations has some level of uncertainty associated with the quality of the underlying toxicity dataset upon which it is based, and on the relevance of the endpoint to biological effects that may impact receptor populations. For high-sensitivity species, the total PCB dietary TRVs developed by Dr. James Chapman of USEPA and employed in the Site-Wide BERA (CDM 2003) were used. The primary uncertainty with these values is that they were extrapolated by combining results from multiple studies that incorporated different methodologies. The selected values are not specific effect levels observed from a specific study, but were extrapolated from a dose-response curve compiled based on data results that may or may not be comparable. Nevertheless, the underlying dataset is considered sufficient, and the reproductive endpoint evaluated (reduced hatchability) is considered relevant to population-level effects. For mid-range sensitivity avian species, the total PCB dietary TRV dataset includes eight studies. The selected value is based on a high-quality study conducted across two breeding seasons in which a number of relevant reproductive effects (egg production, fertility, and hatchability) were measured. The lowest observed adverse effect level (LOAEL) was based on an observed reduction in hatchability. While the no observable adverse effect level (NOAEL) is extrapolated from the LOAEL, it is bounded by a screech owl study with a NOAEL for egg production, hatch, and fledge.

For egg-based total PCB TRVs, the dataset considered included five studies for high-sensitivity species and four studies for mid-range sensitivity species. For the high-sensitivity avian species, two of the five studies did not clearly report effect concentrations for eggs, and values were estimated from graphs and text. For two other studies, the effect levels had to be extrapolated to whole egg values from yolk concentrations, and the study selected as the basis for the TRV was one of these



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studies. The LOAEL selected is based on a relevant endpoint (hatchability). While there is some uncertainty with this study because of the extrapolation required, a similar effect level was also observed in another study in which whole egg concentrations were measured. For mid-range sensitivity species, none of the identified studies resulted in bounded effect or no effect levels. While the quality of the studies is considered adequate and the endpoints measured relevant, this lack of bounded effect levels results in uncertainty with these TRVs.

For egg-based TEQ TRVs, the datasets are more robust than for egg-based total PCB TRVs for both mid- and high-sensitivity species (15 and 24 studies, respectively). The primary uncertainty associated with these TRVs is the egg-injection method of dosing. How PCB concentrations achieved by a single injection relate to concentrations resulting from maternal deposition over time is uncertain. In addition, there is some level of uncertainty associated with reliance on toxic equivalency factors to convert dioxin and other PCB congeners to TEQs. While this is a well-accepted method, recent research suggests that the actual potency of dioxin and furan congeners may be variable across species (Cohen-Barnhouse et al. 2011). For the high-sensitivity TEQ TRV, the measured endpoint was slightly reduced growth in chicks at 4 weeks. The biological relevance of this endpoint to population effects is uncertain. However, other studies indicate more relevant effects (e.g., hatchability) at similar TEQ concentrations.

A more detailed analysis of all of these uncertainties can be found in Section 6.2 of the Area 1 TBERA. Table 5-4 (in the ASTM) summarizes the uncertainties for each of these elements to demonstrate relative confidence in each approach. Based on the uncertainties outlined above for each Approach and set of TRVs, Approach 1 – the dietary total PCB approach – has the least uncertainty (i.e., the highest level of confidence) of the three options. Comparing the two egg-based approaches, the level of certainty is similar due to the uncertainties associated with exposure modeling and conversion of total PCB exposure estimates to TEQs.



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**Appendix A –  
Development of Soil  
Preliminary Remedial  
Goals and Remedial  
Action Levels**

**3. Risk Management Summary**

To provide risk managers with an understanding of the relationships among the candidate RALs and the full range of potential PRGs (independent of relative uncertainty considerations among PRG values), the hill-topping results are also presented in comparison to a series of concentration intervals that are not based on the risk assessment results, but span the range of RBCs for the types of receptors found to potentially be at risk, if present in these areas. Figures A-47 and A-48 present the 1 and 2 acre moving window results in this manner. In addition, Figures A-41 and A-42 present the EPCs and their probability of occurring within a specified area. The percent of EPCs (i.e., home ranges) greater than any concentration can be deduced from these plots.



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**Appendix A –  
Development of Soil  
Preliminary Remedial  
Goals and Remedial  
Action Levels**

**4. References**

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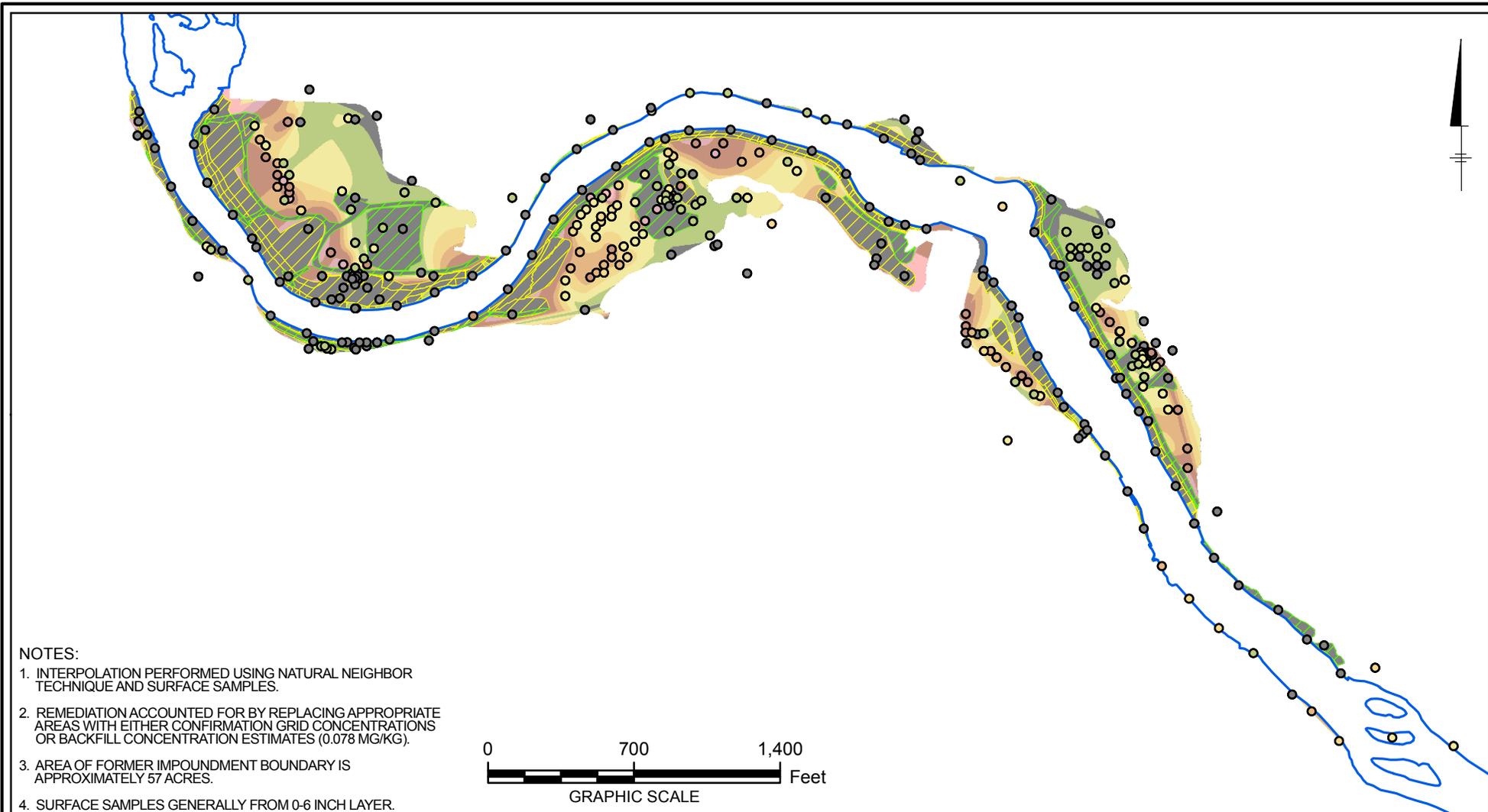
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Dickson, K., L. Barnthouse, A. Fairbrother, K. Grasman, M. Harwell, L. McDonald, C. Menzie, W. Warren-Hicks. 2008. The Final Report on the Peer Review of Michigan State University's PCB Exposure and Effects Studies in the Floodplain of the Kalamazoo River. (Final Report). December 5, 2008.



**Figures**



**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.
4. SURFACE SAMPLES GENERALLY FROM 0-6 INCH LAYER.

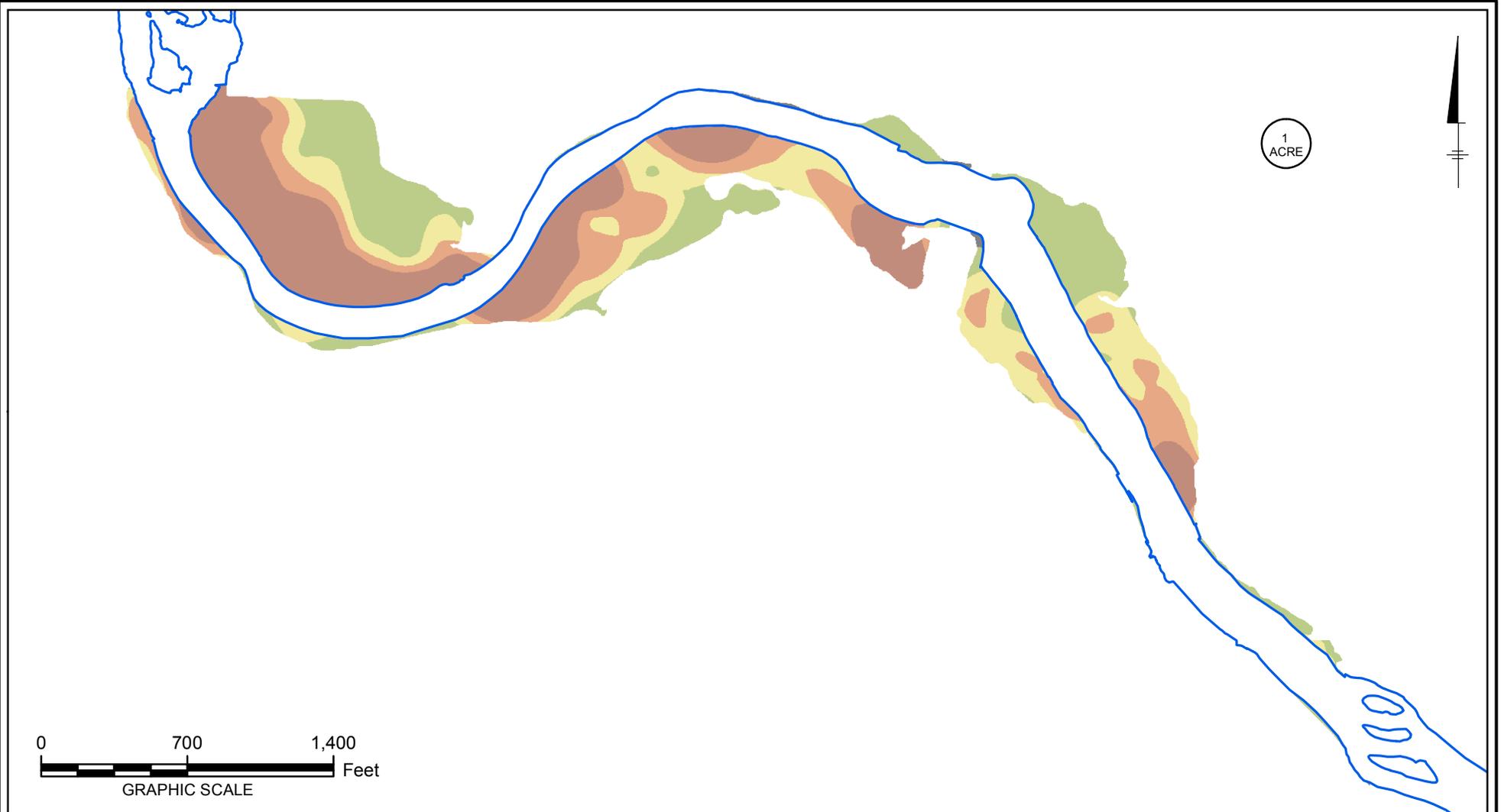


**LEGEND:**

- |   |   |   |
|---|---|---|
| <ul style="list-style-type: none"> <li>● SAMPLE LOCATIONS INSIDE REMOVAL/BACKFILL AREA</li> <li> TCRA ACCESS ROAD AND STAGING AREA</li> <li> TCRA REMOVAL AREA</li> <li> KALAMAZOO RIVER</li> </ul> | <p>SOIL PCB (MG/KG) AT SAMPLING LOCATIONS:</p> <ul style="list-style-type: none"> <li>● ≤ 1</li> <li>○ &gt;1 and ≤ 5</li> <li>○ &gt;5 and ≤ 10</li> <li>○ &gt;10 and ≤ 15</li> <li>○ &gt;15 and ≤ 20</li> <li>○ &gt;20 and ≤ 35</li> <li>○ &gt;35 and ≤ 50</li> <li>○ &gt;50</li> </ul> | <p>SOIL PCB (MG/KG):</p> <ul style="list-style-type: none"> <li> ≤ 1</li> <li> &gt;1 and ≤ 5</li> <li> &gt;5 and ≤ 10</li> <li> &gt;10 and ≤ 15</li> <li> &gt;15 and ≤ 20</li> <li> &gt;20 and ≤ 35</li> <li> &gt;35 and ≤ 50</li> <li> &gt;50</li> </ul> |
|---|---|---|

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**INTERPOLATED FLOODPLAIN SOIL  
 PCB CONCENTRATIONS FORMER  
 PLAINWELL IMPOUNDMENT - POST-TCRA**

**FIGURE  
A-01**



**LEGEND:**  
 SOIL PCB (MG/KG)<sup>\*1,2</sup>:

	≤ 0.5
	> 0.5 and ≤ 6
	> 6 and ≤ 11
	> 11 and ≤ 18
	> 18
	KALAMAZOO RIVER

**NOTES:**

- INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
- AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR-SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

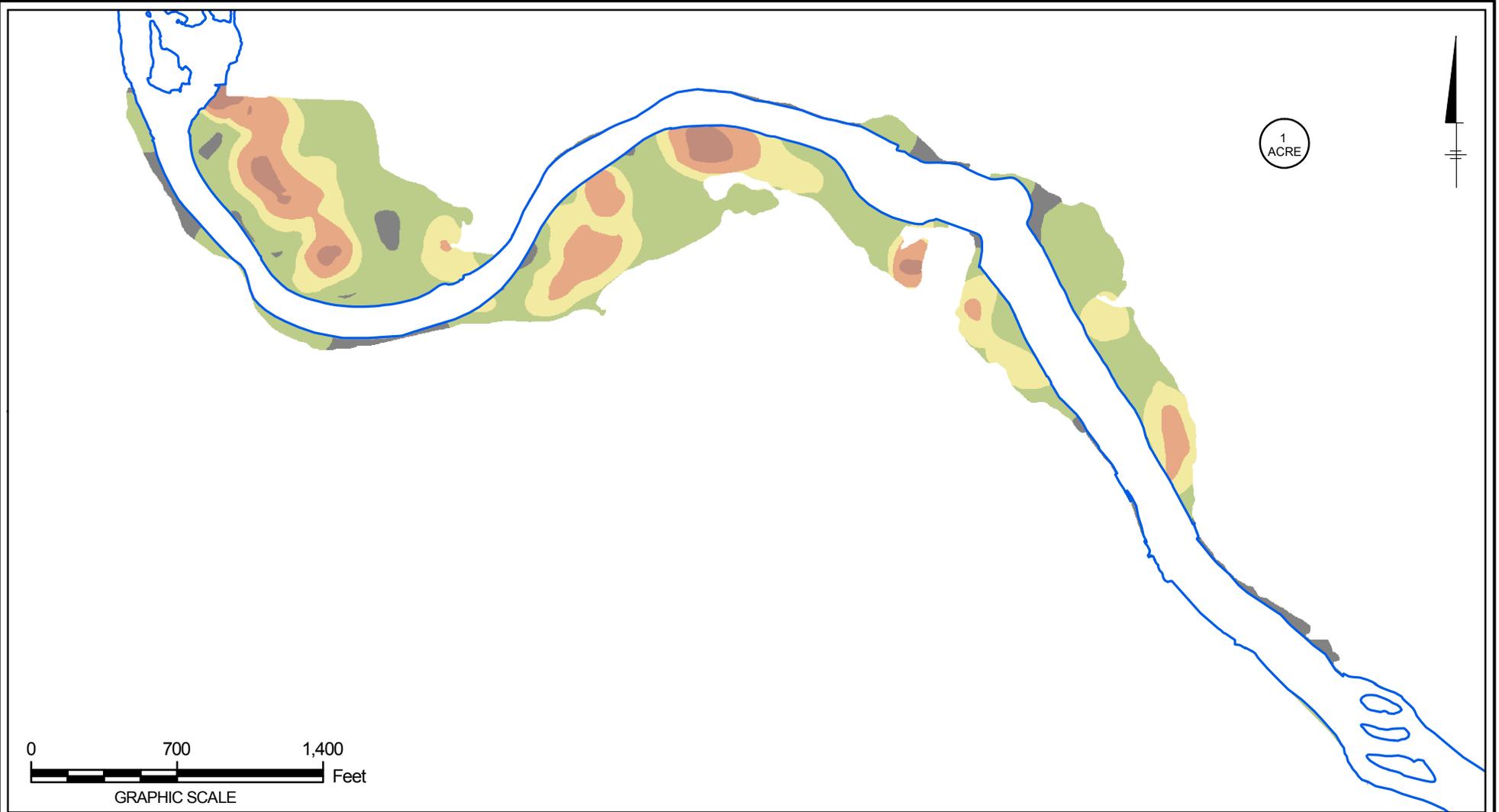
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**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 1 ACRE MOVING WINDOW  
 FORMER PLAINWELL IMPOUNDMENT - PRE-TCRA**



**FIGURE  
 A-02**



**LEGEND:**

SOIL PCB (MG/KG)<sup>\*1,2</sup>:

	≤ 0.5
	> 0.5 and ≤ 6
	> 6 and ≤ 11
	> 11 and ≤ 18
	> 18
	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR-SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

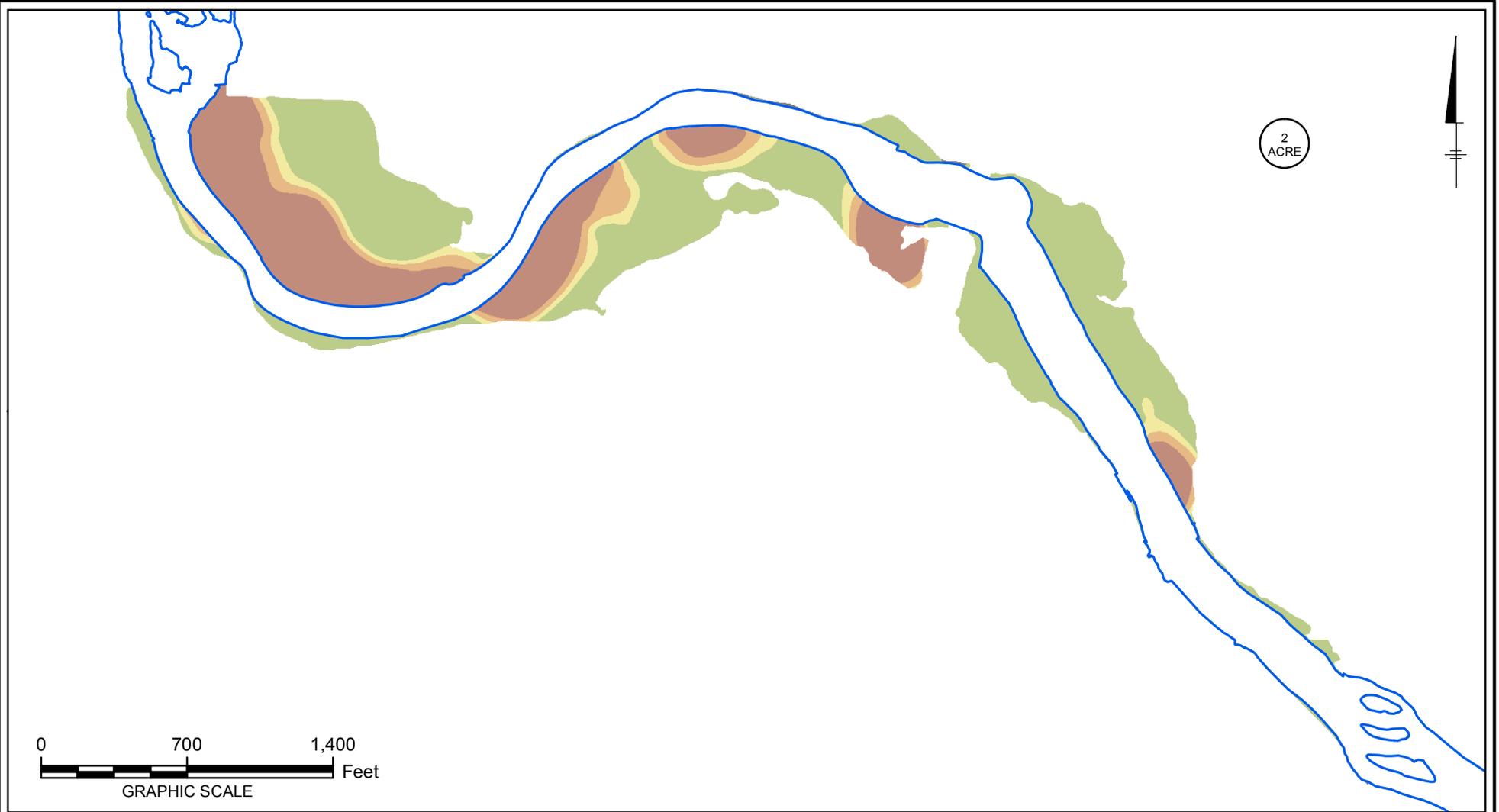
<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 1 ACRE MOVING WINDOW  
 FORMER PLAINWELL IMPOUNDMENT - POST-TCRA**



FIGURE  
**A-03**



**LEGEND:**

SOIL PCB (MG/KG)<sup>\*1,2</sup>:

Dark Grey	≤ 0.5
Light Green	> 0.5 AND ≤ 13
Yellow	> 13 AND ≤ 16
Orange	> 16 AND ≤ 20
Brown	> 20
Blue outline	KALAMAZOO RIVER

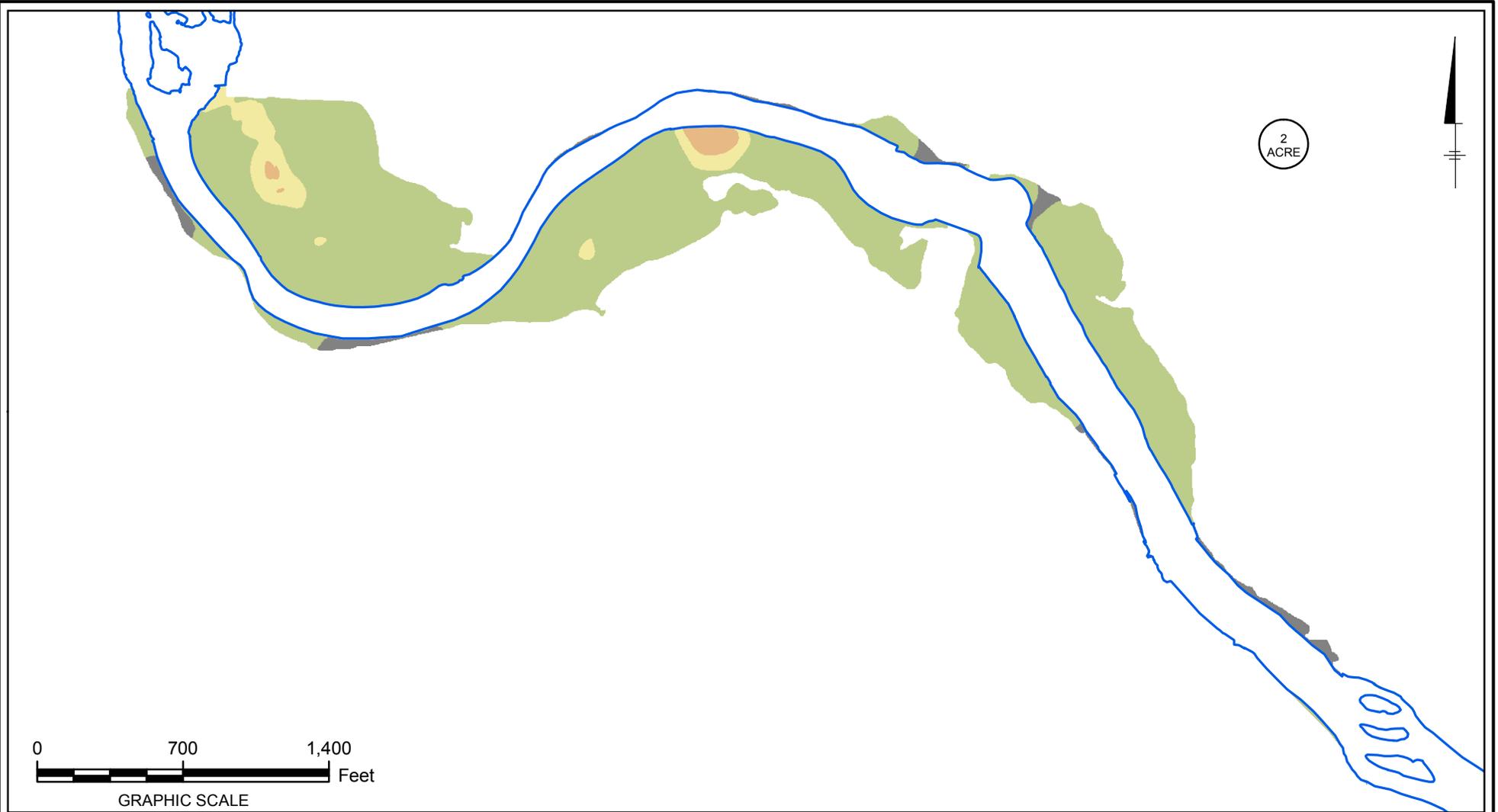
- NOTES:**
- INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  - AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.
- <sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR-SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.
- <sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 2 ACRE MOVING WINDOW  
 FORMER PLAINWELL IMPOUNDMENT - PRE-TCRA**



**FIGURE  
 A-04**



**LEGEND:**

SOIL PCB (MG/KG)<sup>\*1,2</sup>:

	≤ 0.5
	> 0.5 AND ≤ 13
	> 13 AND ≤ 16
	> 16 AND ≤ 20
	> 20
	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR-SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

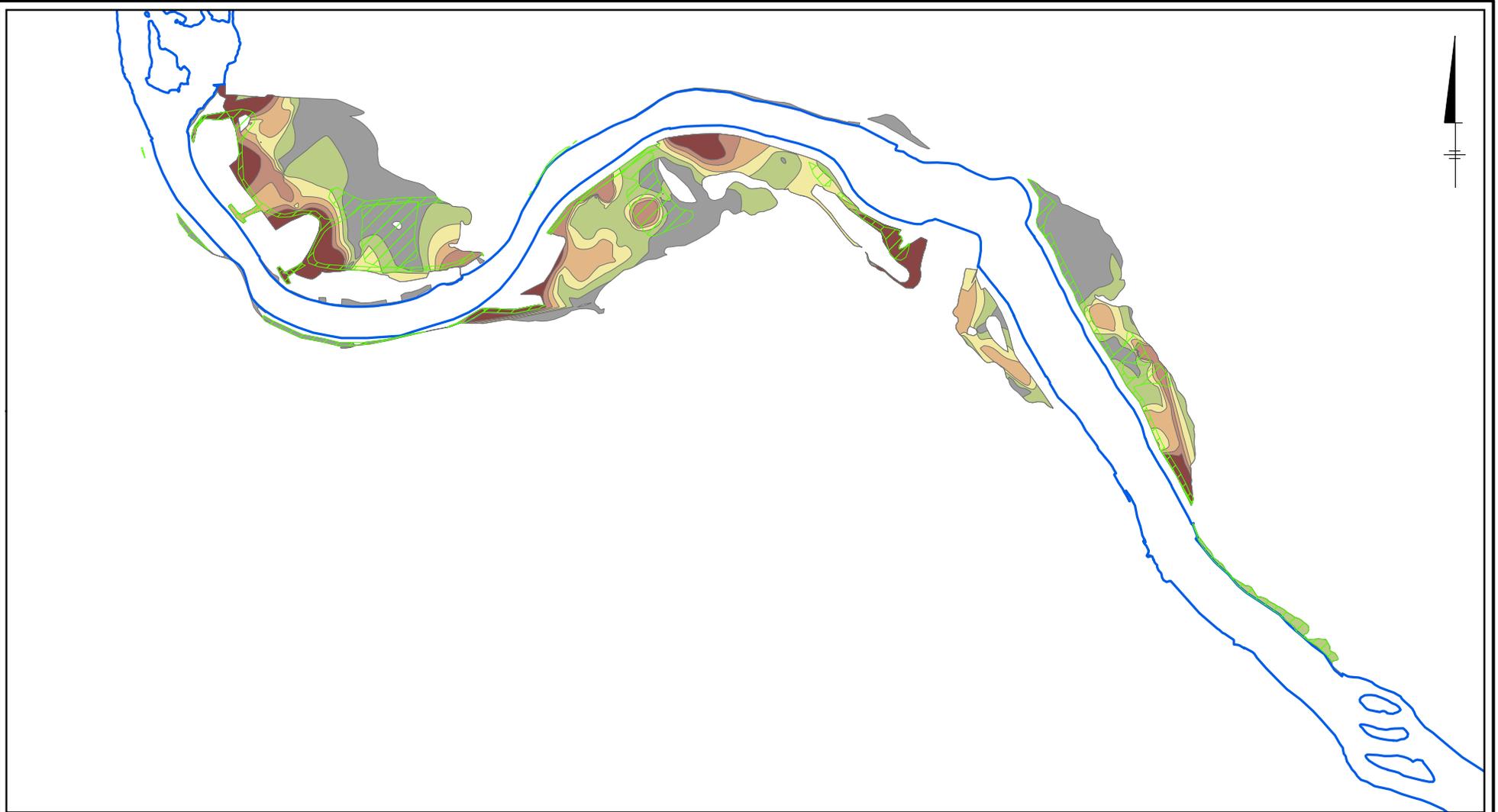
<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 2 ACRE MOVING WINDOW  
 FORMER PLAINWELL IMPOUNDMENT - POST-TCRA**



FIGURE  
**A-05**



- LEGEND:**
- AREA OVER 1/4 ACRE AND >25 mg/kg
  - AREA OVER 1/4 ACRE AND AREA >20 mg/kg
  - AREA OVER 1/4 ACRE AND AREA >15 mg/kg
  - AREA OVER 1/4 ACRE AND AREA >10 mg/kg
  - AREA OVER 1/4 ACRE AND AREA >5 mg/kg
  - AREA OVER 1/4 ACRE AND AREA >0.5 mg/kg
  - TCRA ACCESS ROAD AND STAGING AREA
  - KALAMAZOO RIVER



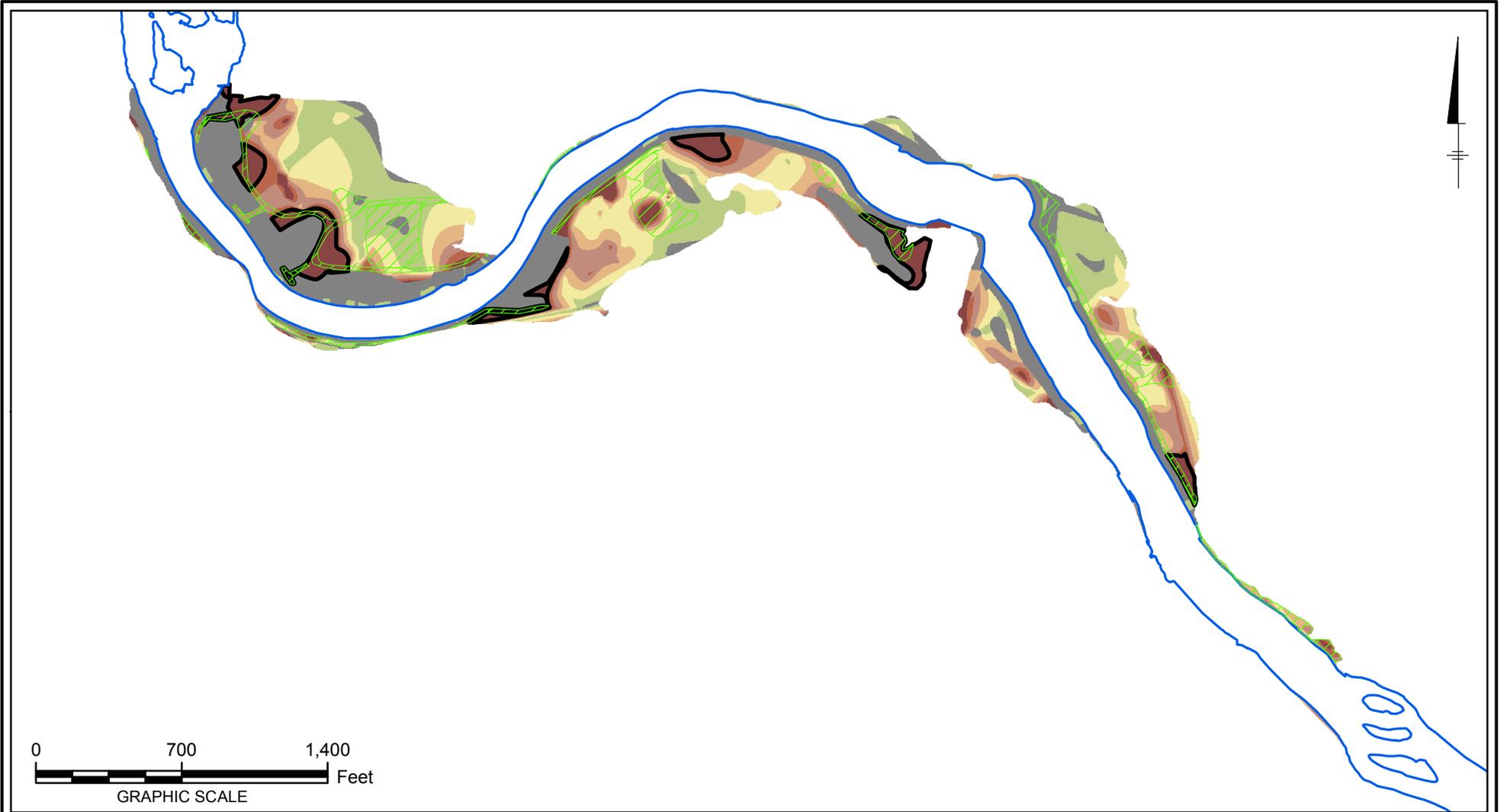
- NOTES:**
1. CONTIGUOUS AREAS OF OVER 1/4 ACRE GREATER THAN SPECIFIED CONCENTRATIONS.
  2. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

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**FLOODPLAIN SOIL AREAS GREATER THAN SPECIFIED CONCENTRATION BASED ON NATURAL NEIGHBOR INTERPOLATED SURFACE FORMER PLAINWELL IMPOUNDMENT**



**FIGURE A-06**



**LEGEND:**

**SOIL PCB (MG/KG):**

- < 1
- > 1 and ≤ 5
- > 5 and ≤ 10
- > 10 and ≤ 15
- > 15 and ≤ 20
- > 20 and ≤ 25
- > 25

- AREA OVER 1/4 ACRE AND >25 mg/kg
- TCRA ACCESS ROAD AND STAGING AREA
- KALAMAZOO RIVER

**NOTES:**

1. CONTIGUOUS AREAS OF OVER 1/4 ACRE GREATER THAN 25 MG/KG.
2. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
3. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
4. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

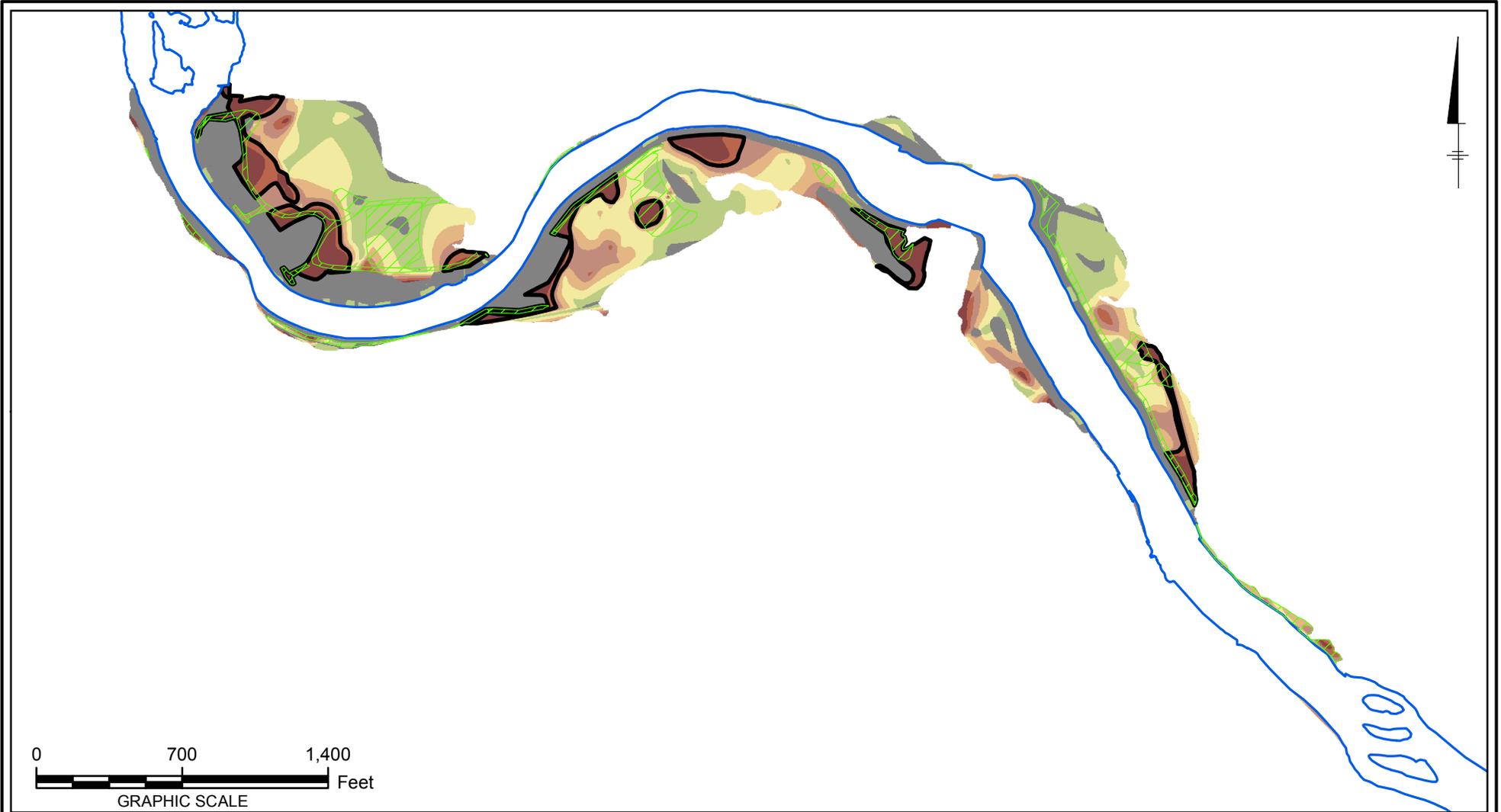
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**FLOODPLAIN SOIL AREAS GREATER THAN 25 MG/KG  
 BASED ON NATURAL NEIGHBOR INTERPOLATED  
 SURFACE FORMER PLAINWELL IMPOUNDMENT**



**FIGURE  
 A-07**



**LEGEND:**

SOIL PCB (MG/KG):	AREA OVER 1/4 ACRE AND AREA >20 mg/kg
< 1	TCRA ACCESS ROAD AND STAGING AREA
> 1 and ≤ 5	KALAMAZOO RIVER
> 5 and ≤ 10	
> 10 and ≤ 15	
> 15 and ≤ 20	
> 20 and ≤ 25	
> 25	

**NOTES:**

1. CONTIGUOUS AREAS OF OVER 1/4 ACRE GREATER THAN 20 MG/KG.
2. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
3. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
4. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

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**FLOODPLAIN SOIL AREAS GREATER THAN 20 MG/KG  
 BASED ON NATURAL NEIGHBOR INTERPOLATED  
 SURFACE FORMER PLAINWELL IMPOUNDMENT**

**ARCADIS** | **FIGURE A-08**



**LEGEND:**

**SOIL PCB (MG/KG):**

- < 1
- > 1 and ≤ 5
- > 5 and ≤ 10
- > 10 and ≤ 15
- > 15 and ≤ 20
- > 20 and ≤ 25
- > 25

- AREA OVER 1/4 ACRE AND AREA >15 mg/kg
- TCRA ACCESS ROAD AND STAGING AREA
- KALAMAZOO RIVER

**NOTES:**

1. CONTIGUOUS AREAS OF OVER 1/4 ACRE GREATER THAN 15 MG/KG.
2. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
3. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
4. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

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**FLOODPLAIN SOIL AREAS GREATER THAN 15 MG/KG  
 BASED ON NATURAL NEIGHBOR INTERPOLATED  
 SURFACE FORMER PLAINWELL IMPOUNDMENT**



**FIGURE  
 A-09**



**LEGEND:**

**SOIL PCB (MG/KG):**

- < 1
- > 1 and ≤ 5
- > 5 and ≤ 10
- > 10 and ≤ 15
- > 15 and ≤ 20
- > 20 and ≤ 25
- > 25

- AREA OVER 1/4 ACRE AND AREA >10 mg/kg
- TCRA ACCESS ROAD AND STAGING AREA
- KALAMAZOO RIVER

**NOTES:**

1. CONTIGUOUS AREAS OF OVER 1/4 ACRE GREATER THAN 10 MG/KG.
2. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
3. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
4. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

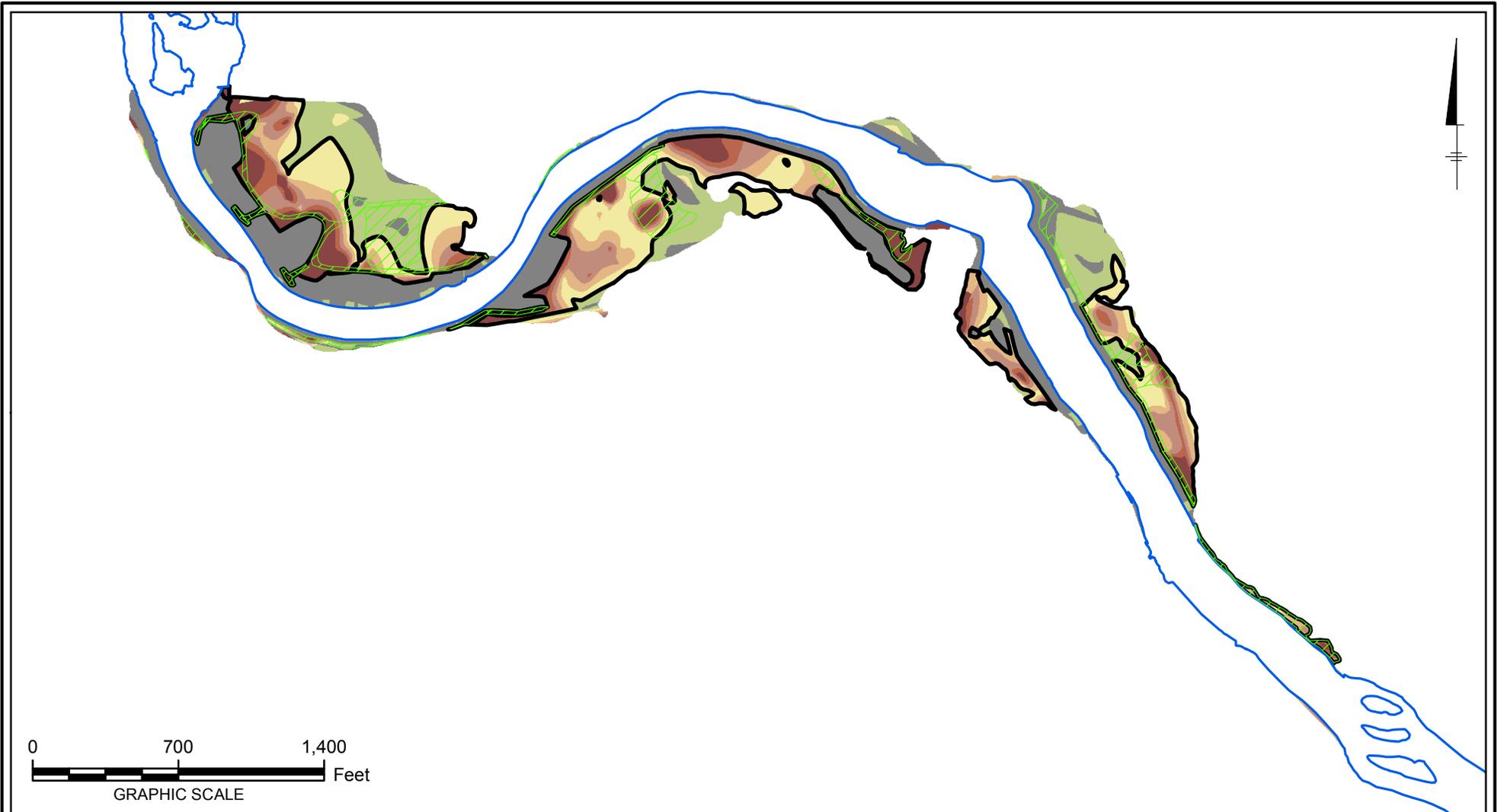
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**FLOODPLAIN SOIL AREAS GREATER THAN 10 MG/KG  
 BASED ON NATURAL NEIGHBOR INTERPOLATED  
 SURFACE FORMER PLAINWELL IMPOUNDMENT**



**FIGURE  
 A-10**



**LEGEND:**

**SOIL PCB (MG/KG):**

- < 1
- > 1 and ≤ 5
- > 5 and ≤ 10
- > 10 and ≤ 15
- > 15 and ≤ 20
- > 20 and ≤ 25
- > 25

- AREA OVER 1/4 ACRE AND AREA >5 mg/kg
- TCRA ACCESS ROAD AND STAGING AREA
- KALAMAZOO RIVER

**NOTES:**

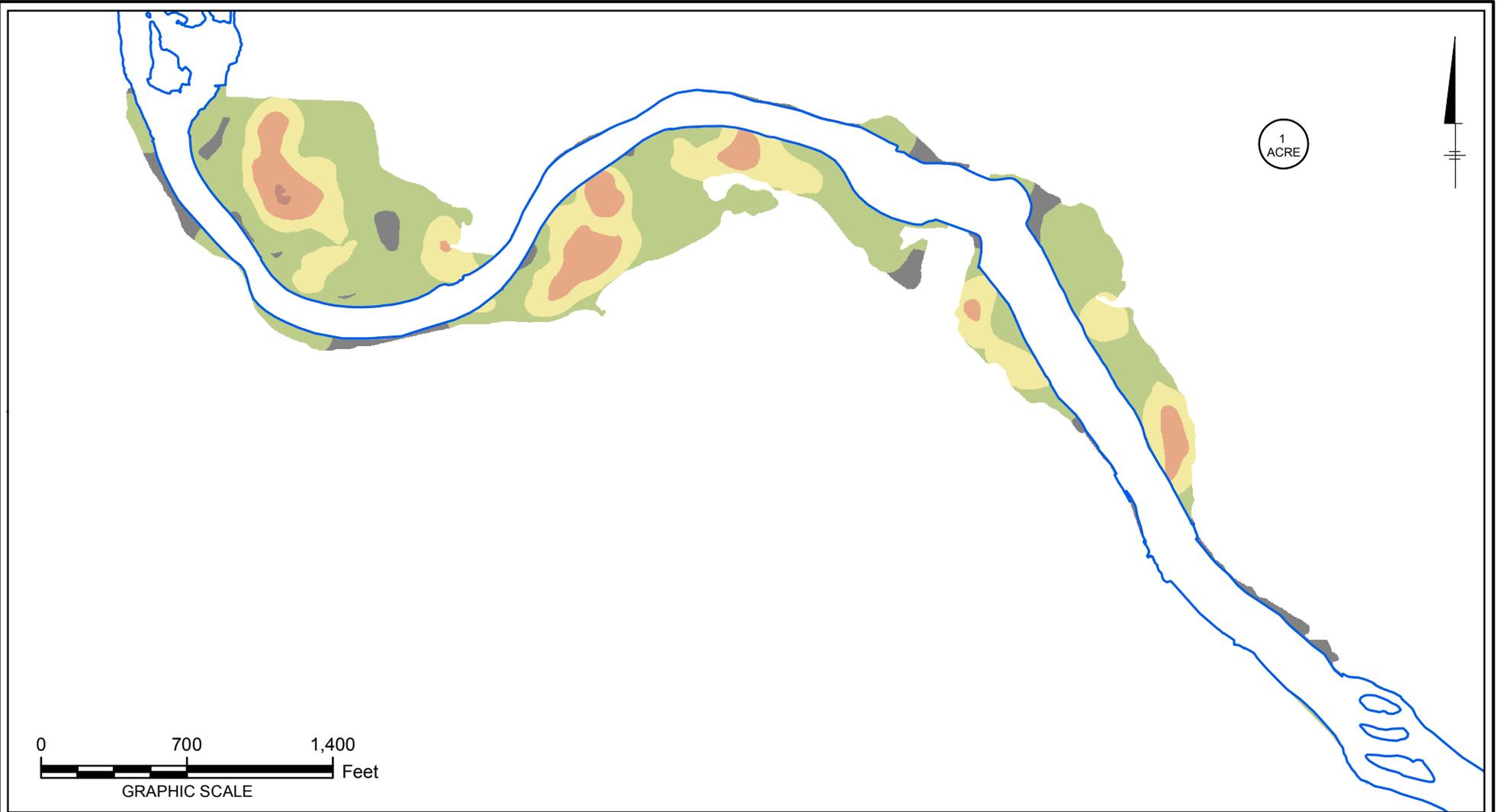
1. CONTIGUOUS AREAS OF OVER 1/4 ACRE GREATER THAN 5 MG/KG.
2. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
3. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
4. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

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**FLOODPLAIN SOIL AREAS GREATER THAN 5 MG/KG  
 BASED ON NATURAL NEIGHBOR INTERPOLATED  
 SURFACE FORMER PLAINWELL IMPOUNDMENT**



**FIGURE  
 A-11**



**LEGEND:**

SOIL PCB (MG/KG)<sup>1,2</sup>:

Dark Grey	≤ 0.5
Light Green	> 0.5 and ≤ 6
Yellow	> 6 and ≤ 11
Orange	> 11 and ≤ 18
Red	> 18
Blue Outline	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

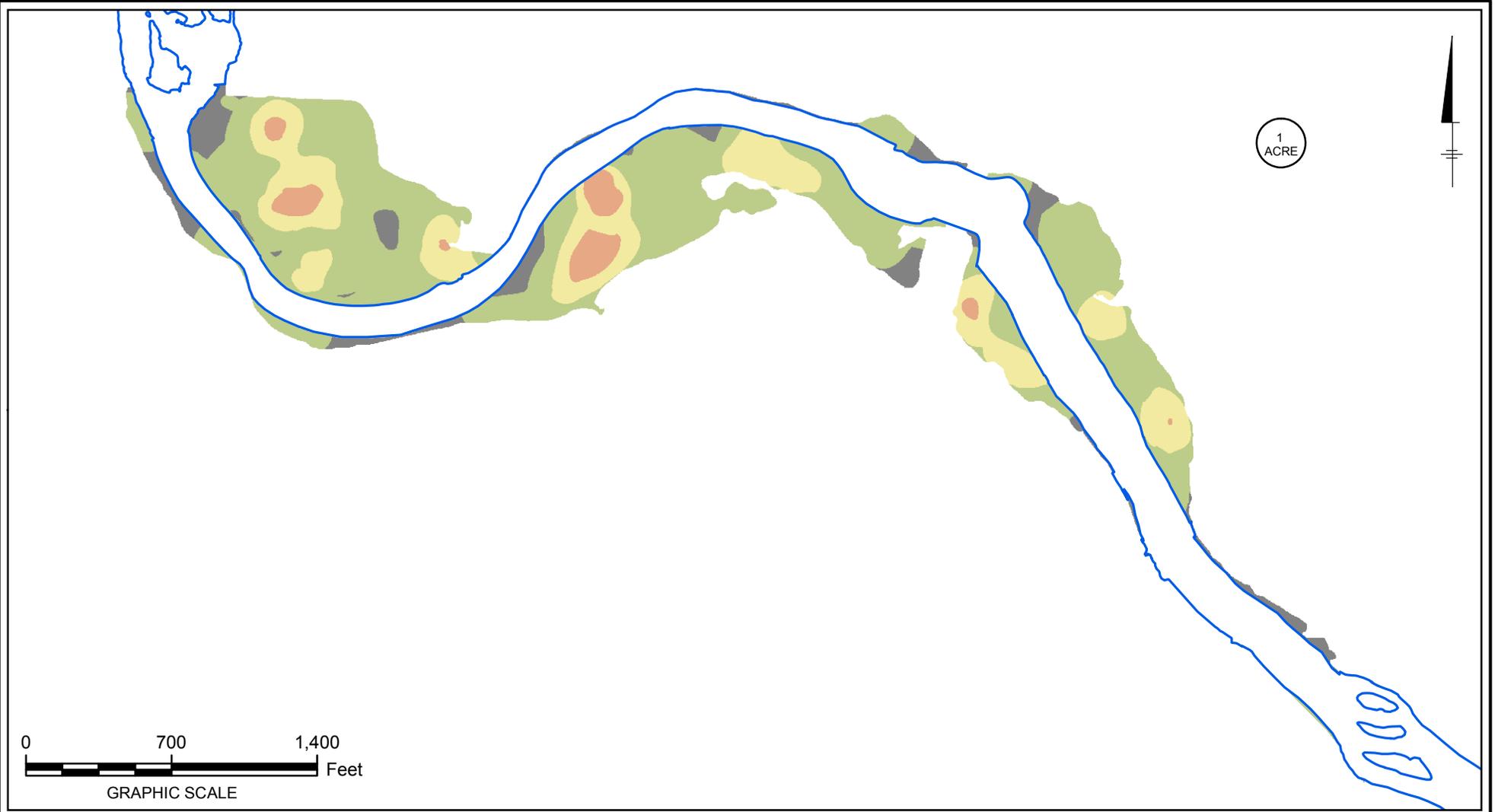
<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 1 ACRE MOVING WINDOW FORMER  
 PLAINWELL IMPOUNDMENT-25 MG/KG HILL TOP**



**FIGURE  
 A-12**



**LEGEND:**

SOIL PCB (MG/KG)<sup>1,2</sup>:

Dark Grey	≤ 0.5
Light Green	> 0.5 and ≤ 6
Yellow	> 6 and ≤ 11
Orange	> 11 and ≤ 18
Red	> 18
Blue outline	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

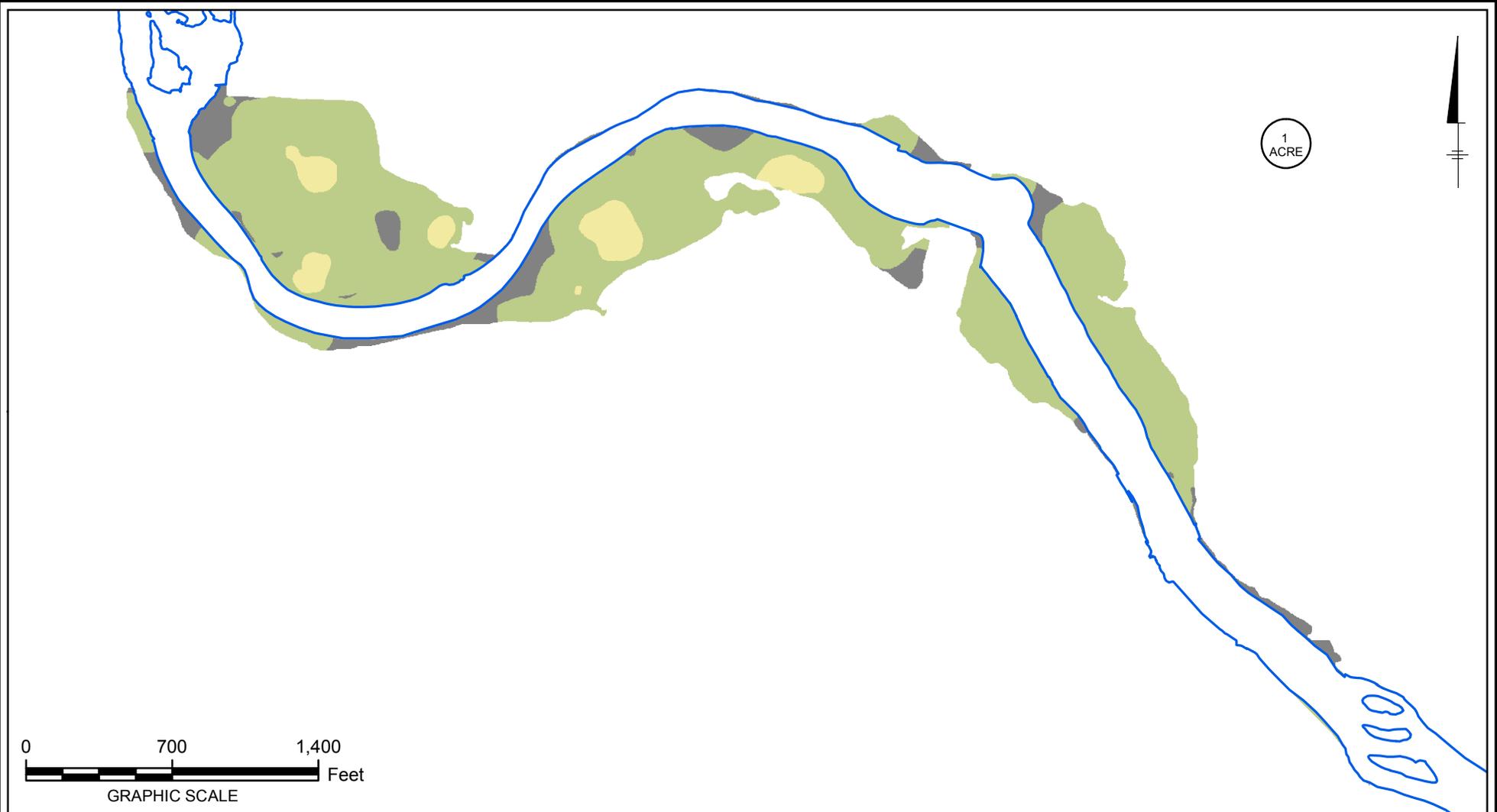
<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 1 ACRE MOVING WINDOW FORMER  
 PLAINWELL IMPOUNDMENT-20 MG/KG HILL TOP**



FIGURE  
**A-13**



**LEGEND:**

SOIL PCB (MG/KG)<sup>\*1,2</sup>:

	≤ 0.5
	> 0.5 and ≤ 6
	> 6 and ≤ 11
	> 11 and ≤ 18
	> 18
	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

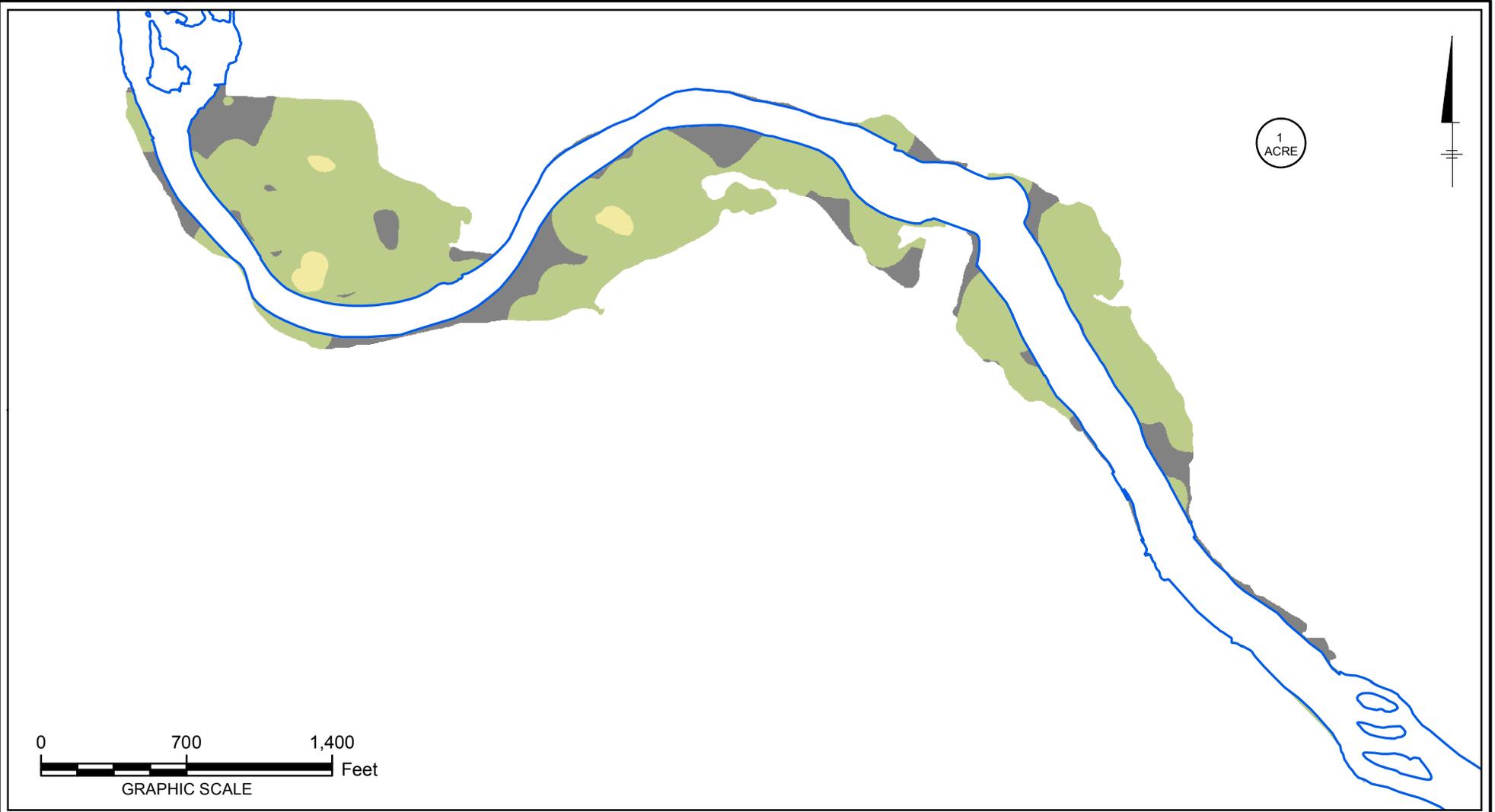
- <sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.
- <sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 1 ACRE MOVING WINDOW FORMER  
 PLAINWELL IMPOUNDMENT-15 MG/KG HILL TOP**



FIGURE  
**A-14**



**LEGEND:**

SOIL PCB (MG/KG)<sup>\*1,2</sup>:

	≤ 0.5
	> 0.5 and ≤ 6
	> 6 and ≤ 11
	> 11 and ≤ 18
	> 18
	KALAMAZOO RIVER

**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

\*<sup>1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

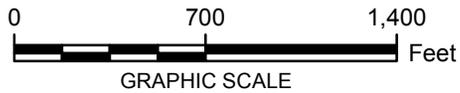
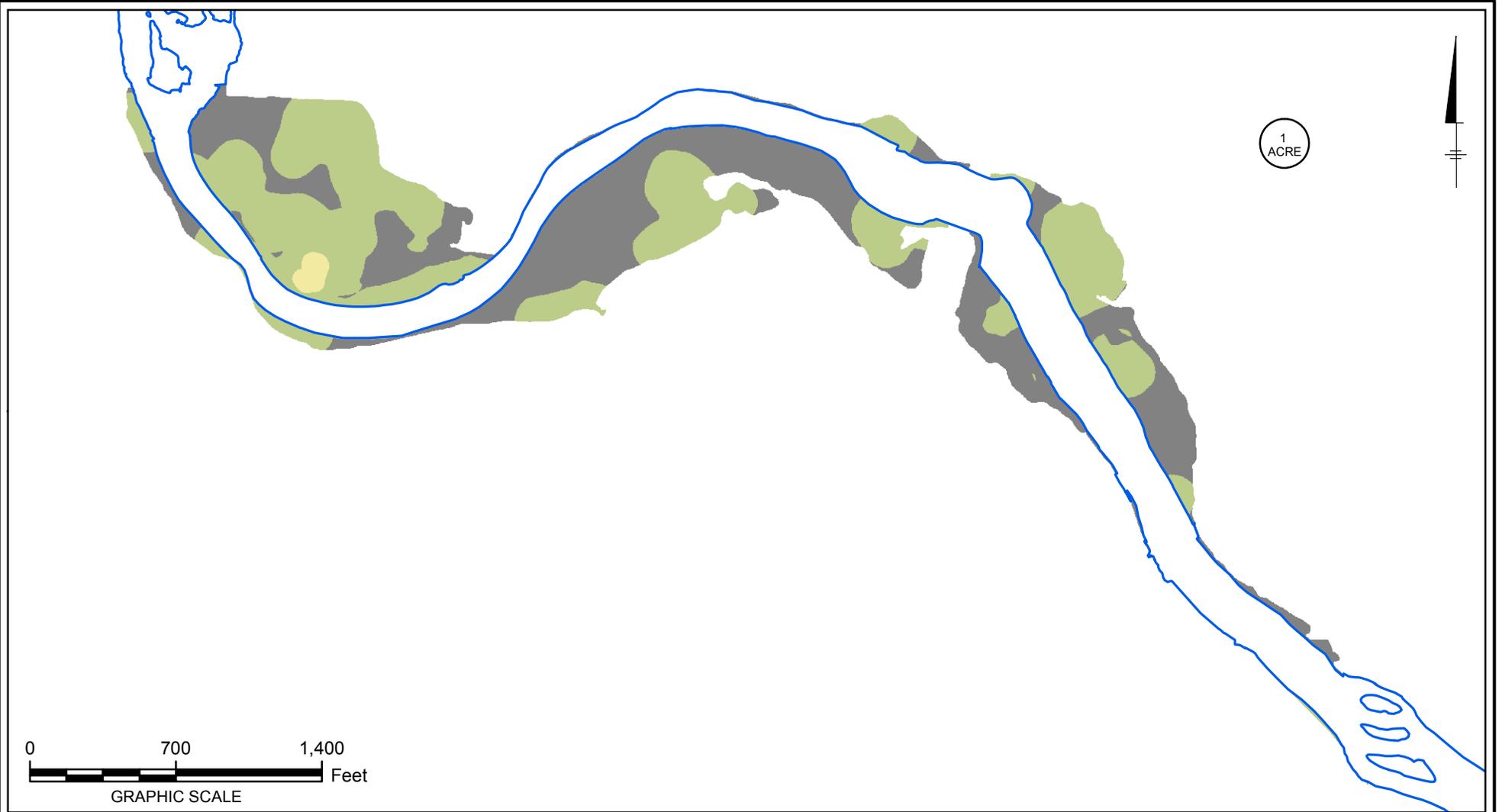
\*<sup>2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 1 ACRE MOVING WINDOW FORMER  
 PLAINWELL IMPOUNDMENT-10 MG/KG HILL TOP**



**FIGURE  
 A-15**



**LEGEND:**  
 SOIL PCB (MG/KG)<sup>1,2</sup>:

	≤ 0.5
	> 0.5 and ≤ 6
	> 6 and ≤ 11
	> 11 and ≤ 18
	> 18
	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES..

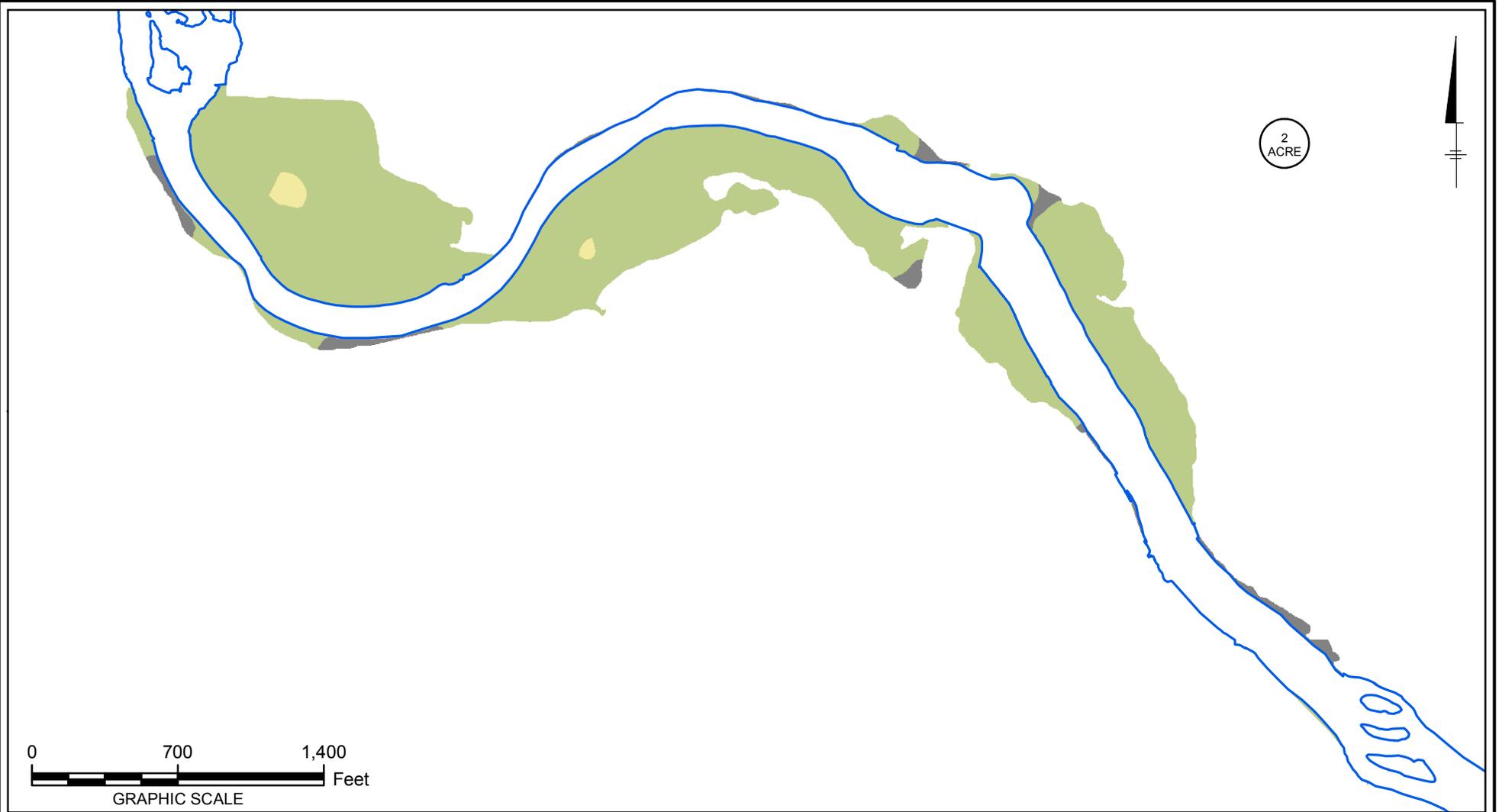
<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**INTERPOLATED FLOODPLAIN SOIL PCB**  
**CONCENTRATION 1 ACRE MOVING WINDOW FORMER**  
**PLAINWELL IMPOUNDMENT-5 MG/KG HILL TOP**



FIGURE  
**A-16**



**LEGEND:**

SOIL PCB (MG/KG)<sup>\*1,2</sup>:

	≤ 0.5
	> 0.5 AND ≤ 13
	> 13 AND ≤ 16
	> 16 AND ≤ 20
	> 20
	KALAMAZOO RIVER

**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

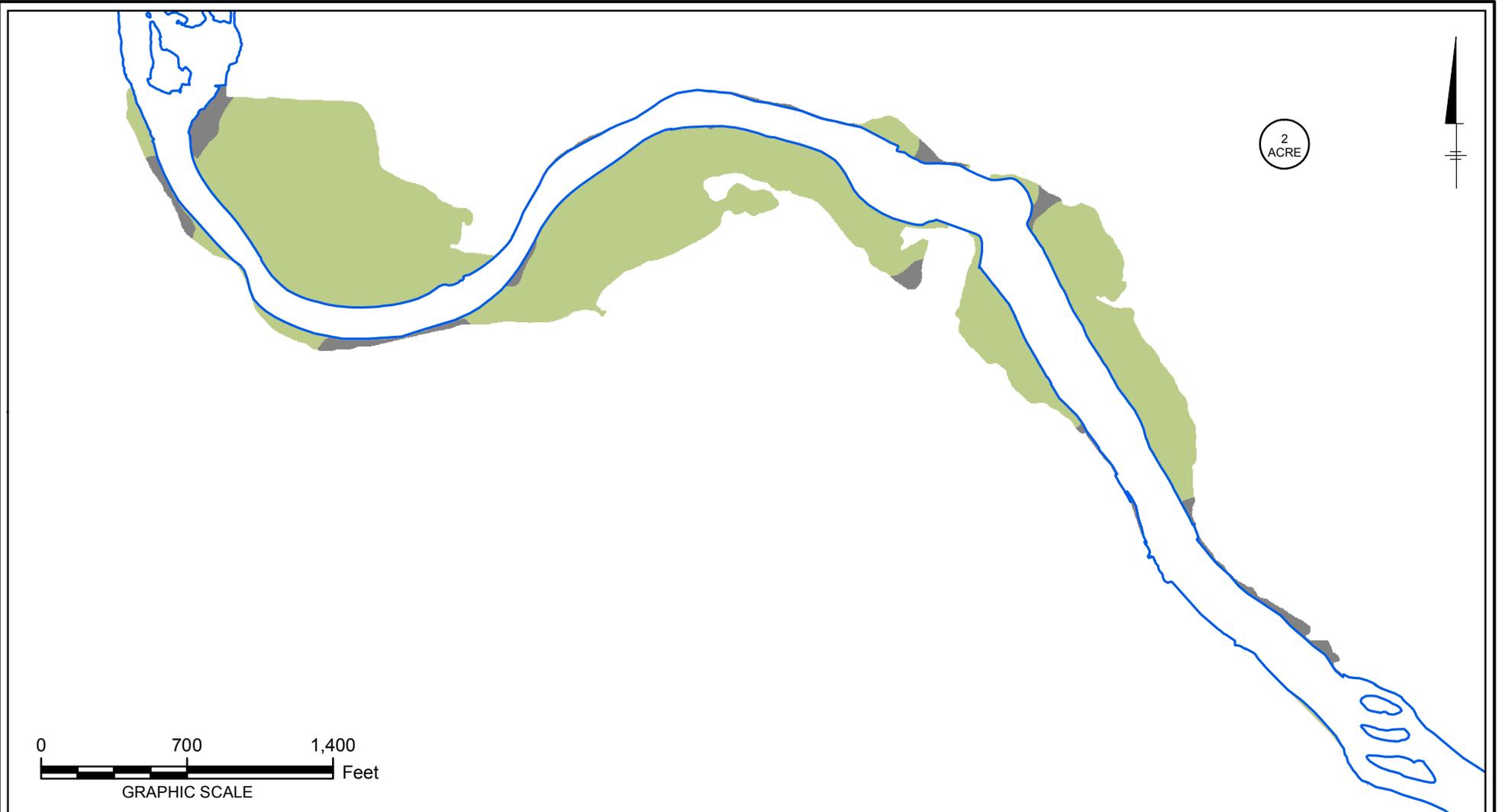
<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 2 ACRE MOVING WINDOW FORMER  
 PLAINWELL IMPOUNDMENT-25 MG/KG HILL TOP**



FIGURE  
**A-17**



**LEGEND:**

SOIL PCB (MG/KG)<sup>\*1,2</sup>:

	≤ 0.5
	> 0.5 AND ≤ 13
	> 13 AND ≤ 16
	> 16 AND ≤ 20
	> 20
	KALAMAZOO RIVER

**NOTES:**

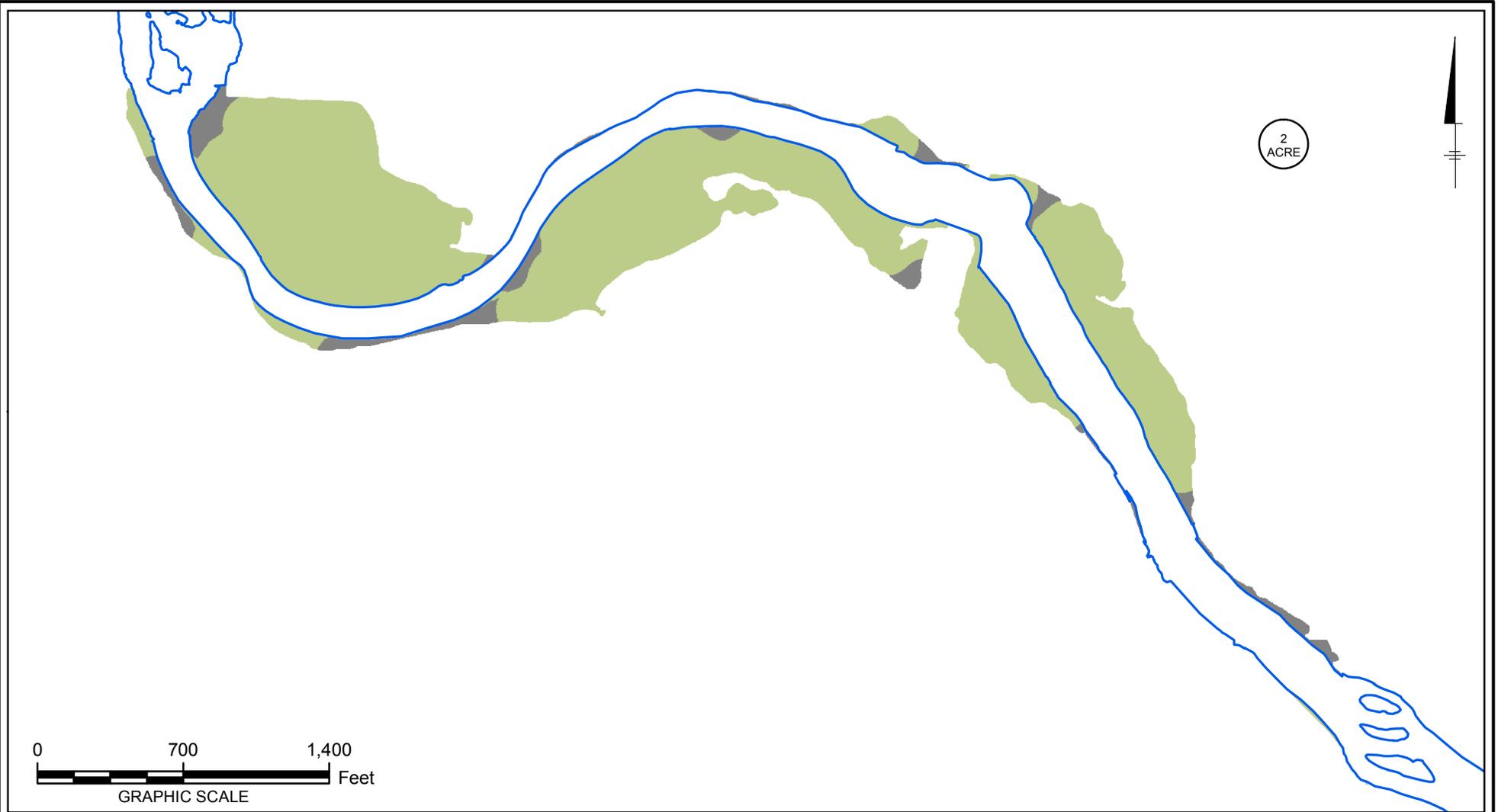
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.
- <sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.
- <sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 2 ACRE MOVING WINDOW FORMER  
 PLAINWELL IMPOUNDMENT-20 MG/KG HILL TOP**

FIGURE  
**A-18**



**LEGEND:**

SOIL PCB (MG/KG)<sup>\*1,2</sup>:

	≤ 0.5
	> 0.5 AND ≤ 13
	> 13 AND ≤ 16
	> 16 AND ≤ 20
	> 20
	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

\*<sup>1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

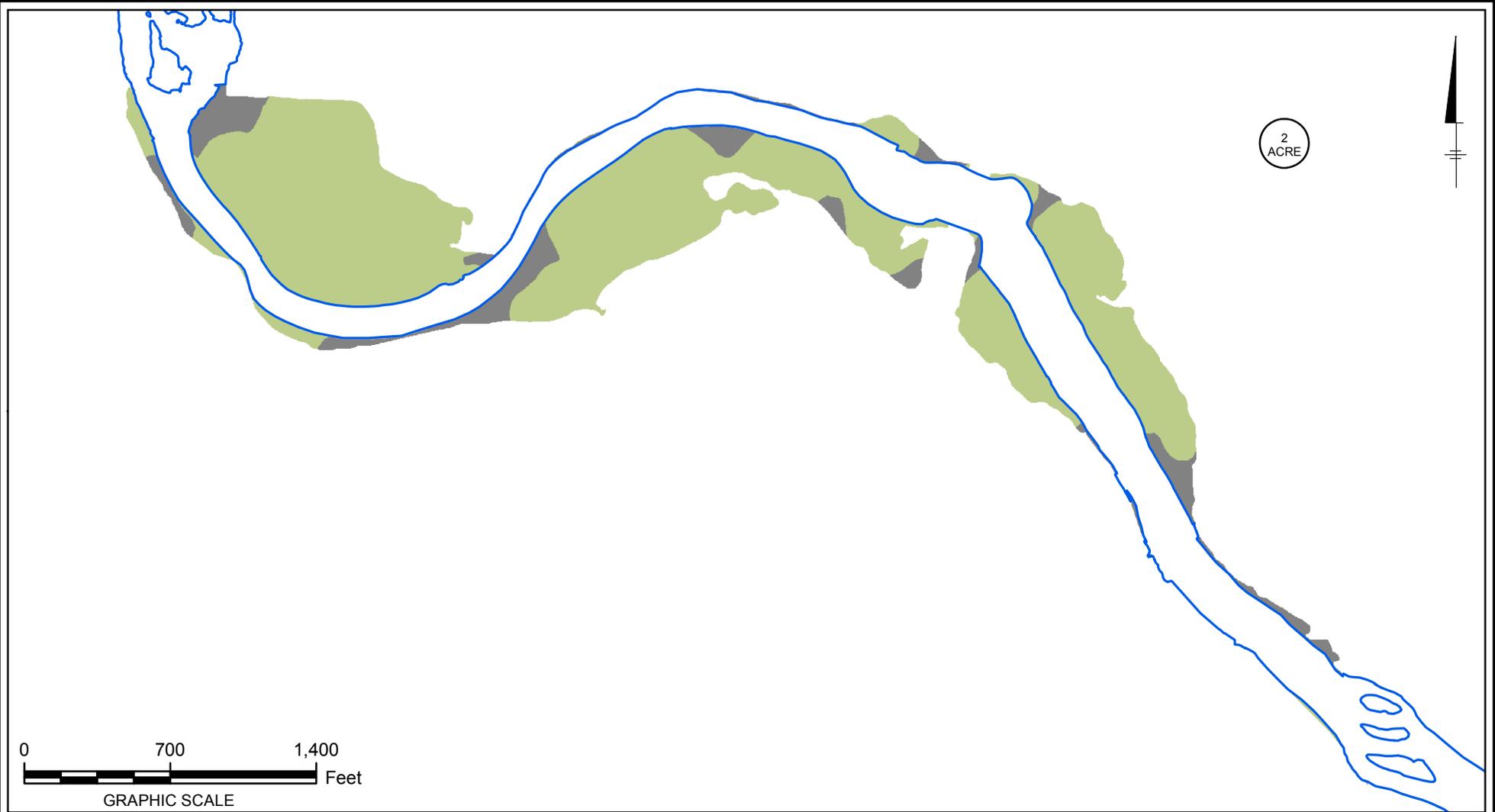
\*<sup>2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 2 ACRE MOVING WINDOW FORMER  
 PLAINWELL IMPOUNDMENT-15 MG/KG HILL TOP**



FIGURE  
**A-19**



**LEGEND:**

SOIL PCB (MG/KG)<sup>\*1,2</sup>:

	≤ 0.5
	> 0.5 AND ≤ 13
	> 13 AND ≤ 16
	> 16 AND ≤ 20
	> 20
	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

\*<sup>1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

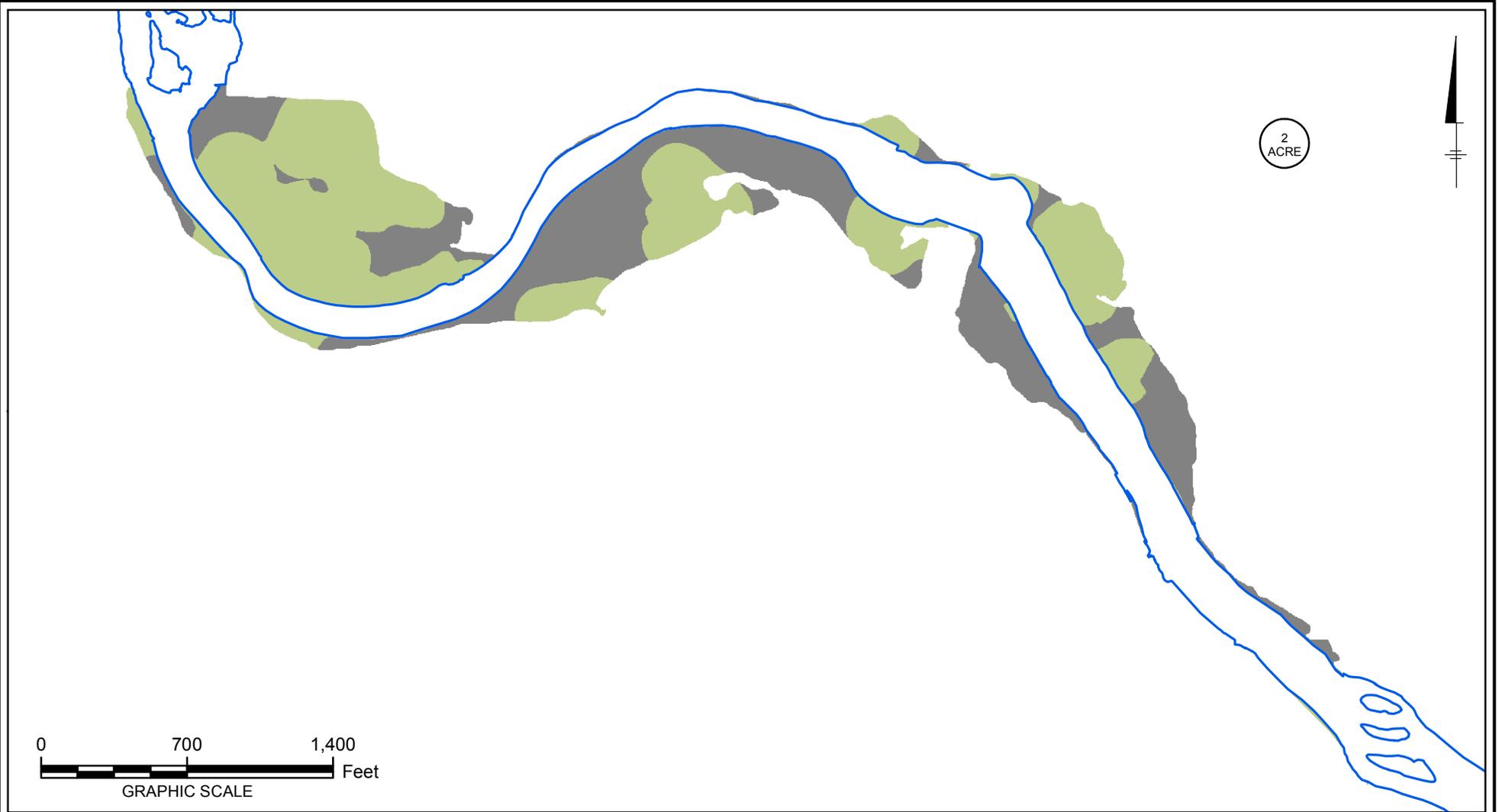
\*<sup>2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

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**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 2 ACRE MOVING WINDOW FORMER  
 PLAINWELL IMPOUNDMENT-10 MG/KG HILL TOP**



FIGURE  
**A-20**



**LEGEND:**

SOIL PCB (MG/KG)<sup>\*1,2</sup>:

Dark Grey	≤ 0.5
Light Green	> 0.5 AND ≤ 13
Yellow	> 13 AND ≤ 16
Orange	> 16 AND ≤ 20
Brown	> 20
Blue Outline	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

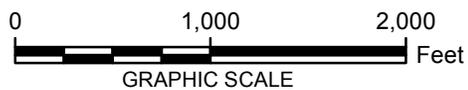
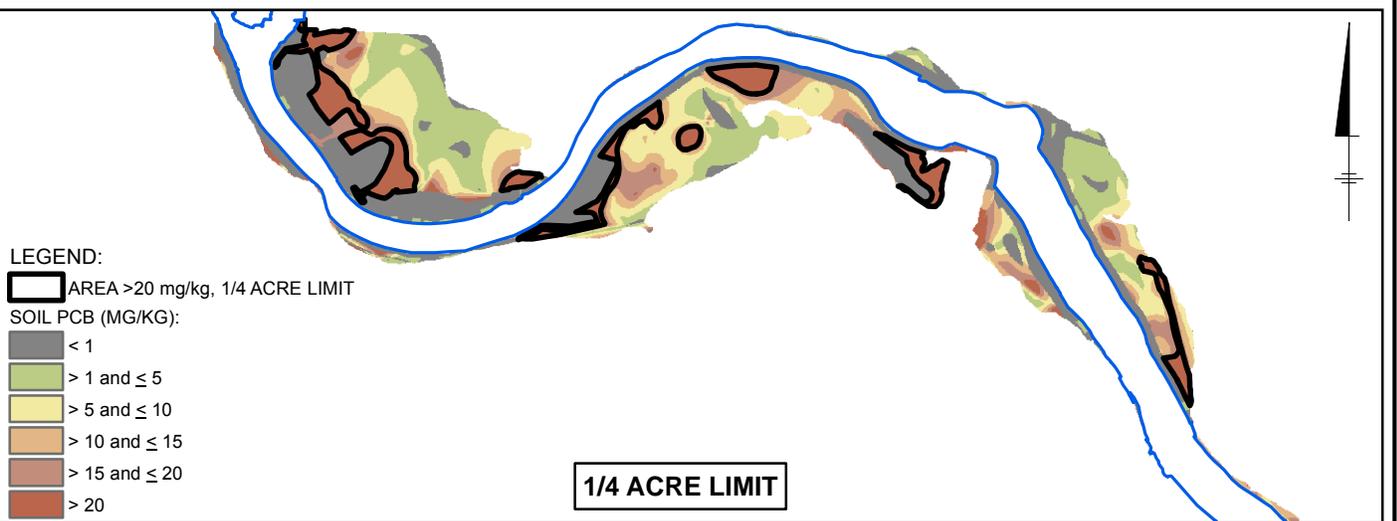
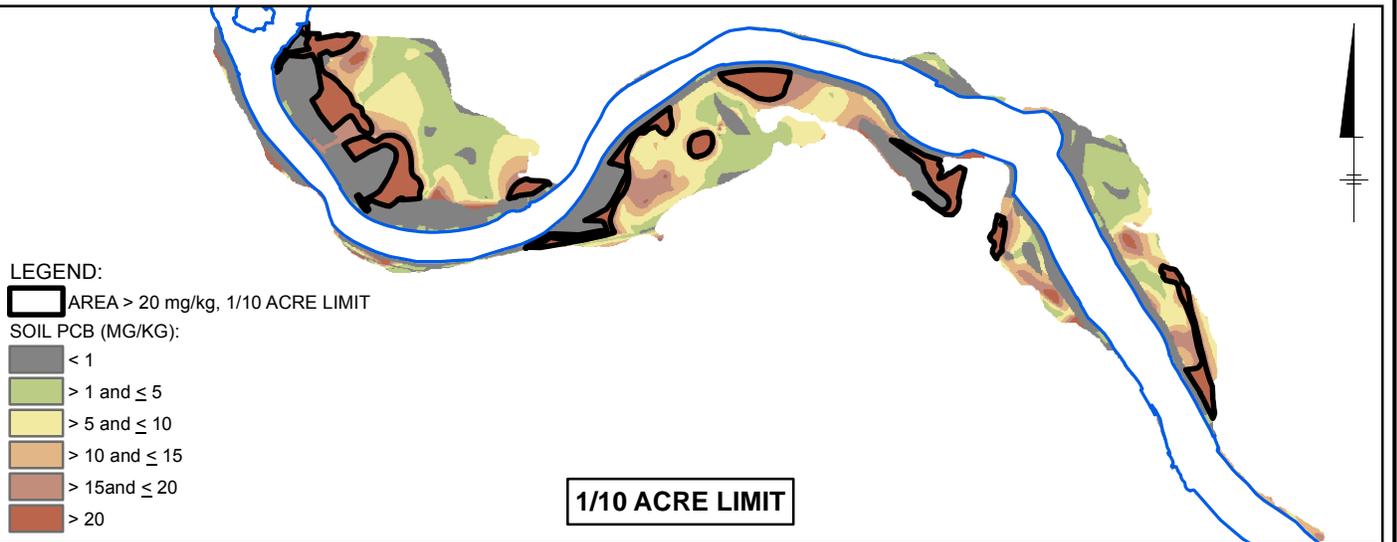
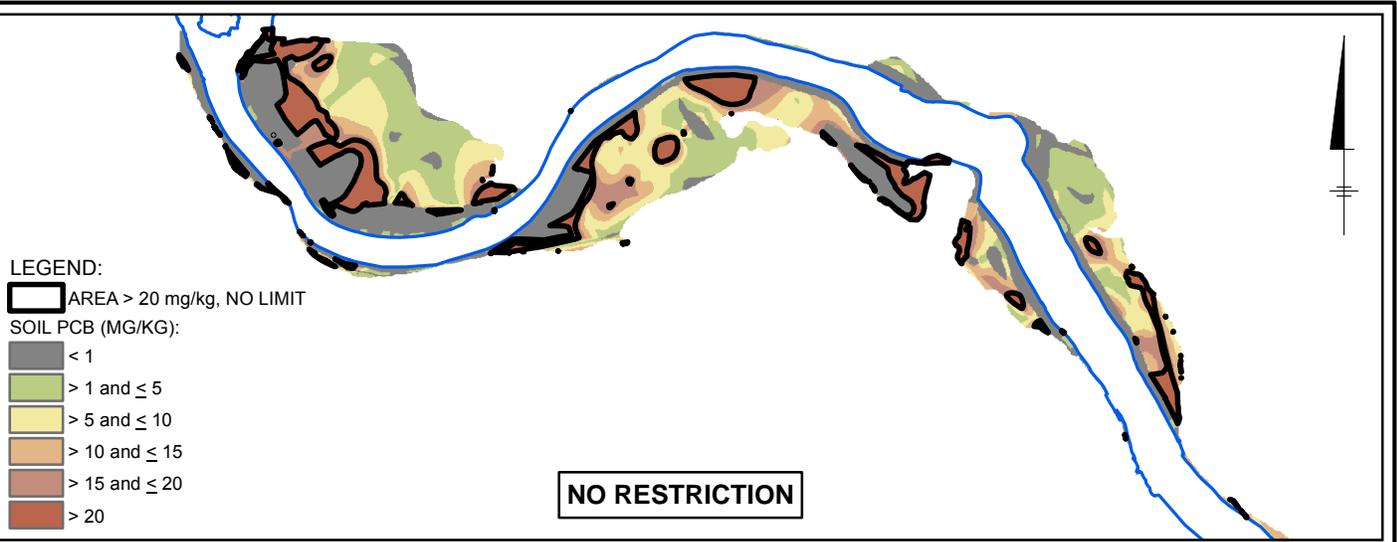
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**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 2 ACRE MOVING WINDOW FORMER  
 PLAINWELL IMPOUNDMENT-5 MG/KG HILL TOP**



FIGURE  
**A-21**

DRAFT



NOTES:

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

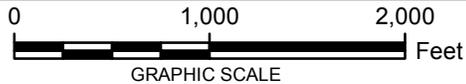
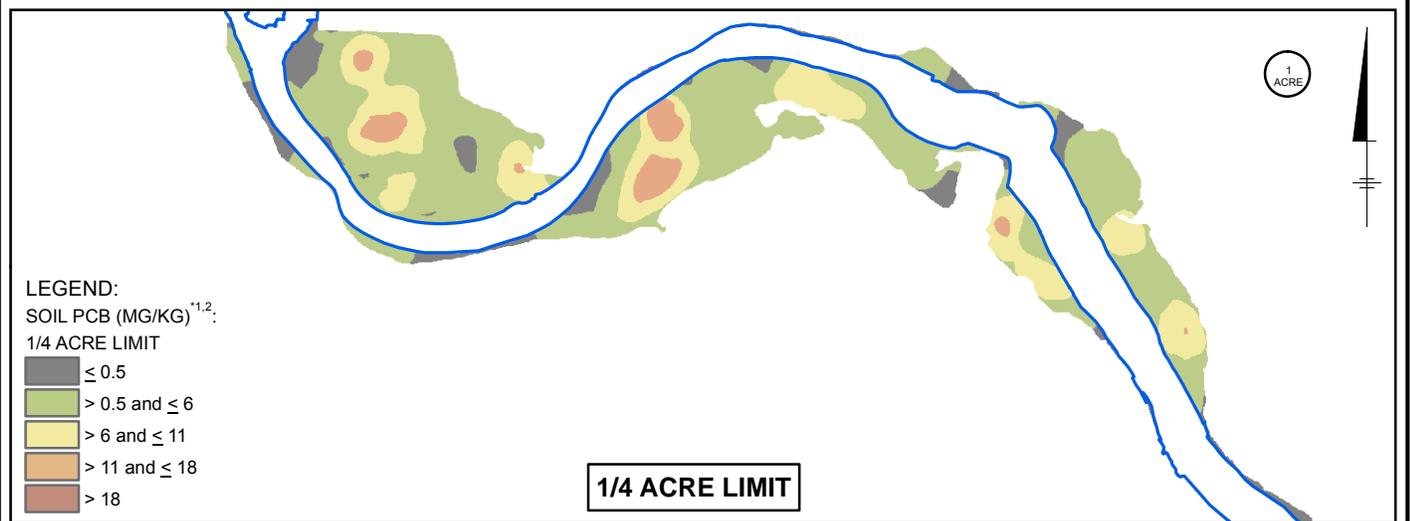
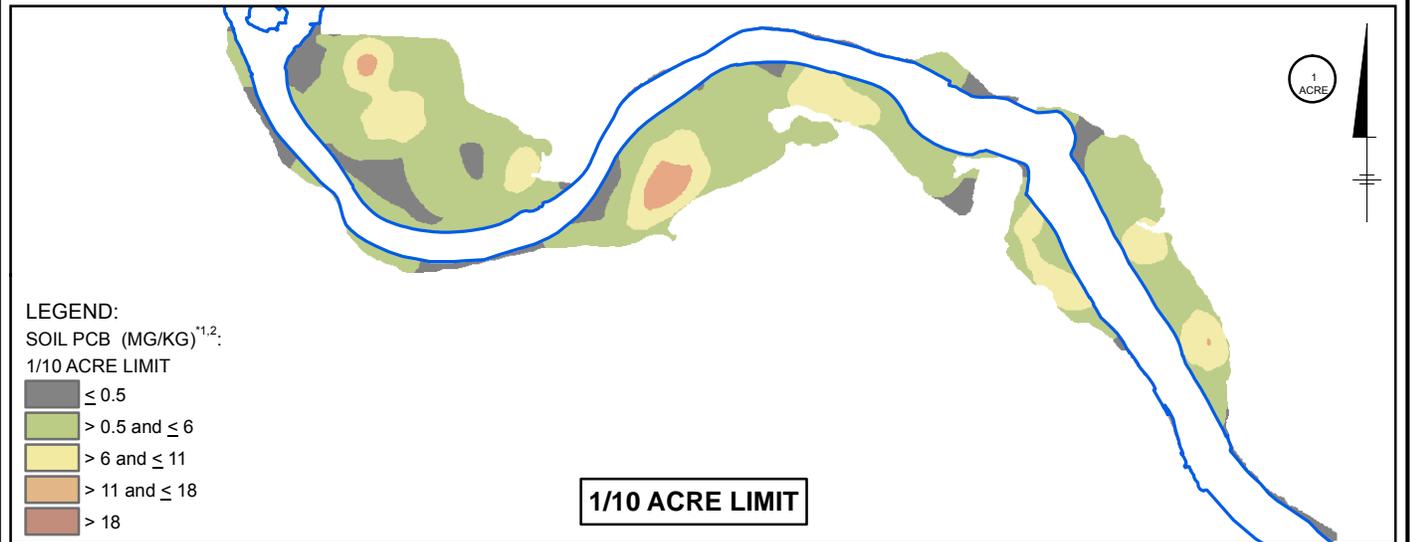
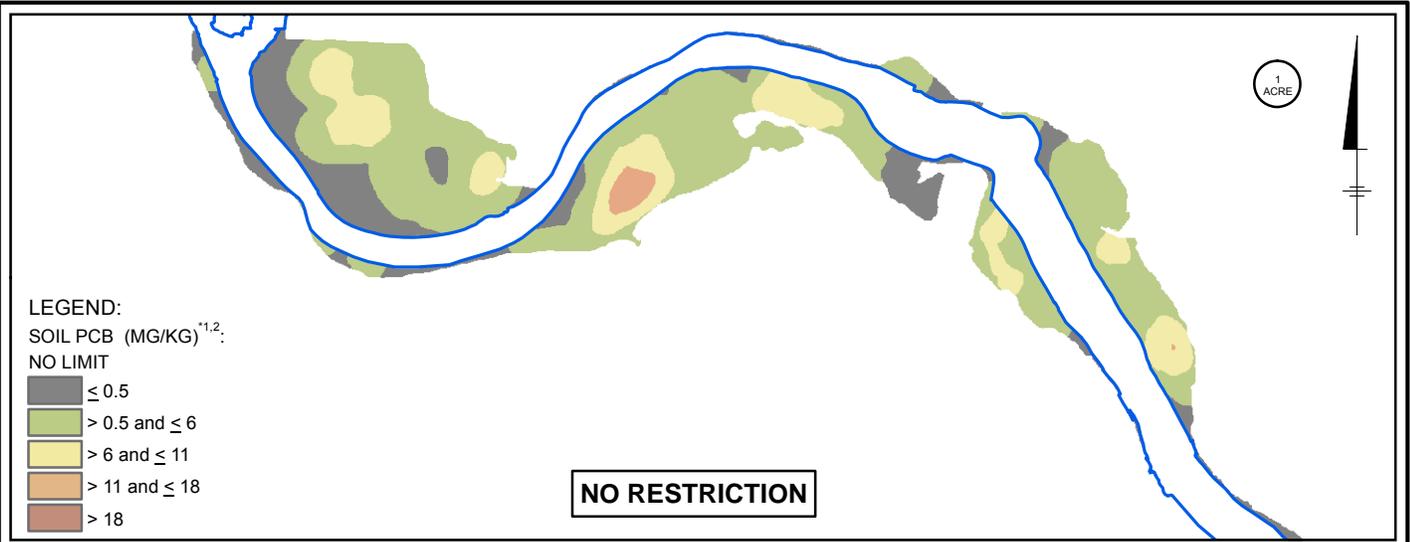
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**SENSITIVITY OF 20 MG/KG HILL TOP  
 TO CONTIGUOUS AREA SIZE RESTRICTION  
 FORMER PLAINWELL IMPOUNDMENT**



FIGURE  
**A-22**

City: SYR Div/Group: SED GIS Created By: J.RAPP Last Saved By: bdelecrq  
 KRSR AREA 1 (64539.3.635)  
 Q:\KRSR\WorowDamToPlainwellDam\AlternativesScreeningTechMemo\mxd\Comparison\_NatNeighbor\_Interpolation\_20ppm\_Plainwell\_v2.mxd 4/13/2012 10:59:53 AM



**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR-SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.  
<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA.

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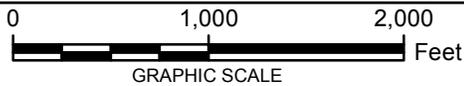
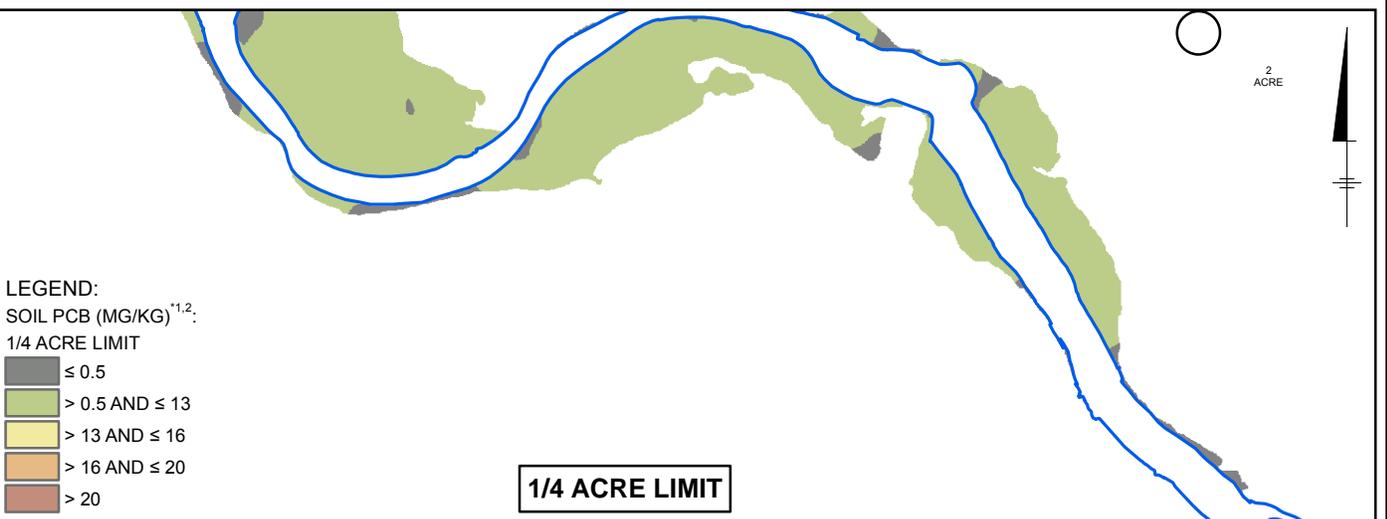
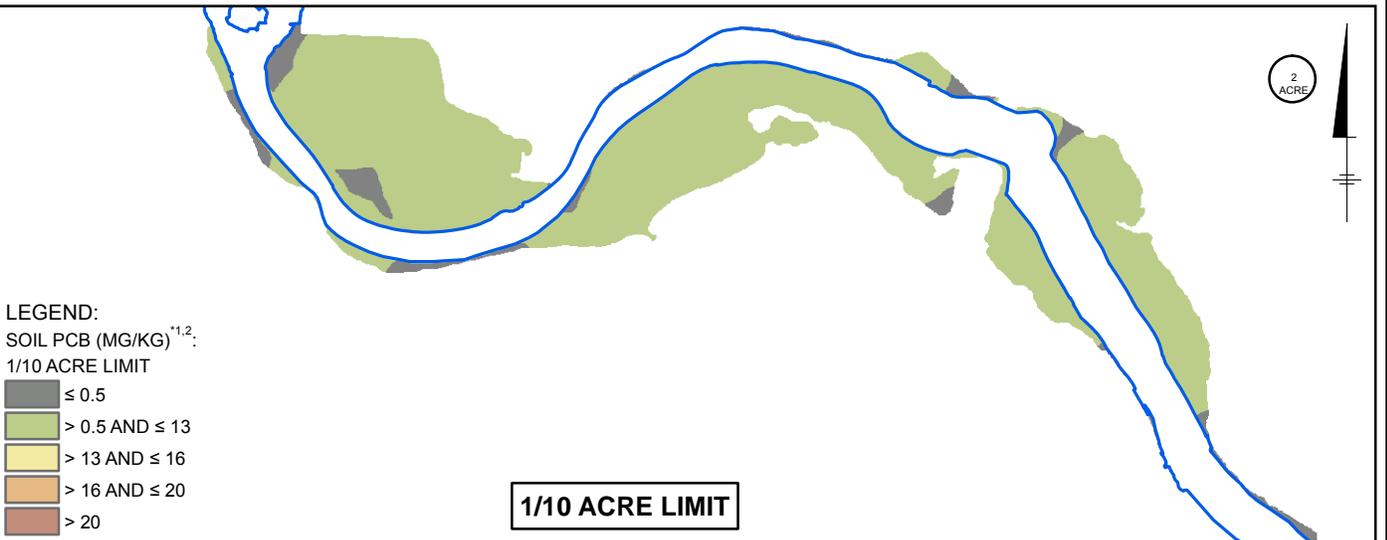
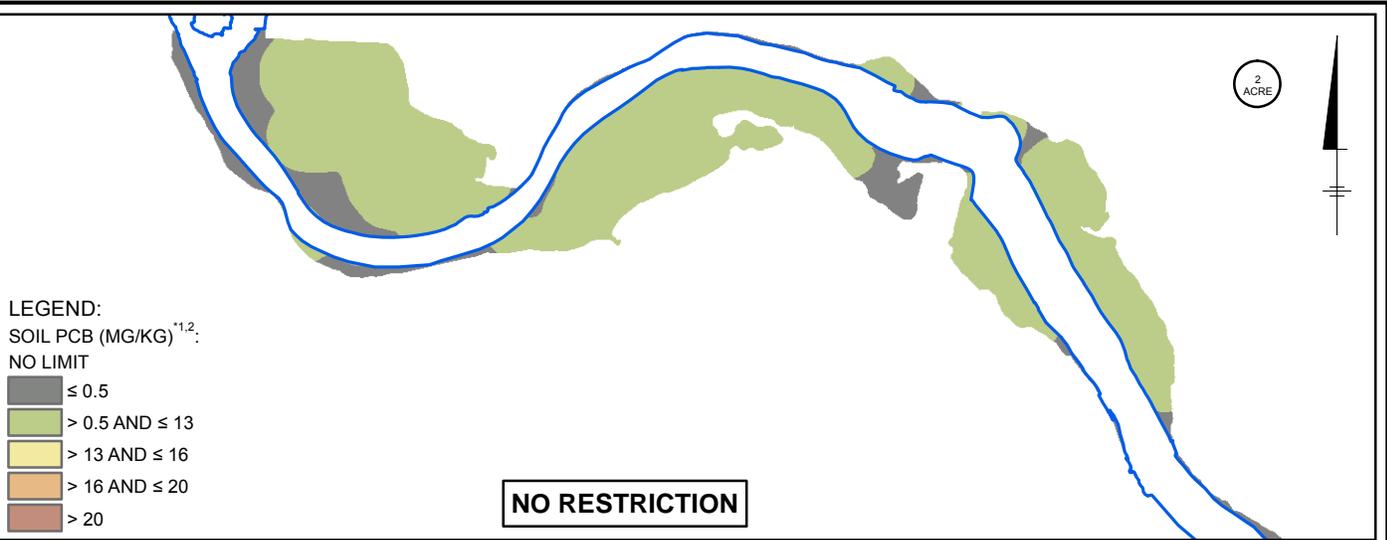
**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**SENSITIVITY OF 20 MG/KG HILL TOP TO  
 CONTIGUOUS AREA SIZE RESTRICTION 1 ACRE  
 MOVING WINDOW FORMER PLAINWELL IMPOUNDMENT**

**ARCADIS**

**FIGURE  
 A-23**

**DRAFT**



**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR-SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA.

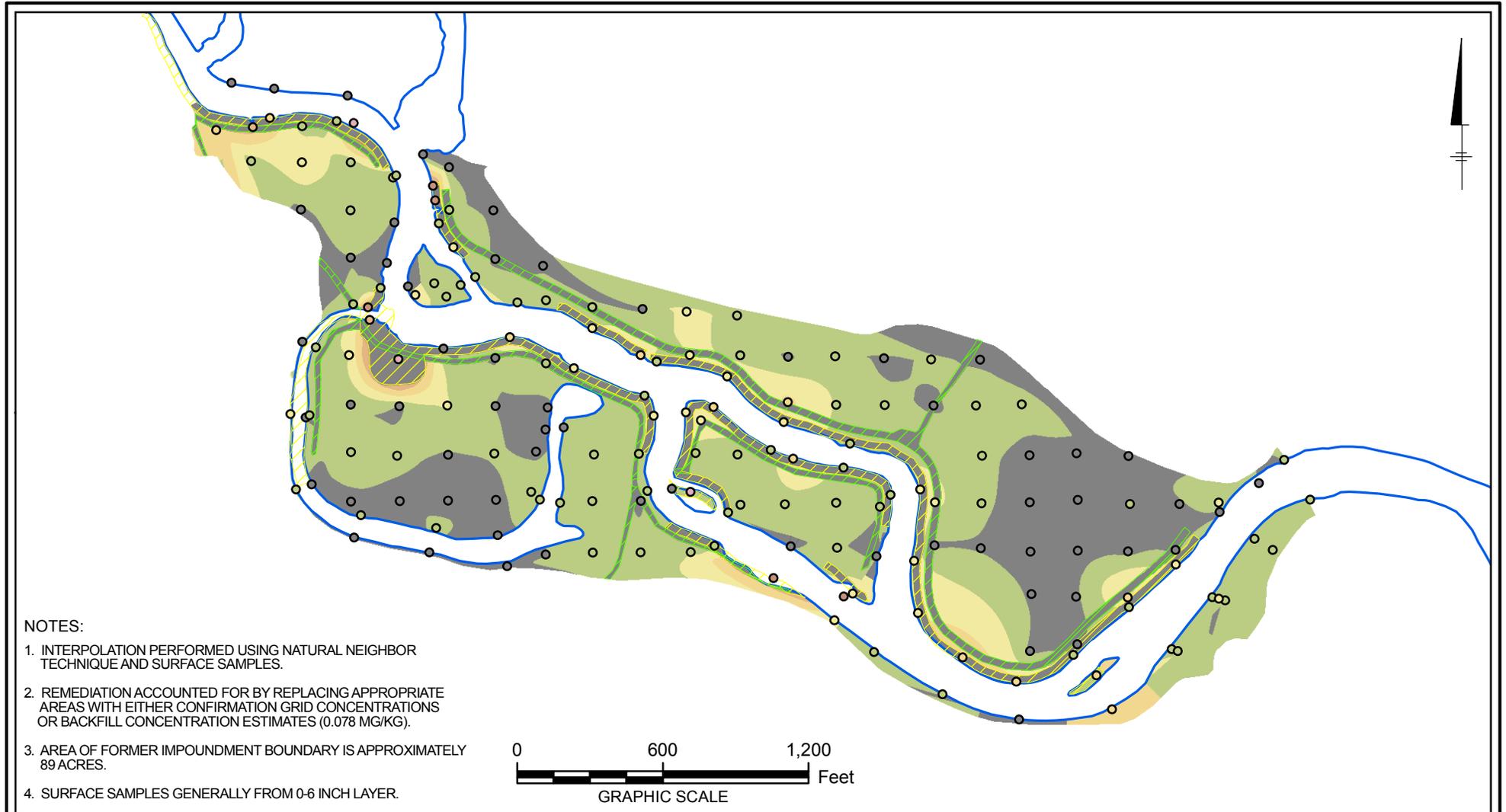
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**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**SENSITIVITY OF 20 MG/KG HILL TOP TO  
CONTIGUOUS AREA SIZE RESTRICTION 2 ACRE  
MOVING WINDOW FORMER PLAINWELL IMPOUNDMENT**



**FIGURE  
A-24**



**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 89 ACRES.
4. SURFACE SAMPLES GENERALLY FROM 0-6 INCH LAYER.



**LEGEND:**

- TCRA ACCESS ROAD
- TCRA REMOVAL AREA
- KALAMAZOO RIVER

**SOIL PCB (MG/KG) AT SAMPLING LOCATIONS:**

- ≤ 1
- >1 and ≤ 5
- >5 and ≤ 10
- >10 and ≤ 15
- >15 and ≤ 20
- >20 and ≤ 35
- >35 and ≤ 50
- > 50

**SOIL PCB (MG/KG):**

- ≤ 1
- >1 and ≤ 5
- >5 and ≤ 10
- >10 and ≤ 15
- >15 and ≤ 20
- >20 and ≤ 35
- >35 and ≤ 50
- > 50

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**INTERPOLATED FLOODPLAIN  
 SOIL PCB CONCENTRATIONS  
 PLAINWELL NO. 2 DAM AREA - POST-TCRA**



FIGURE  
**A-25**



**LEGEND:**  
 SOIL PCB (MG/KG)<sup>\*1,2</sup>:

	< 0.5
	0.5 - 6
	6 - 11
	11 - 18
	> 18
	KALAMAZOO RIVER

**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. AREA OF FORMER INUNDATION IS APPROXIMATELY 89 ACRES.
- <sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR-SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.
- <sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA, APPROXIMATELY 89 ACRES.

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**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 1 ACRE MOVING WINDOW  
 PLAINWELL NO. 2 DAM AREA - PRE-TCRA**



FIGURE  
**A-26**



**LEGEND:**

SOIL PCB (MG/KG)<sup>\*1,2</sup>:

	≤ 0.5
	> 0.5 AND ≤ 6
	> 6 AND ≤ 11
	> 11 AND ≤ 18
	> 18
	KALAMAZOO RIVER

**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER INUNDATION IS APPROXIMATELY 89 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 89 ACRES.

GEORGIA-PACIFIC LLC  
 ALLIED PAPER, INC./PORTAGE CREEK/  
 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 1 ACRE MOVING WINDOW  
 PLAINWELL NO. 2 DAM AREA - POST-TCRA**



FIGURE  
**A-27**



**LEGEND:**

SOIL PCB (MG/KG)<sup>1,2</sup>:

	≤ 0.5
	> 0.5 AND ≤ 13
	> 13 AND ≤ 16
	> 16 AND ≤ 20
	> 20
	KALAMAZOO RIVER

- NOTES:**
- INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  - AREA OF FORMER INUNDATION IS APPROXIMATELY 89 ACRES.
- <sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR-SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.
- <sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 89 ACRES.

GEORGIA-PACIFIC LLC  
 ALLIED PAPER, INC./PORTAGE CREEK/  
 KALAMAZOO RIVER SUPERFUND SITE

**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 2 ACRE MOVING WINDOW  
 PLAINWELL NO. 2 DAM AREA - PRE-TCRA**



**FIGURE  
A-28**



**LEGEND:**

**SOIL PCB (MG/KG)<sup>1,2</sup>:**

	≤ 0.5
	> 0.5 AND ≤ 13
	> 13 AND ≤ 16
	> 16 AND ≤ 20
	> 20
	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER INUNDATION IS APPROXIMATELY 89 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 89 ACRES.

GEORGIA-PACIFIC LLC  
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 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 2 ACRE MOVING WINDOW  
 PLAINWELL NO. 2 DAM AREA - POST-TCRA**



FIGURE  
**A-29**



**LEGEND:**

-  AREA OVER 1/4 ACRE AND AREA > 10 mg/kg
-  AREA OVER 1/4 ACRE AND AREA > 5 mg/kg
-  AREA OVER 1/4 ACRE AND AREA > 0.5 mg/kg
-  TCRA ACCESS ROAD
-  KALAMAZOO RIVER

**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER INUNDATION IS APPROXIMATELY 89 ACRES.

GEORGIA-PACIFIC LLC  
ALLIED PAPER, INC./PORTAGE CREEK/  
KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**FLOODPLAIN SOIL AREAS GREATER THAN SPECIFIED  
CONCENTRATION BASED ON NATURAL NEIGHBOR  
INTERPOLATED SURFACE PLAINWELL NO. 2 DAM AREA**



FIGURE  
**A-30**



**LEGEND:**

<b>SOIL PCB (MG/KG):</b>	AREA OVER 1/4 ACRE AND AREA > 10 mg/kg
< 1	TCRA ACCESS ROAD
> 1 and ≤ 5	KALAMAZOO RIVER
> 5 and ≤ 10	
> 10 and ≤ 15	
> 15 and ≤ 20	
> 20 and ≤ 25	
> 25	

- NOTES:**
1. CONTIGUOUS AREAS OF OVER 1/4 ACRE GREATER THAN 10 MG/KG.
  2. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  3. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  4. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 89 ACRES.

GEORGIA-PACIFIC LLC  
 ALLIED PAPER, INC./PORTAGE CREEK/  
 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**FLOODPLAIN SOIL AREAS GREATER THAN 10 MG/KG  
 BASED ON NATURAL NEIGHBOR INTERPOLATED  
 SURFACE PLAINWELL NO. 2 DAM AREA**



FIGURE  
**A-31**



**LEGEND:**

**SOIL PCB (MG/KG):**

- < 1
- > 1 and ≤ 5
- > 5 and ≤ 10
- > 10 and ≤ 15
- > 15 and ≤ 20
- > 20 and ≤ 25
- > 25

- AREA OVER 1/4 ACRE AND AREA > 5 mg/kg
- TCRA ACCESS ROAD
- KALAMAZOO RIVER

**NOTES:**

1. CONTIGUOUS AREAS OF OVER 1/4 ACRE GREATER THAN 5 MG/KG.
2. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
3. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
4. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 89 ACRES.

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 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**FLOODPLAIN SOIL AREAS GREATER THAN 5 MG/KG  
 BASED ON NATURAL NEIGHBOR INTERPOLATED  
 SURFACE PLAINWELL NO. 2 DAM AREA**



**FIGURE  
 A-32**



**LEGEND:**

SOIL PCB (MG/KG)<sup>1,2</sup>:

	≤ 0.5
	> 0.5 AND ≤ 6
	> 6 AND ≤ 11
	> 11 AND ≤ 18
	> 18
	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER INUNDATION IS APPROXIMATELY 89 ACRES.

\*<sup>1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

\*<sup>2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 89 ACRES.

GEORGIA-PACIFIC LLC  
 ALLIED PAPER, INC./PORTAGE CREEK/  
 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 1 ACRE MOVING WINDOW  
 PLAINWELL NO. 2 DAM AREA - 10 MG/KG HILL TOP**



FIGURE  
**A-33**



**LEGEND:**

SOIL PCB (MG/KG)<sup>1,2</sup>:

	≤ 0.5
	> 0.5 AND ≤ 6
	> 6 AND ≤ 11
	> 11 AND ≤ 18
	> 18
	KALAMAZOO RIVER

- NOTES:**
1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  3. AREA OF FORMER INUNDATION IS APPROXIMATELY 89 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 89 ACRES.

GEORGIA-PACIFIC LLC  
 ALLIED PAPER, INC./PORTAGE CREEK/  
 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 1 ACRE MOVING WINDOW  
 PLAINWELL NO. 2 DAM AREA - 5 MG/KG HILL TOP**



FIGURE  
**A-34**



**LEGEND:**

**SOIL PCB (MG/KG)<sup>1,2</sup>:**

	≤ 0.5
	> 0.5 AND ≤ 13
	> 13 AND ≤ 16
	> 16 AND ≤ 20
	> 20
	KALAMAZOO RIVER

**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER INUNDATION IS APPROXIMATELY 89 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 89 ACRES.

GEORGIA-PACIFIC LLC  
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 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 2 ACRE MOVING WINDOW  
 PLAINWELL NO. 2 DAM AREA - 10 MG/KG HILL TOP**



FIGURE  
**A-35**



**LEGEND:**

SOIL PCB (MG/KG)<sup>1,2</sup>:

	≤ 0.5
	> 0.5 AND ≤ 13
	> 13 AND ≤ 16
	> 16 AND ≤ 20
	> 20
	KALAMAZOO RIVER

**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER INUNDATION IS APPROXIMATELY 89 ACRES.

<sup>\*1</sup> CONCENTRATION RANGES ARE BASED ON RECEPTOR- SPECIFIC RISK-BASED CONCENTRATIONS PROVIDED IN TABLE 5-6.

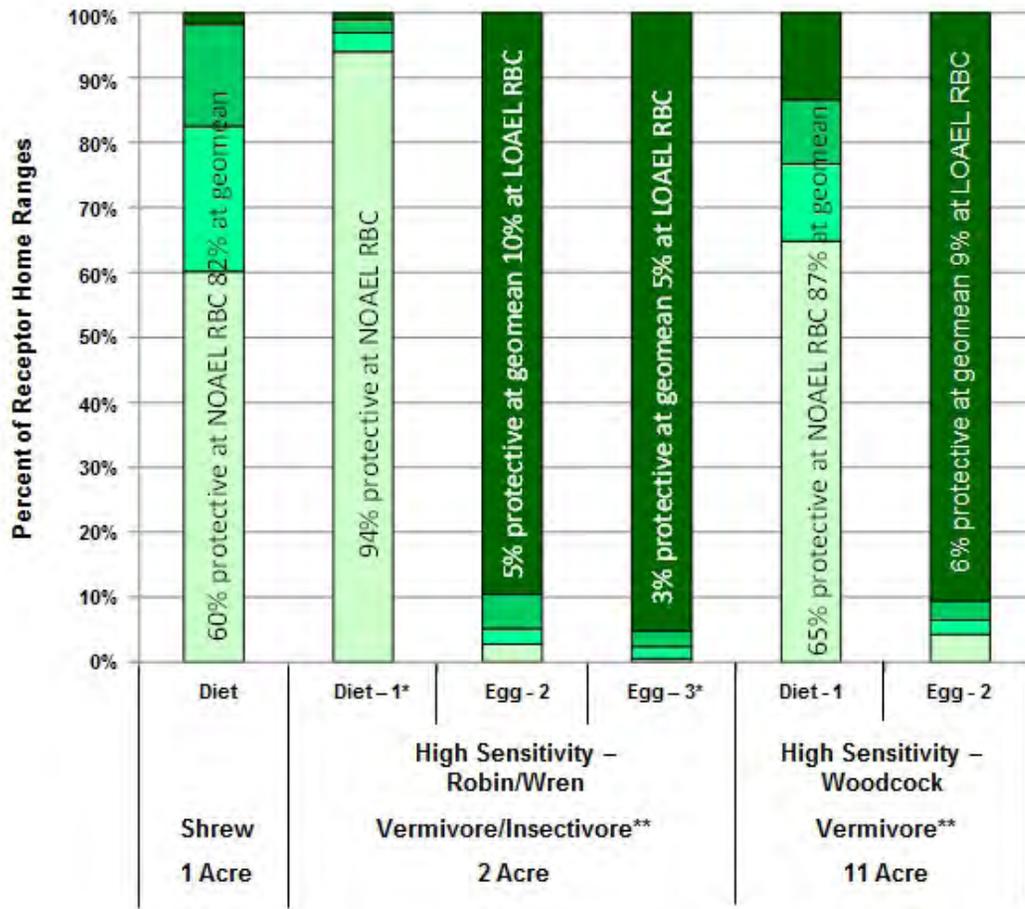
<sup>\*2</sup> CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 89 ACRES.

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**AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM**

**INTERPOLATED FLOODPLAIN SOIL PCB  
 CONCENTRATION 2 ACRE MOVING WINDOW  
 PLAINWELL NO. 2 DAM AREA - 5 MG/KG HILL TOP**



FIGURE  
**A-36**



Scenarios do not include those for which no risk was found in the TBERA

- > LOAEL RBC
- > Geomean and < LOAEL RBC
- > NOAEL RBC and < Geomean
- < NOAEL RBC

**DRAFT**

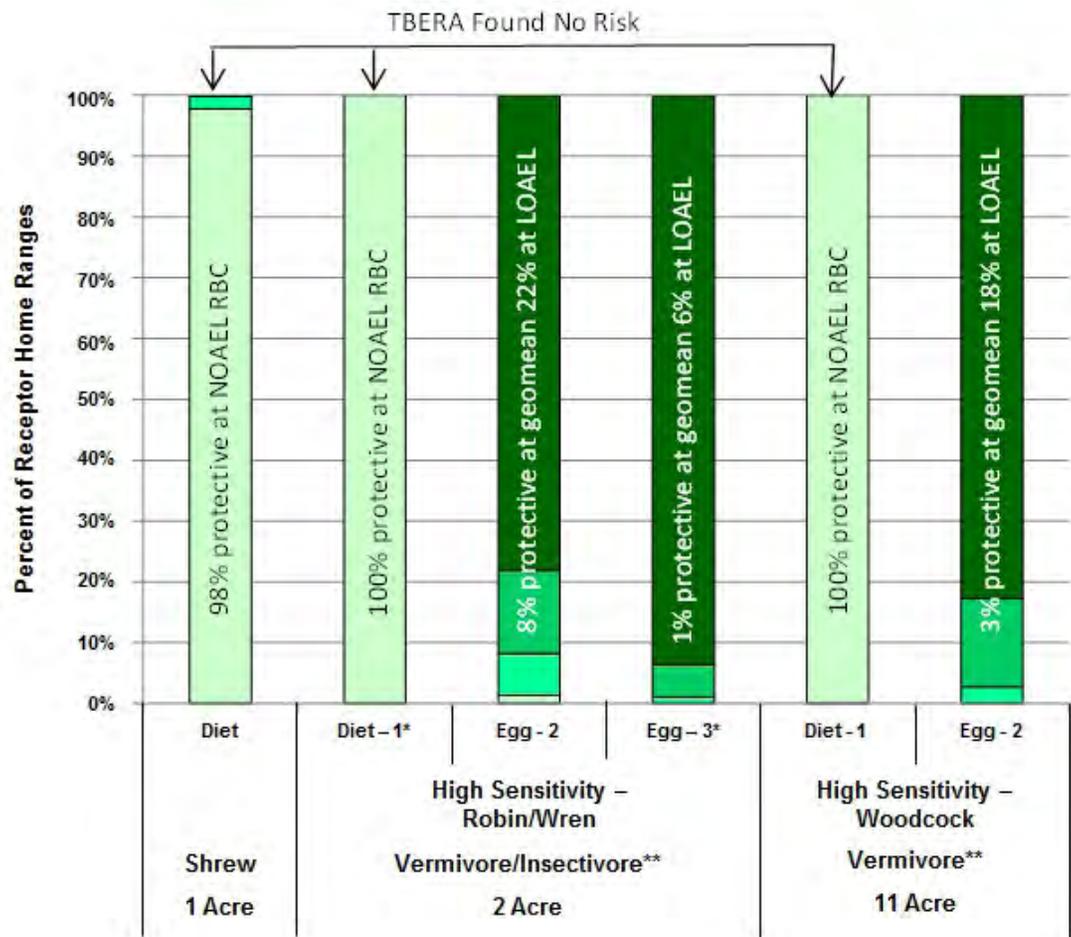
**Notes:**

- RBC = risk-based concentration
- EPC = exposure point concentration for total PCBs
- Acres = size of moving windows evaluated for each receptor
- Diet-1 = Approach 1 (Dietary exposure model)
- Egg-2 = Approach 2 (egg-based exposure model) – RBCs for this approach have no receptor-specific inputs and are the same for all species
- Egg-3 = Approach 3 (combined diet and egg exposure model)
- NOAEL = No observed adverse effect level
- LOAEL = Lowest observed adverse effect level

\* Diet-1 RBCs are for Robin as all EPCs were below Wren-based RBCs. Egg-3 calculated for Robin only

\*\* High-Sensitivity Vermivores are included for conservatism, even though no high sensitivity vermivores (i.e., species with greater than 40% worms in diet) have been documented to be present at the Site.

GEORGIA-PACIFIC LLC ALLIED PAPER, INC./PORTAGE CREEK/ KALAMAZOO RIVER SUPERFUND SITE <b>AREA 1 ALTERNATIVES SCREENING                  TECHNICAL MEMORANDUM</b>	
<b>PERCENT OF HOME RANGES WITH EPCs &gt; OR                  ≤ RESPECTIVE RBCs – CURRENT CONDITIONS                  FORMER PLAINWELL IMPOUNDMENT</b>	
	FIGURE <b>A-37</b>



- > LOAEL RBC
- > Geomean and < LOAEL RBC
- > NOAEL RBC and < Geomean
- < NOAEL RBC

**DRAFT**

**Notes:**

- RBC = risk-based concentration
- EPC = exposure point concentration for total PCBs
- Acres = size of moving windows evaluated for each receptor
- Diet-1 = Approach 1 (Dietary exposure model)
- Egg-2 = Approach 2 (egg-based exposure model) – RBCs for this approach have no receptor-specific inputs and are the same for all species
- Egg-3 = Approach 3 (combined diet and egg exposure model)
- NOAEL = No observed adverse effect level
- LOAEL = Lowest observed adverse effect level

\* Diet-1 RBCs are for Robin as all EPCs were below Wren-based RBCs. Egg-3 calculated for Robin only

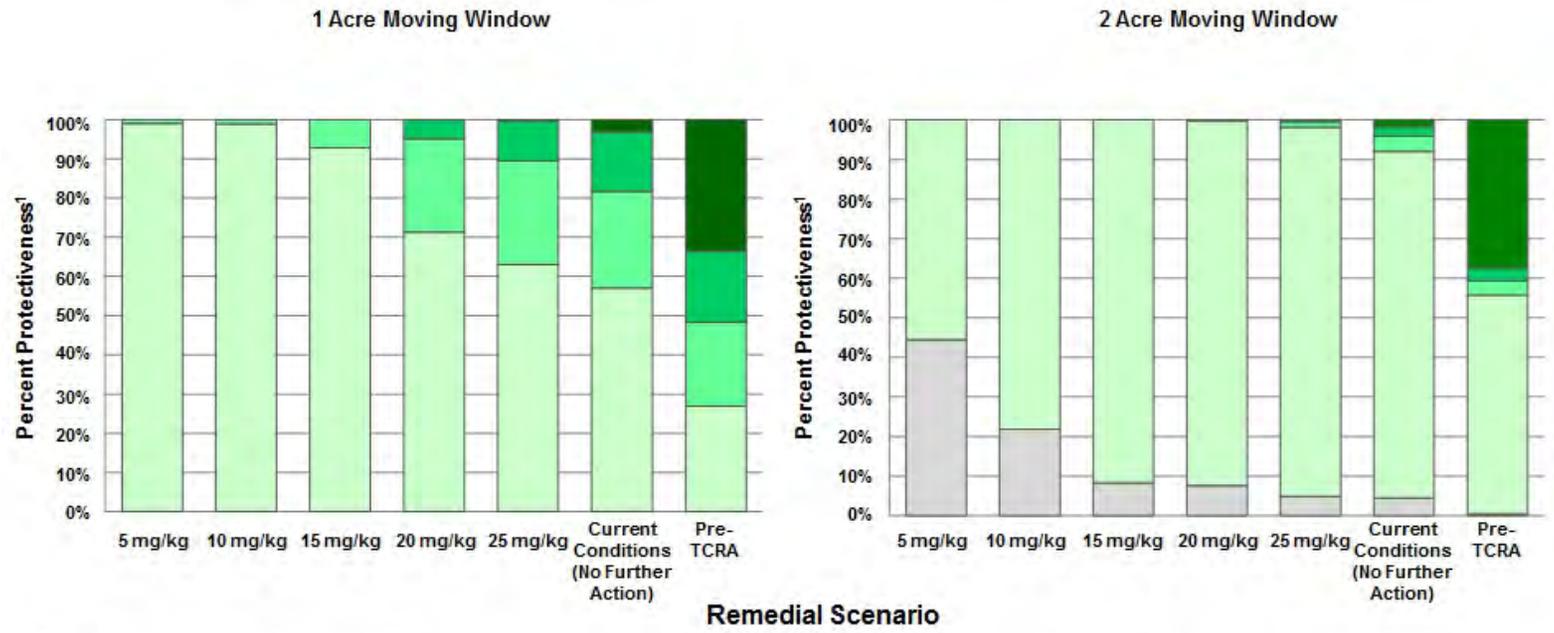
\*\* High-Sensitivity Vermivores are included for conservatism, even though no high sensitivity vermivores (i.e., species with greater than 40% worms in diet) have been documented to be present at the Site.

GEORGIA-PACIFIC LLC  
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AREA 1 ALTERNATIVES SCREENING  
TECHNICAL MEMORANDUM

**PERCENT OF HOME RANGES WITH EPCs > OR ≤  
RESPECTIVE RBCs – CURRENT CONDITIONS  
PLAINWELL NO. 2 DAM AREA**



FIGURE  
**A-38**



**Notes:**

- For the purposes of this assessment, a measure of relative protectiveness of the different RBC values is quantified as the percent of possible home range EPCs that are below specified RBCs.
- RBCs based on tPCB for vermivorous mammals and 1 acre moving window
- NOAELs and LOAELs are for high sensitivity (HS) vermivores (i.e., species with greater than 40% worms in diet) and the 2 acre moving window. These values are also protective of high sensitivity insectivores.

RBC = risk-based concentration  
 EPC = exposure point concentration for total PCBs  
 NOAEL = No observed adverse effect level  
 LOAEL = Lowest observed adverse effect level

**RBC Ranges for 1 Acre Moving Window<sup>2</sup>**

- > LOAEL RBC
- > Geomean and < LOAEL RBC
- > NOAEL RBC and < Geomean
- < NOAEL RBC

**RBC Ranges for 2 Acre Moving Window<sup>3</sup>**

- > HS Diet LOAEL
- > Geomean and < HS Diet LOAEL
- > HS Diet NOAEL and < HS Diet Geomean
- > 0.5 and < HS Diet NOAEL
- < 0.5 (HS egg RBC range)

**DRAFT**

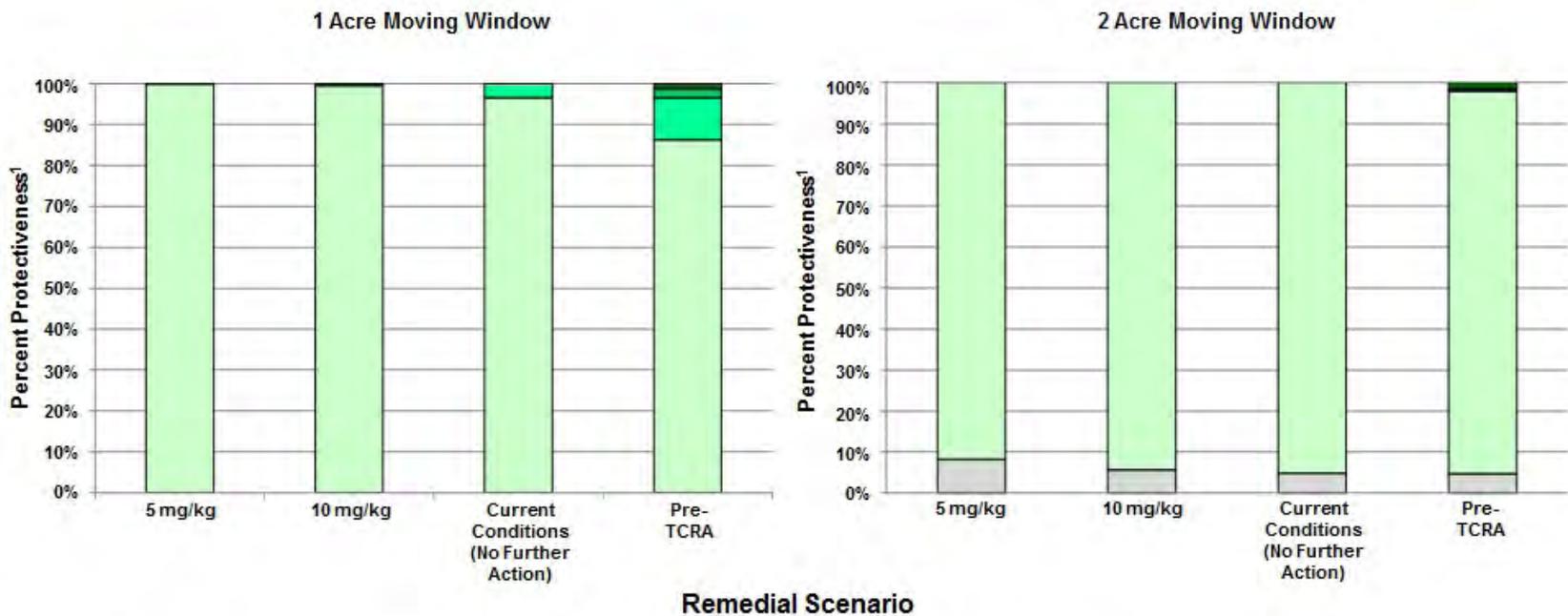
GEORGIA-PACIFIC LLC  
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 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 ALTERNATIVES SCREENING  
 TECHNICAL MEMORANDUM**

---

**SUMMARY OF PROTECTIVENESS OF EACH RAL  
 SCENARIO – 1 AND 2 ACRE MOVING WINDOWS  
 FORMER PLAINWELL IMPOUNDMENT**

---

FIGURE  
**A-39**



**Notes:**

- For the purposes of this assessment, a measure of relative protectiveness of the different RBC values is quantified as the percent of possible home range EPCs that are below specified RBCs.
- RBCs based on tPCB for vermivorous mammals and 1 acre moving window
- NOAELs and LOAELs are for high sensitivity (HS) vermivores (i.e., species with greater than 40% worms in diet) and the 2 acre moving window. These values are also protective of high sensitivity insectivores.
- 15, 20, and 25 mg/kg RALs were not evaluated because no contiguous areas of greater than ¼ acre with SWACs greater than these concentrations are present under current conditions.

RBC = risk-based concentration  
 EPC = exposure point concentration for total PCBs  
 NOAEL = No observed adverse effect level  
 LOAEL = Lowest observed adverse effect level

**RBC Ranges for 1 Acre Moving Window<sup>2</sup>**

- > LOAEL RBC
- > Geomean and < LOAEL RBC
- > NOAEL RBC and < Geomean
- < NOAEL RBC

**RBC Ranges for 2 Acre Moving Window<sup>3</sup>**

- > HS Diet LOAEL
- > Geomean and < HS Diet LOAEL
- > HS Diet NOAEL and < HS Diet Geomean
- > 0.5 and < HS Diet NOAEL
- < 0.5 (HS egg RBC range)

**DRAFT**

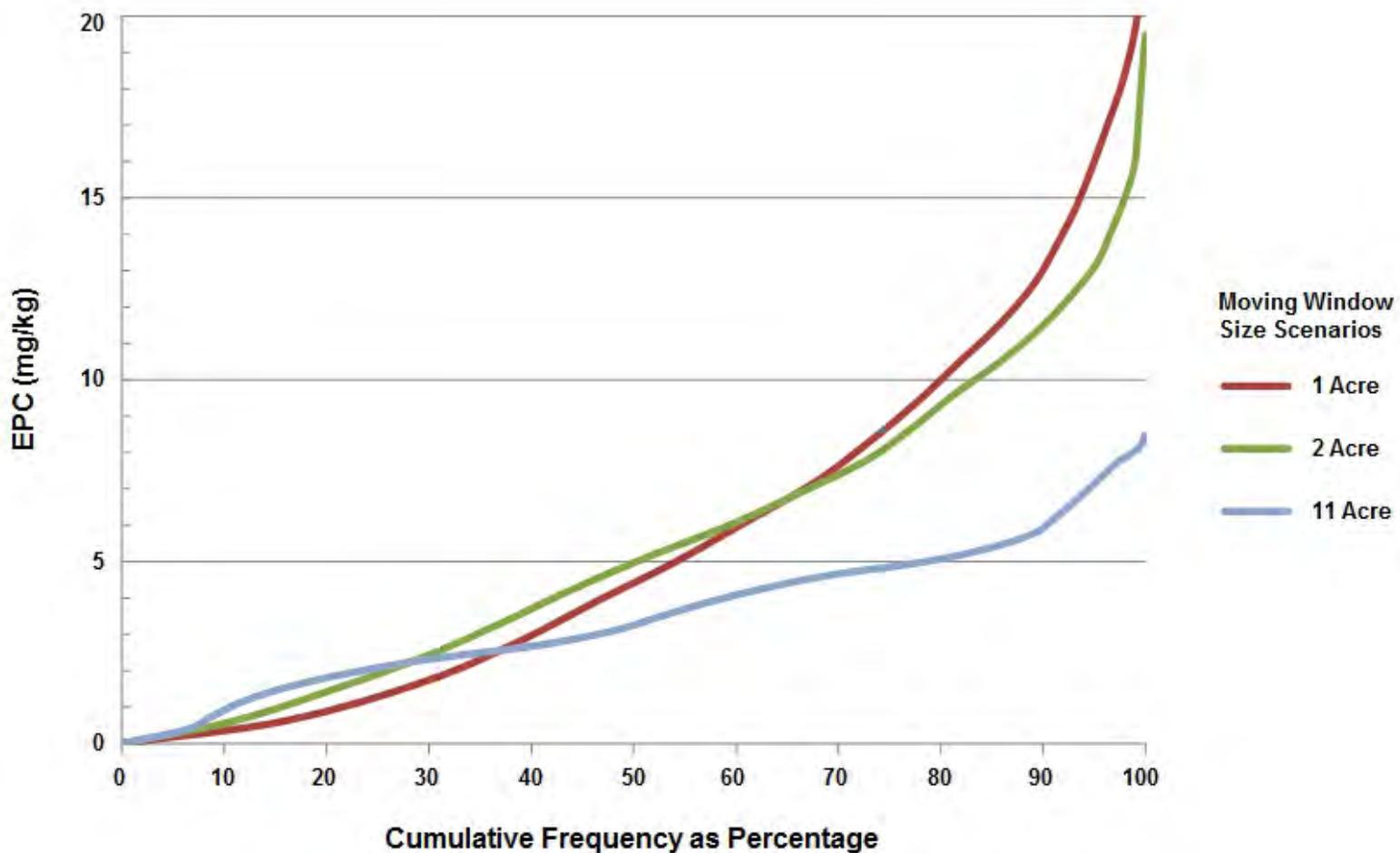
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**AREA 1 ALTERNATIVES SCREENING  
 TECHNICAL MEMORANDUM**

---

**SUMMARY OF PROTECTIVENESS OF EACH RAL  
 SCENARIO – 1 AND 2 ACRE MOVING WINDOWS  
 PLAINWELL NO. 2 DAM AREA**

---

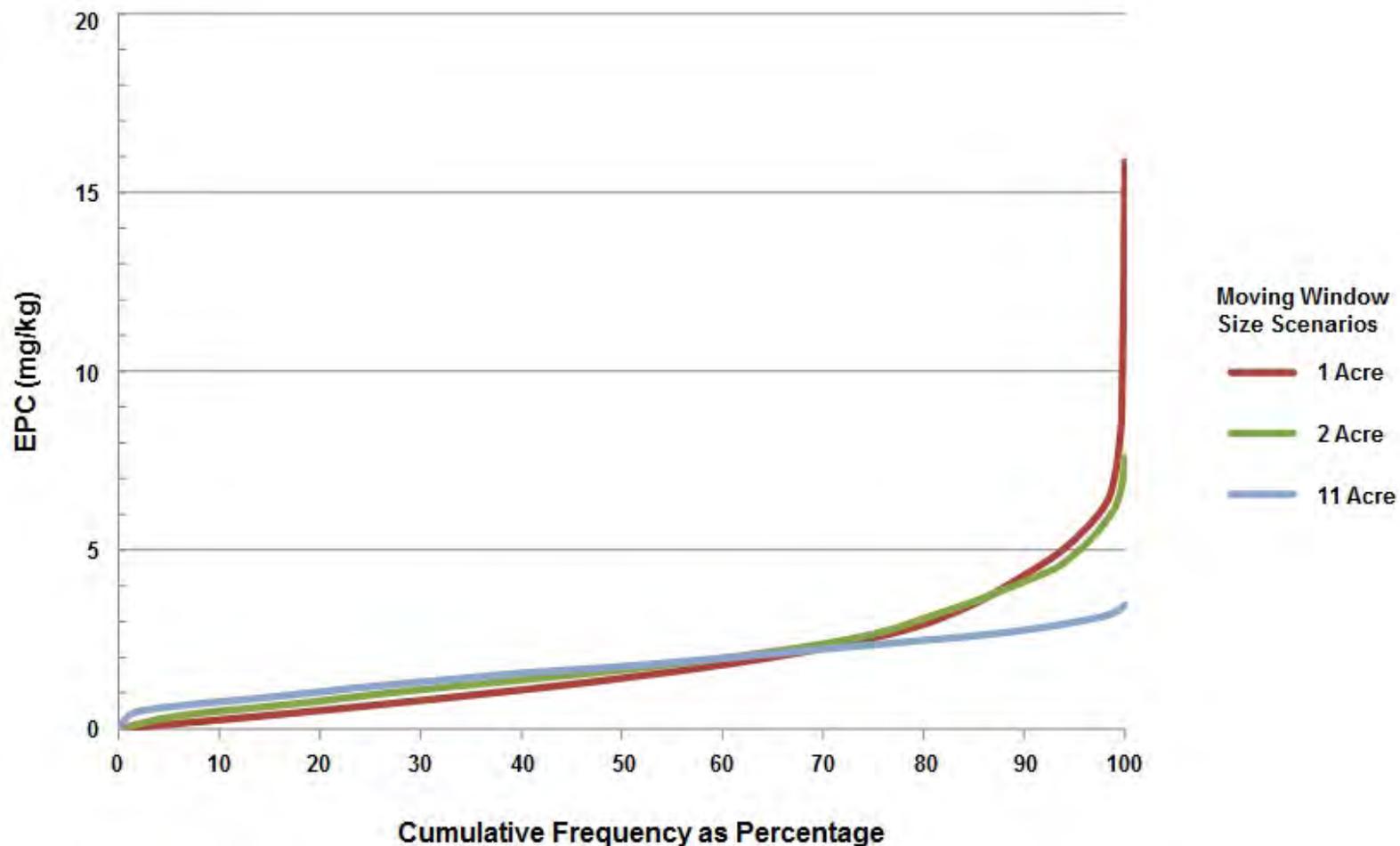
FIGURE  
**A-40**



Note:  
EPC = Exposure point concentration for total PCBs

**DRAFT**

GEORGIA-PACIFIC LLC ALLIED PAPER, INC./PORTAGE CREEK/ KALAMAZOO RIVER SUPERFUND SITE AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM	
CUMULATIVE FREQUENCY DISTRIBUTIONS OF EPCS (1 ACRE, 2 ACRE, AND 11 ACRE MOVING WINDOWS) FORMER PLAINWELL IMPOUNDMENT	
	FIGURE <b>A-41</b>



**Note:**  
EPC = Exposure point concentration for total PCBs

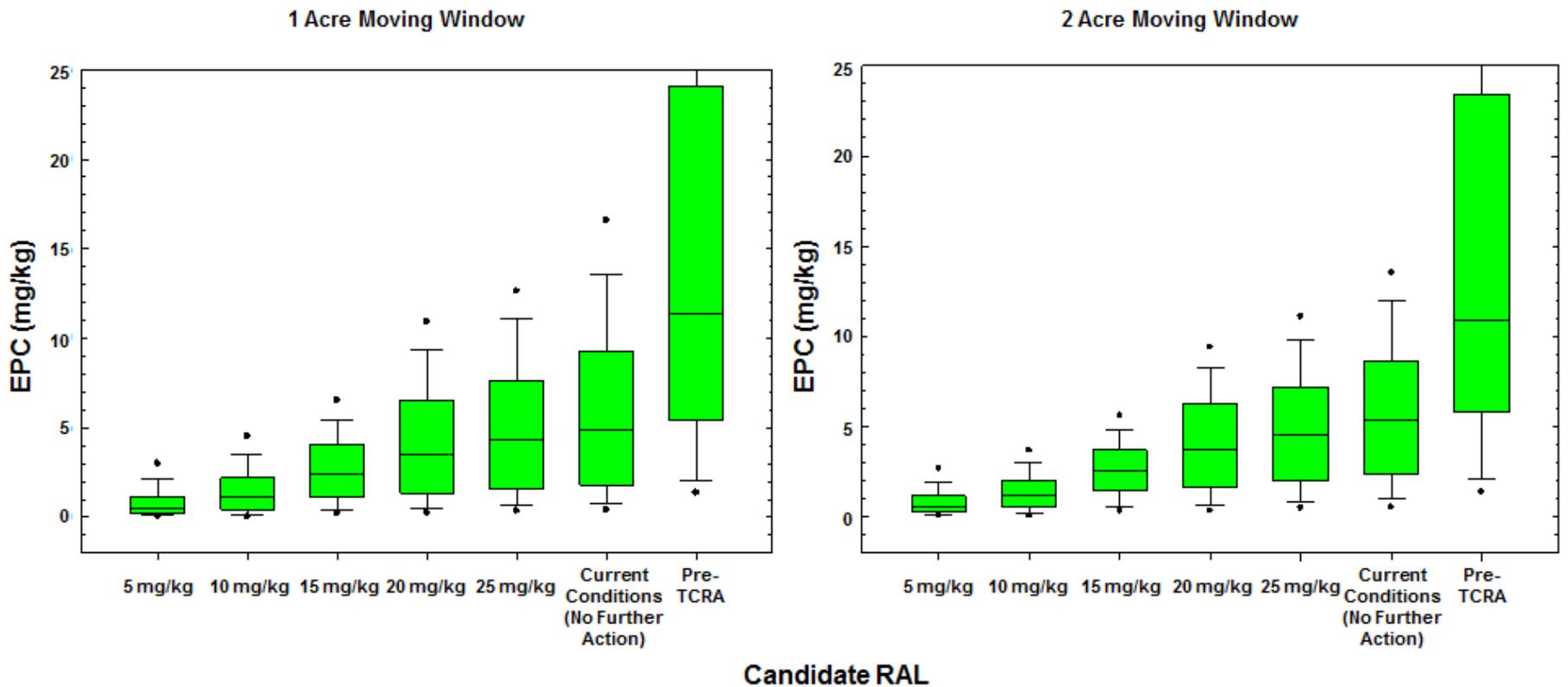
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ALLIED PAPER, INC./PORTAGE CREEK/  
KALAMAZOO RIVER SUPERFUND SITE  
AREA 1 ALTERNATIVES SCREENING  
TECHNICAL MEMORANDUM

**CUMULATIVE FREQUENCY DISTRIBUTIONS OF  
EPCS (1 ACRE, 2 ACRE, AND 11 ACRE MOVING  
WINDOWS) PLAINWELL NO. 2 DAM AREA**



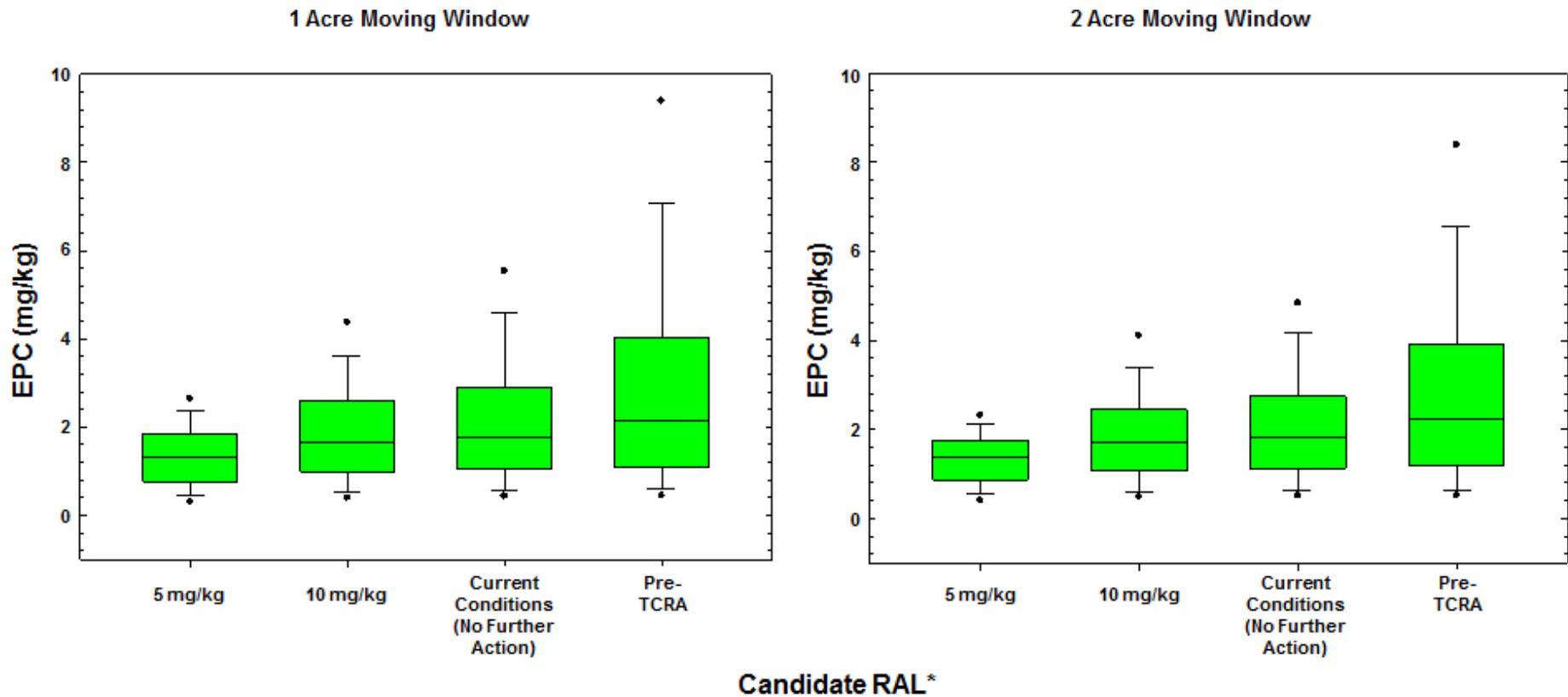
FIGURE  
**A-42**



Notes:  
 EPC = Exposure point concentration for total PCBs based on 1 and 2 acre moving windows  
 \* pre-TCRA scenario 95% tail is cut-off to improve scale for other scenarios

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GEORGIA-PACIFIC LLC ALLIED PAPER, INC./PORTAGE CREEK/ KALAMAZOO RIVER SUPERFUND SITE AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM	
SUMMARY OF EPCS BASED ON 1 AND 2 ACRE MOVING WINDOWS FOR 5, 10, 15, 20, AND 25 MG/KG CANDIDATE RALS, CURRENT POST-TCRA CONDITIONS AND PRE-TCRA SCENARIOS FORMER PLAINWELL IMPOUNDMENT	
	FIGURE <b>A-43</b>



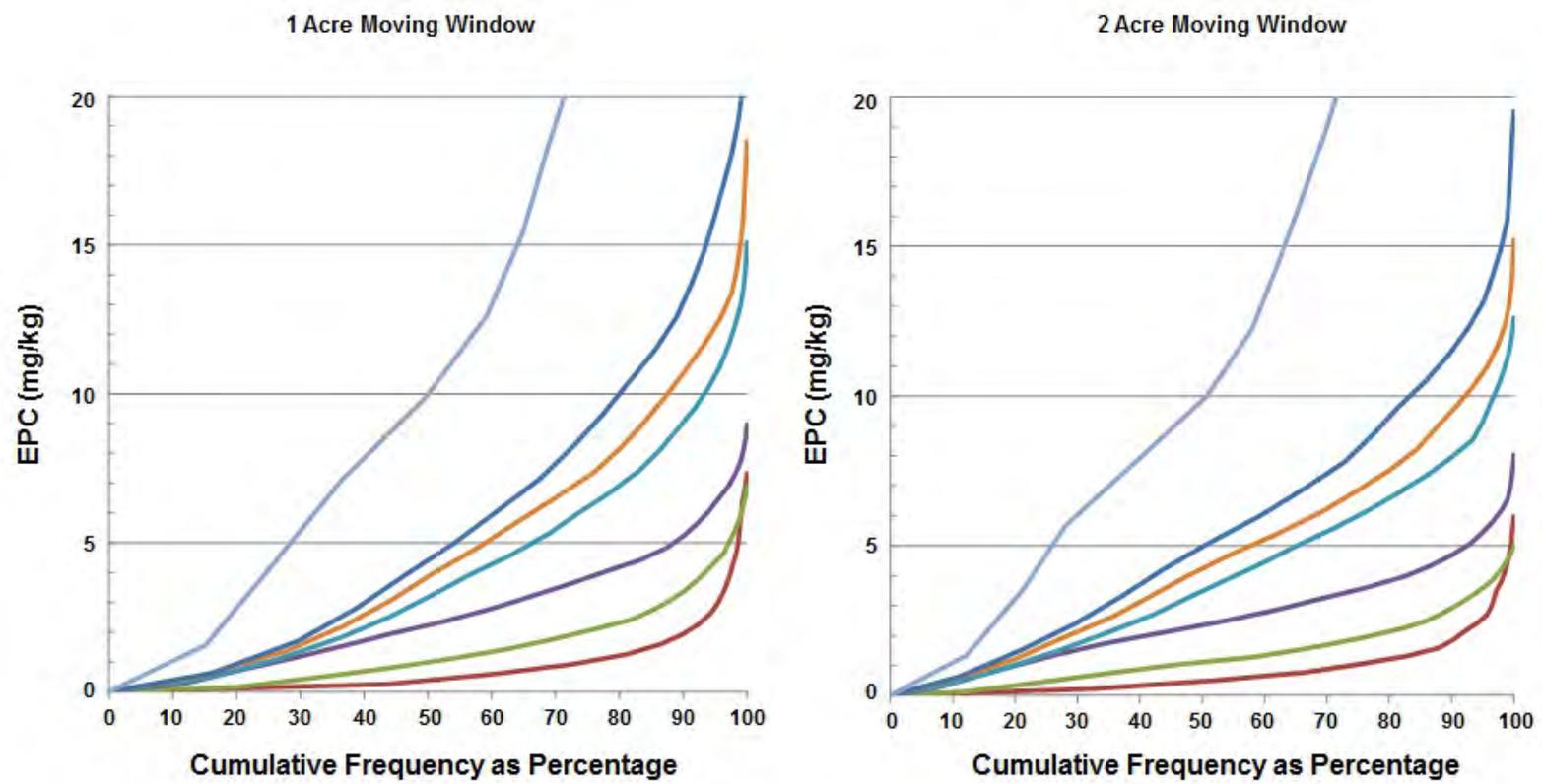
Notes:

EPC = Exposure point concentration for total PCBs based on 1 and 2 acre moving windows.

\*Only Candidate RALs of 5 and 10 mg/kg are presented as no contiguous areas greater than 1/4 acre with SWACs greater than 15, 20, and 25 mg/kg are present under current conditions in the Plainwell No. 2 Dam Area.

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GEORGIA-PACIFIC LLC ALLIED PAPER, INC./PORTAGE CREEK/ KALAMAZOO RIVER SUPERFUND SITE AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM	
SUMMARY OF EPCS BASED ON 1 AND 2 ACRE MOVING WINDOWS FOR 5, 10, 15, 20, AND 25 MG/KG CANDIDATE RALs, CURRENT POST-TCRA CONDITIONS AND PRE-TCRA SCENARIOS PLAINWELL NO. 2 DAM AREA	
	FIGURE <b>A-44</b>



**Candidate RALs and Pre-TCRA Condition**

- Pre-TCRA
- Current Conditions (No Further Action)
- 25 mg/kg
- 20 mg/kg
- 15 mg/kg
- 10 mg/kg
- 5 mg/kg

**Notes:**

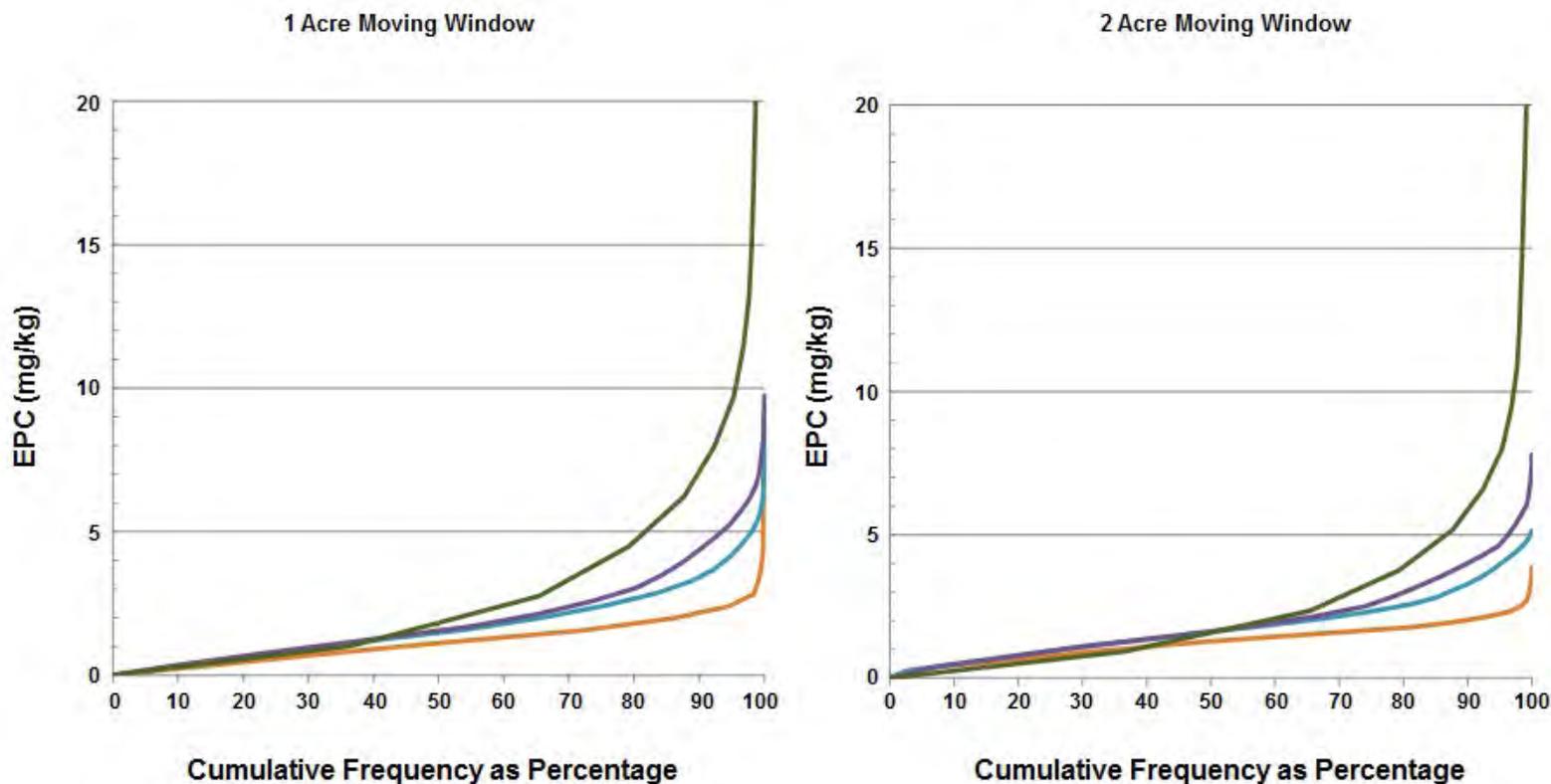
EPC = Exposure point concentration for total PCBs based on 1 and 2 acre moving windows.

RAL = Remediation Action Level

y-axis is cut off at 20 mg/kg to highlight differences between candidate RALs and pre-TCRA condition

**DRAFT**

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<b>CUMULATIVE FREQUENCY DISTRIBUTIONS OF EPCS VS.                  CANDIDATE RALS FOR THE SHREW (1 ACRE MOVING                  WINDOW) AND FOR THE AMERICAN ROBIN AND HOUSE                  WREN (2 ACRE MOVING WINDOW)                  FORMER PLAINWELL IMPOUNDMENT</b>	
	FIGURE <b>A-45</b>



**Candidate RALs and Pre-TCRA Condition**

- Pre-TCRA
- Current Conditions (No Further Action)
- 10 mg/kg
- 5 mg/kg

**Notes:**

EPC = Exposure point concentration for total PCBs based on 1 and 2 acre moving windows.

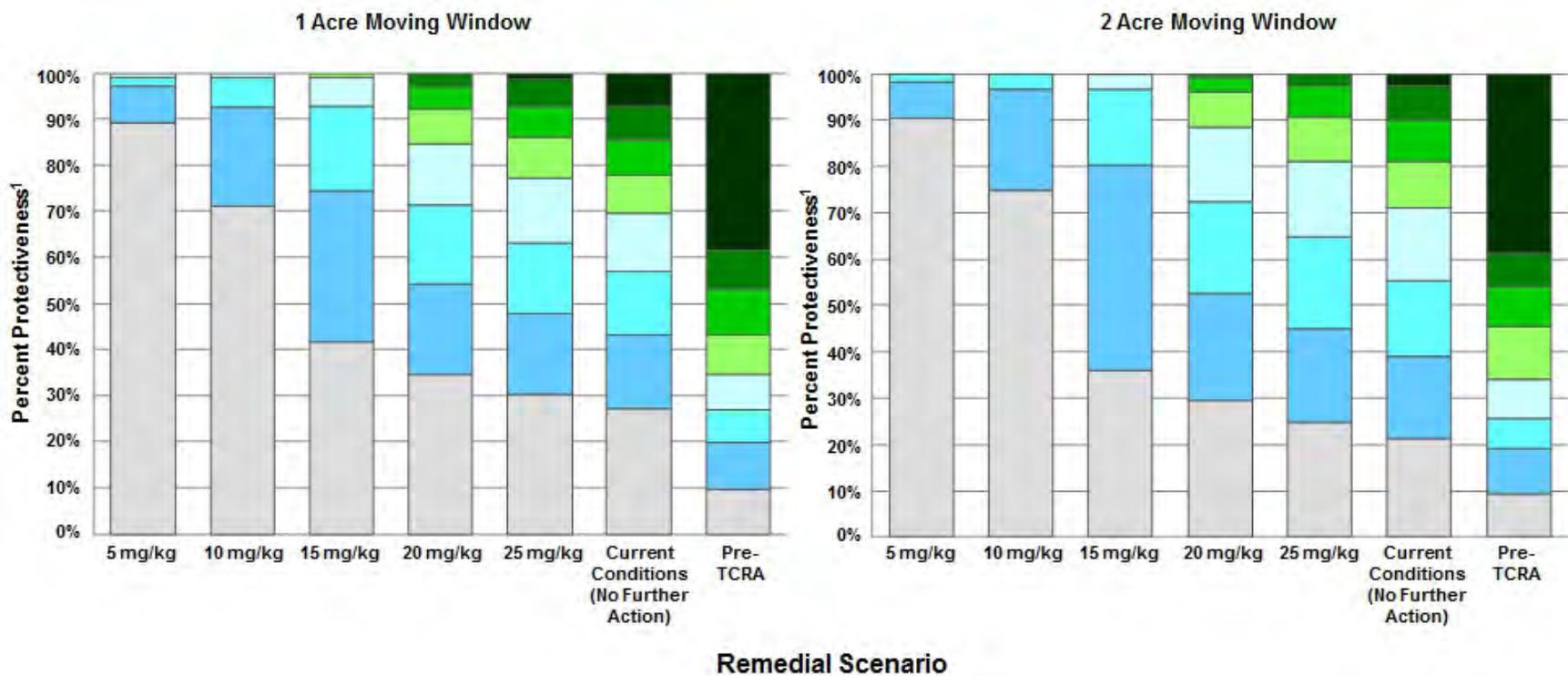
RAL = Remediation Action Level

y-axis is cut off at 20 mg/kg to highlight differences between candidate RALs and pre-TCRA condition

Only candidate RALs of 5 and 10 mg/kg are presented as no contiguous areas greater than 1/4 acre with SWACs greater than 15, 20 and 25 mg/kg are present under current conditions.

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GEORGIA-PACIFIC LLC ALLIED PAPER, INC./PORTAGE CREEK/ KALAMAZOO RIVER SUPERFUND SITE <b>AREA 1 ALTERNATIVES SCREENING                  TECHNICAL MEMORANDUM</b>	
<b>CUMULATIVE FREQUENCY DISTRIBUTIONS OF EPCS VS.                  CANDIDATE RALS FOR THE SHREW (1 ACRE MOVING                  WINDOW) AND FOR THE AMERICAN ROBIN AND HOUSE                  WREN (2 ACRE MOVING WINDOW)                  PLAINWELL NO. 2 DAM AREA</b>	
	FIGURE <b>A-46</b>



**Generic RBC Ranges**

- 15-20 mg/kg
- 12-15 mg/kg
- 10-12 mg/kg
- 8-10 mg/kg
- 6-8 mg/kg
- 4-6 mg/kg
- 2-4 mg/kg
- 0-2 mg/kg

**Notes:**

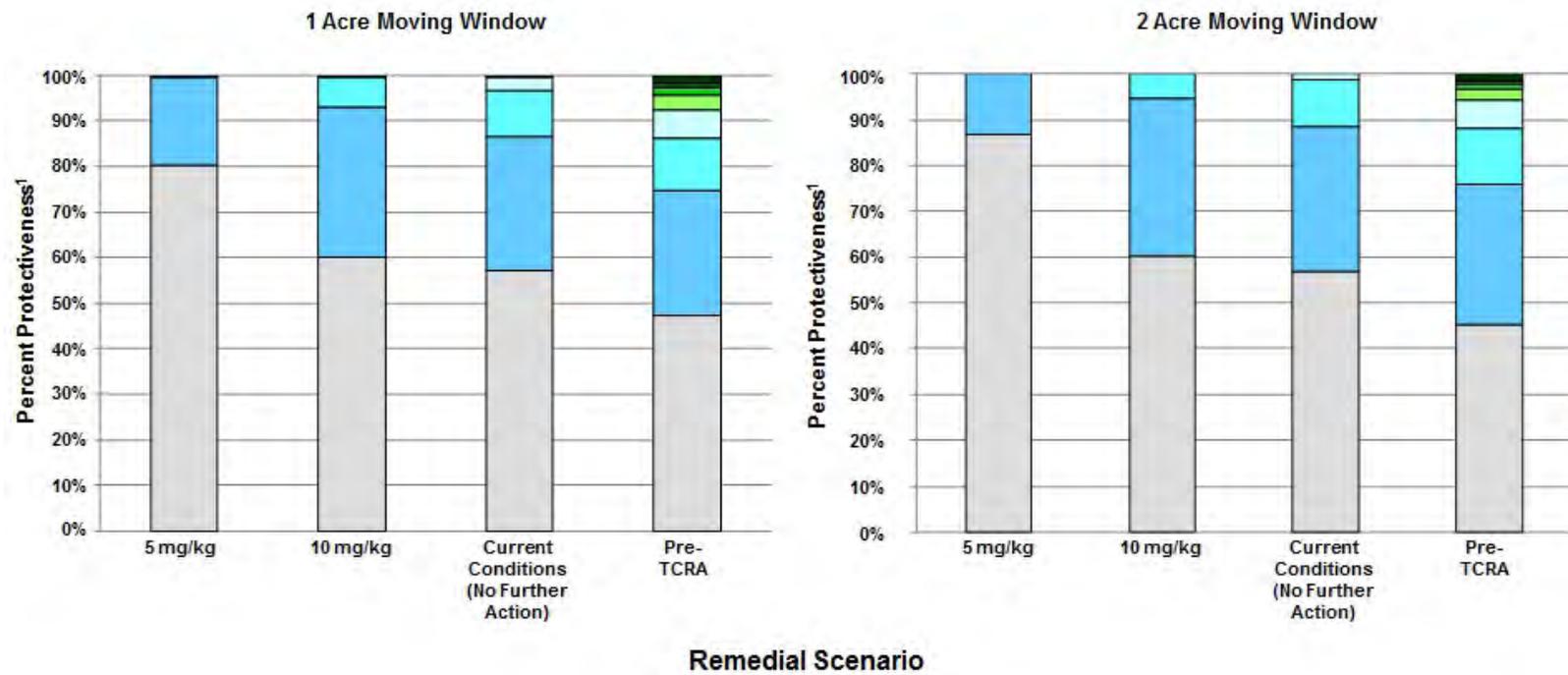
1. For the purposes of this assessment, a measure of relative protectiveness of the different RBC values is quantified as the percent of possible home range EPCs that are below specified RBCs.

RBC = risk-based concentration

EPC = exposure point concentration for total PCBs

**DRAFT**

GEORGIA-PACIFIC LLC ALLIED PAPER, INC./PORTAGE CREEK/ KALAMAZOO RIVER SUPERFUND SITE AREA 1 ALTERNATIVES SCREENING TECHNICAL MEMORANDUM	
<b>SUMMARY OF THE PROTECTIVENESS OF EACH RAL                  SCENARIO USING GENERIC CONCENTRATION RANGES                  – 1 AND 2 ACRE MOVING WINDOWS                  FORMER PLAINWELL IMPOUNDMENT</b>	
	FIGURE <b>A-47</b>



**Generic RBC Ranges**

- 15-20 mg/kg
- 12-15 mg/kg
- 10-12 mg/kg
- 8-10 mg/kg
- 6-8 mg/kg
- 4-6 mg/kg
- 2-4 mg/kg
- 0-2 mg/kg

**Notes:**

1. For the purposes of this assessment, a measure of relative protectiveness of the different RBC values is quantified as the percent of possible home range EPCs that are below specified RBCs.
2. Only Candidate RALs of 5 and 10 mg/kg are presented as no contiguous areas greater than 1/4 acre with SWACs greater than 15, 20, and 25 mg/kg are present under current conditions in the Plainwell No. 2 Dam Area.

RBC = risk-based concentration

EPC = exposure point concentration for total PCBs

**DRAFT**

GEORGIA-PACIFIC LLC  
 ALLIED PAPER, INC./PORTAGE CREEK/  
 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 ALTERNATIVES SCREENING  
 TECHNICAL MEMORANDUM**

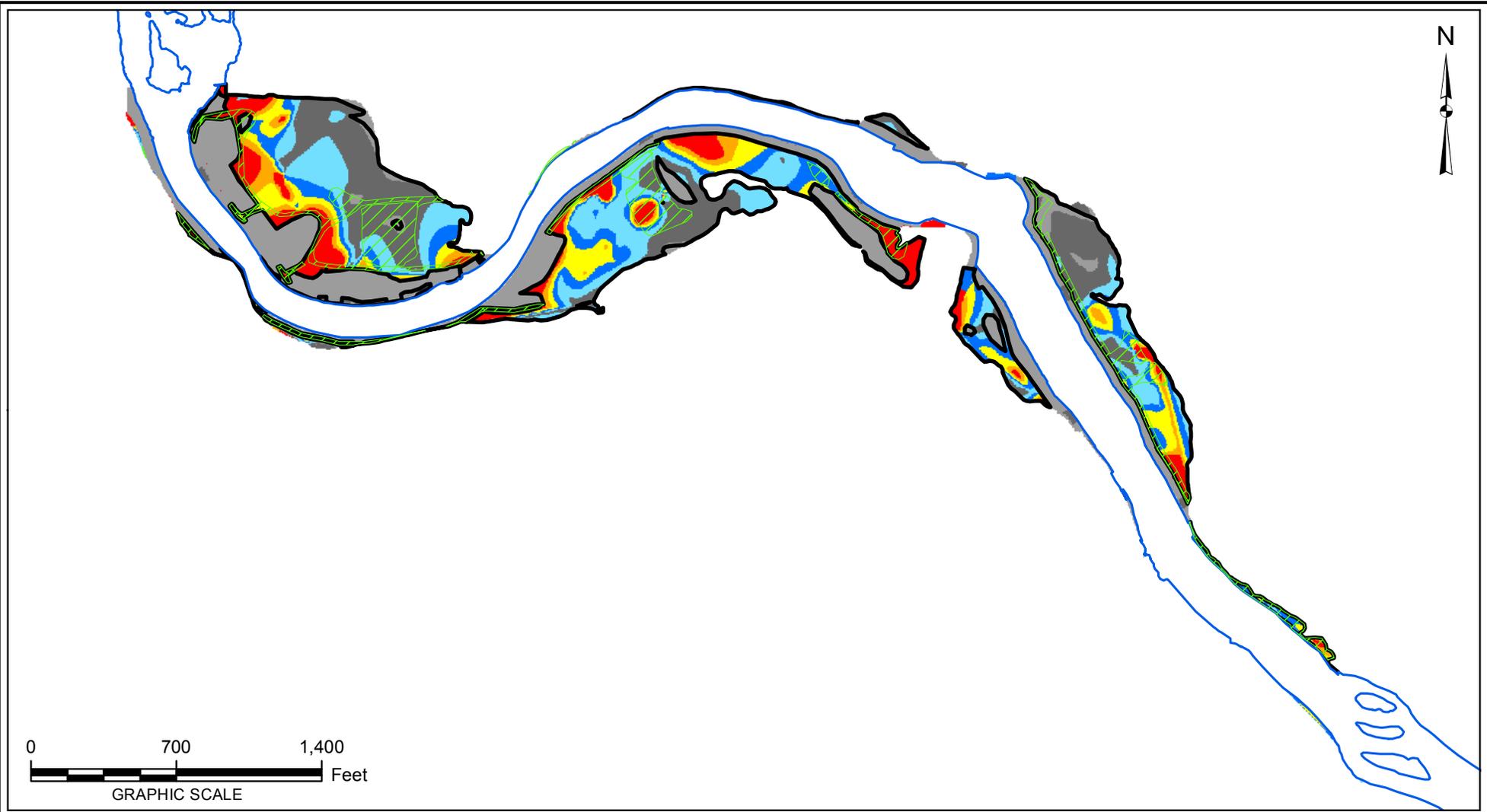
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**SUMMARY OF THE PROTECTIVENESS OF EACH RAL  
 SCENARIO USING GENERIC CONCENTRATION RANGES  
 - 1 AND 2 ACRE MOVING WINDOWS  
 PLAINWELL NO. 2 DAM AREA**

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FIGURE  
**A-48**



**LEGEND:**

SOIL PCB (MG/KG):	AREA OVER 1/4 ACRE AND AREA >0.5 mg/kg
< 1	TCRA ACCESS ROAD AND STAGING AREA
> 1 and ≤ 5	KALAMAZOO RIVER
> 5 and ≤ 10	
> 10 and ≤ 15	
> 15 and ≤ 20	
> 20 and ≤ 25	
> 25	

- NOTES:**
1. CONTIGUOUS AREAS OF OVER 1/4 ACRE GREATER THAN 0.5 MG/KG.
  2. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
  3. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
  4. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

GEORGIA-PACIFIC LLC  
 ALLIED PAPER, INC./PORTAGE CREEK/  
 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 FEASIBILITY STUDY REPORT –  
 MORROW DAM TO FORMER PLAINWELL DAM**

**FLOODPLAIN SOILS AREAS GREATER THAN 0.5 MG/KG  
 BASED ON NATURAL NEIGHBOR INTERPOLATED  
 SURFACE FORMER PLAINWELL IMPOUNDMENT**

Prepared by/Date: CLS 03/13/14
Checked by/Date: MTP 07/15/13
Project Number: 3293131541



**FIGURE  
 G-2**

Source: Area 1 Alternatives Screening Technical Memorandum (ARCADIS 2012b)



**LEGEND:**

**SOIL PCB (MG/KG):**

- < 1
- > 1 and ≤ 5
- > 5 and ≤ 10
- > 10 and ≤ 15
- > 15 and ≤ 20
- > 20 and ≤ 25
- > 25

- AREA OVER 1/4 ACRE AND AREA > 0.5 mg/kg
- TCRA ACCESS ROAD
- KALAMAZOO RIVER

**NOTES:**

1. CONTIGUOUS AREAS OF OVER 1/4 ACRE GREATER THAN 0.5 MG/KG.
2. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
3. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
4. AREA OF PLAINWELL NO. 2 FLOODPLAIN STUDY AREA BOUNDARY IS APPROXIMATELY 89 ACRES.

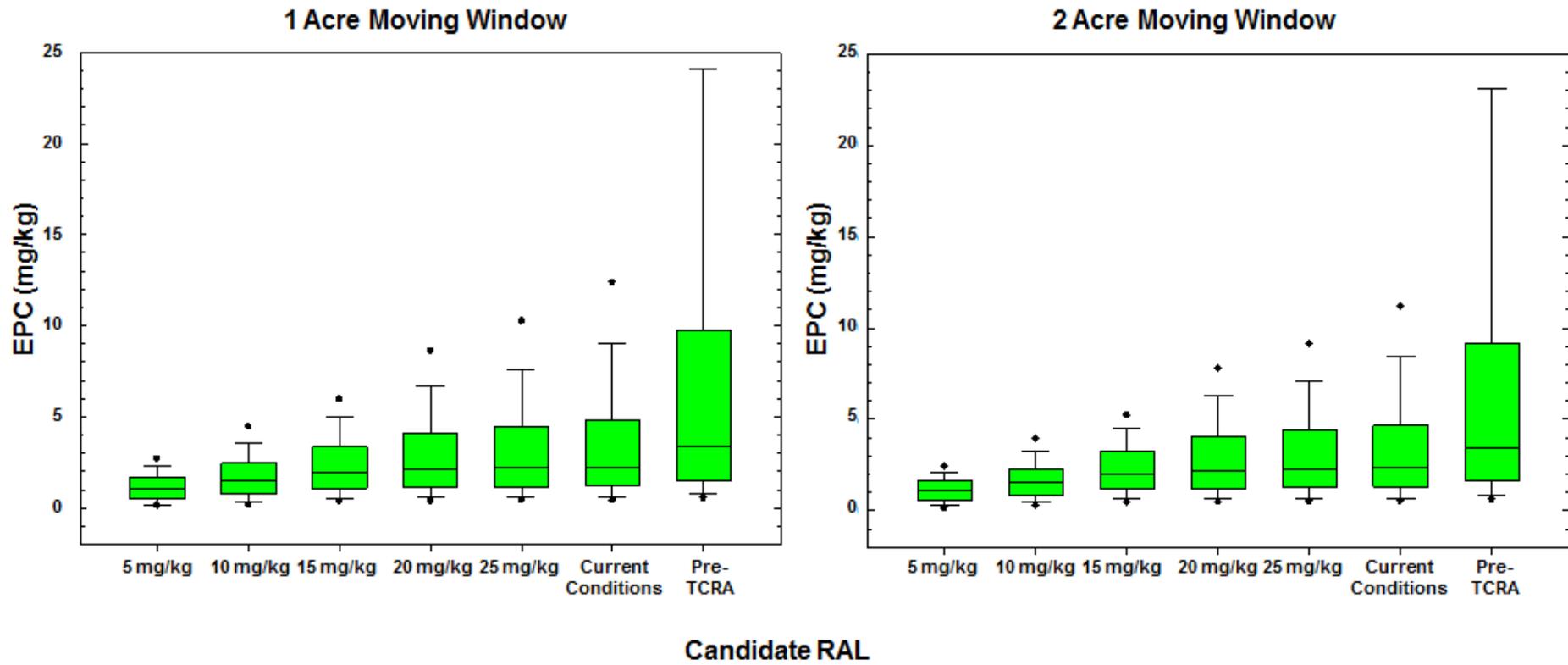
GEORGIA-PACIFIC LLC  
 ALLIED PAPER, INC./PORTAGE CREEK/  
 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 FEASIBILITY STUDY REPORT –  
 MORROW DAM TO FORMER PLAINWELL DAM**

**FLOODPLAIN SOILS AREAS GREATER THAN 0.5 MG/KG  
 BASED ON NATURAL NEIGHBOR INTERPOLATED  
 SURFACE PLAINWELL NO. 2 DAM AREA**

Prepared by/Date:  
 CLS 03/13/14  
 Checked by/Date:  
 MTP 07/15/13  
 Project Number:  
 3293131541



**FIGURE  
 G-3**



Note:  
 EPC = Exposure point concentration for total PCBs based on 1 and 2 acre moving windows

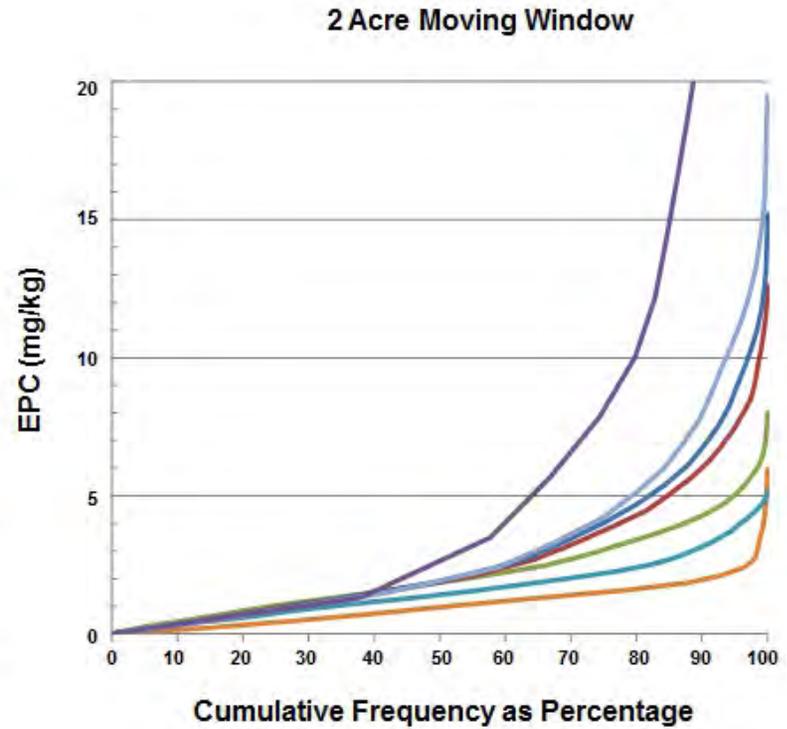
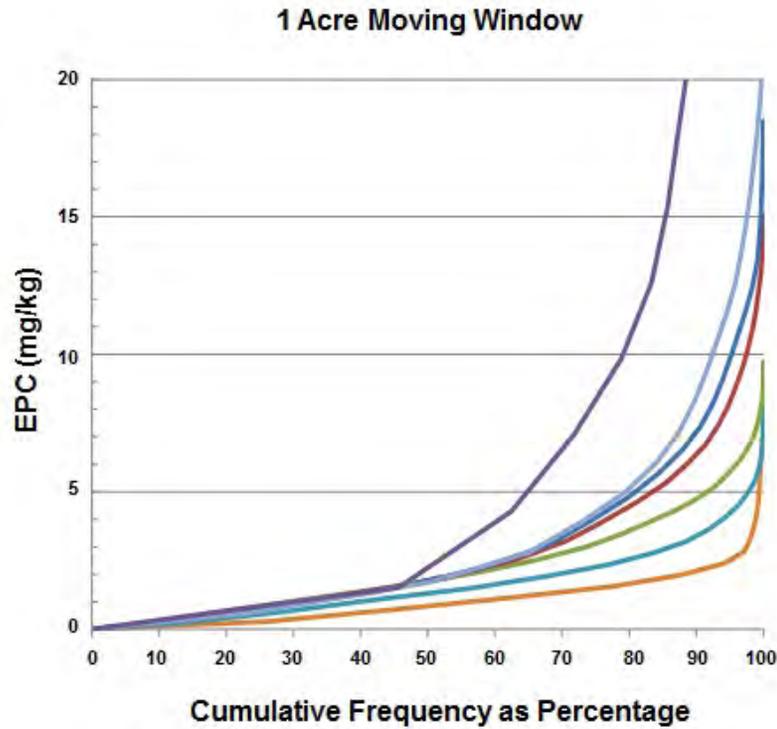
GEORGIA-PACIFIC LLC  
 ALLIED PAPER, INC./PORTAGE CREEK/  
 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 ALTERNATIVES SCREENING  
 TECHNICAL MEMORANDUM**

---

**SUMMARY OF EPCS BASED ON 1 AND 2 ACRE MOVING  
 WINDOWS FOR 5, 10, 15, 20, AND 25 MG/KG CANDIDATE  
 RALS, CURRENT POST-TCRA CONDITIONS AND PRE-TCRA  
 SCENARIOS FORMER PLAINWELL IMPOUNDMENT AND  
 PLAINWELL NO. 2 DAM AREA COMBINED**

---


Figure  
G-4



**Candidate RALs and Pre-TCRA Condition**

- Pre-TCRA
- Current Conditions (No Further Action)
- 25 mg/kg
- 20 mg/kg
- 15 mg/kg
- 10 mg/kg
- 5 mg/kg

**Notes:**

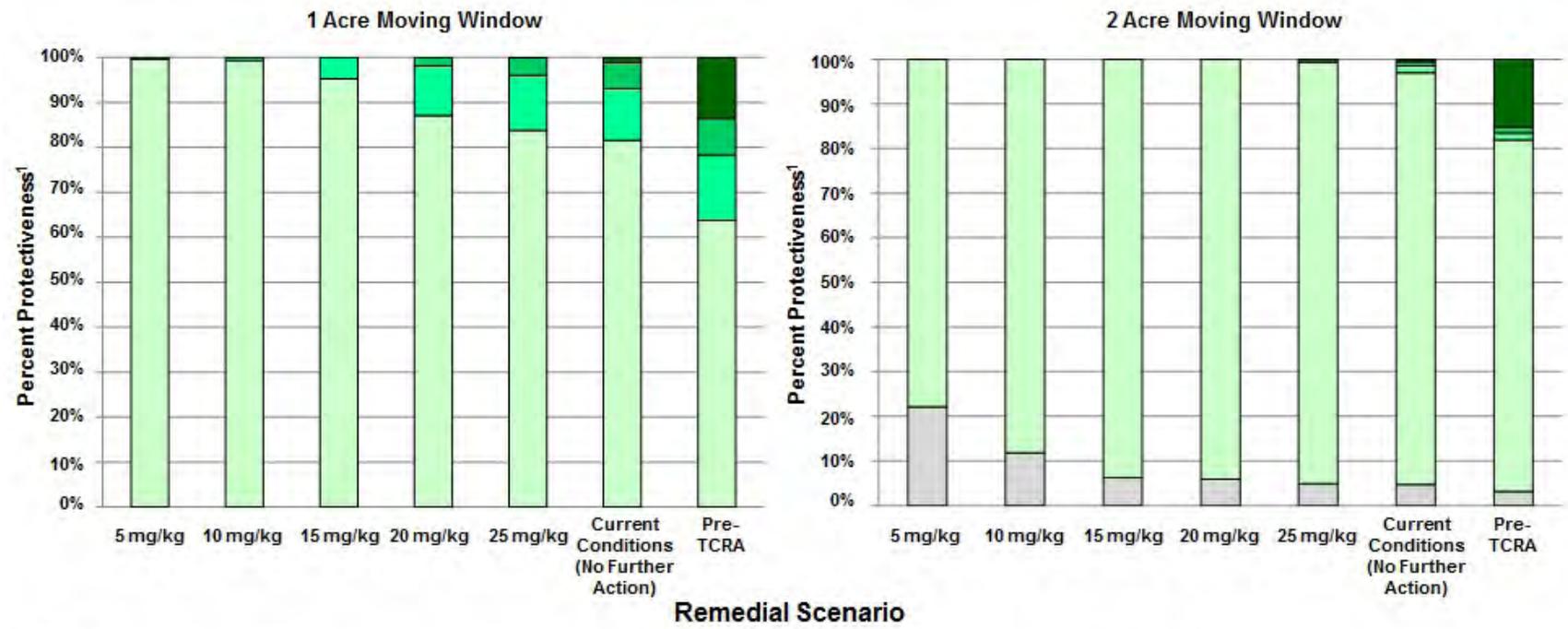
EPC = Exposure point concentration for total PCBs based on 1 and 2 acre moving windows.

RAL = Remediation Action Level

y-axis is cut off at 20 mg/kg to highlight differences between candidate RALs and pre-TCRA condition

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**AREA 1 ALTERNATIVES SCREENING  
 TECHNICAL MEMORANDUM**

**CUMULATIVE FREQUENCY DISTRIBUTIONS OF EPCS  
 COMPARED TO RBCS FOR THE SHREW (1 ACRE MOVING  
 WINDOW) AND FOR THE AMERICAN ROBIN AND HOUSE  
 WREN (2 ACRE MOVING WINDOW). FORMER PLAINWELL  
 IMPOUNDMENT AND PLAINWELL NO. 2 DAM AREA COMBINED**



**Notes:**

1. For the purposes of this assessment, a measure of relative protectiveness of the different RBC values is quantified as the percent of possible home range EPCs that are below specified RBCs.
2. RBCs based on tPCB for vermivorous mammals and 1 acre moving window
3. NOAELs and LOAELs are for high sensitivity (HS) vermivores (i.e., species with greater than 40% worms in diet) and the 2 acre moving window. These values are also protective of high sensitivity insectivores.

RBC = risk-based concentration  
 EPC = exposure point concentration for total PCBs based on 1 and 2 acre moving windows  
 NOAEL = No observed adverse effect level  
 LOAEL = Lowest observed adverse effect level

**RBC Ranges for 1 Acre Moving Window<sup>2</sup>**

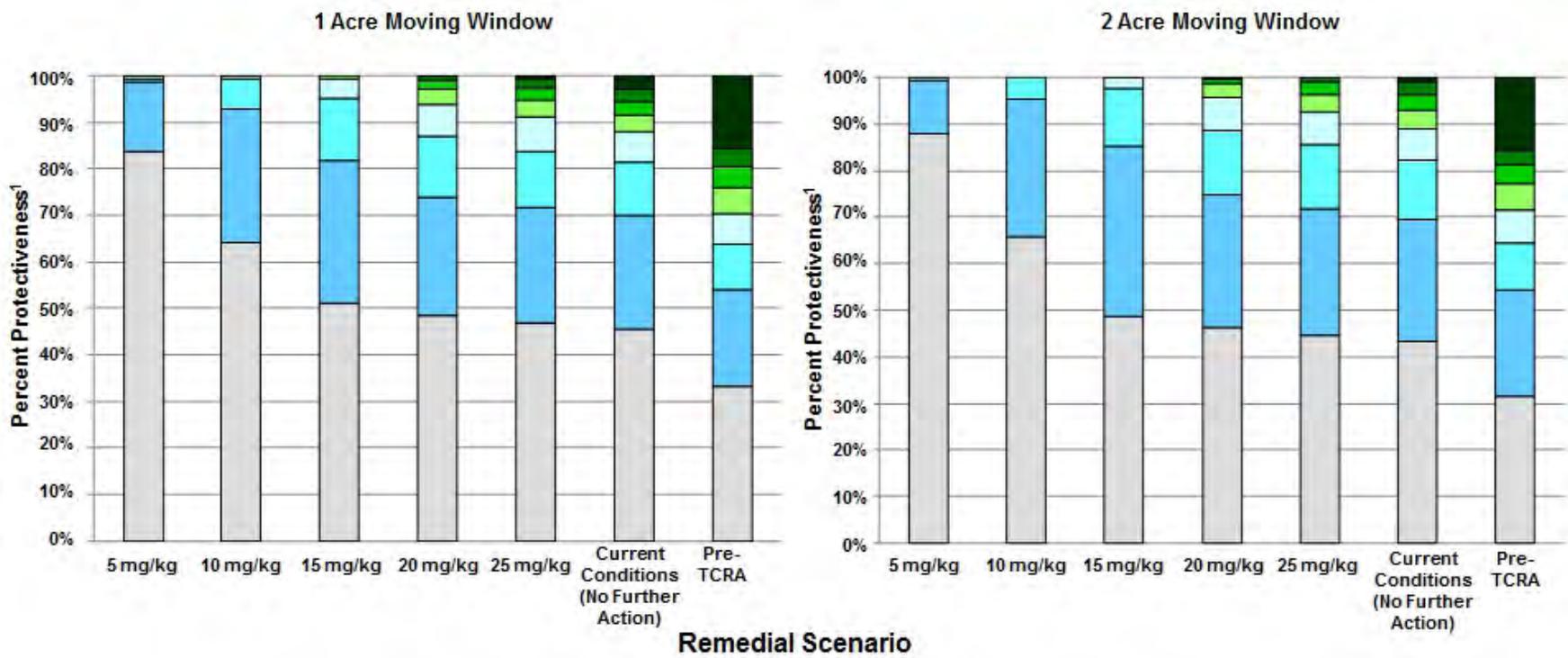
- > LOAEL RBC
- > Geomean and < LOAEL RBC
- > NOAEL RBC and < Geomean
- < NOAEL RBC

**RBC Ranges for 2 Acre Moving Window<sup>3</sup>**

- > HS Diet LOAEL
- > Geomean and < HS Diet LOAEL
- > HS Diet NOAEL and < HS Diet Geomean
- > 0.5 and < HS Diet NOAEL
- < 0.5 (HS egg RBC range)

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**AREA 1 ALTERNATIVES SCREENING  
 TECHNICAL MEMORANDUM**  
**SUMMARY OF PROTECTIVENESS OF EACH RAL  
 SCENARIO – 1 AND 2 ACRE MOVING WINDOWS  
 FORMER PLAINWELL IMPOUNDMENT AND PLAINWELL  
 NO. 2 DAM AREA COMBINED**





**Generic RBC Ranges**

■ 15-20 mg/kg	Bin H
■ 12-15 mg/kg	Bin G
■ 10-12 mg/kg	Bin F
■ 8-10 mg/kg	Bin E
■ 6-8 mg/kg	Bin D
■ 4-6 mg/kg	Bin C
■ 2-4 mg/kg	Bin B
■ 0-2 mg/kg	Bin A

**Notes:**

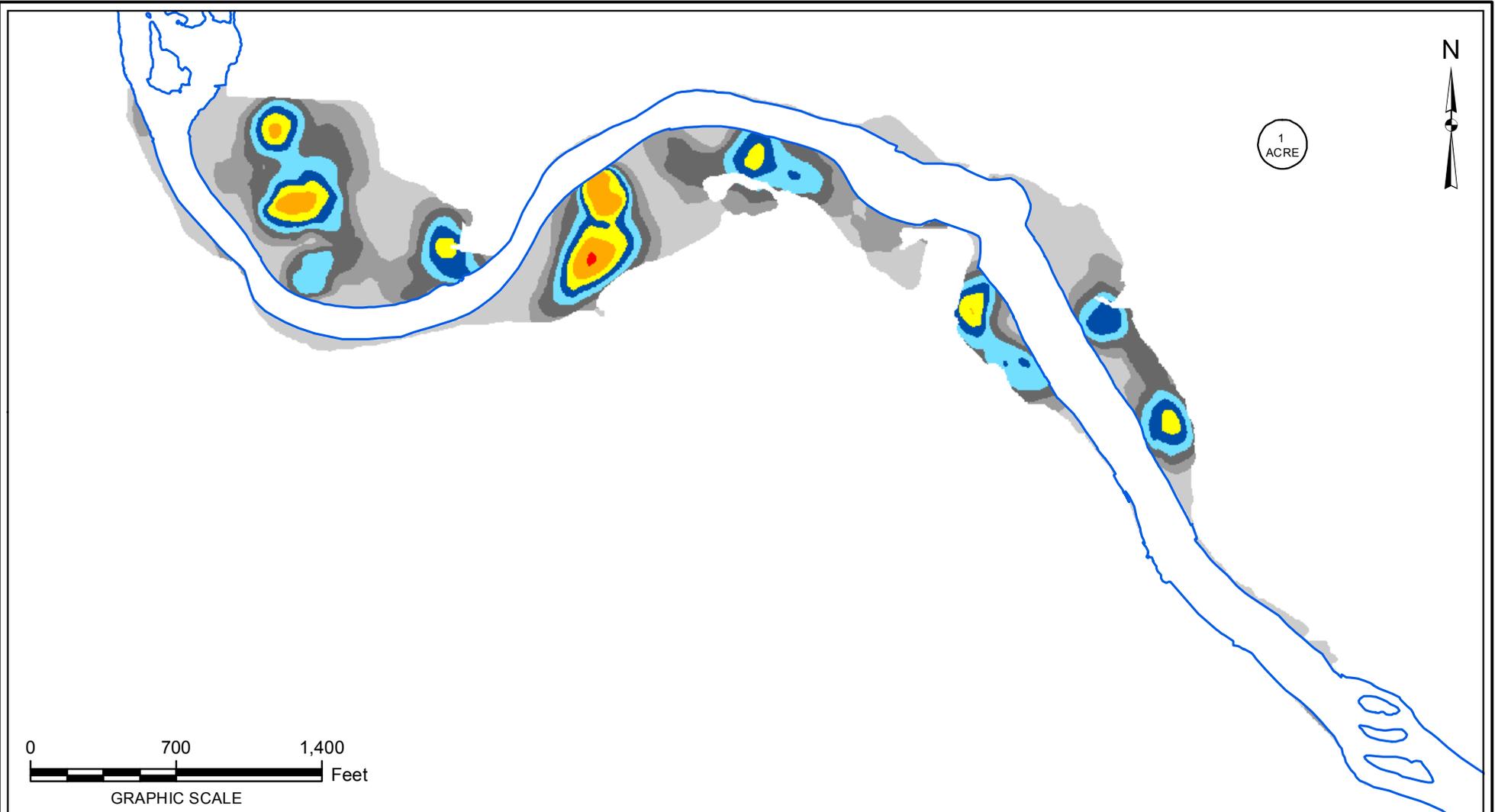
- For the purposes of this assessment, a measure of relative protectiveness of the different RBC values is quantified as the percent of possible home range EPCs that are below specified RBCs.

RBC = risk-based concentration

EPC = exposure point concentration for total PCBs based on 1 and 2 acre moving windows

GEORGIA-PACIFIC LLC  
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**AREA 1 ALTERNATIVES SCREENING  
 TECHNICAL MEMORANDUM**

**SUMMARY OF PROTECTIVENESS OF EACH RAL SCENARIO –  
 USING GENERIC CONCENTRATION RANGES – 1 AND 2 ACRE  
 MOVING WINDOWS. FORMER PLAINWELL IMPOUNDMENT  
 AND PLAINWELL NO. 2 DAM AREA COMBINED**



**LEGEND:**

SOIL PCB (MG/KG)\*1:  KALAMAZOO RIVER

<span style="display: inline-block; width: 15px; height: 10px; background-color: #cccccc;"></span>	≤ 2
<span style="display: inline-block; width: 15px; height: 10px; background-color: #808080;"></span>	> 2 and ≤ 4
<span style="display: inline-block; width: 15px; height: 10px; background-color: #404040;"></span>	> 4 and ≤ 6
<span style="display: inline-block; width: 15px; height: 10px; background-color: #add8e6;"></span>	> 6 and ≤ 8
<span style="display: inline-block; width: 15px; height: 10px; background-color: #0000ff;"></span>	> 8 and ≤ 10
<span style="display: inline-block; width: 15px; height: 10px; background-color: #ffff00;"></span>	> 10 and ≤ 12
<span style="display: inline-block; width: 15px; height: 10px; background-color: #ffa500;"></span>	> 12 and ≤ 15
<span style="display: inline-block; width: 15px; height: 10px; background-color: #ff0000;"></span>	> 15 and ≤ 20
<span style="display: inline-block; width: 15px; height: 10px; background-color: #800000;"></span>	> 20

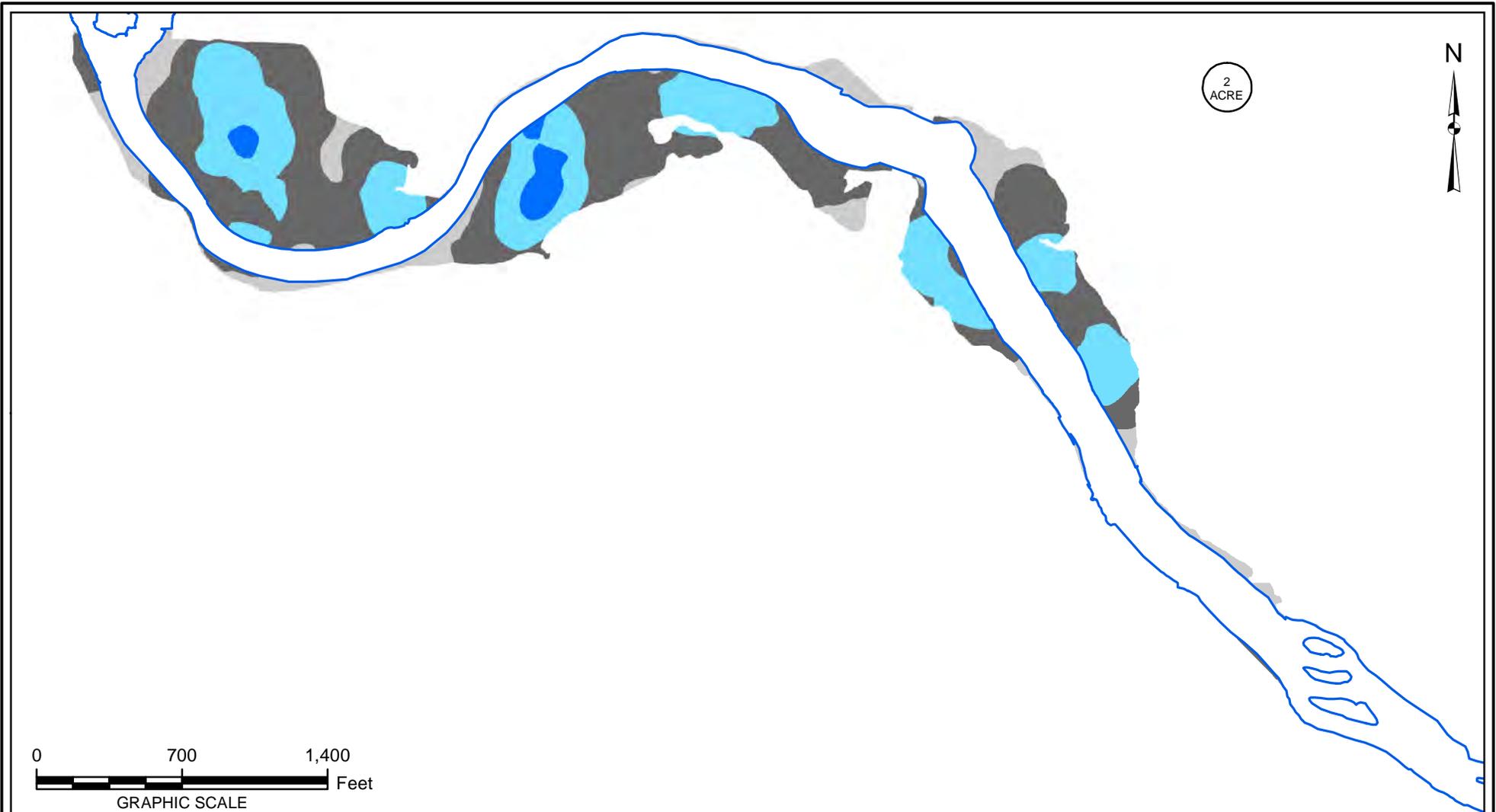
**NOTES:**

- INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
- REMEDATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
- AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

\*1 CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 1 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA. APPROXIMATELY 57 ACRES.

Source: Area 1 Alternatives Screening Technical Memorandum (ARCADIS 2012b)

GEORGIA-PACIFIC LLC ALLIED PAPER, INC./PORTAGE CREEK/ KALAMAZOO RIVER SUPERFUND SITE <b>AREA 1 FEASIBILITY STUDY REPORT –          MORROW DAM TO FORMER PLAINWELL DAM</b>	
<b>INTERPOLATED FLOODPLAIN SOIL PCB CONCENTRATION          1 ACRE MOVING WINDOW FORMER PLAINWELL          IMPOUNDMENT - 20 MG/KG HILLTOP USING GENERIC BINS</b>	
Prepared by/Date: CLS 03/13/14	<b>FIGURE G-8</b>
Checked by/Date: MTP 07/15/13	
Project Number: 3293131541	



**LEGEND:**

SOIL PCB (MG/KG)*:	KALAMAZOO RIVER
< 1	
> 1 and ≤ 5	
> 5 and ≤ 10	
> 10 and ≤ 15	
> 15 and ≤ 20	
> 20 and ≤ 25	
> 25	

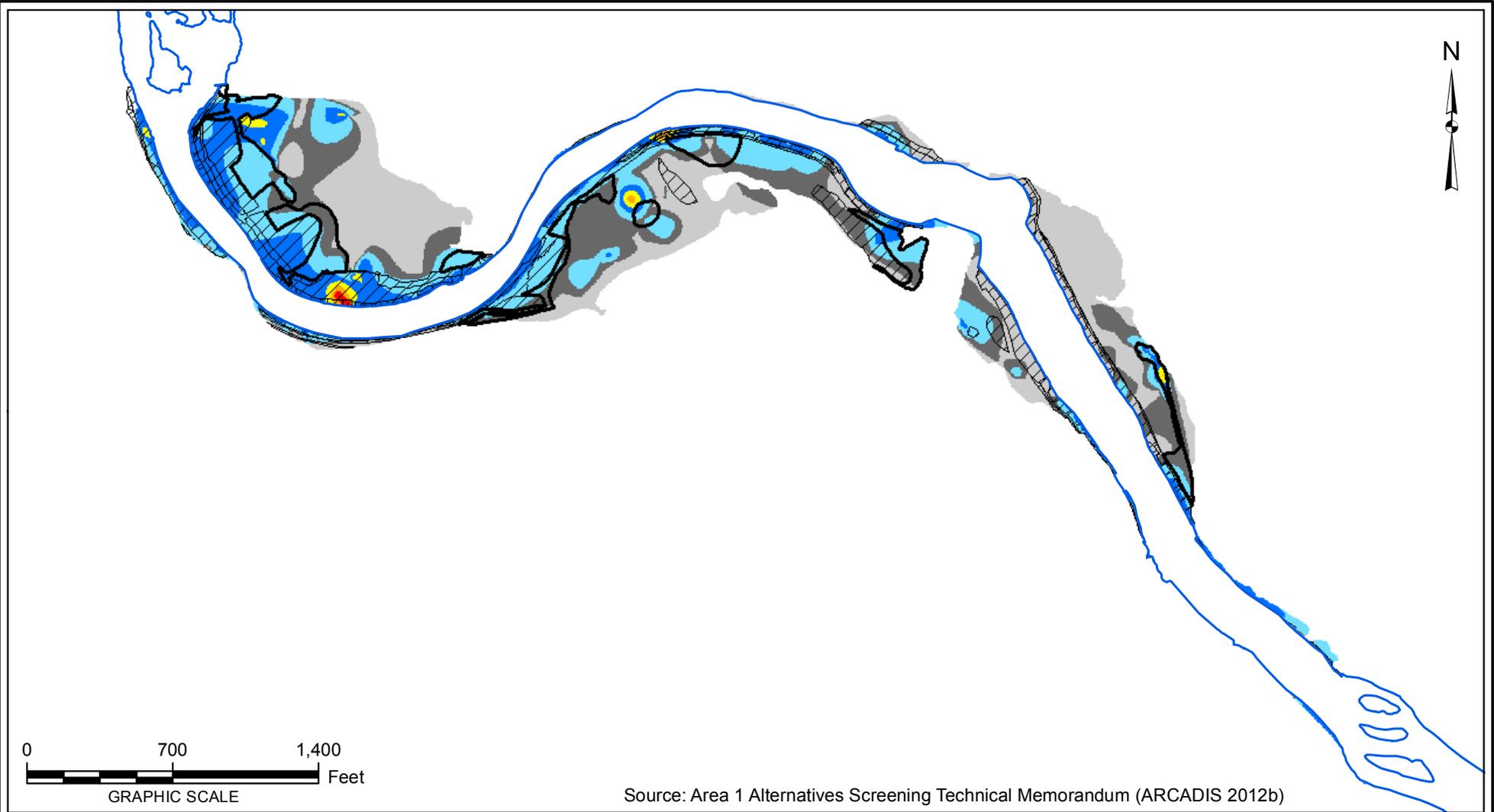
**NOTES:**

1. INTERPOLATION PERFORMED USING NATURAL NEIGHBOR TECHNIQUE AND SURFACE SAMPLES.
2. REMEDIATION ACCOUNTED FOR BY REPLACING APPROPRIATE AREAS WITH EITHER CONFIRMATION GRID CONCENTRATIONS OR BACKFILL CONCENTRATION ESTIMATES (0.078 MG/KG).
3. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

\* CONCENTRATIONS SHOWN REPRESENT AN AVERAGE OF A 2 ACRE CIRCULAR HOME RANGE CENTERED ON POINTS SPACED AT 1 FOOT RESOLUTION ACROSS THE AREA APPROXIMATELY 57 ACRES.

Source: Area 1 Alternatives Screening Technical Memorandum (ARCADIS 2012b)

GEORGIA-PACIFIC LLC ALLIED PAPER, INC./PORTAGE CREEK/ KALAMAZOO RIVER SUPERFUND SITE <b>AREA 1 FEASIBILITY STUDY REPORT –          MORROW DAM TO FORMER PLAINWELL DAM</b>	
<b>INTERPOLATED FLOODPLAIN SOIL PCB CONCENTRATION          2 ACRE MOVING WINDOW FORMER PLAINWELL          IMPOUNDMENT-20 MG/KG HILLTOP USING GENERIC BINS</b>	
Prepared by/Date: JRM 05/21/14	<b>FIGURE G-9</b>
Checked by/Date: MTP 05/21/14	
Project Number: 3293131541	



Source: Area 1 Alternatives Screening Technical Memorandum (ARCADIS 2012b)

**LEGEND:**  
 5 MG/KG SURFACE DEPTH CONCENTRATION

- < 6"
- > 6" and ≤ 12"
- > 12" and ≤ 24"
- > 24" and ≤ 36"
- > 36" and ≤ 48"
- > 48" and ≤ 60"
- > 60"

- AREA OVER 1/4 ACRE AND AREA >20 mg/kg
- TCRA REMOVAL AREA
- KALAMAZOO RIVER

**NOTES:**

1. INTERPOLATION OF DEPTH TO 5 MG/KG PERFORMED USING NATURAL NEIGHBOR TECHNIQUE.
2. AREA OF FORMER IMPOUNDMENT BOUNDARY IS APPROXIMATELY 57 ACRES.

GEORGIA-PACIFIC LLC  
 ALLIED PAPER, INC./PORTAGE CREEK/  
 KALAMAZOO RIVER SUPERFUND SITE  
**AREA 1 FEASIBILITY STUDY REPORT –  
 MORROW DAM TO FORMER PLAINWELL DAM**

**INTERPOLATED DEPTH TO 5 MG/KG**

Prepared by/Date:  
 CLS 03/13/14  
 Checked by/Date:  
 MTP 07/15/13  
 Project Number:  
 3293131541



**FIGURE  
 G-10**