HOUSATONIC RIVER
CORRECTIVE MEASURES STUDY (CMS)

Citizens Coordinating Council

March 27, 2008

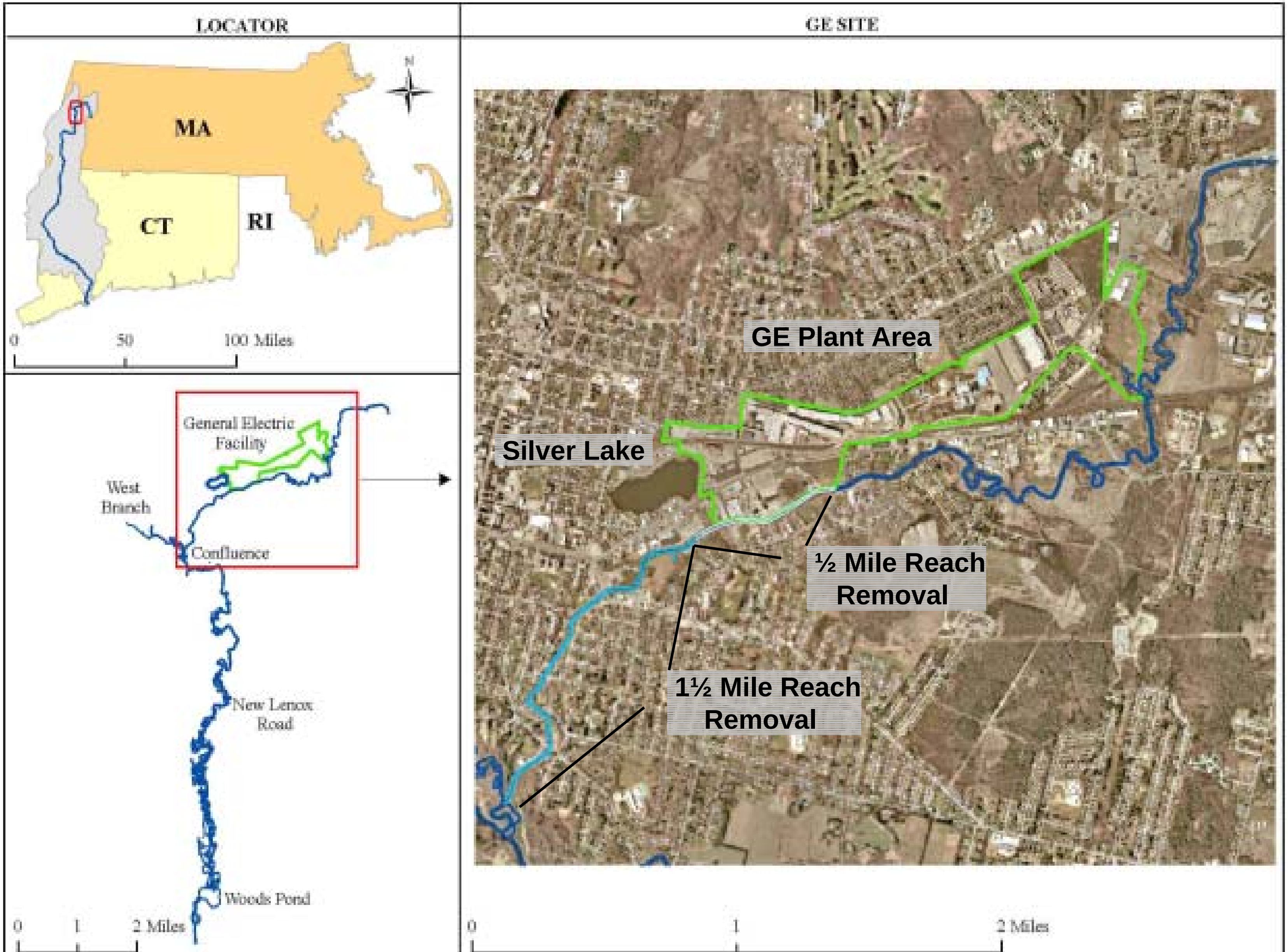
PRESENTATION ORGANIZATION

- Background and overview of Corrective Measures Study (CMS).
- Sediment remedial alternatives.
- Floodplain soil remedial alternatives.
- Treatment/disposal alternatives.
- Summary.

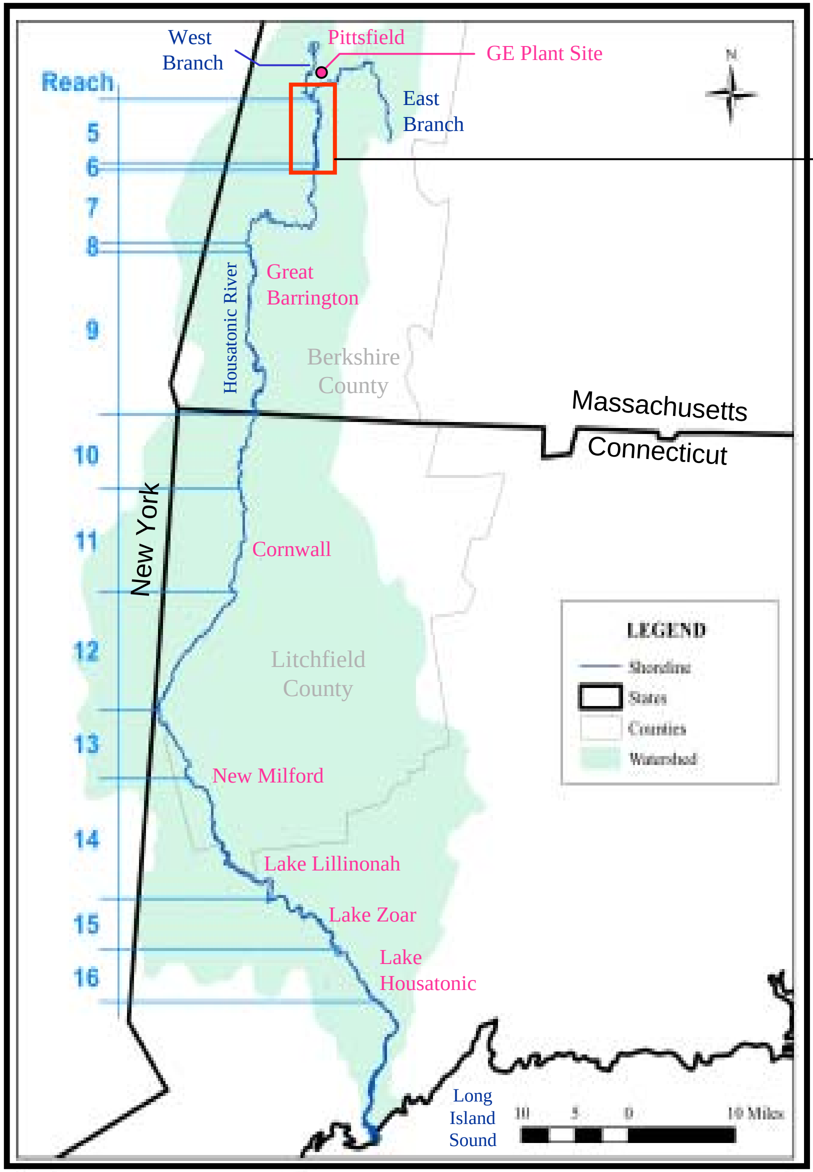
SETTLEMENT – OVERVIEW

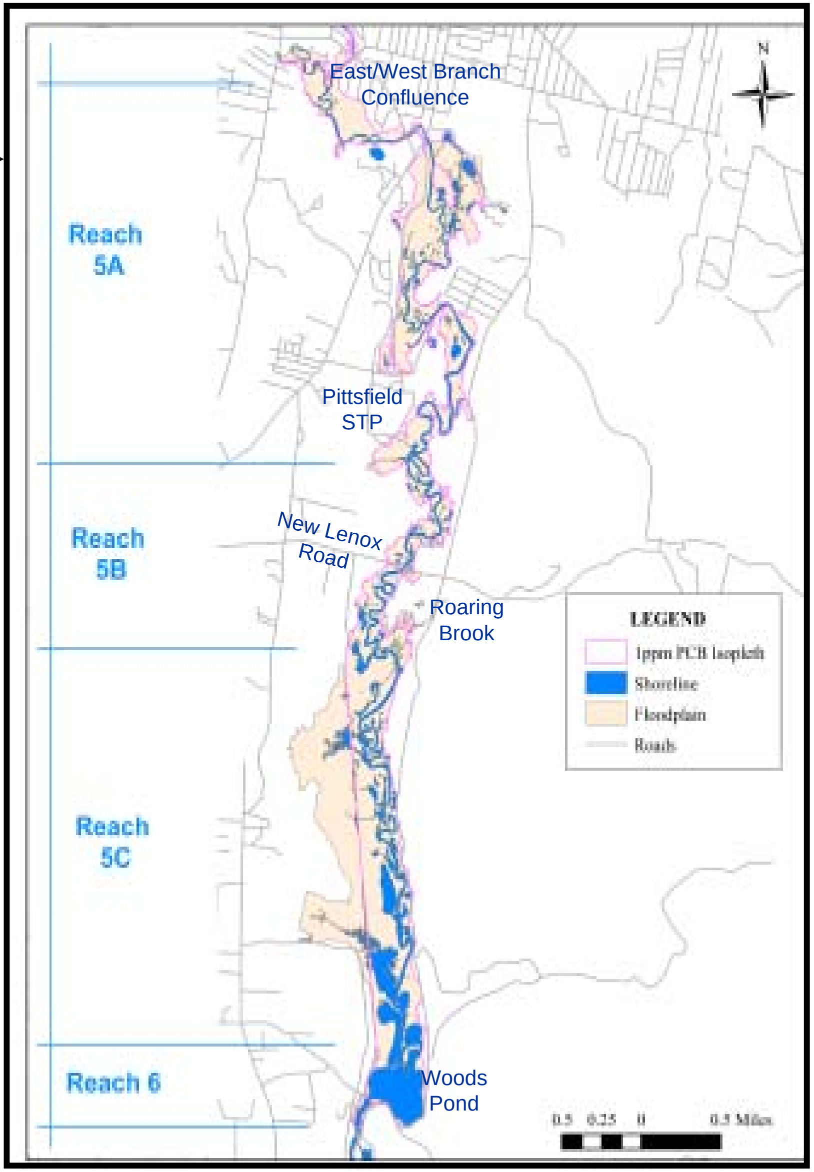
- Comprehensive settlement negotiated between GE and 11 govt. agencies between 1997 and 1999. Court entered Consent Decree (CD) in October 2000.
- Areas covered by CD:
  - – Areas Outside River: GE Plant, Former Oxbows, Allendale School, Silver Lake.
    - -- Remediation by GE under Performance Standards set out in CD.
  - – Housatonic River:
    - -- Upper ½ Mile: Remediation by GE.
    - -- Next 1½ Miles: Remediation by EPA.
    - -- Rest of River: CD prescribes process for investigation/evaluation; remedy to be selected by EPA.

SITE MAP – FACILITY AND EAST BRANCH OF HOUSATONIC RIVER

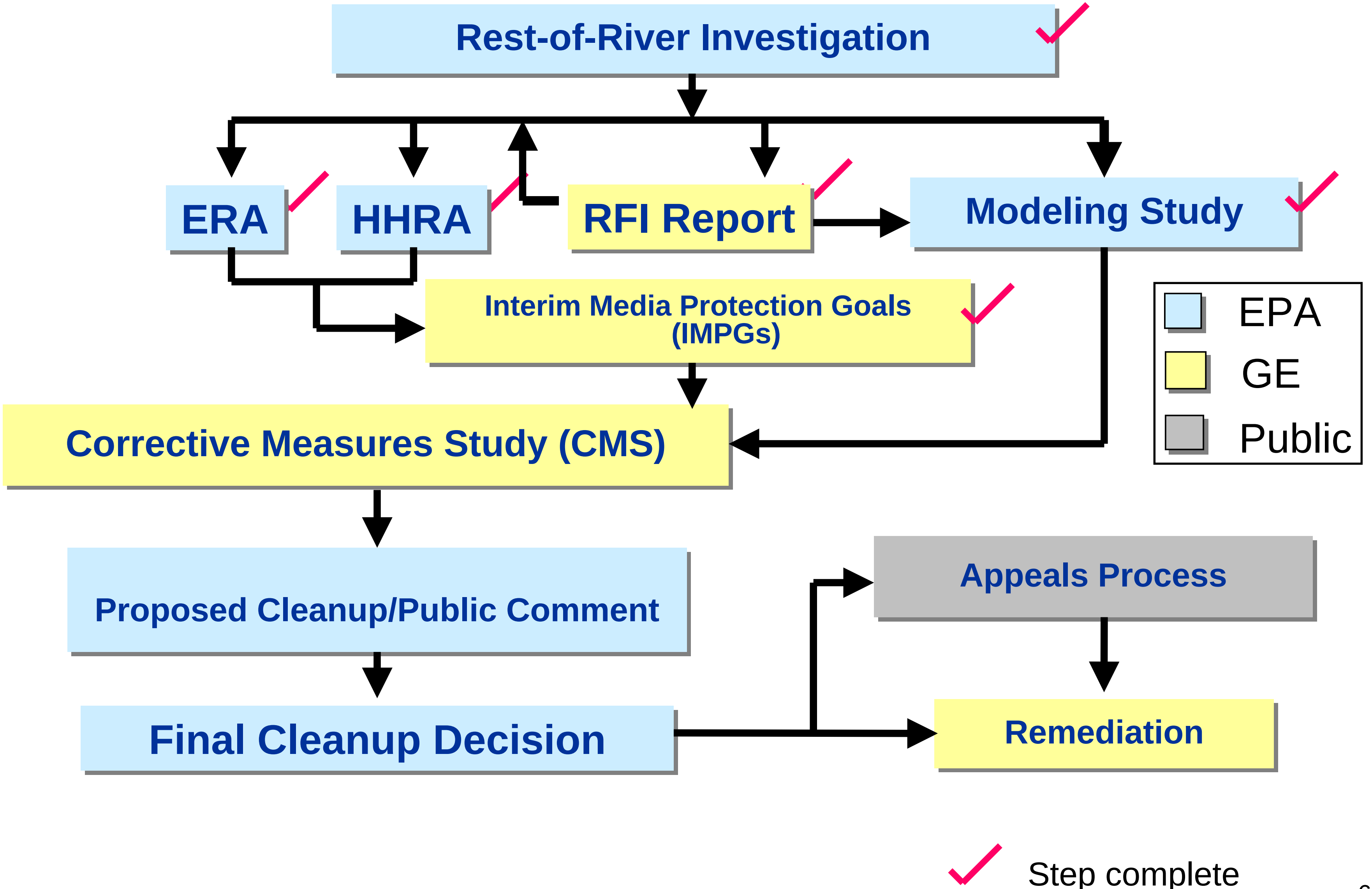


SITE MAP – REST OF RIVER





REST OF RIVER PROCESS DESCRIBED IN CD



INTERIM MEDIA PROTECTION GOALS (IMPGs)

- Interim Media Protection Goals (IMPGs) represent preliminary goals for protection of human health and environment.
- To be considered in CMS as one factor to evaluate potential remedial alternatives – not cleanup standards that remedy must meet.
- IMPGs were developed based on EPA’s Human Health and Ecological Risk Assessments including exposure assumptions, toxicity values, and data interpretations.
- EPA approved IMPGs in April 2006.

EXAMPLES OF EPA-APPROVED HEALTH-BASED IMPGs

Exposure Scenario	Medium	PCB RME Range (mg/kg)		PCB CTE Range (mg/kg)	
		Cancer *	NC	Cancer *	NC
Based on Direct Human Contact					
High-use general recreation (young child)	FP soil	1.3 – 134	4.6	18 – 1842	32
High-use general recreation (adult)	FP soil	1.4 – 143	38	63 – 6305	234
Medium-use general recreation (adult)	FP soil	2.1 – 215	58	63 – 6305	234
Bank fishing (adult)	FP soil	2.6 – 256	56	70 – 7015	220
Based on Fish Consumption					
Bass consumption (adult)	Bass fillets	0.002 – 0.2	0.06	0.05 – 5	0.43
Trout consumption in CT (adult)	Trout fillets	0.005 – 0.5	0.16	0.1 – 11	0.9

- * Based on cancer risk range of 10^{-6} to 10^{-4}.
- NC : Non-cancer.

EPA-APPROVED ECOLOGICAL IMPGs

Receptor Group	Medium	PCB IMPG Values (mg/kg)
Benthic invertebrates	Sediments	3 to 10
Amphibians	Vernal pool sediments	3.27 to 5.6
Fish	Fish tissue upstream of Woods Pond Dam	55
	Fish tissue downstream of Woods Pond Dam	55 for warmwater fish 14 for coldwater fish
Piscivorous birds (represented by osprey)	Fish tissue	3.2
Insectivorous birds (represented by wood ducks)	Aquatic and terrestrial invertebrate prey	4.4
Piscivorous mammals (mink and otter)	Prey items	0.98 to 2.43
Omnivorous and carnivorous mammals (represented by short-tailed shrew)	Floodplain soil	21 to 34
Threatened and endangered species (represented by bald eagle)	Fish tissue	30.4

PCB FATE AND TRANSPORT MODEL

- EPA developed a model framework to simulate Rest of River from Confluence to Rising Pond (Reaches 5 to 8).
- Includes three linked mathematical models:
  - Watershed model (HSPF).
  - Water, sediment, PCB fate & transport model (EFDC).
  - Food chain model (FCM).
- Simulates each sediment/bank remediation alternative for minimum 52-yr period, including:
  - Time for cleanup.
  - Residual sediment concentrations.
  - Resuspension rates caused by the remedial activity.
  - Atmospheric and other PCB and solids loadings.
- Model outputs included water, sediment, and fish PCB levels over time for each alternative.
- These outputs were used to evaluate effectiveness and timeframe for each sediment alternative.
- An extrapolation method (CT 1-D Analysis) was used to estimate responses in fish in Connecticut.

PCB FATE AND TRANSPORT MODEL (cont'd)

- The following remedial technologies were assumed:
  - Mechanical removal in the dry for Reaches 5A and 5B based on shallow water depths and relatively narrow channel width.
  - Mechanical/Hydraulic dredging in the wet for Reaches 5C-8 based on deeper water depths, increased river width, and some access limitations.
  - Thin-layer capping and engineered capping consistent with the approved alternatives.
- Each of these technologies was represented in the model using EPA-approved removal rates, resuspension rates, and residual PCB concentrations.

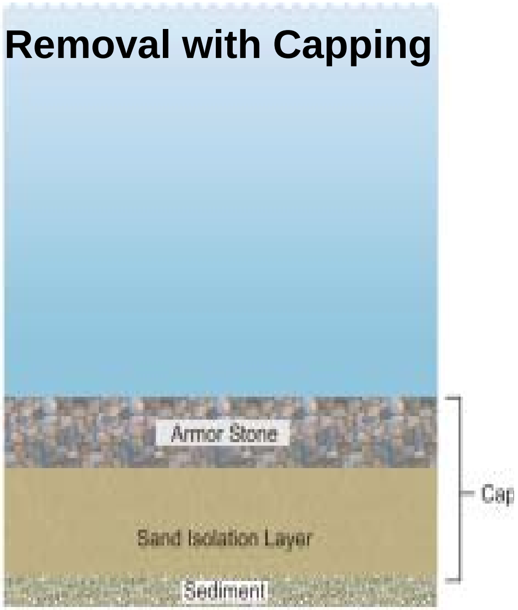
OVERVIEW OF CMS WORK PLAN

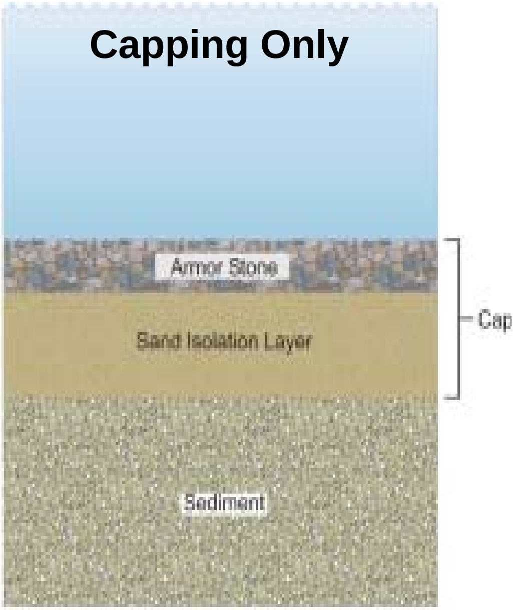
- Range of remedial technologies for sediments, floodplain soils, and treatment/disposition were compiled and screened consistent with EPA guidance.
- Initial screening to identify potentially viable remedial technologies:
  - Technically implementable based on site conditions, chemical or physical characteristics of sediments/soils.
  - Full-scale application on other PCB sites.
- Secondary screening to determine the most promising technologies based on:
  - General effectiveness.
  - Implementability.
- Retained technologies were then combined into a set of alternatives for detailed and comparative evaluation in the CMS Report.
- EPA approved CMS Work Plan and supplemental documents.

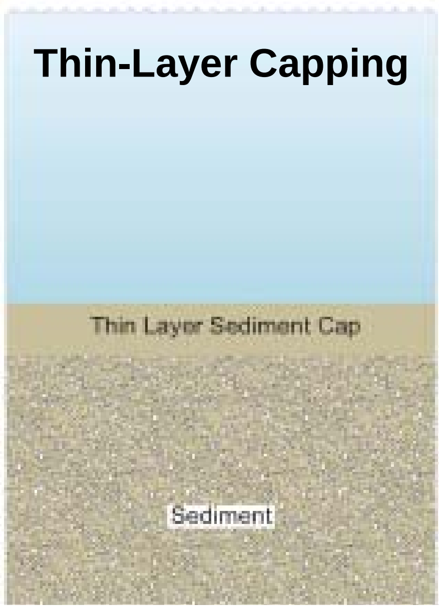
DEVELOPMENT OF SEDIMENT ALTERNATIVES

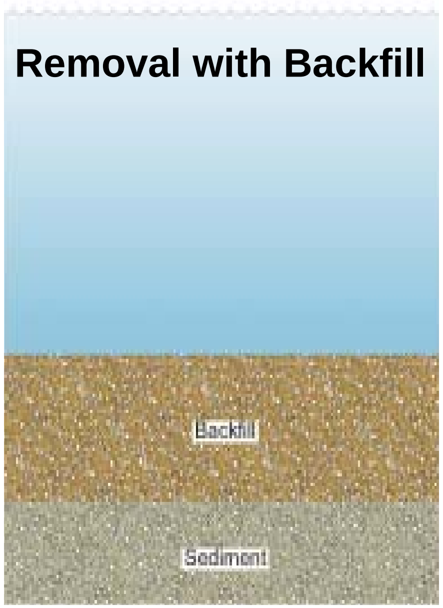
- 8 sediment/riverbank alternatives proposed for detailed evaluation ranging from no action to extensive removal.
- Alternatives focus on reaches with highest remaining PCB concentrations.
- All alternatives incorporate monitored natural recovery below Rising Pond Dam due to low sediment and fish PCB levels in those reaches.
- Use various combinations of three main sediment remedial technologies identified in EPA guidance – capping, removal, and monitored natural recovery.
- Consider suitability of technologies for different river conditions:
  - Water depth.
  - Water velocities.
  - Presence of backwaters or impounded areas.

EXAMPLES OF REMOVAL AND CAPPING TECHNOLOGIES

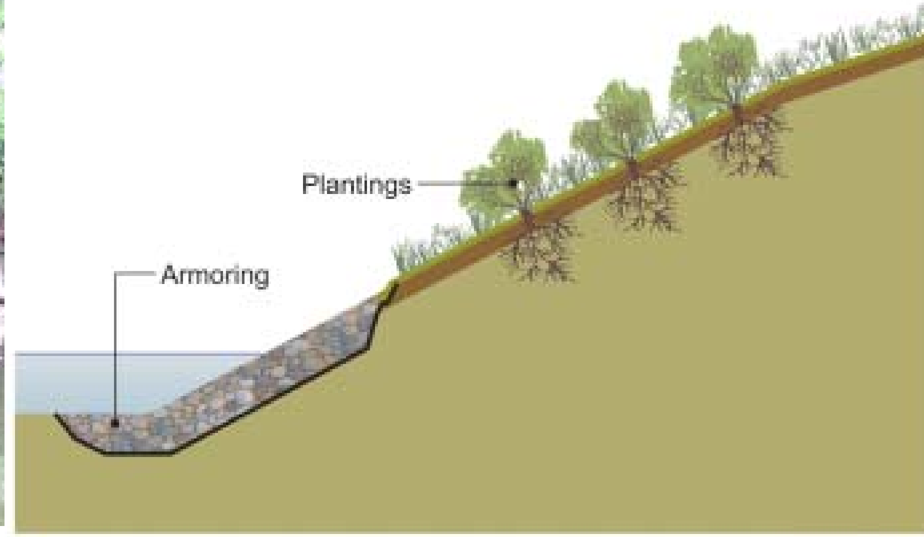








ERODIBLE RIVERBANKS



- Alternatives SED 3 – SED 8 address erodible riverbanks in Reaches 5A and 5B through a combination of excavation and restoration.
- Restoration techniques were assumed to include:
  - Armoring.
  - Bioengineering.
  - Revetment mat.
- Estimated excavation volume is ~33,000 cy.

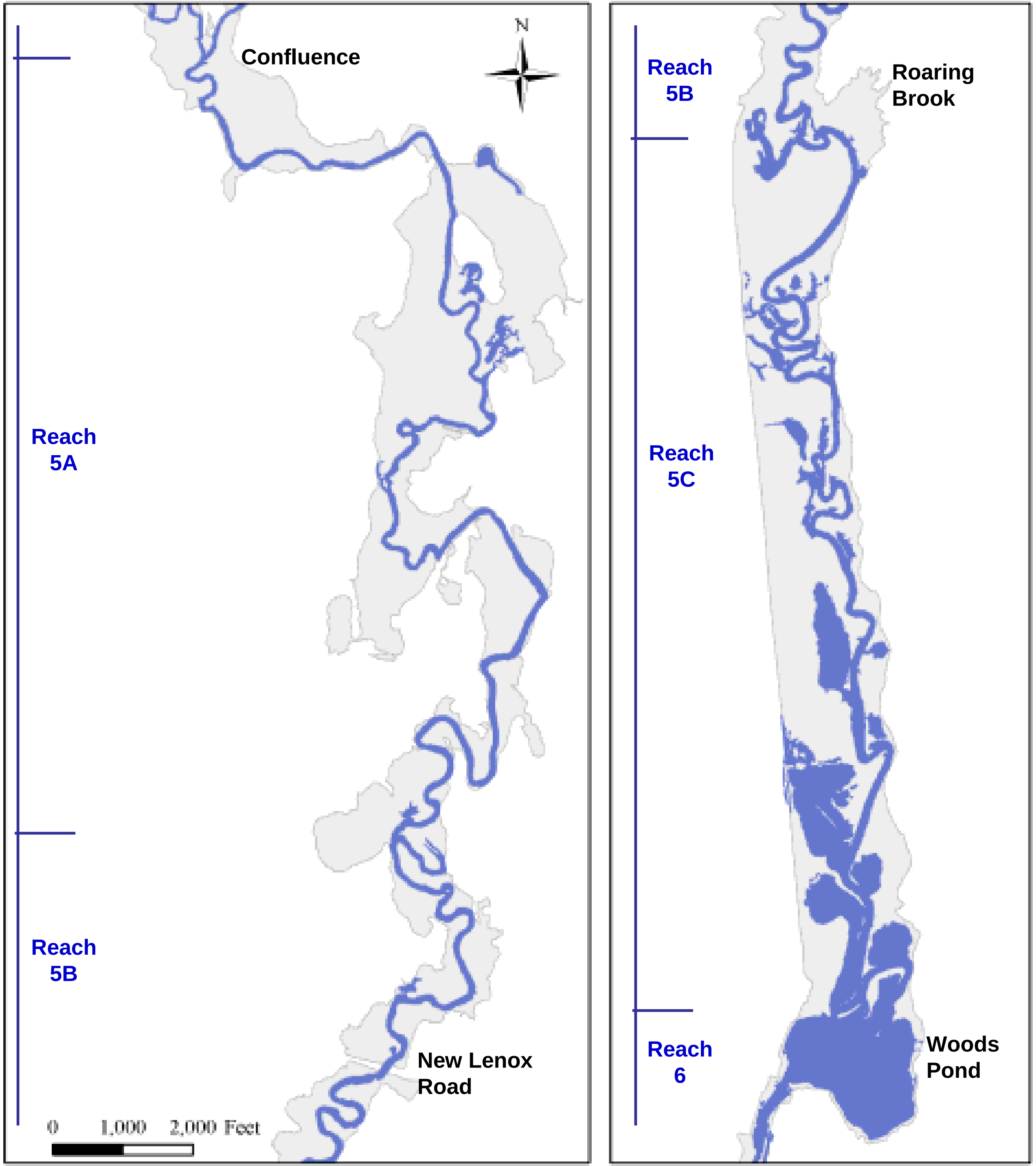
SUMMARY OF SEDIMENT ALTERNATIVES

	SED 1 / SED 2	SED 3	SED 4	SED 5	SED 6	SED 7	SED 8
Volume (cy)	---	167,000	295,000	410,000	554,000	793,000	2,250,000
Capping after removal (acres)	---	42	91	126	178	146	---
Backfill after removal (acres)	---	---	---	---	---	69	340
Capping w/o removal (acres)	---	---	37	60	45	45	---
Thin-layer capping (acres)	---	97	119	102	101	65	---
Total surface area (acres)	---	139	247	288	324	325	340
Construction duration (years)	0	10	15	18	21	25	51

Note: Monitored natural recovery (MNR) would be a component of all alternatives except SED 1.

Reaches 5 and 6

SED 1 / SED 2



Removal vol.: 0 cy

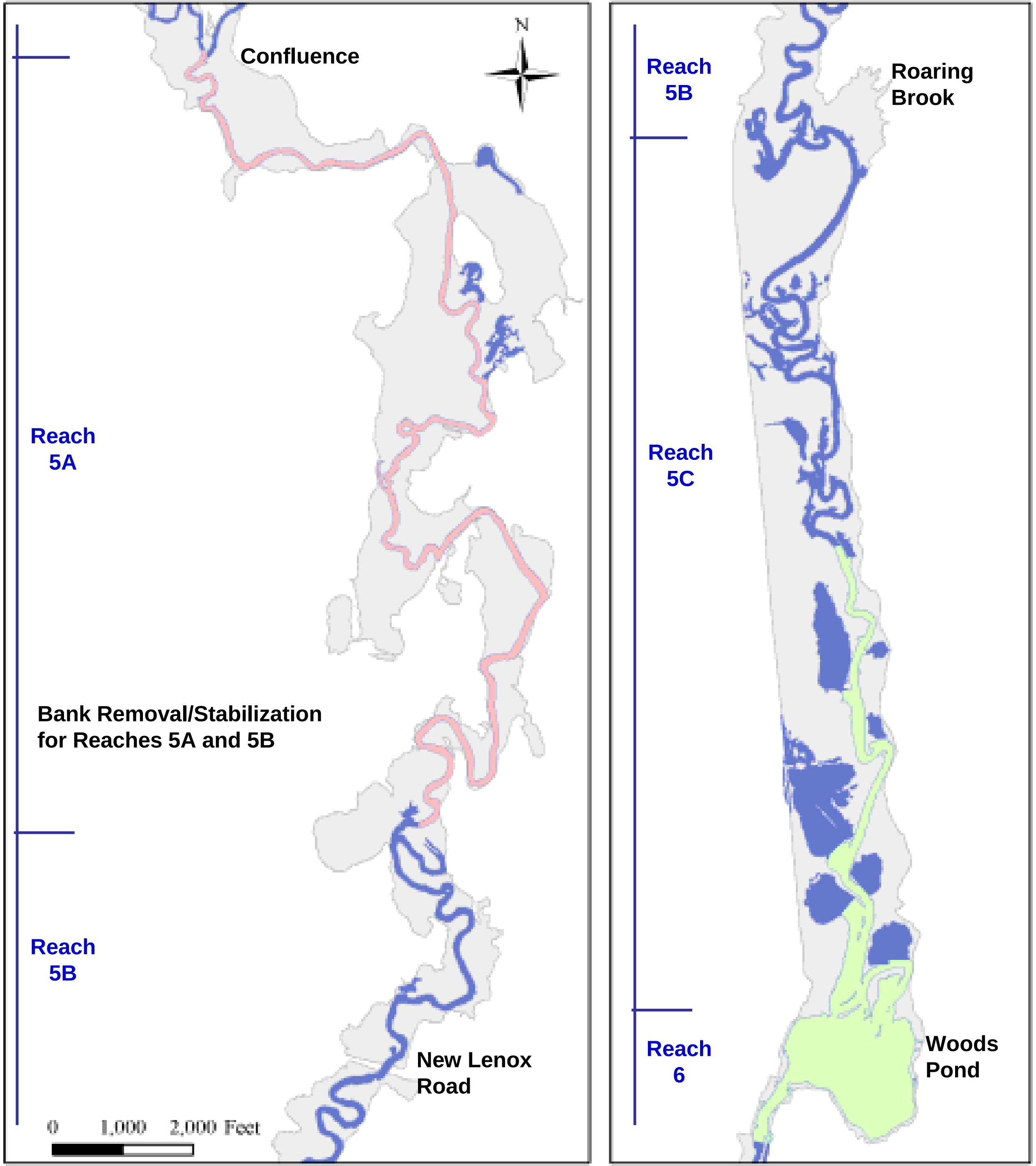
Thin-layer cap: 0 acres

Cap: 0 acres

Duration: 0 years

- Surface Water
- 1 ppm PCB Isopleth
- Thin Layer Cap
- Cap
- Removal with Cap/Backfill
  - Top 1-1.5 ft
  - Top 2 ft
  - Top 2.5 ft
  - Top 3-3.5-ft
  - Top 4-7 ft

Reaches 5 and 6
SED 3



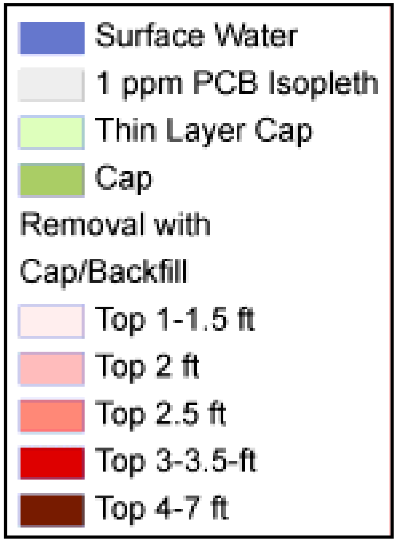
Removal vol.: 167,000 cy

Removal/cap: 42 acres

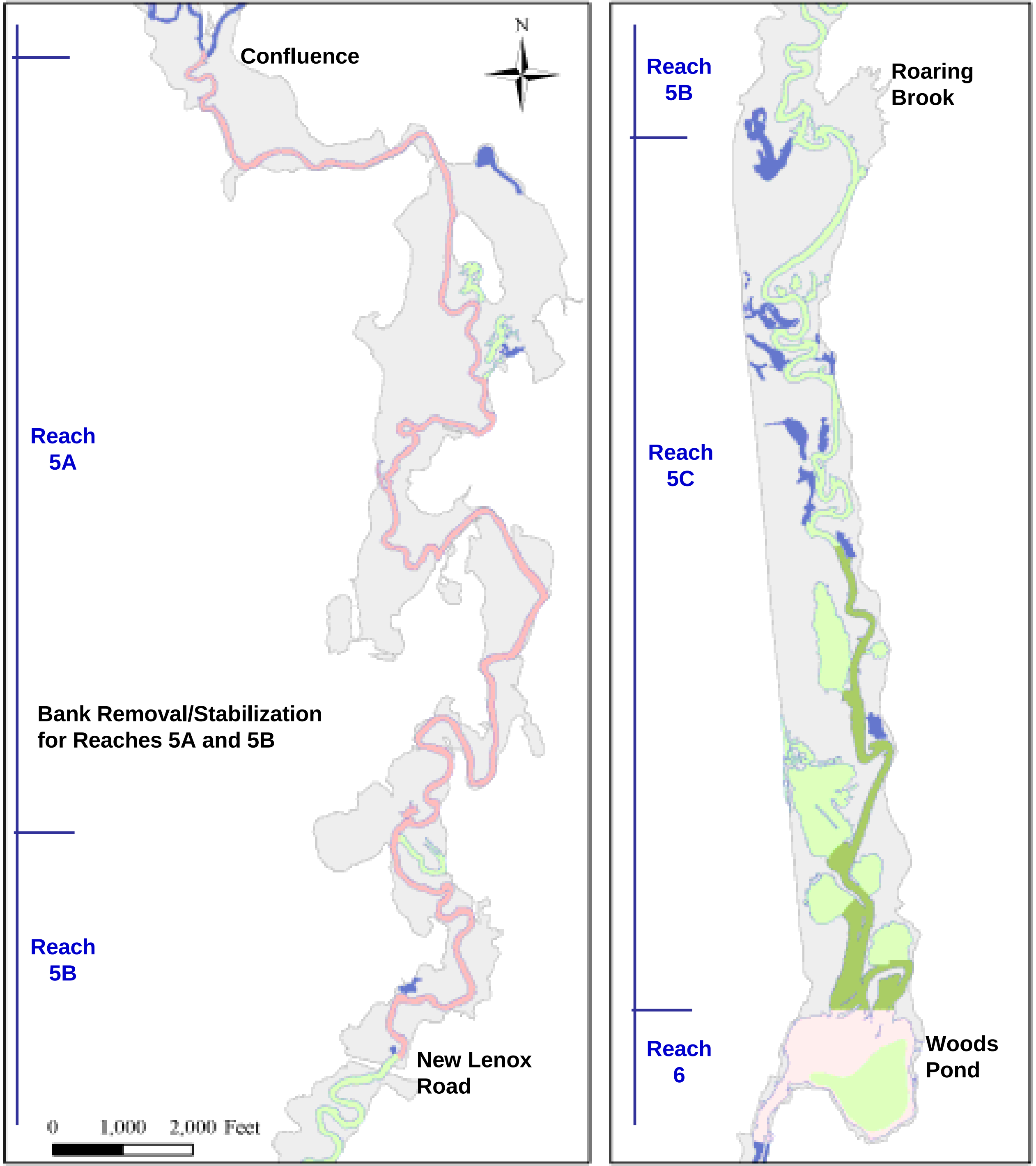
Thin-layer cap: 97 acres

Cap: 0 acres

Duration: 10 years



Reaches 5 and 6
SED 4



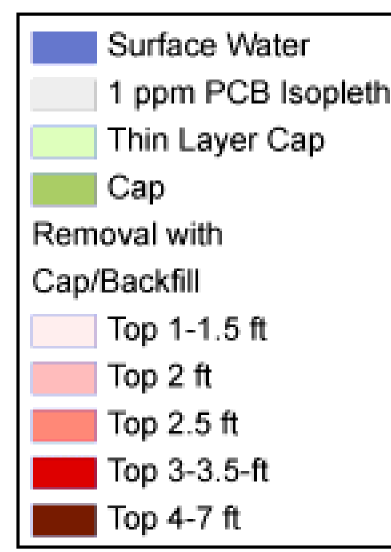
Removal vol.: 295,000 cy

Removal/cap: 91 acres

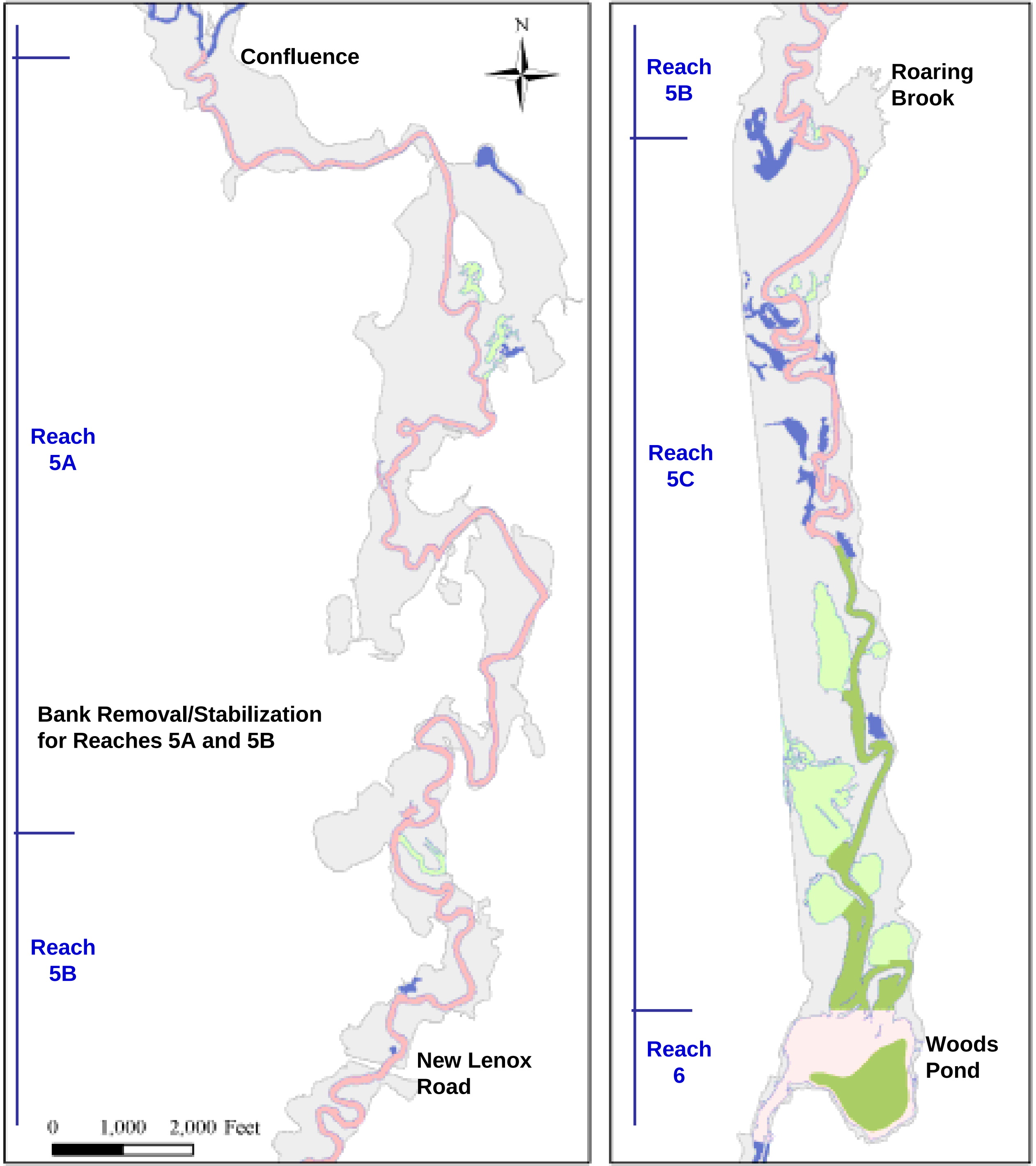
Thin-layer cap: 119 acres

Cap: 37 acres

Duration: 15 years



Reaches 5 and 6
SED 5



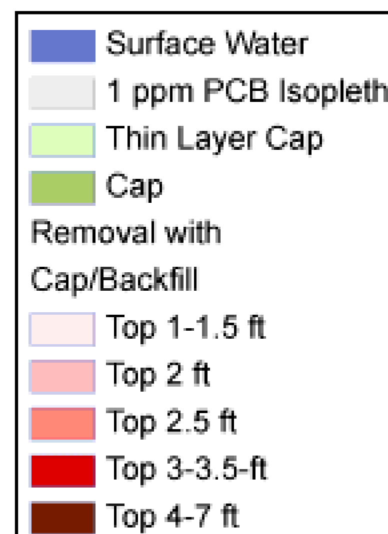
Volume: 410,000 cy

Removal/cap: 126 acres

Thin-layer cap: 102 acres

Cap: 60 acres

Duration: 18 years



Reach 7 Impoundments and Reach 8
SED 5

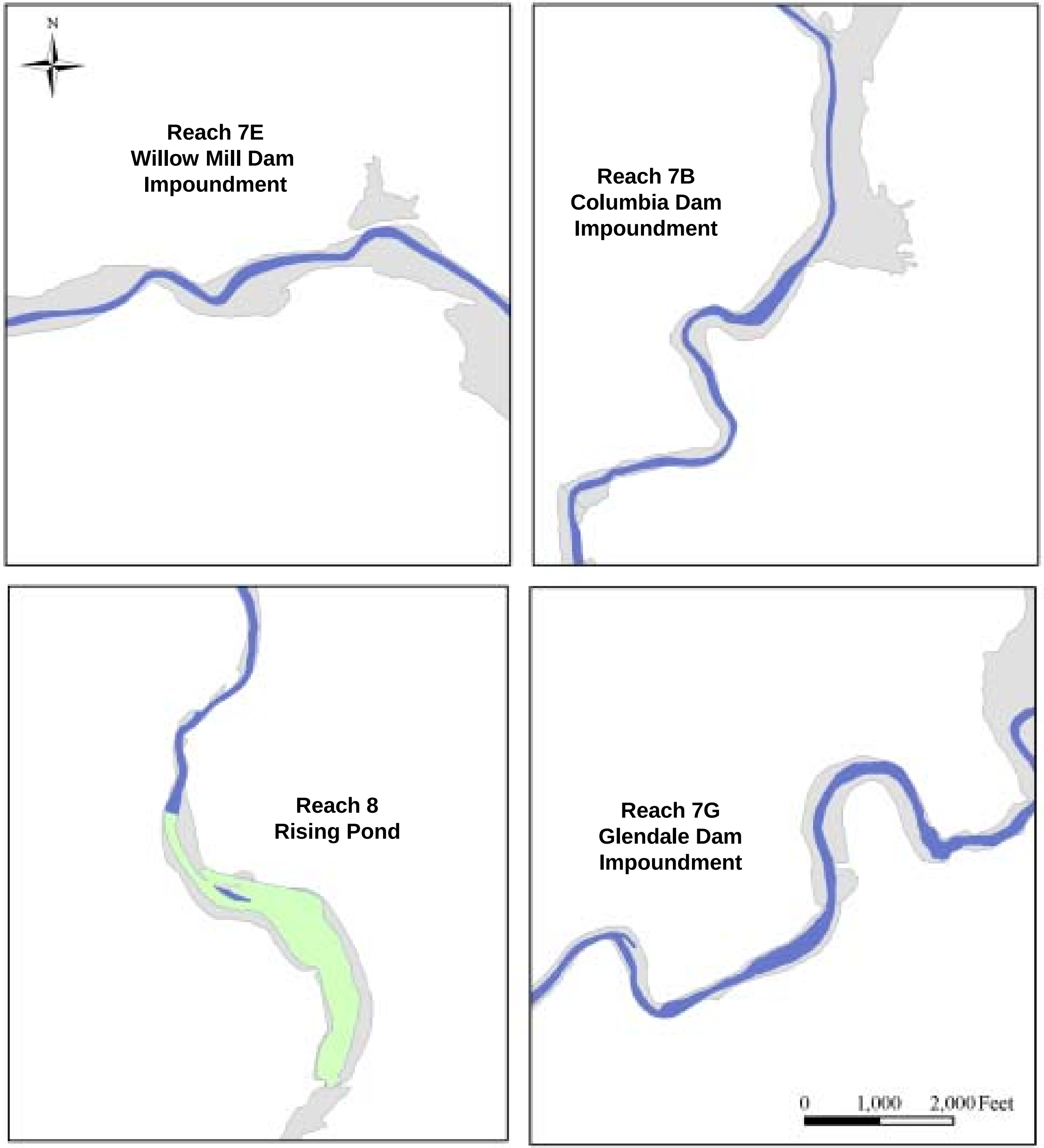
Volume: 410,000 cy

Removal/cap: 126 acres

Thin-layer cap: 102 acres

Cap: 60 acres

Duration: 18 years



Surface Water

100-year Floodplain

Thin Layer Cap

Cap

Removal with Cap/Backfill

Top 1-1.5 ft

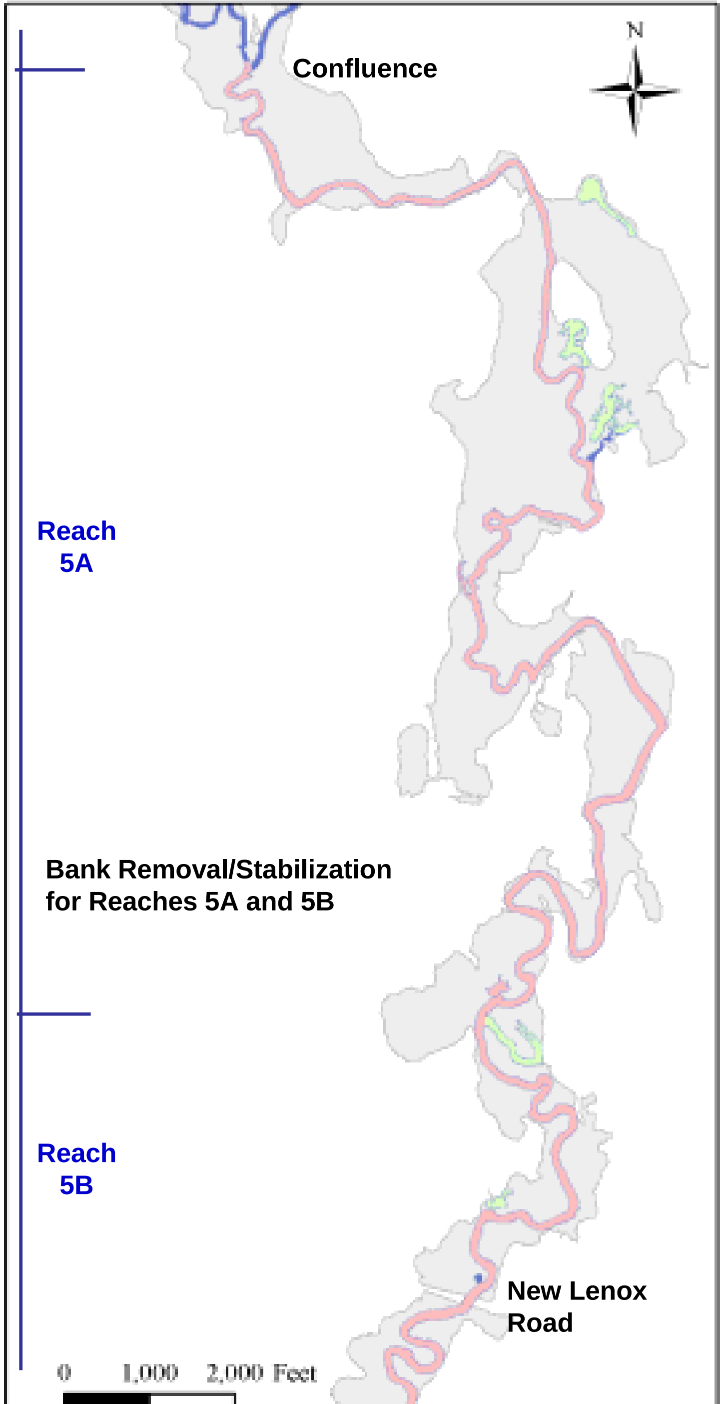
Top 2 ft

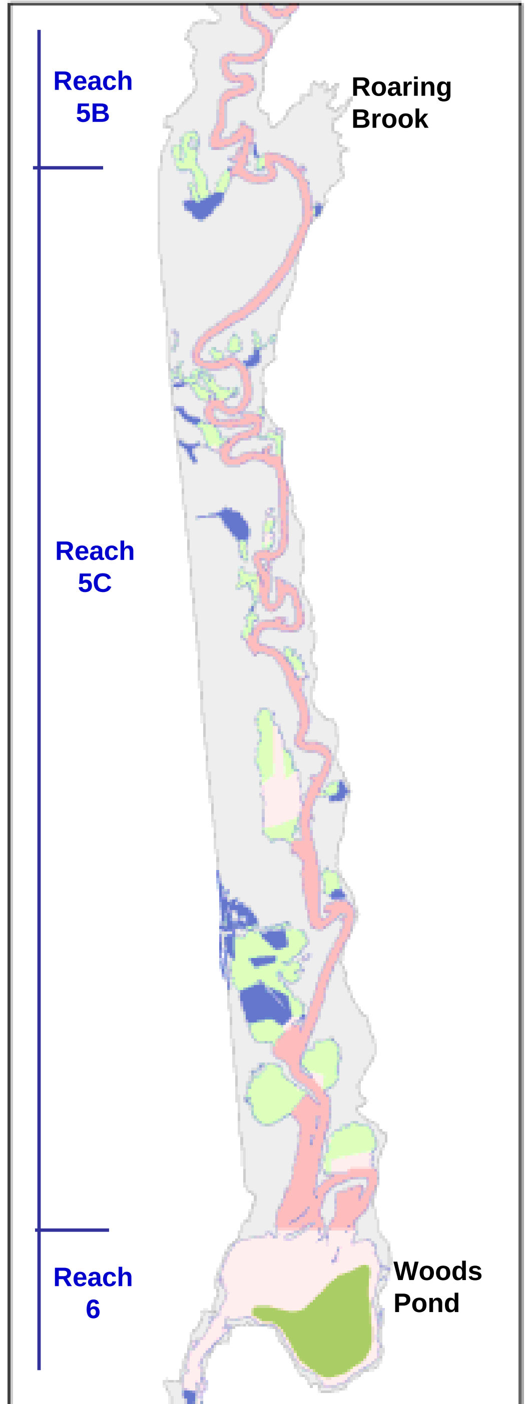
Top 2.5 ft

Top 3-3.5-ft

Top 4-7 ft

Reaches 5 and 6
SED 6





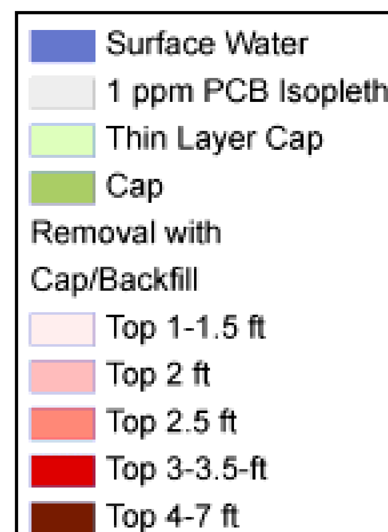
Volume: 554,000 cy

Removal/cap: 178 acres

Thin-layer cap: 101 acres

Cap: 45 acres

Duration: 21 years



Reach 7 Impoundments and Reach 8
SED 6

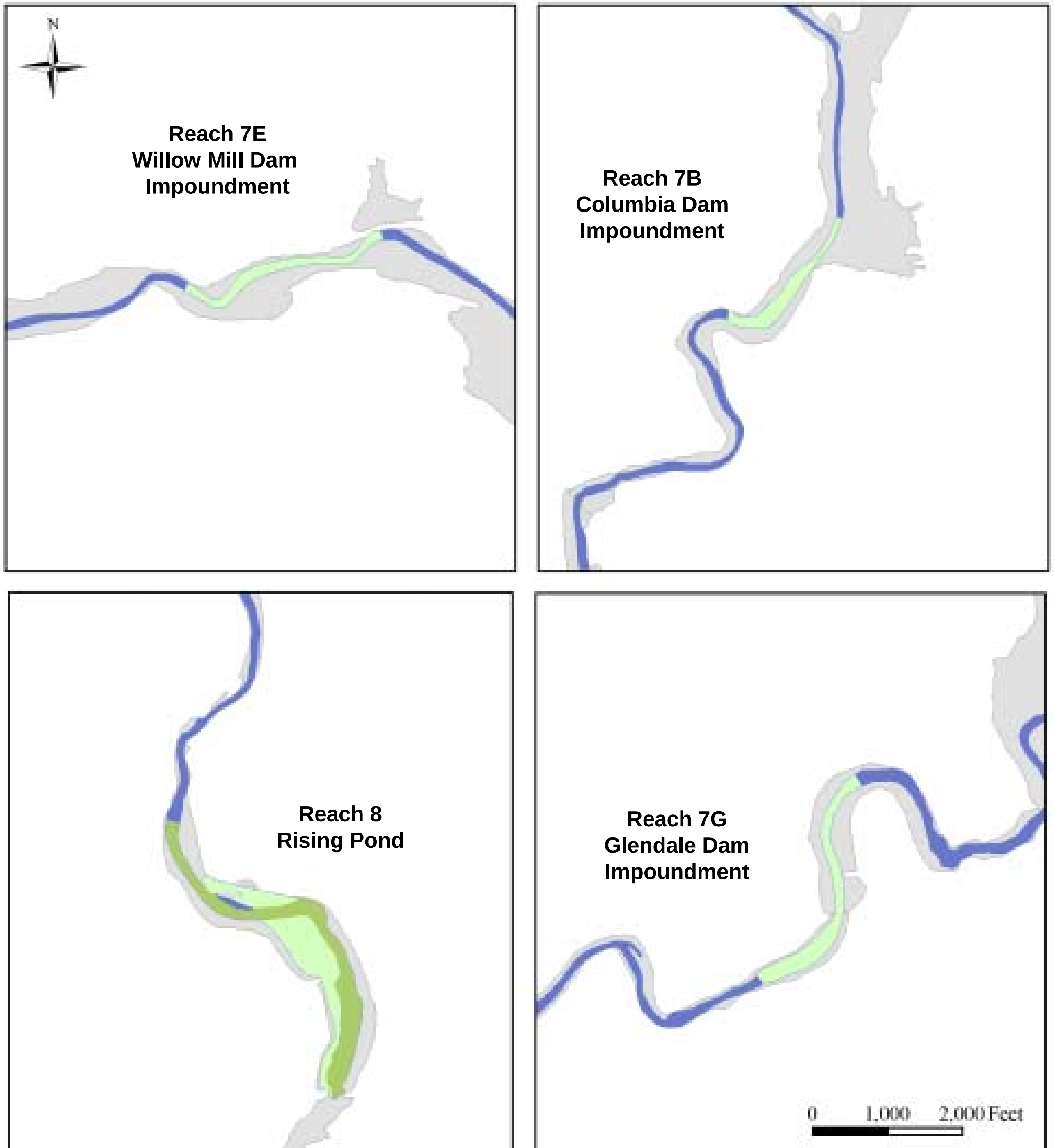
Volume: 554,000 cy

Removal/cap: 178 acres

Thin-layer cap: 101 acres

Cap: 45 acres

Duration: 21 years



Reaches 5 and 6
SED 7

Volume: 793,000 cy

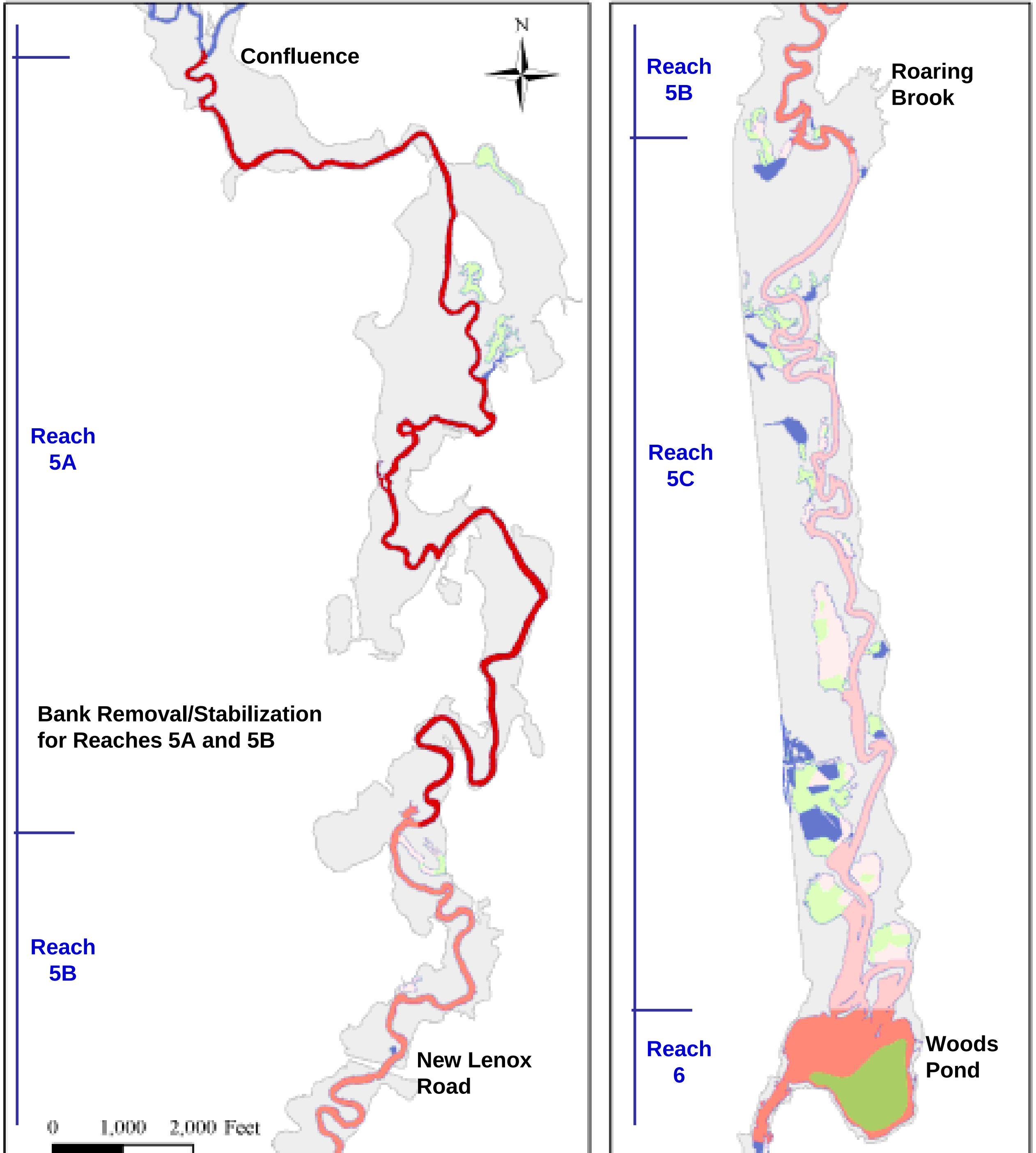
Removal/cap: 146 acres

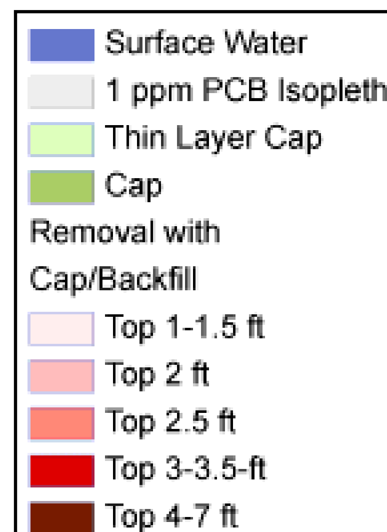
Removal/backfill: 69 acres

Thin-layer cap: 65 acres

Cap: 45 acres

Duration: 25 years





Reach 7 Impoundments and Reach 8

SED 7

Volume: 793,000 cy

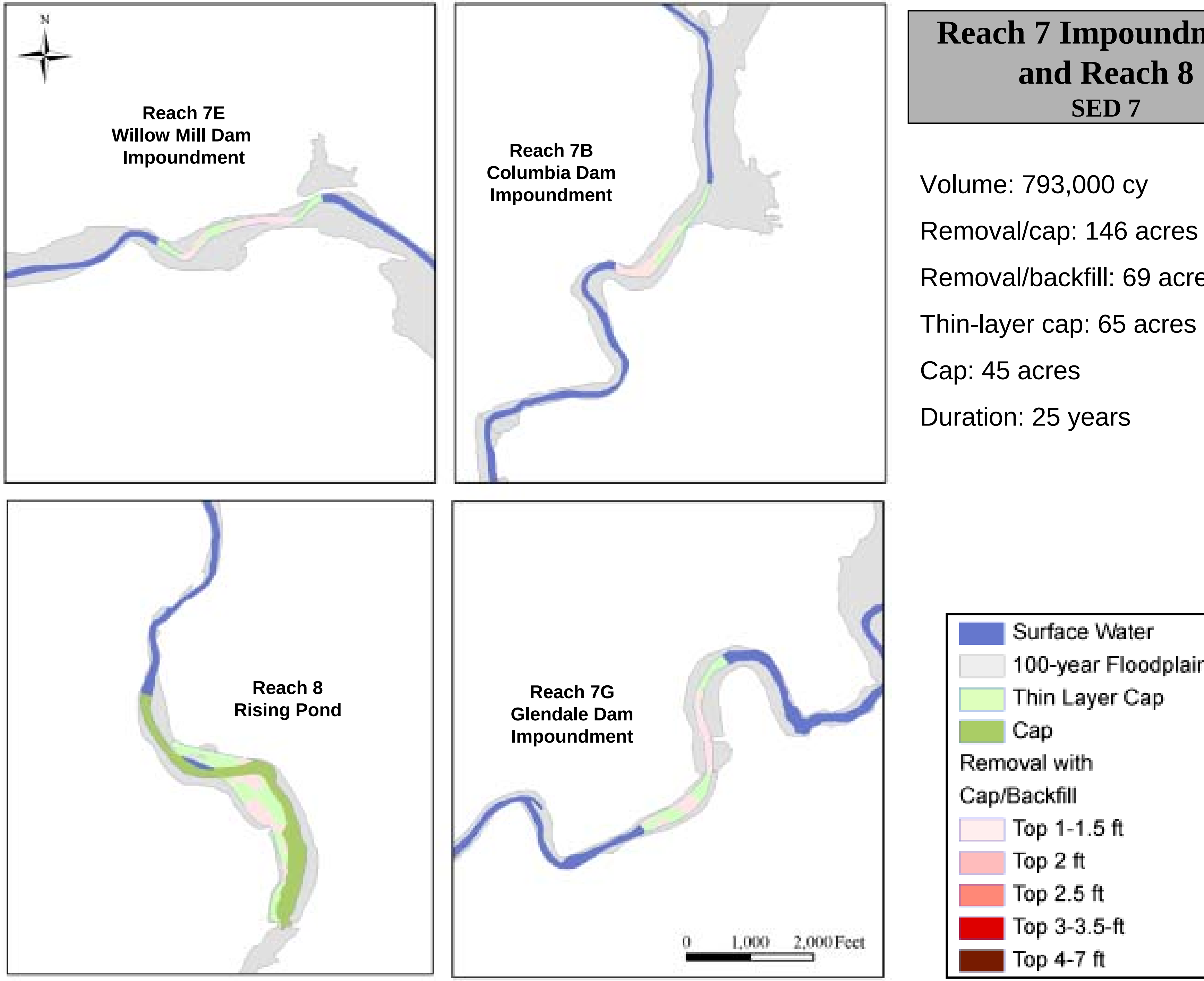
Removal/cap: 146 acres

Removal/backfill: 69 acres

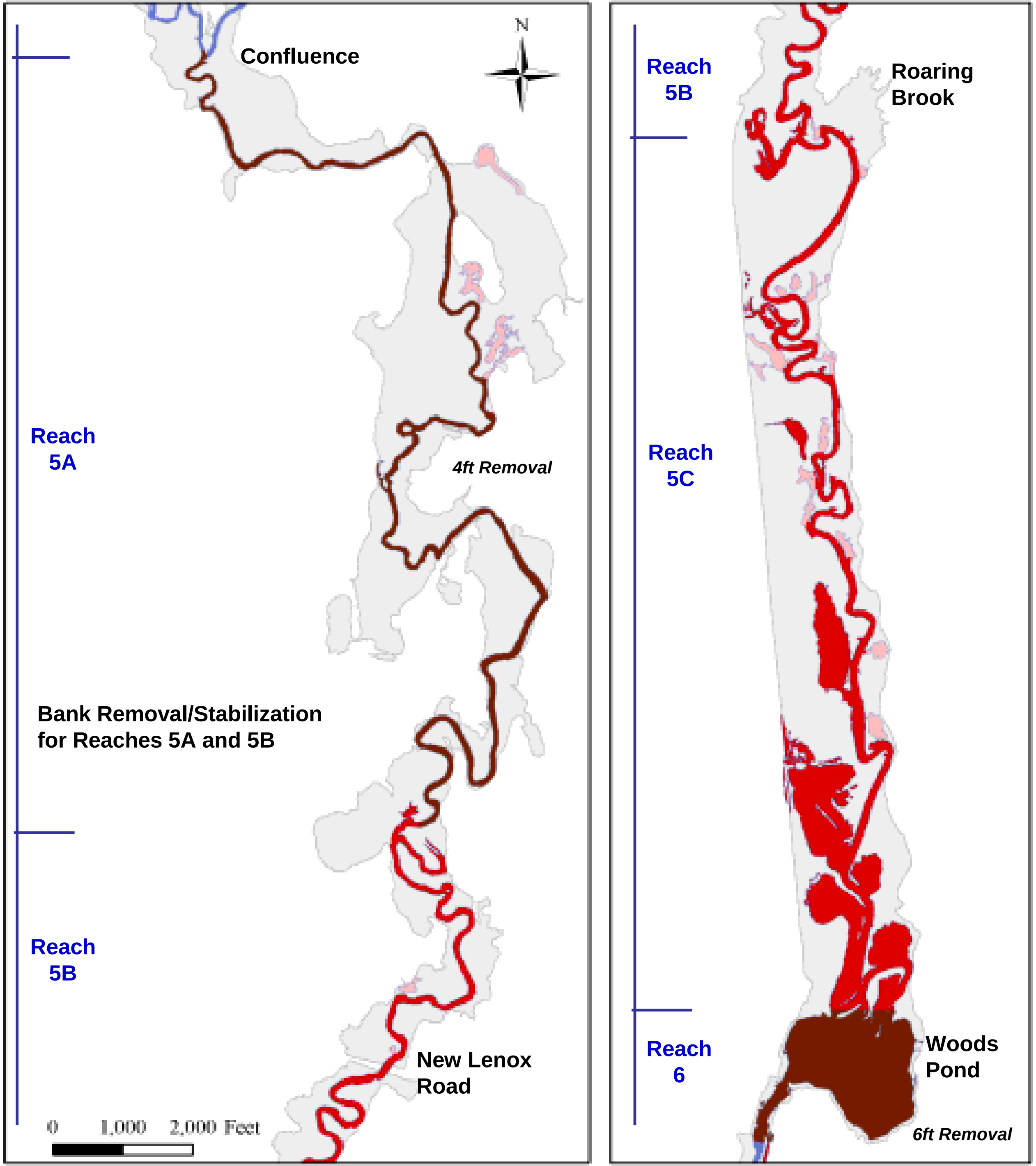
Thin-layer cap: 65 acres

Cap: 45 acres

Duration: 25 years



Reaches 5 and 6
SED 8



Volume: 2,250,000 cy

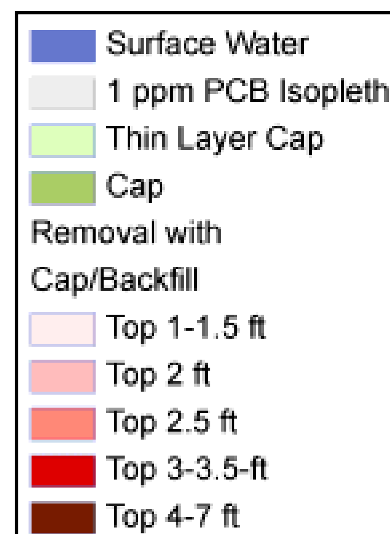
Removal/cap: 0 acres

Removal/backfill: 340 acres

Thin-layer cap: 0 acres

Cap: 0 acres

Duration: 51 years



Reach 7 Impoundments and Reach 8
SED 8

Volume: 2,250,000 cy

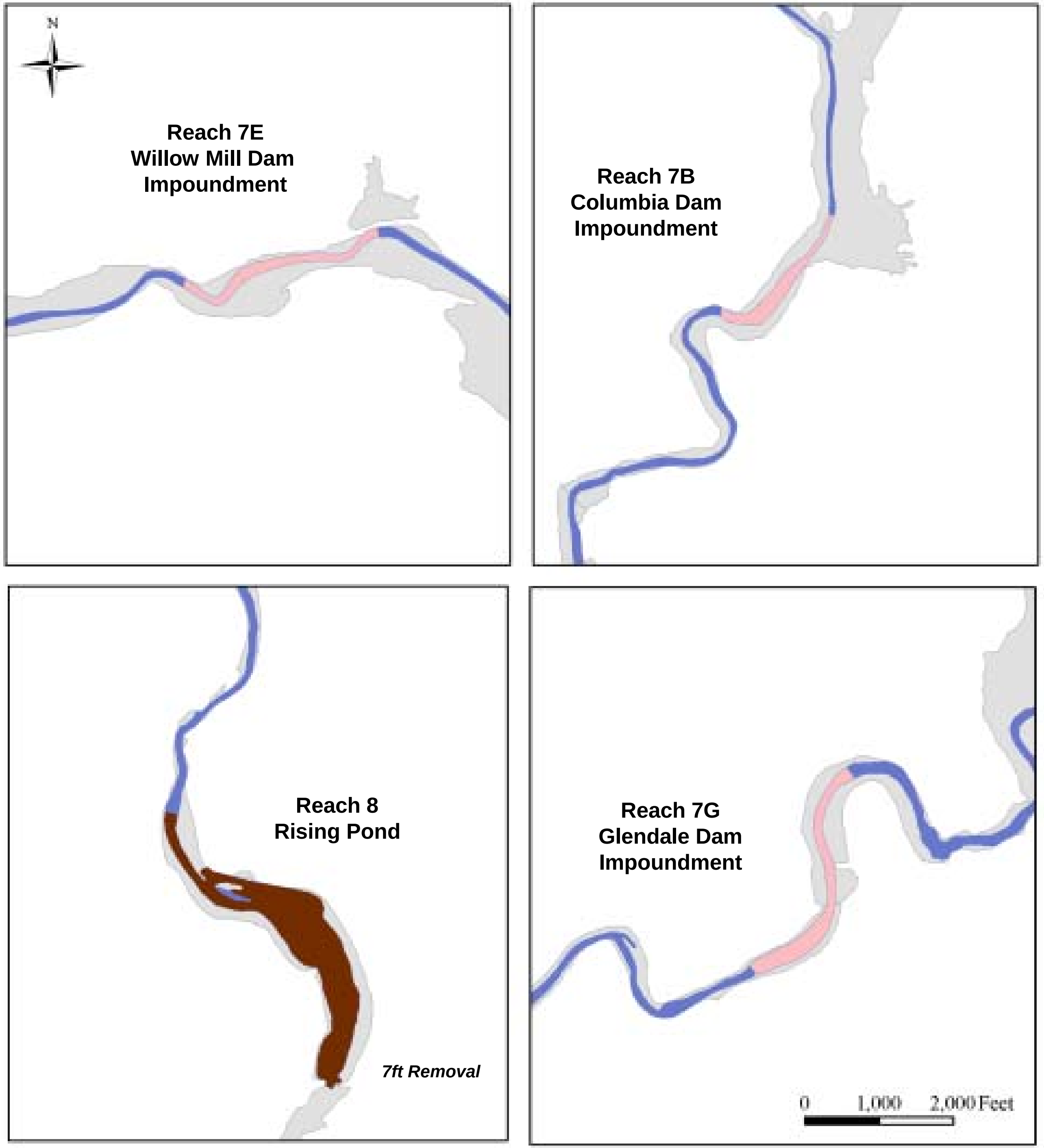
Removal/cap: 0 acres

Removal/backfill: 340 acres

Thin-layer cap: 0 acres

Cap: 0 acres

Duration: 51 years



- Surface Water
- 100-year Floodplain
- Thin Layer Cap
- Cap

Removal with Cap/Backfill

- Top 1-1.5 ft
- Top 2 ft
- Top 2.5 ft
- Top 3-3.5-ft
- Top 4-7 ft

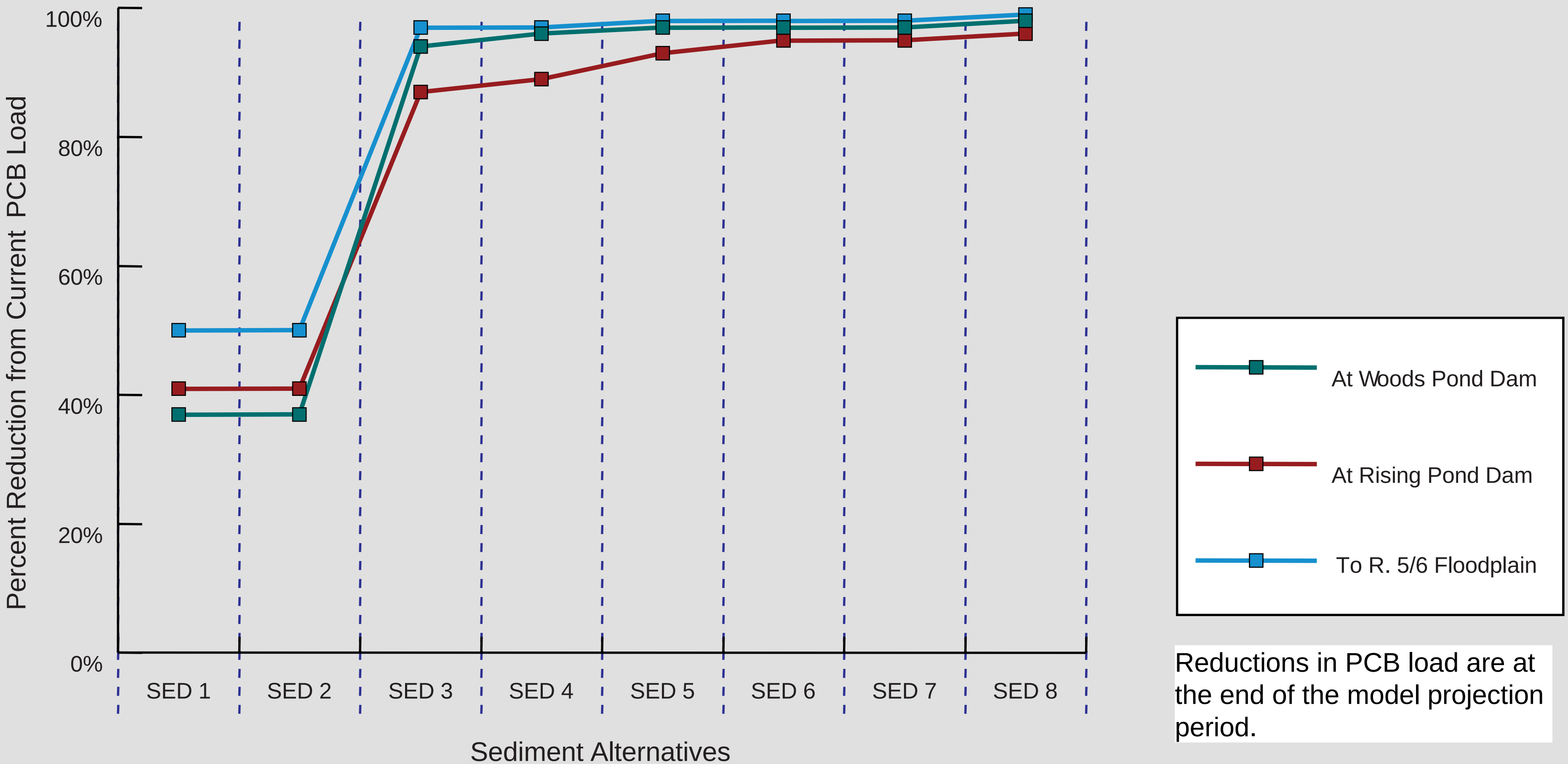
EVALUATION CRITERIA FOR ALTERNATIVES UNDER PERMIT

- General Standards
  1. Overall Protection of Human Health and the Environment, taking into account EPA's risk assessments.
  2. Control of Sources of Releases.
  3. Compliance with Federal and State ARARs (or basis for ARAR waiver).
- Selection Decision Factors (balancing factors)
  1. Long-Term Reliability and Effectiveness – Magnitude of residual risk, adequacy and reliability of alternatives, and any potential long-term adverse impacts.
  2. Attainment of IMPGs – Ability of alternatives to achieve IMPGs.
  3. Reduction of Toxicity, Mobility, or Volume of Wastes.
  4. Short-Term Effectiveness – Impacts to nearby communities, workers, or environment during implementation.
  5. Implementability – Ability to implement the alternative and availability of services, materials, and necessary space.
  6. Cost.
- Use of these 9 criteria involves an evaluation of tradeoffs between the potential benefits and the damage to the environment and other factors for each alternative.

SEDIMENT: CONTROL OF SOURCES OF RELEASES

- Completed and ongoing source control and remediation upstream of the Confluence, along with natural recovery processes, have resulted in significant declines in PCB transport to Rest of River.
- In order to quantify the ability of each alternative to control sources of releases, EPA's model was used to simulate each sediment alternative.
- The model forecasts future PCB transport within the water column and from the river to the floodplain.

CONTROL OF SOURCES OF RELEASES



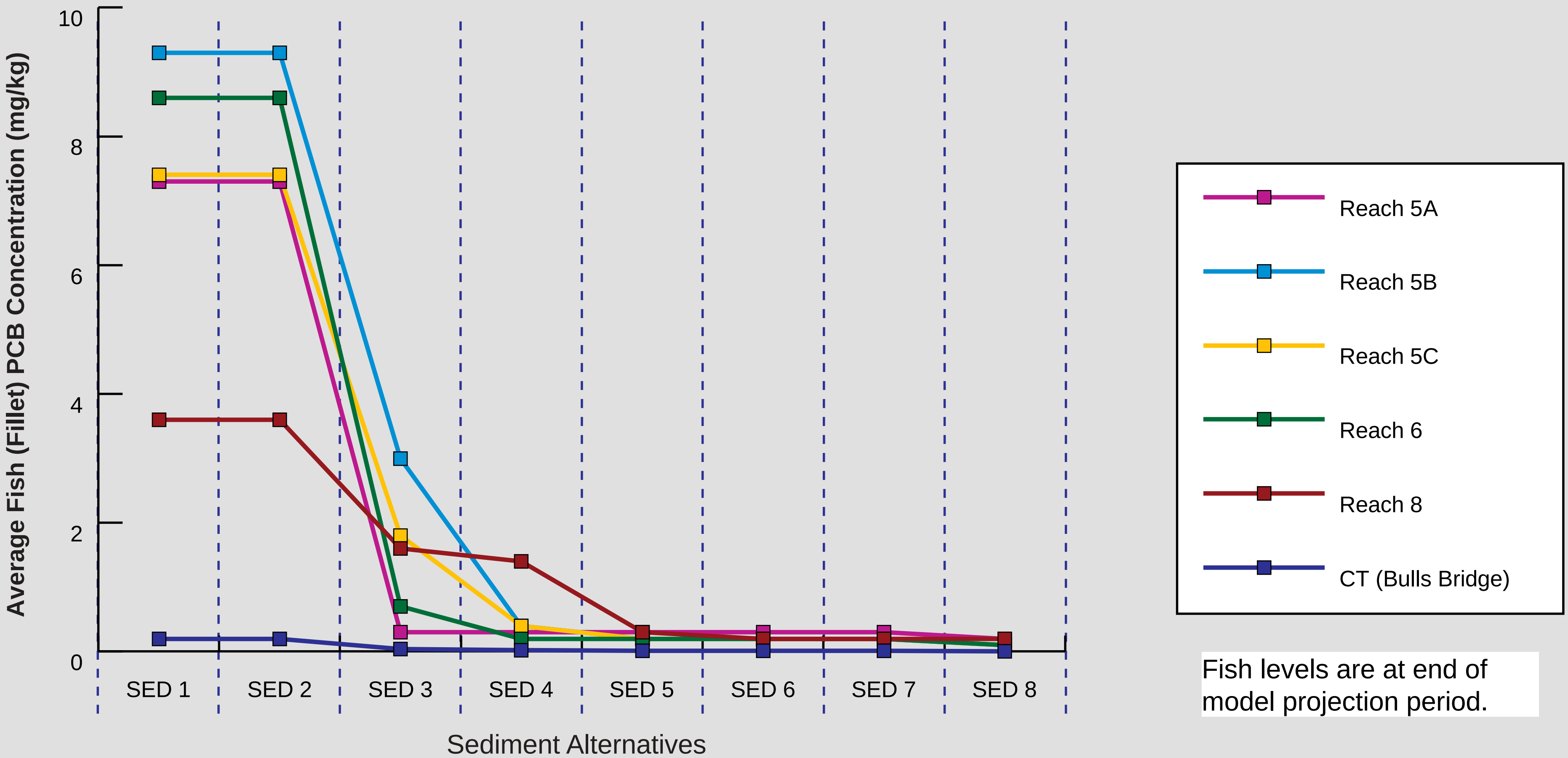
Reductions in PCB load are at the end of the model projection period.

- SED 1/2 achieves ~40% reduction in PCB transport.
- SED 3 achieves ~90% reduction in PCB transport.
- SEDs 4 – 8 only achieve small incremental reductions in longer timeframes.

LONG-TERM RELIABILITY AND EFFECTIVENESS

- The assessment of long-term reliability and effectiveness includes evaluation of:
  - Magnitude of residual risk.
  - Adequacy and reliability of the alternatives.
  - Potential long-term adverse impacts on human health and the environment.
- Magnitude of residual risk:
  - Source control and remediation at and near the GE Plant together with natural recovery processes have reduced PCB levels entering Rest of River.
  - EPA's model was used to predict the extent to which the sediment alternatives would further reduce PCBs in sediment, water, and fish.
  - For comparison purposes, fish are used because they integrate the effects of changes in surface sediment and water over time.

LONG-TERM RELIABILITY AND EFFECTIVENESS: MAGNITUDE OF RESIDUAL RISK



Fish levels are at end of model projection period.

- SED 1/SED 2 achieve 43-60% reduction in fish PCB levels from current levels.
- SED 3 achieves 99% reduction in Reach 5A and 70-95% in other reaches.
- SED 4 – SED 8 yield small incremental improvements.

LONG-TERM RELIABILITY AND EFFECTIVENESS: ADEQUACY AND RELIABILITY

Model Simulation of Caps, Backfill, and Thin-Layer Caps

- Alternatives SED 3 through SED 8 include use of caps, thin-layer caps, and/or backfill.
- EPA's model was used to assess the long-term stability of these materials.
- The model was run for 50+ years which represented numerous high flow events (including one extreme event) to assess:
  - Changes in bed surface elevation due to deposition and/or erosion.
  - Changes in PCB concentrations within the materials and underlying sediments.

LONG-TERM RELIABILITY AND EFFECTIVENESS: ADEQUACY AND RELIABILITY

- The model results indicate that caps, thin-layer caps, and backfill would generally be stable and effective in all alternatives:

Reach		% Area Eroded			Increase in Surface PCBs due to Erosion (mg/kg)	Overall % Reduction in Surface PCB Levels
		Cap	Thin-Layer Cap	Backfill		
Reach 5 Channel		0%	≤ 6%	≤ 2%	≤ 0.5	90 - 99%
Reach 5 Backwaters		0%	≤ 1%	0%	≤ 0.2	97 - 99%
Woods Pond		0%	≤ 5%	0%	≤ 1.0	96 - 99%
Reach 7 Impoundments	Columbia Mill	0%	≤ 46%	0%	≤ 0.5	50 - 60%
	Willow Mill	0%	≤ 25%	17%	≤ 0.3	70 - 85%
	Glendale	0%	≤ 11%	4%	≤ 1.5	80 - 90%
Rising Pond		0%	≤ 7%	0%	≤ 0.4	91 - 99%

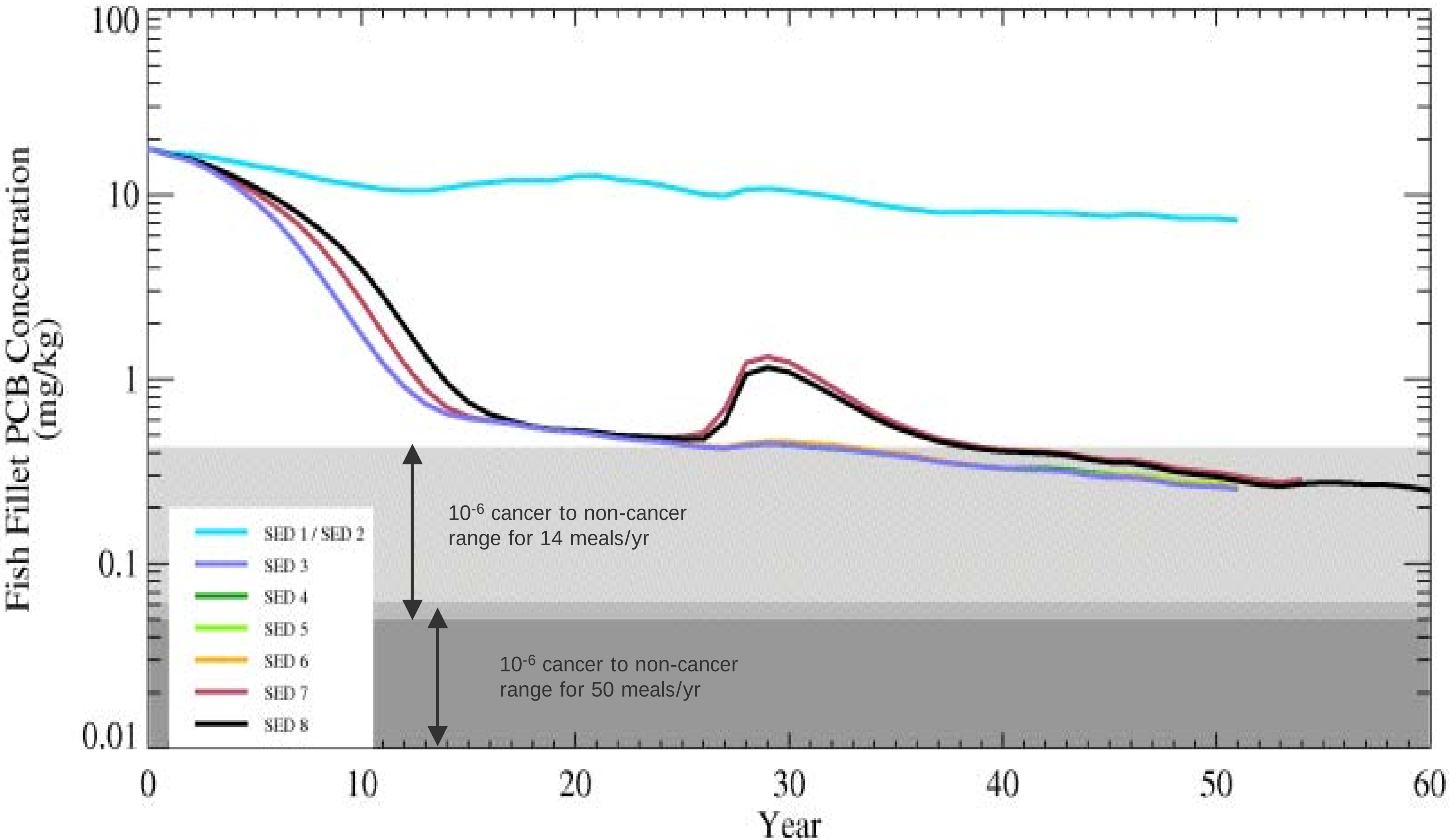
LONG-TERM RELIABILITY AND EFFECTIVENESS: POTENTIAL LONG-TERM ADVERSE IMPACTS ON ENVIRONMENT

- All of the alternatives involving removal or capping could produce some long-term adverse impacts to ecological habitats:
  - Installation of a thin-layer cap or a cap without prior removal could have impacts where the water is shallow.
    - The vegetative characteristics of the riverine wetlands in these areas could be modified through the decrease in the water depth.
  - Bank stabilization activities could impact habitats near the edge of the river.
  - Implementation of a sediment alternative could impact floodplain biota and their habitat through the construction of staging areas and access roads. These activities would also likely impact the aesthetics of the floodplain due to the removal of mature trees and the time required for replanted trees to mature.
    - The total floodplain acreage estimated to be impacted through the implementation of SED 3 – SED 8 varies from 90 to 118 acres.

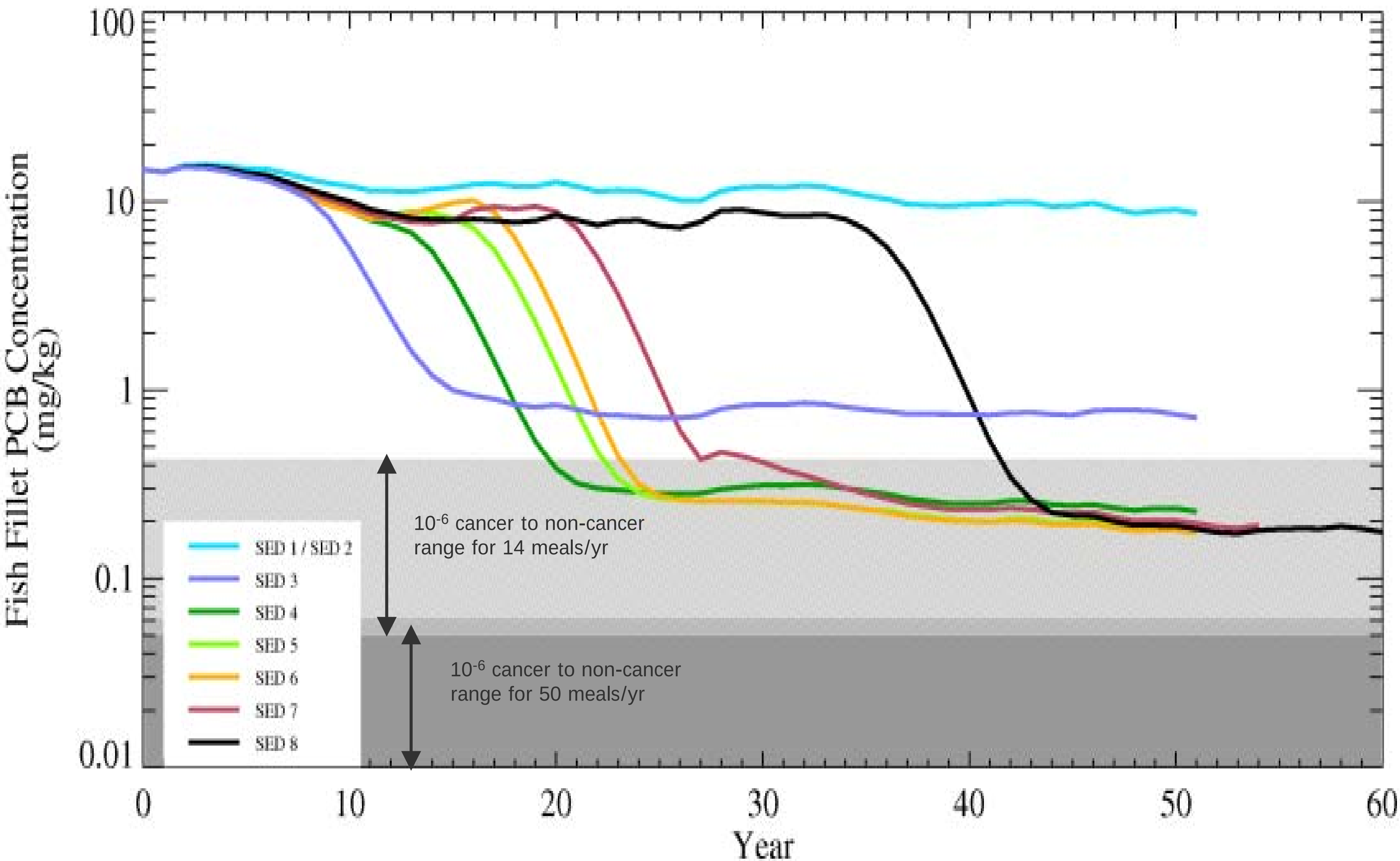
ATTAINMENT OF IMPGs

- IMPGs developed for:
  - Human direct contact with sediment.
  - Human consumption of fish.
  - Various ecological receptors.
- Evaluation of attainment of IMPGs involves comparing those goals to the average sediment and fish PCB concentrations for each alternative as predicted by EPA's model (or by the CT 1-D Analysis).
  - This comparison focuses on the number of EPA averaging areas with predicted PCB levels that either achieve the IMPG or are in the range of IMPGs.
- All of the sediment alternatives would achieve the IMPGs for direct contact with sediments in all areas.

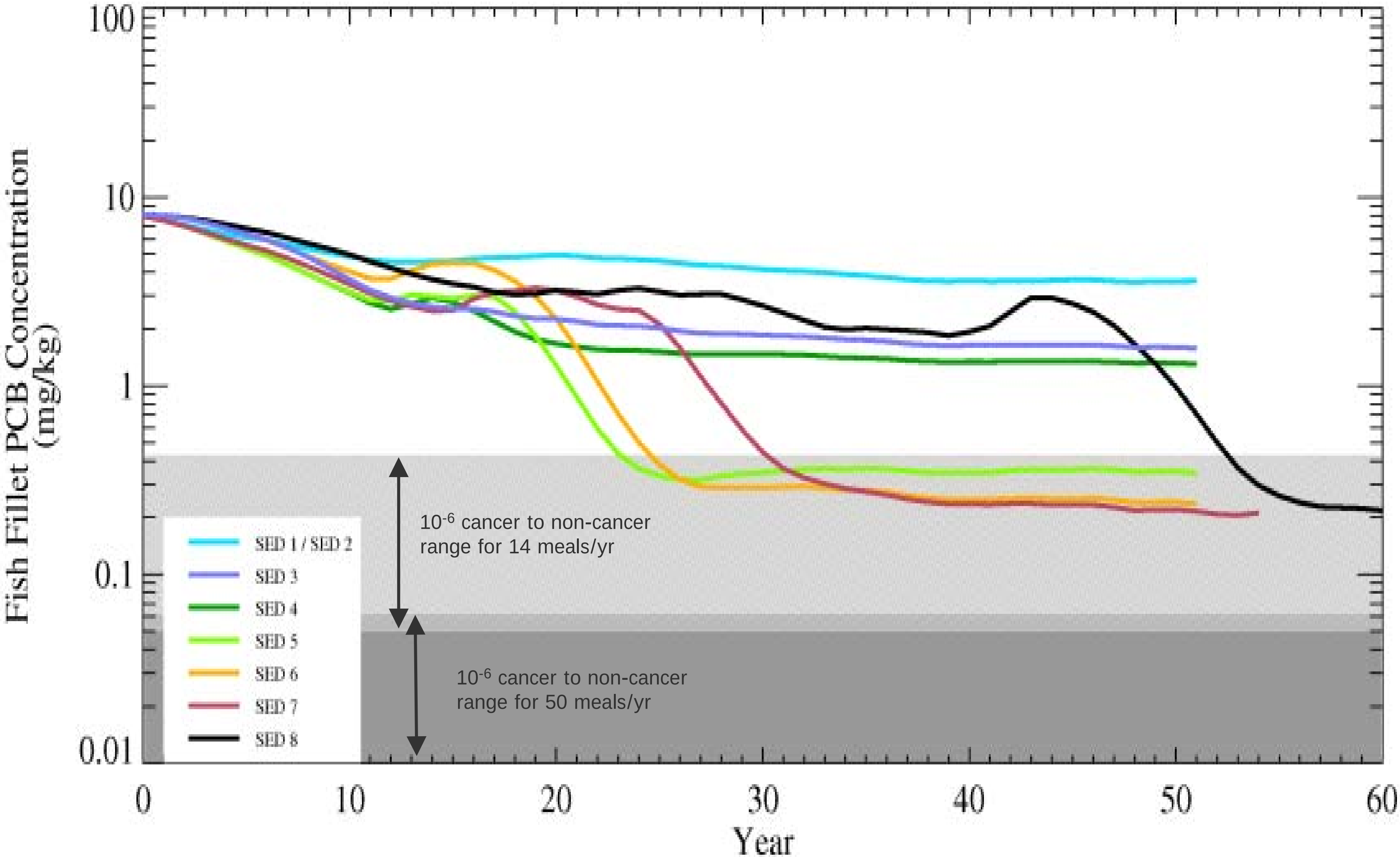
REACH 5A: PREDICTED ATTAINMENT OF EPA FISH CONSUMPTION IMPGs



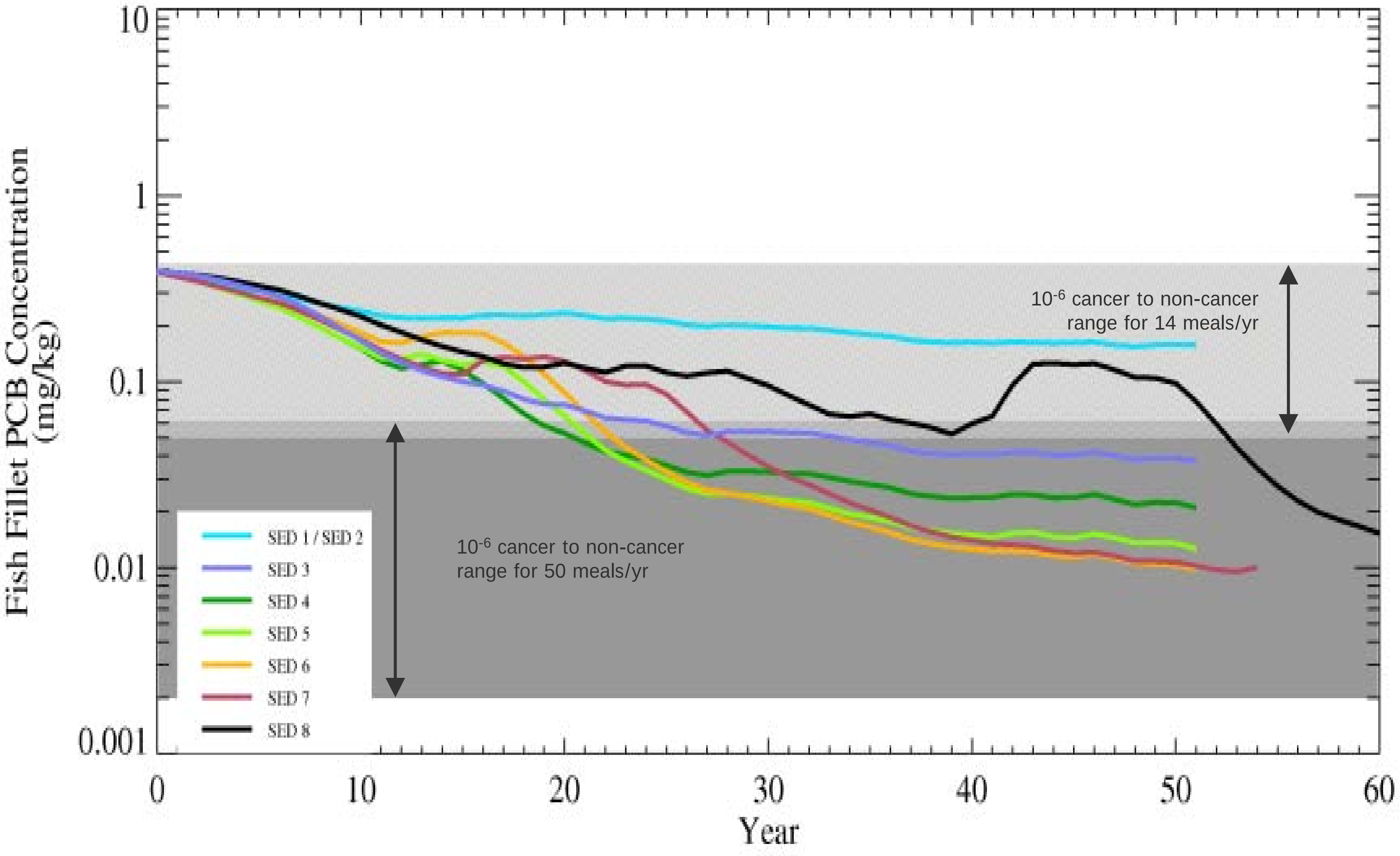
WOODS POND: PREDICTED ATTAINMENT OF EPA FISH CONSUMPTION IMPGs



RISING POND: PREDICTED ATTAINMENT OF EPA FISH CONSUMPTION IMPGs



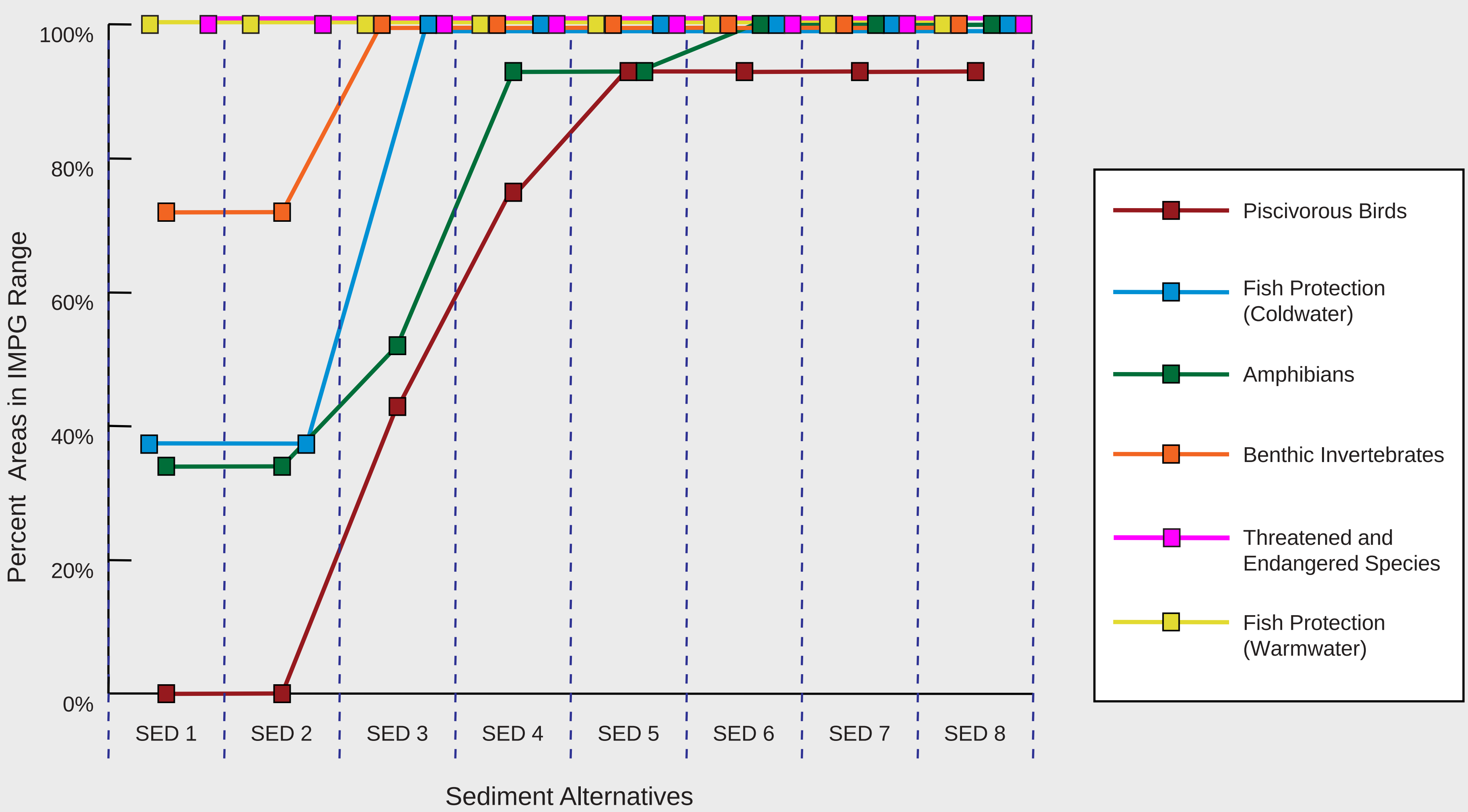
BULLS BRIDGE DAM IMPOUNDMENT:
ESTIMATED ATTAINMENT OF EPA FISH CONSUMPTION IMPGs



IMPACTS OF SEDIMENT REMOVAL ON HUMAN FISH CONSUMPTION

- Model results indicate that no sediment alternative would achieve the fish PCB levels that EPA considers protective for unrestricted fish consumption (50 meals/year) by humans in the MA reaches of the River.
  - Thus, fish consumption advisories will be needed in MA for the foreseeable future.
- SEDs 3-8 would achieve levels that EPA considers protective for limited fish consumption (14 meals/year) in some MA reaches. The number of reaches increases from SED 3 – SED 8.
- In CT, extrapolation from EPA's model indicates that SEDs 3-8 would achieve unrestricted fish consumption levels within the model period (or shortly thereafter). These extrapolations are uncertain.

IMPG ATTAINMENT FOR KEY ECOLOGICAL RECEPTORS



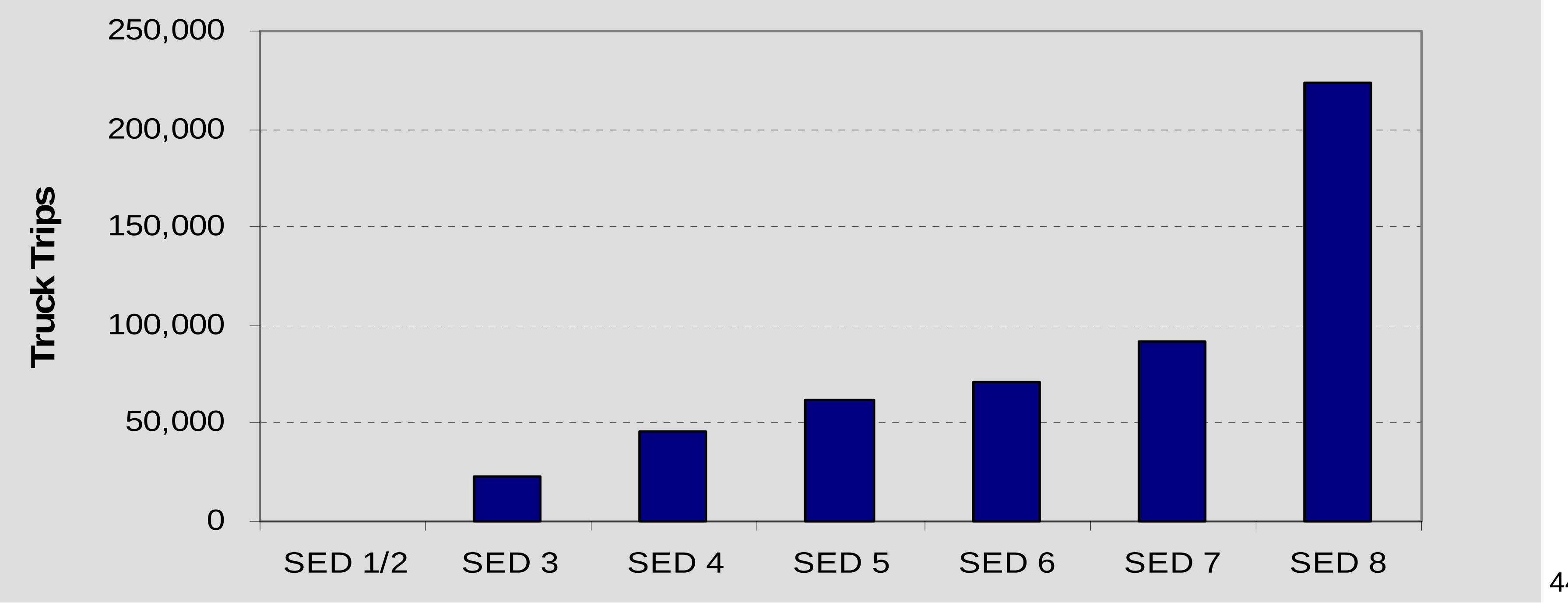
Note: IMPG attainment for insectivorous birds and mink depends on combination of sediment and floodplain soil PCB levels.

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

- **Reduction of toxicity**: The alternatives do not include treatment processes that would directly reduce the toxicity of PCBs in sediment.
- **Reduction of mobility**:
  - For SED 1 and SED 2, reduction in mobility would be achieved through upstream source control and remediation as well as naturally occurring processes.
  - For SED 3 – SED 8, further reduction would be achieved through removal, capping, backfilling, thin-layer capping, and/or bank stabilization activities.
  - SED 3 would achieve the largest incremental reduction with smaller additional reductions achieved by SED 4 – SED 8.
- **Reduction in volume**: SED 3 – SED 8 would reduce the volume of PCB-containing sediment and bank soil through the permanent removal of the material.

SHORT-TERM EFFECTIVENESS

- Short-term impacts on the environment:
  - Potential impacts to the water column, air and biota. Impacts to benthic habitat.
  - Loss of mature trees and other vegetation within riparian habitat.
  - Loss of floodplain habitat and disruption to biota from construction of support areas.
  - Impacts increase from SED 3 – SED 8.
- Short-term impacts on local communities:
  - Disruption to recreational uses of River, riverbanks, and portions of floodplain.
  - Increased noise and truck traffic. Number of truck trips to import backfill:



OVERALL PROTECTION OF HUMAN HEALTH AND ENVIRONMENT

The predicted benefits of each alternative differ in several key areas:

- PCB transport reduction:
  - SED 3 achieves ~94% annual PCB load reduction at Woods Pond Dam and 87% at Rising Pond Dam.
  - SED 4 – SED 8 show small incremental improvement over SED 3.
- Fish PCB level reduction:
  - SED 3 achieves 72 – 99% reduction in fish PCB levels.
  - SED 4 – SED 8 only achieve incrementally more reduction for higher cost.
- All alternatives achieve protective levels for direct human contact with sediments.
- Fish consumption risk:
  - Model results indicate that no alternative would achieve EPA levels for unrestricted fish consumption (50 meals/year) by humans in the MA reaches.
  - SEDs 3-8 would achieve levels that EPA considers protective for limited fish consumption (14 meals/year) in some reaches in MA.
  - Under all alternatives, fish consumption advisories will need to be continued for foreseeable future to provide protection of human health.

OVERALL PROTECTION OF HUMAN HEALTH AND ENVIRONMENT

- Ecological IMPG attainment:
  - Benthic invertebrates, threatened and endangered species, and warm and cold water fish protection are all in IMPG range for SED 3 – SED 8.
  - Piscivorous birds and amphibians are in IMPG range in ~40-50% of areas for SED 3 and ~80-100% of areas for SED 4 – SED 8.
- Time to achieve benefits of remediation:
  - Significant variations exist in the time that it takes for the predicted benefits to occur.
  - Variation is small in Reach 5A since it is near the start of Rest of River.
  - In Woods Pond, SED 3 achieves the benefits in ~15 yrs, while SED 8 takes ~45 yrs.

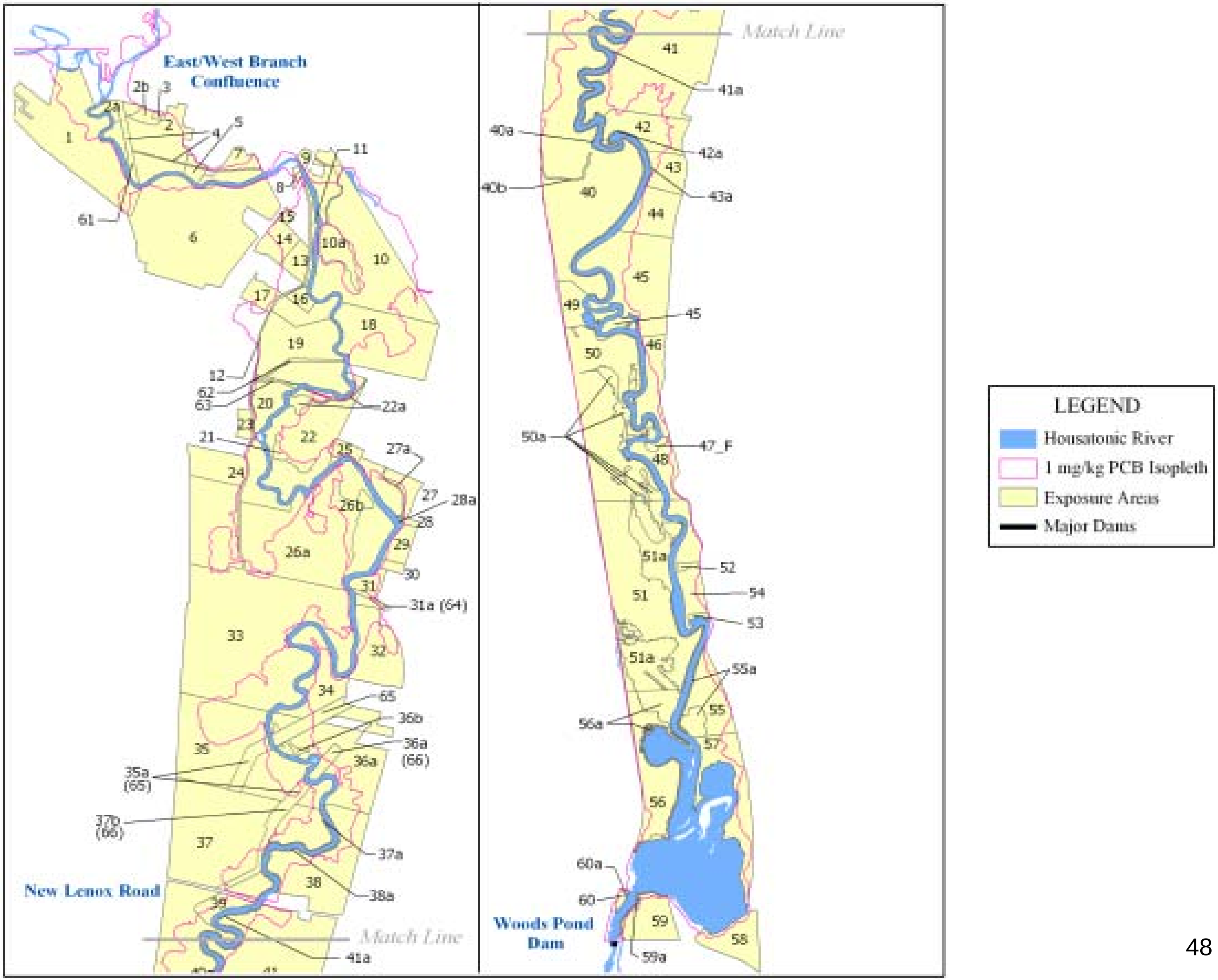
CONCLUSION

- GE believes that SED 3 – SED 8 all achieve the General Standards of the Permit.
- GE has concluded that, among these alternatives, based on a consideration and balancing of the Selection Decision Factors, SED 3 is “best suited” to meet the General Standards.
  - Large reduction in PCB transport in River and PCB concentrations in fish.
  - Fewest adverse impacts on environment and least disruption of local communities.
  - Fewest complications in implementation.
  - Most cost-effective.

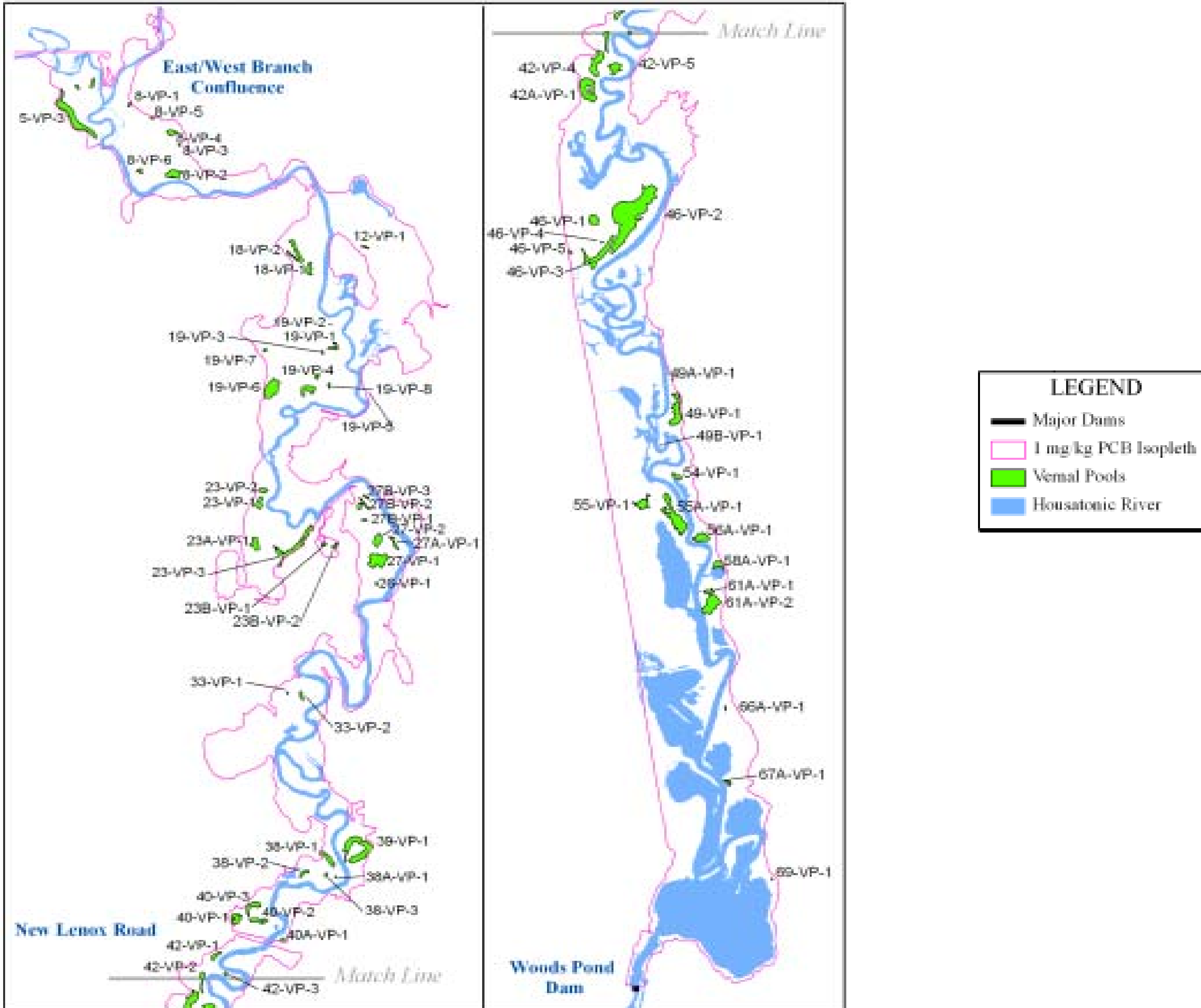
DEVELOPMENT OF FLOODPLAIN SOIL ALTERNATIVES

- 7 floodplain soil alternatives proposed for detailed evaluation ranging from no action to extensive removal :
  - No action.
  - 4 IMPG-based alternatives.
  - 2 threshold-based alternatives.
- Floodplain areas to be evaluated consistent with EPA's HHRA and ERA:
  - 120 exposure areas for human health.
  - Farm areas.
  - Ecological habitat areas (some overlap with above areas).
- Alternatives first consider human health IMPGs.
- Alternatives then consider need/extent of additional remediation based on ecological IMPGs:
  - Separate evaluations for amphibians (wood frogs), omnivorous/carnivorous mammals (shrews), piscivorous mammals (mink) and insectivorous birds (wood ducks).

HUMAN HEALTH EXPOSURE AREAS FROM EPA'S RISK ASSESSMENT



VERNAL POOL MAPPING FROM EPA'S RISK ASSESSMENT

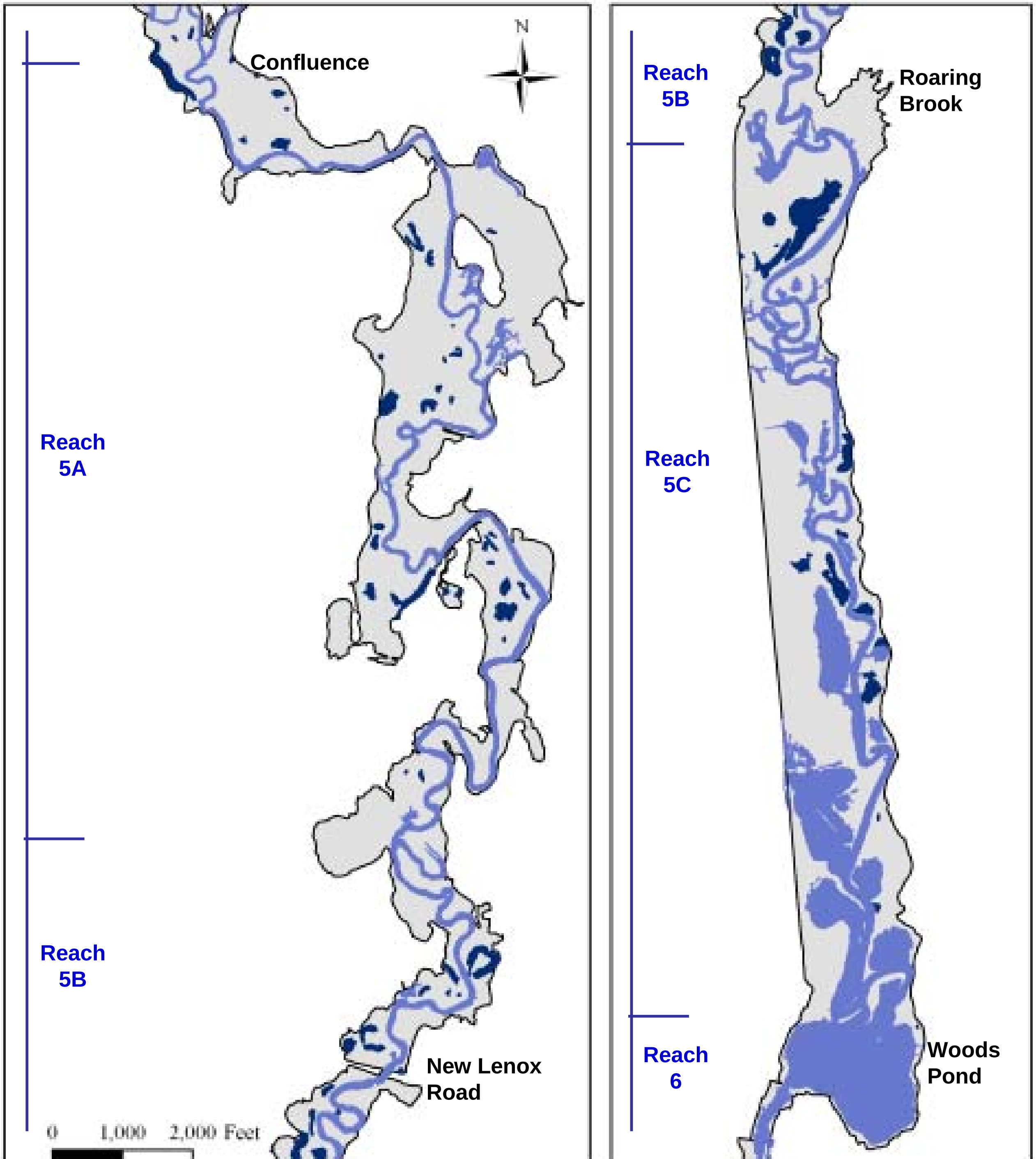


SUMMARY OF FLOODLAIN SOIL ALTERNATIVES

	FP 1	FP 2	FP 3	FP 4	FP 5	FP 6	FP 7
Removal Volume (cy)	0	17,000	60,000	99,000	100,000	316,000	570,000
Removal Area (acres)	0	11	38	62	60	194	350
Years to Implement	0	1	3	4	4	13	22

Note: Time to implement a floodplain soil alternative will likely be influenced by the associated sediment alternative duration.

Reaches 5 and 6
FP 1



Human health: no action.

Eco: no action.

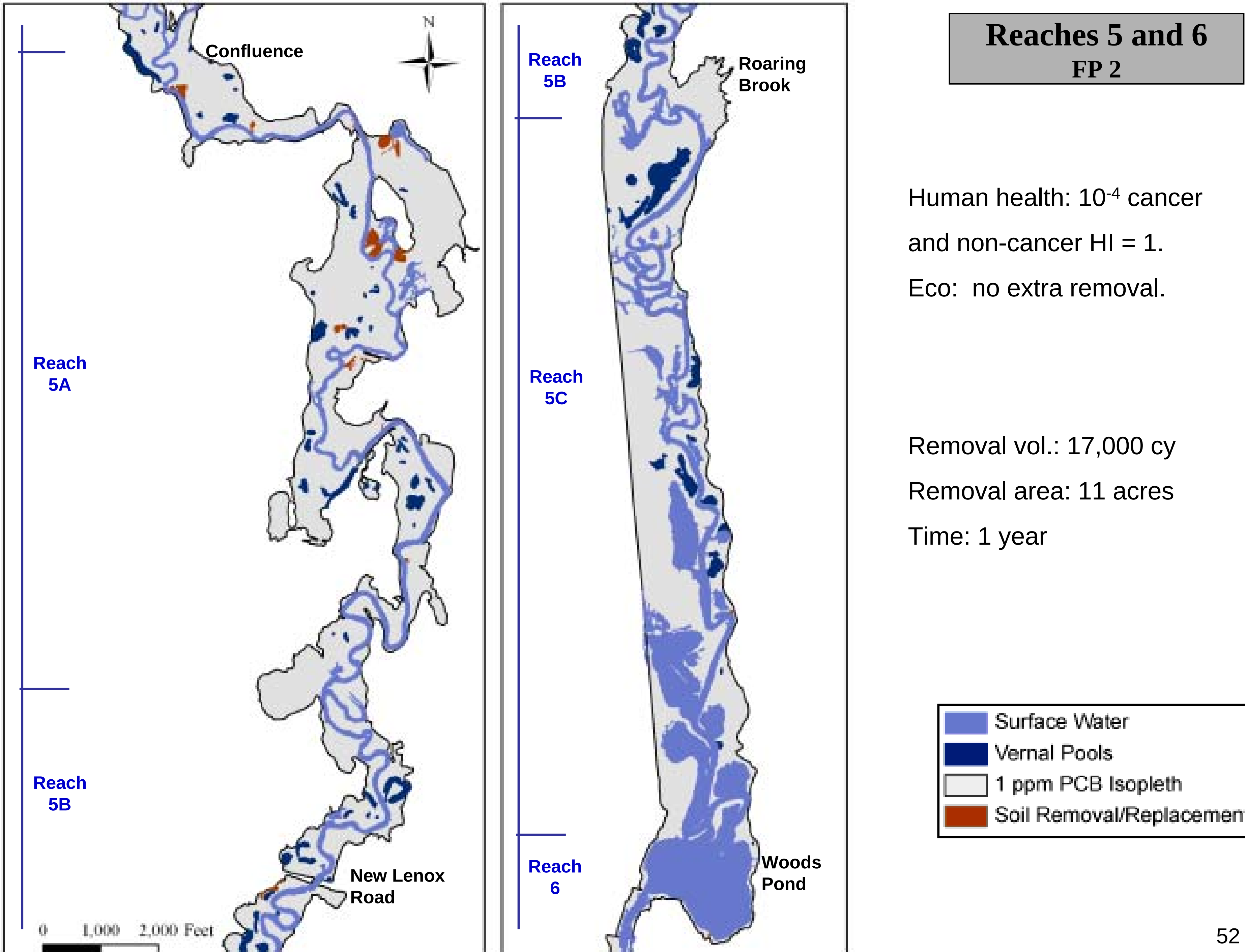
Removal vol.: 0 cy

Removal area: 0 acres

Time: 0 years

- Surface Water
- Vernal Pools
- 1 ppm PCB Isopleth
- Soil Removal/Replacement

Reaches 5 and 6
FP 2



Human health: 10^{-4} cancer and non-cancer HI = 1.

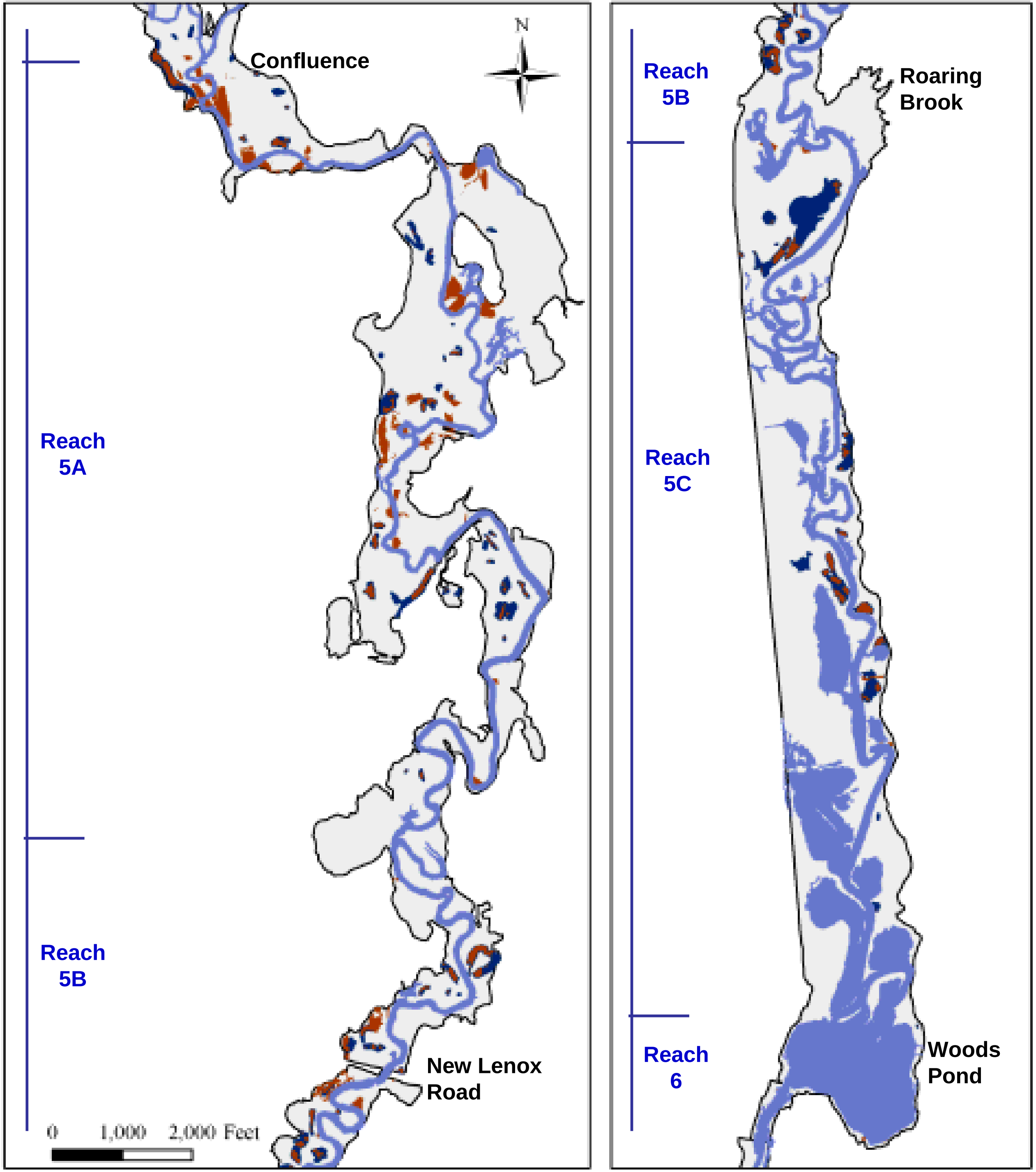
Eco: no extra removal.

Removal vol.: 17,000 cy

Removal area: 11 acres

Time: 1 year

Reaches 5 and 6
FP 3



Human health: 10^{-4} cancer (10^{-5} in frequent-use and farm areas) and non-cancer HI = 1.

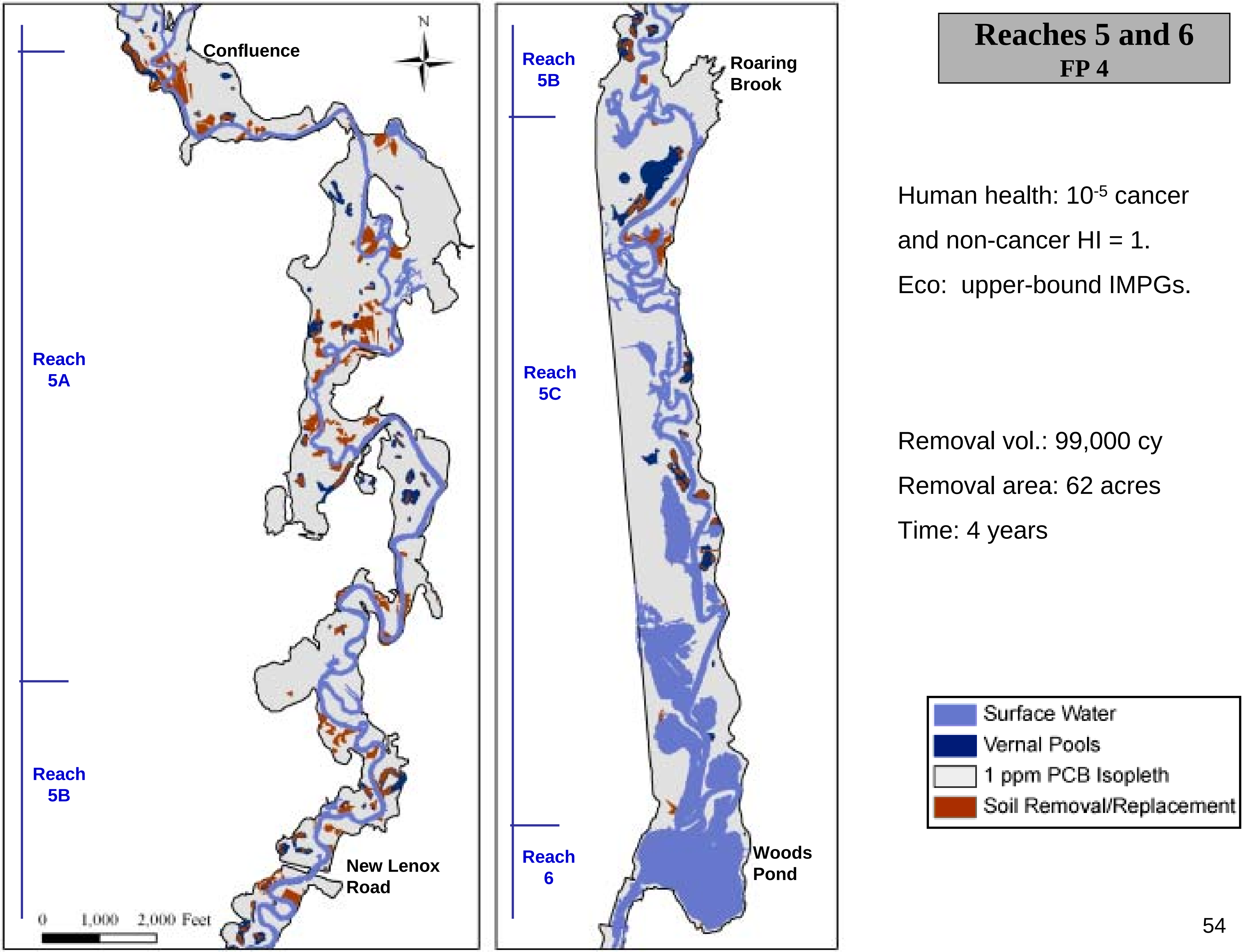
Eco: upper-bound IMPGs.

Removal vol.: 60,000 cy

Removal area: 38 acres

Time: 3 years

Reaches 5 and 6
FP 4



Human health: 10^{-5} cancer

and non-cancer HI = 1.

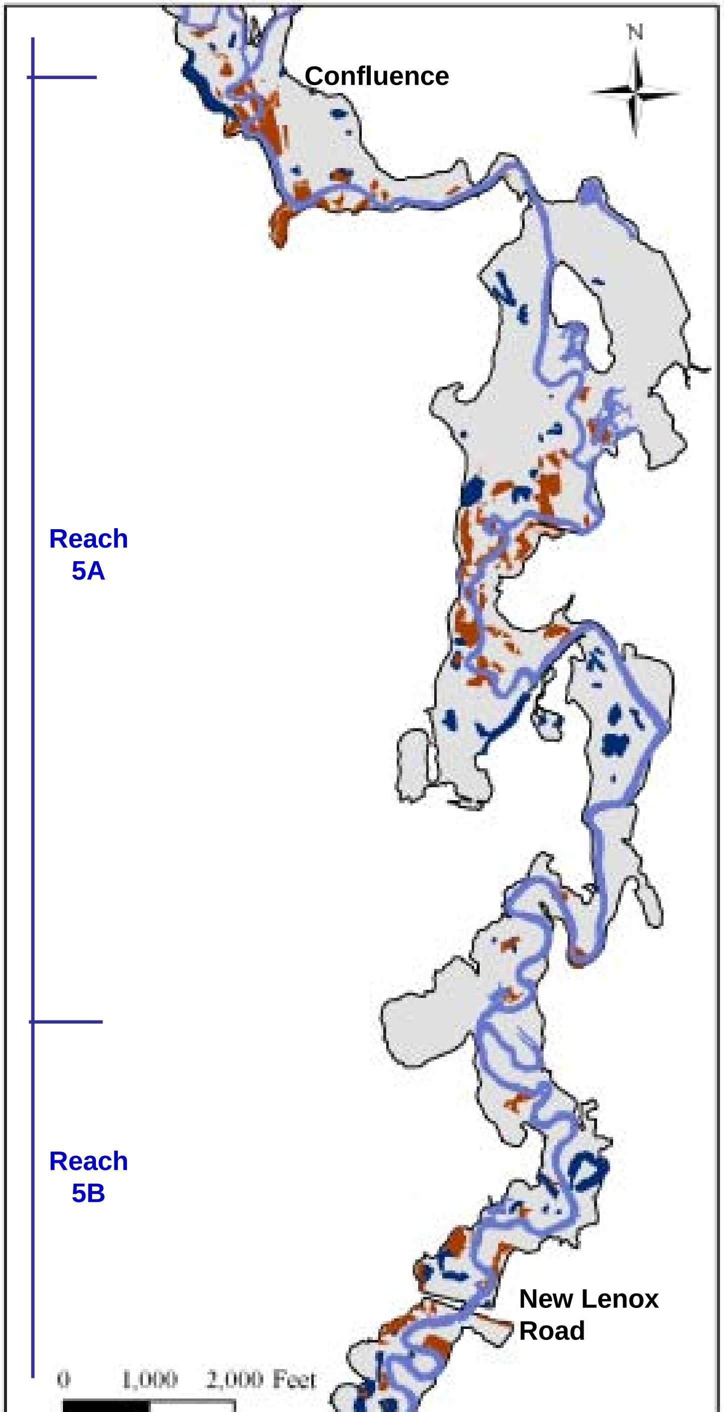
Eco: upper-bound IMPGs.

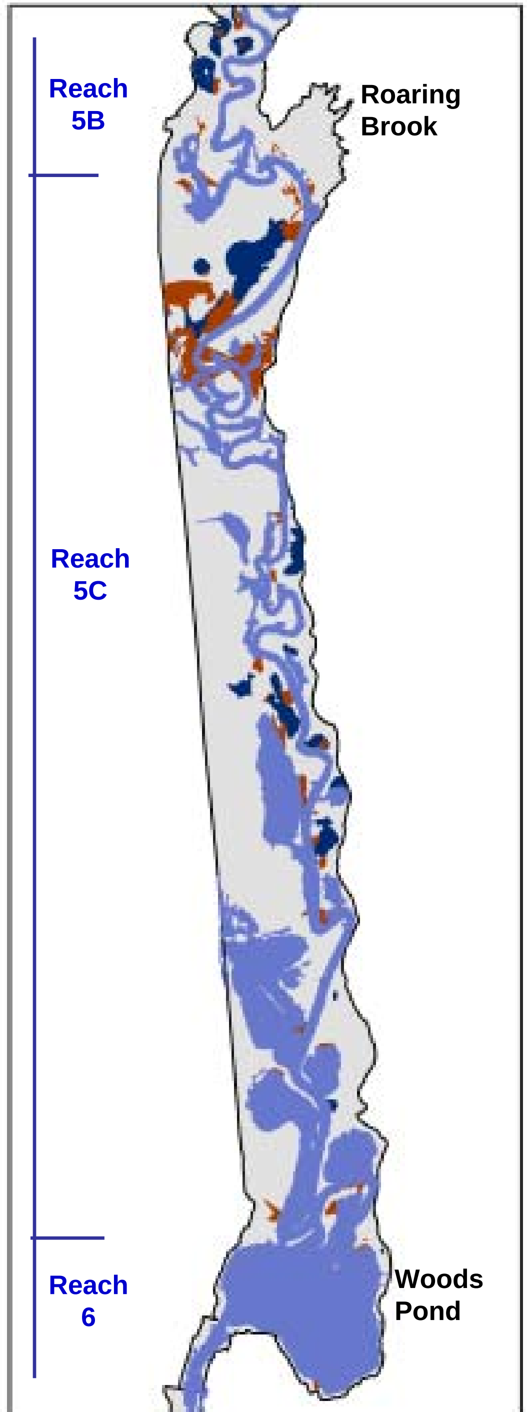
Removal vol.: 99,000 cy

Removal area: 62 acres

Time: 4 years

Reaches 5 and 6
FP 5





Removal/backfill

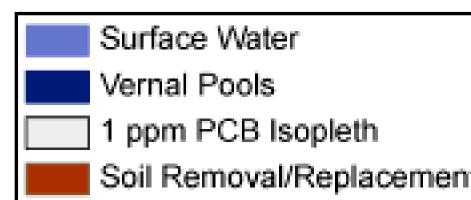
of soils > 50 ppm PCBs

in top foot.

Removal vol.: 100,000 cy

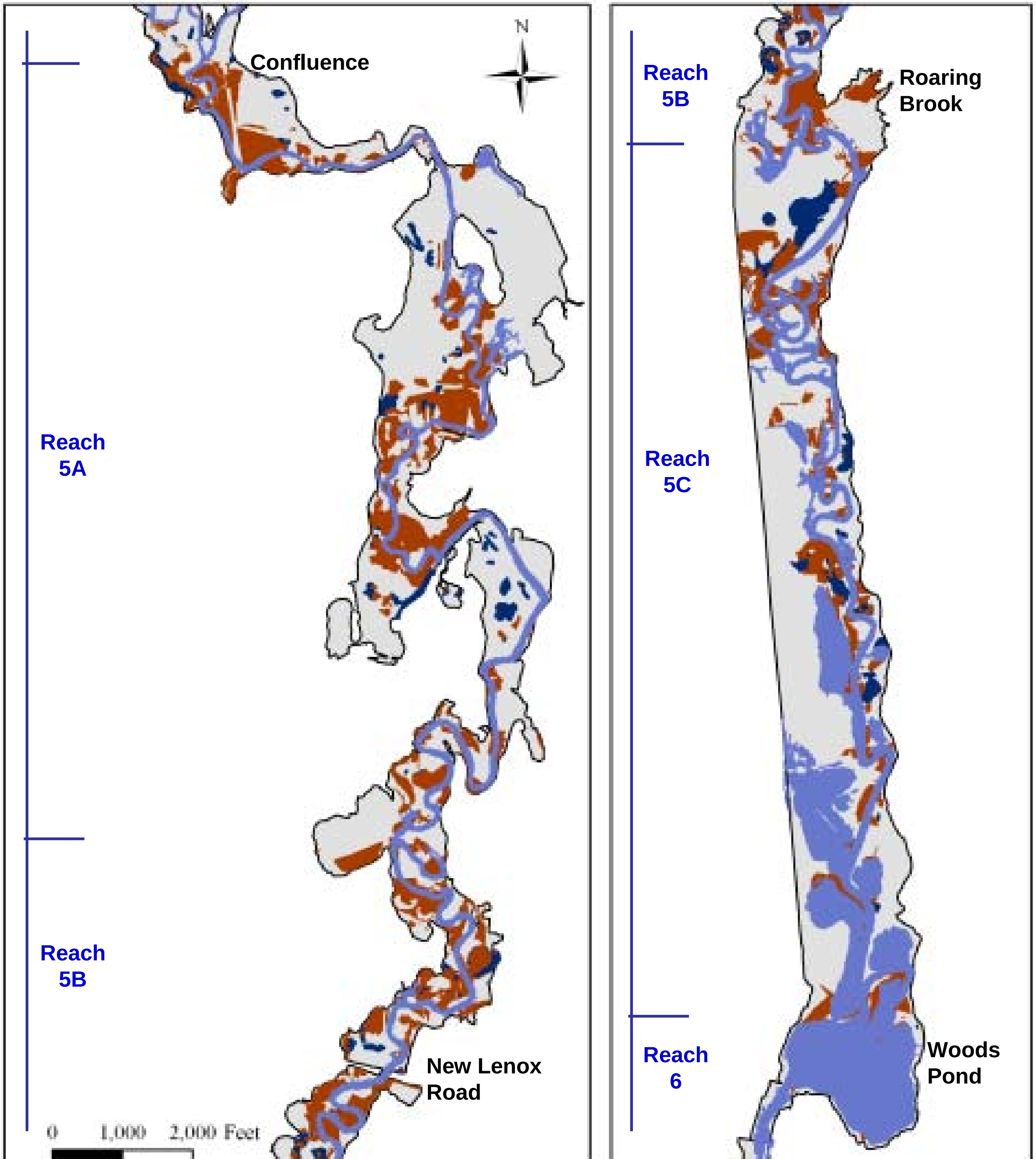
Removal area: 62 acres

Time: 4 years



Reaches 5 and 6

FP 6



Removal/backfill

of soils > 25 ppm PCBs

in top foot.

Removal vol.: 316,000 cy

Removal area: 194 acres

Time: 13 years

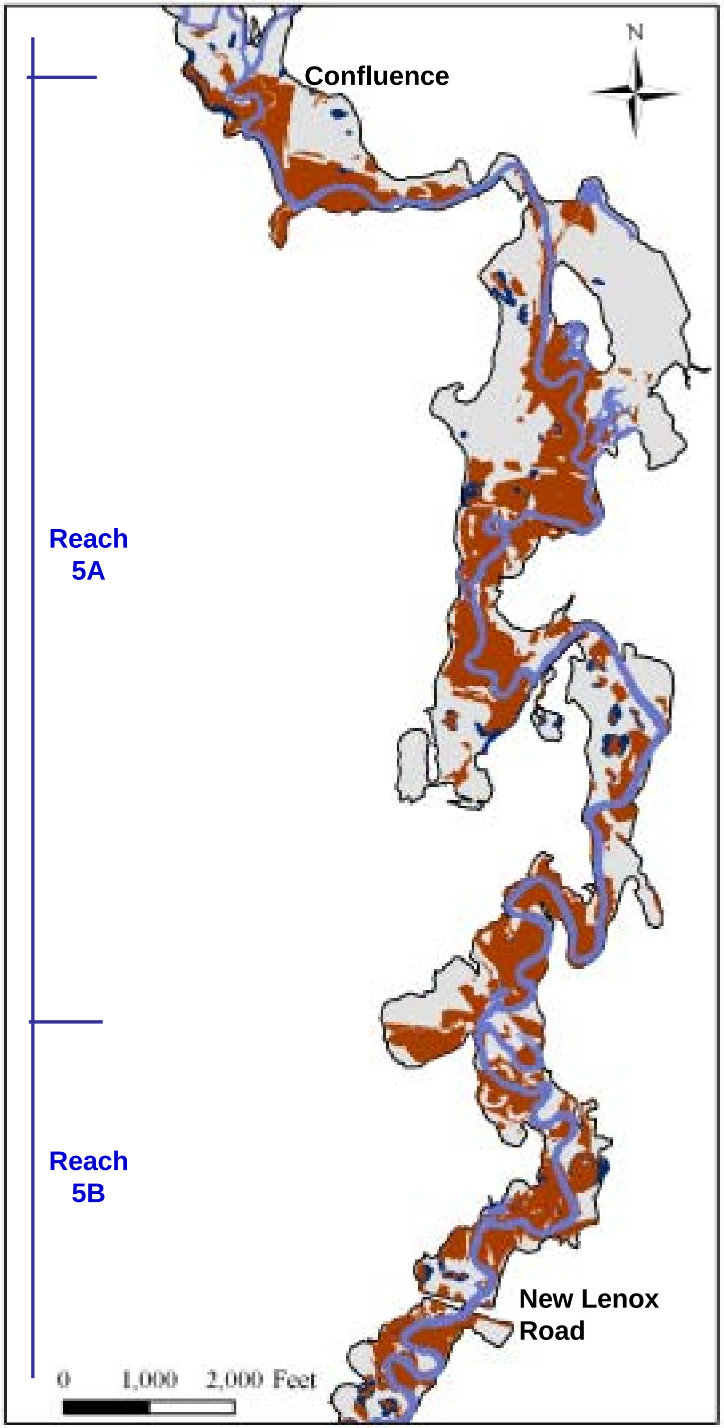
Surface Water

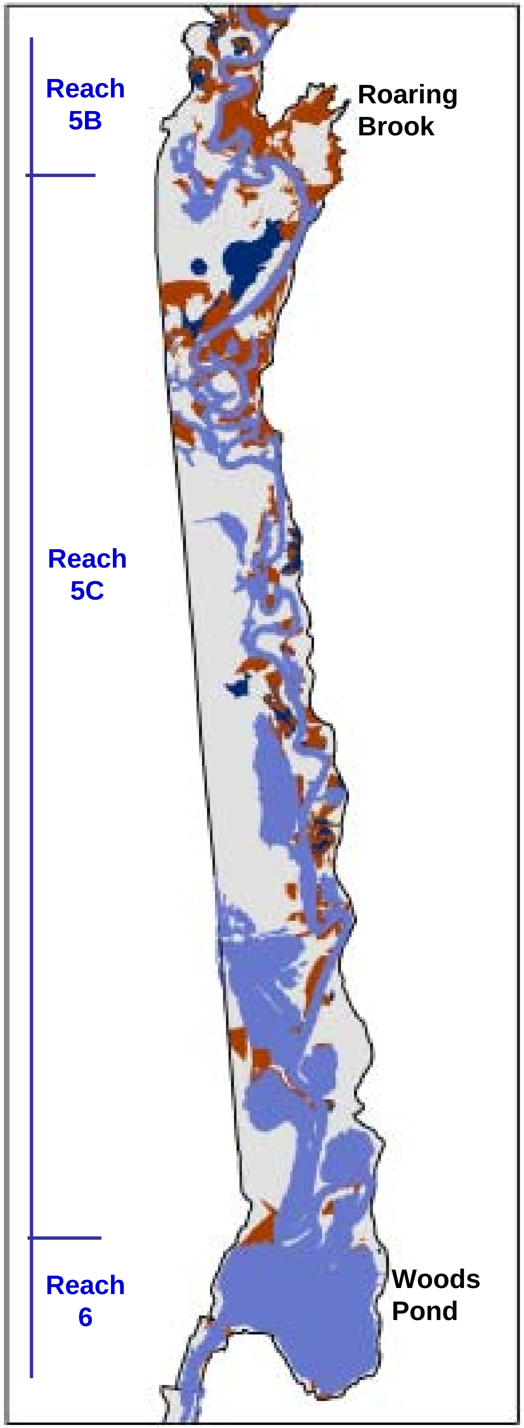
Vernal Pools

1 ppm PCB Isopleth

Soil Removal/Replacement

Reaches 5 and 6
FP 7





Human health: 10^{-6} cancer and non-cancer HI = 1 (but not less than 2 ppm).

Eco: lower-bound IMPGs.

Removal vol.: 570,000 cy

Removal area: 350 acres

Time: 22 years

Surface Water	
Vernal Pools	
1 ppm PCB Isopleth	
Soil Removal/Replacement	

CONTROL OF SOURCES OF RELEASES

- Floodplain soils are not a significant source of PCBs to the River.
  - Floodplain is generally flat, well vegetated, and depositional in nature.
  - EPA's model indicates that the contribution of PCBs from the floodplain to the River is insignificant.
- Short-term releases possible from open excavations during remediation.
  - Primarily a function of remedy duration.
  - FP 6 and FP 7 have the greatest potential for releases during remediation.

LONG-TERM RELIABILITY AND EFFECTIVENESS

- Magnitude of residual risk:
  - The IMPG-based alternatives that target specific exposure scenarios are more effective at reducing risk in individual exposure areas than the threshold-based alternatives.
  - PCBs that remain at depth would be addressed, as needed, by institutional controls.
- Adequacy and reliability of alternatives:
  - FP 2 – FP 7 rely on removal of floodplain soils, backfilling the excavations, and replanting/restoration activities.
  - Excavation and replacement of soils has been performed at a number of sites across the country. However, GE is unaware of any site similar to Rest of River where removal/restoration of a complex mixture of floodplain habitats on the scale of FP 6 (315,000 cy over 194 acres) or FP 7 (570,000 cy over 350 acres) have been conducted.

LONG-TERM RELIABILITY AND EFFECTIVENESS: FLOODPLAIN HABITATS SUBJECT TO REMOVAL

- Potential long-term adverse impacts:
  - All floodplain alternatives would produce some long-term adverse impacts on ecological habitats. The larger removal activities would have a greater potential for such impacts.
  - Primary long-term impacts would be loss or change in habitats and corresponding wildlife community. Extent of impacts dependent on types of habitat affected, size of affected areas, and success of restoration.
    - Impacts on upland forests: Loss of mature trees. After replanting, would take 50-75 years to reach functional level/appearance comparable to current conditions, 5-10 years to begin to support woodland biological community.
    - Impacts on wetlands: Most vulnerable wetlands are mature wooded wetlands and vernal pools.

Habitat Type	Removal Area by Habitat Type (acres)						
	FP 1	FP 2	FP 3	FP 4	FP 5	FP 6	FP 7
Upland Forest	0	5.4	12	32	27	84	132
Wetlands (incl. vernal pools)	0	< 1	20	25	33	105	127
Other	0	2.0	2.1	2.3	0.5	5	14
Reach 7 Floodplain	0	2.5	2.8	3	< 1	< 1	77
Total Acres of Removal	0	11	38	62	60	194	350

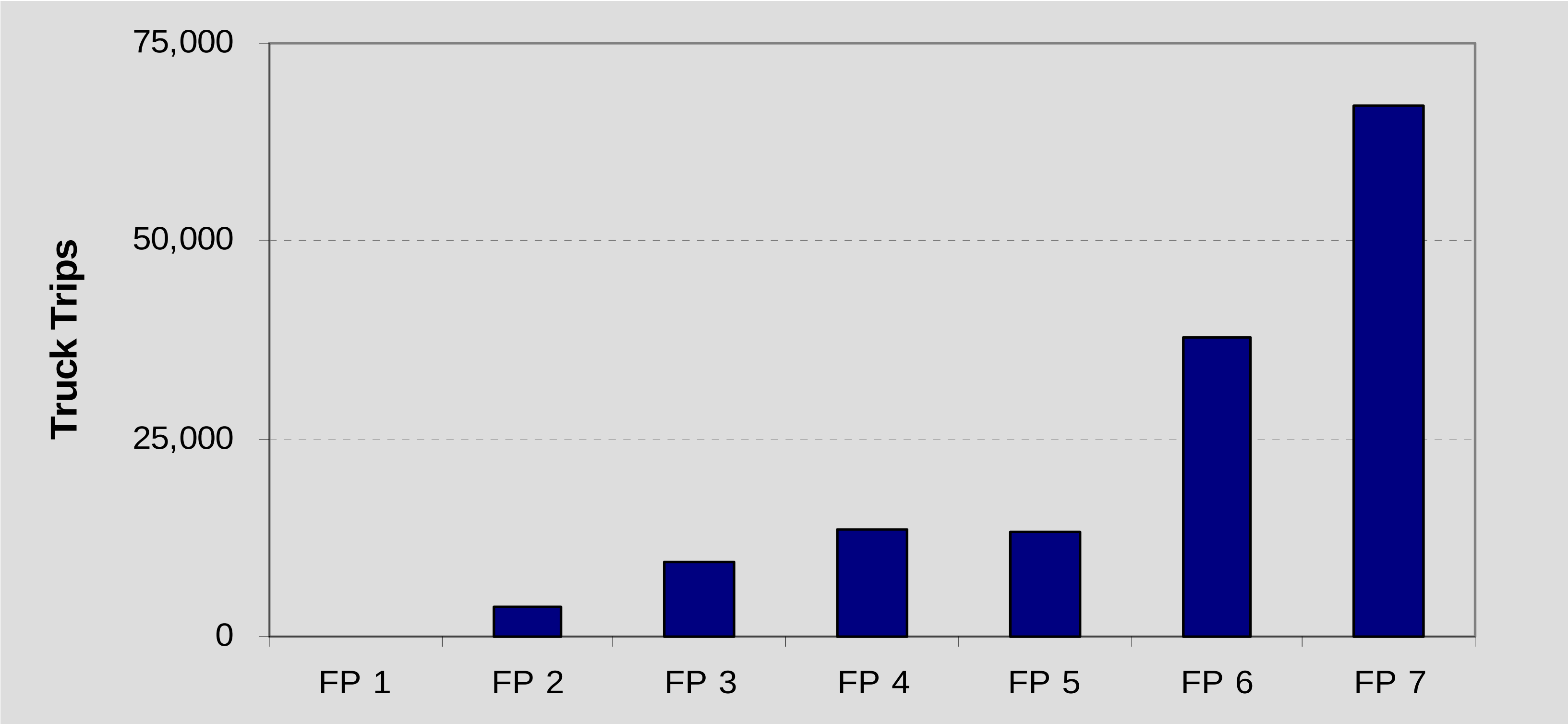
SHORT-TERM EFFECTIVENESS

- Evaluation of short-term effectiveness include the impacts on the environment and local communities.
- The short-term impacts would last for the duration of remedial activities and would range from 1 year (FP 2) to 22 years (FP 7).
- Impacts on the environment:
  - Impacts include the removal of plant and wildlife habitat where remediation and construction of access roads and staging areas would occur.
  - Habitat types subject to removal range from 11 to 350 acres.
  - Additional habitat would be affected by construction of supporting facilities:

Description	FP 2	FP 3	FP 4	FP 5	FP 6	FP 7
Total Staging and Access Road Area (acres)	9	25	39	28	36	48
Wetlands Affected by Staging Areas and Roads (acres)	< 1	4	4	9	18	28

SHORT-TERM EFFECTIVENESS (cont'd)

- Short-term impacts on local communities:
  - Disruption to recreational uses of River, riverbanks, and portions of floodplain.
  - Increased noise and truck traffic.
    - Number of truck trips to import backfill material:



OVERALL PROTECTION OF HUMAN HEALTH AND ENVIRONMENT

Human health:

- All floodplain soil removal alternatives provide protection of human health:
  - All alternatives achieve PCB levels within EPA's cancer risk range (10^{-6} to 10^{-4} risk) in all floodplain exposure areas.
    - FP 3 also achieves 10^{-5} risk level in 75% of area, including all frequent-use areas.
    - FP 4 and FP 6 also achieves 10^{-5} risk level in all exposure areas.
    - FP 5 also achieves 10^{-5} risk level in 75% of area.
    - FP 7 achieves 10^{-6} risk level or 2 mg/kg in all areas but takes long time to do so (22 years).
  - FP 2, FP 3, FP 4, and FP 7 achieve EPA's non-cancer IMPGs in all areas. FP 5 and FP 6 do so in 94% of area.

OVERALL PROTECTION OF HUMAN HEALTH AND ENVIRONMENT

Environment:

- FP 3, FP 4, and FP 5 provide overall protection of environment. FP 2 is more uncertain. FP 6 and FP 7 meet most IMPGs but would cause substantial environmental harm.
  - FP 2 achieves levels within IMPG range for omnivorous mammals and insect-eating birds in most or all areas, but generally not for amphibians or mink.
  - FP 3 and FP 4 achieve levels within IMPG range for omnivorous mammals and amphibians in all areas, insect-eating birds in most or all areas, and mink in some circumstances.
  - FP 5 and FP 6 achieve levels within IMPG range for omnivorous mammals and insect-eating birds in most or all areas and mink in some or all areas, but not for amphibians in 60-70% of vernal pool area.
    - However, FP 6 would cause substantial adverse impacts on environment, including forests and wetlands, over 194 acres, resulting in overall negative impact on environment.
  - FP 7 achieves nearly all ecological IMPGs, but would cause widespread and extensive damage to environment, including forests and wetlands and wildlife in them, over 350 acres, resulting in overall negative impact on the environment.

OVERALL CONCLUSION ON FLOODPLAIN ALTERNATIVES

- GE believes that FP 3 is “best suited” to meet the General Standards in the Permit, based on consideration and balancing of the Selection Decision Factors.
- Main reasons are that FP 3 would:
  - Achieve floodplain soil levels within EPA risk range for protection of human health in all areas of the floodplain, including 10^{-5} values in frequently used areas.
  - Achieve levels within the ecological IMPG ranges for most wildlife groups and significantly reduce PCB exposures for other groups.
  - Cause less overall damage to the environment and less disruption of floodplain use than FP 4 – FP 7, with fewer complications and lower cost.

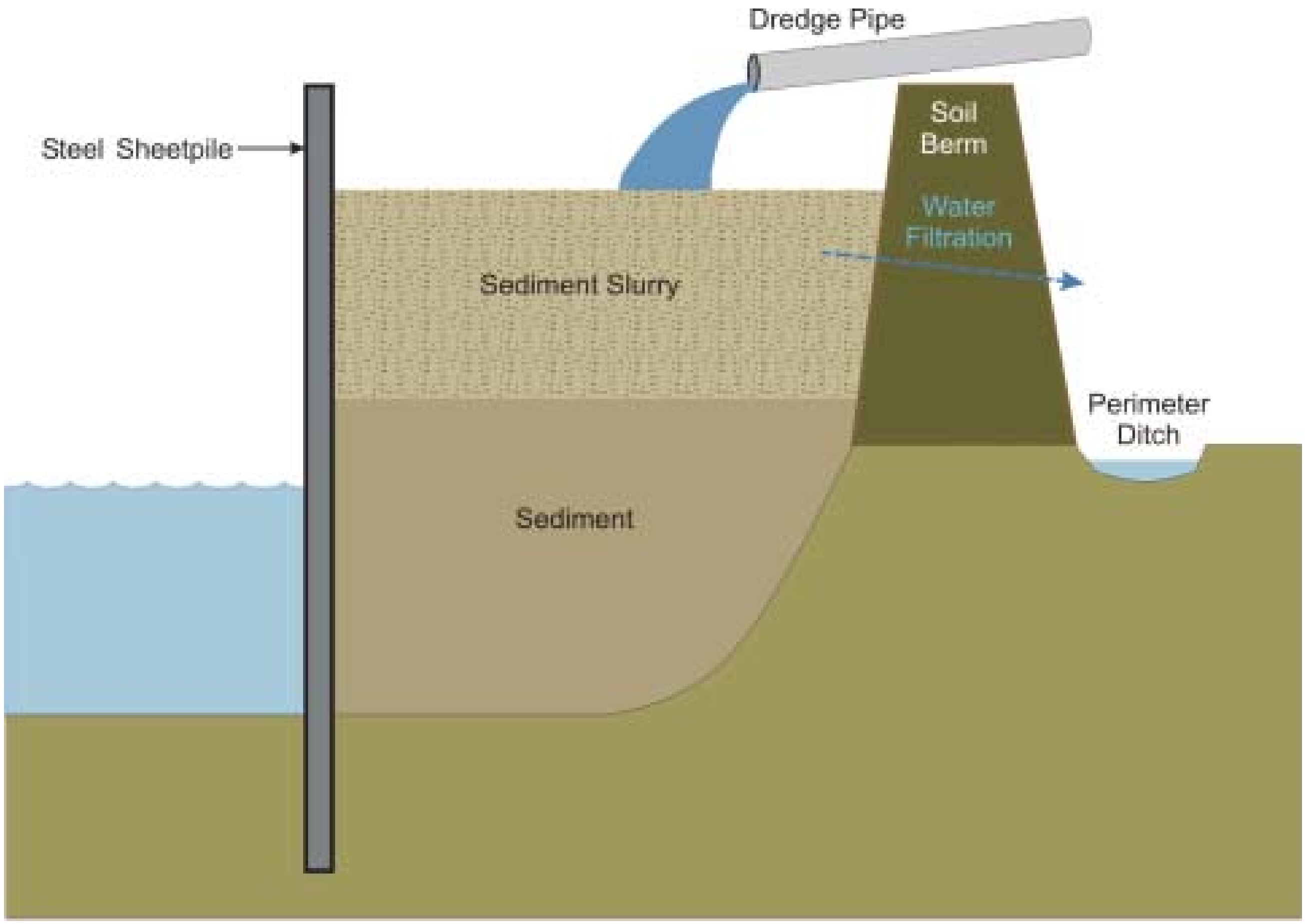
TREATMENT/DISPOSAL ALTERNATIVES

- Five disposition/treatment alternatives were approved by EPA for evaluation in the CMS.
- Disposition alternatives:
  - TD 1 – Off-site disposal in permitted landfill(s).
  - TD 2 – Local disposal in confined disposal facility (CDF) in river.
  - TD 3 – Local disposal in upland disposal facility.
- Treatment alternatives:
  - TD 4 – Chemical extraction.
  - TD 5 – Thermal desorption.

TD 1: OFF-SITE DISPOSAL IN PERMITTED LANDFILL(S)

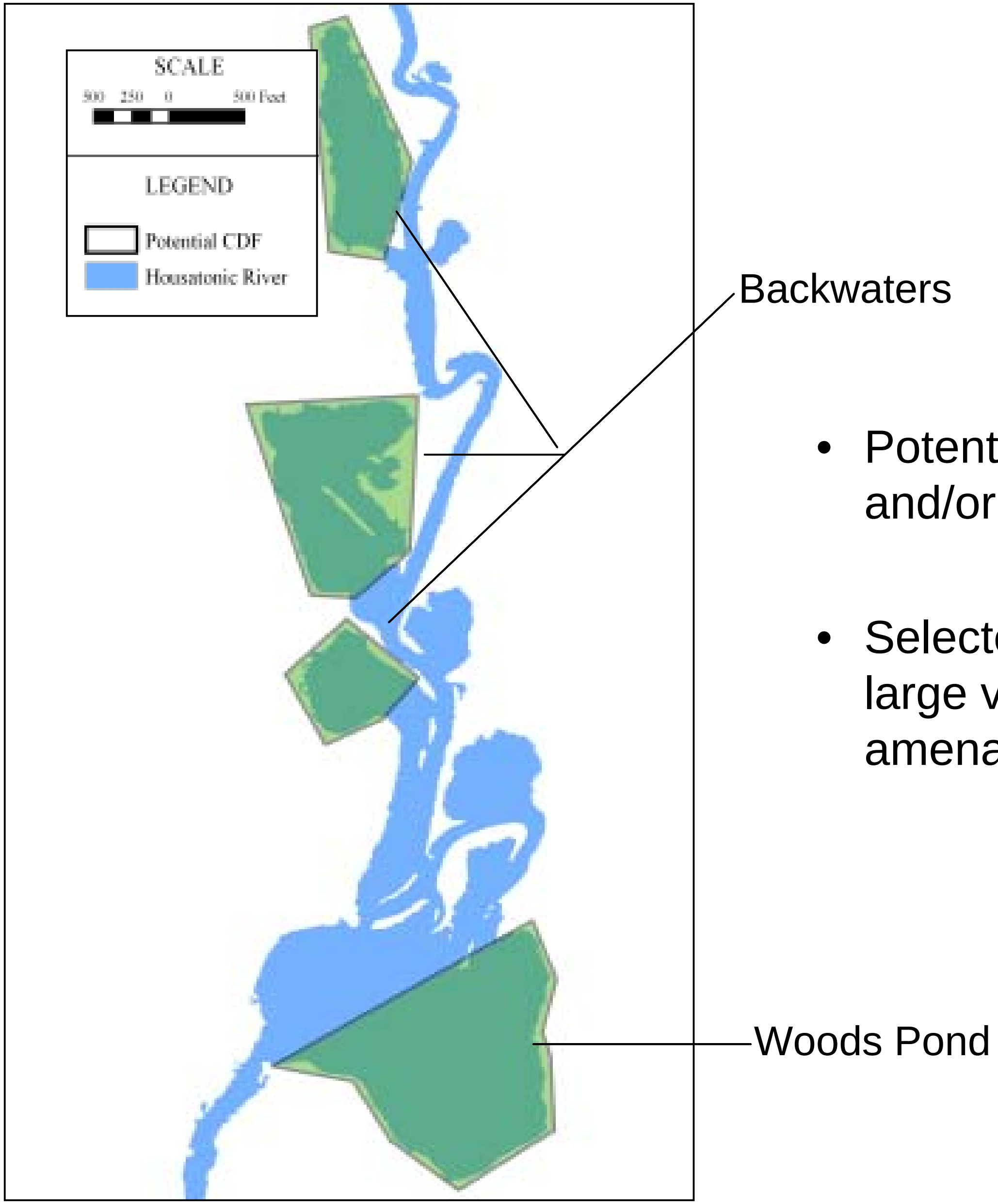
- Process/assumptions:
  - Removed materials are dewatered as necessary, loaded into trucks, and transported over public roads to landfill(s).
  - Materials segregated and transported to different landfills based on PCB concentration
  - Volume range: 185,000 to 2,800,000 cy
- Primary considerations:
  - Eliminates potential for future release/transport of those materials to the River or floodplain
  - Commonly used. Regulatory requirements exist for landfill design, operation, and monitoring, which ensure long-term effectiveness and reliability.
  - Uncertain whether capacity will be available in the future.
  - Potential short-term risks:
    - Up to 211,800 truck trips for SED 8/FP 7
    - Associated noise, emissions, and traffic accidents.

TD 2: DISPOSAL IN CONFINED DISPOSAL FACILITY (CDF)



Sediments are hydraulically pumped to a bermed area within the waterway for dewatering.
Following sediment consolidation, the CDF is closed through construction of a vegetated soil cover.

TD 2: DISPOSAL IN CONFINED DISPOSAL FACILITY (CDF)

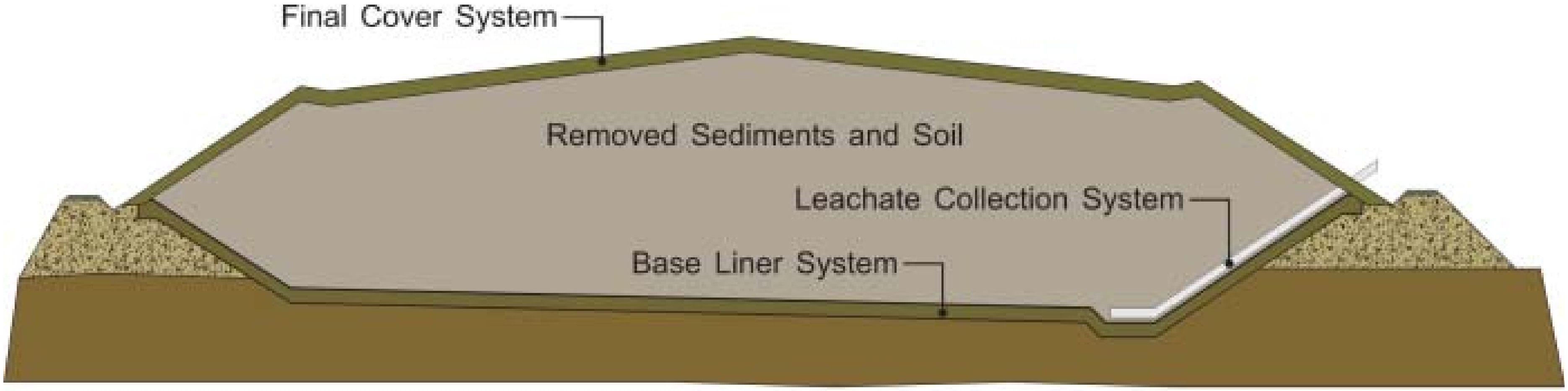


- Potential CDF Locations: Woods Pond and/or large backwaters.
- Selected based on size and proximity to large volume sediment removal areas amenable to hydraulic dredging.

TD 2: DISPOSAL IN CONFINED DISPOSAL FACILITY (CDF)

- Process/assumptions:
  - Permanent access to CDF locations would be obtained.
  - Only appropriate for hydraulically dredged sediments from Reaches 5C, 5D, and Woods Pond. Thus limited to components of alternatives SED 6, SED 7, and SED 8.
  - Off-site disposal assumed for all other removed material under these alternatives.
  - Volume range: 300,000 to 1,240,000 cy.
- Primary considerations:
  - Would minimize potential for future release/transport of those materials to the River or floodplain, however, releases more likely than for other disposition alternatives.
  - Technology demonstrated to be effective and reliable: various engineering manuals exist for design, operation, and long-term management.
  - Would result in permanent long-term loss of aquatic habitat and potentially flood storage capacity.
  - Potential short-term risks:
    - Loss of PCBs to surface water or air during filling.
    - Release due to damage to CDF caused by flood or ice.

TD 3: DISPOSAL IN LOCAL UPLAND DISPOSAL FACILITY



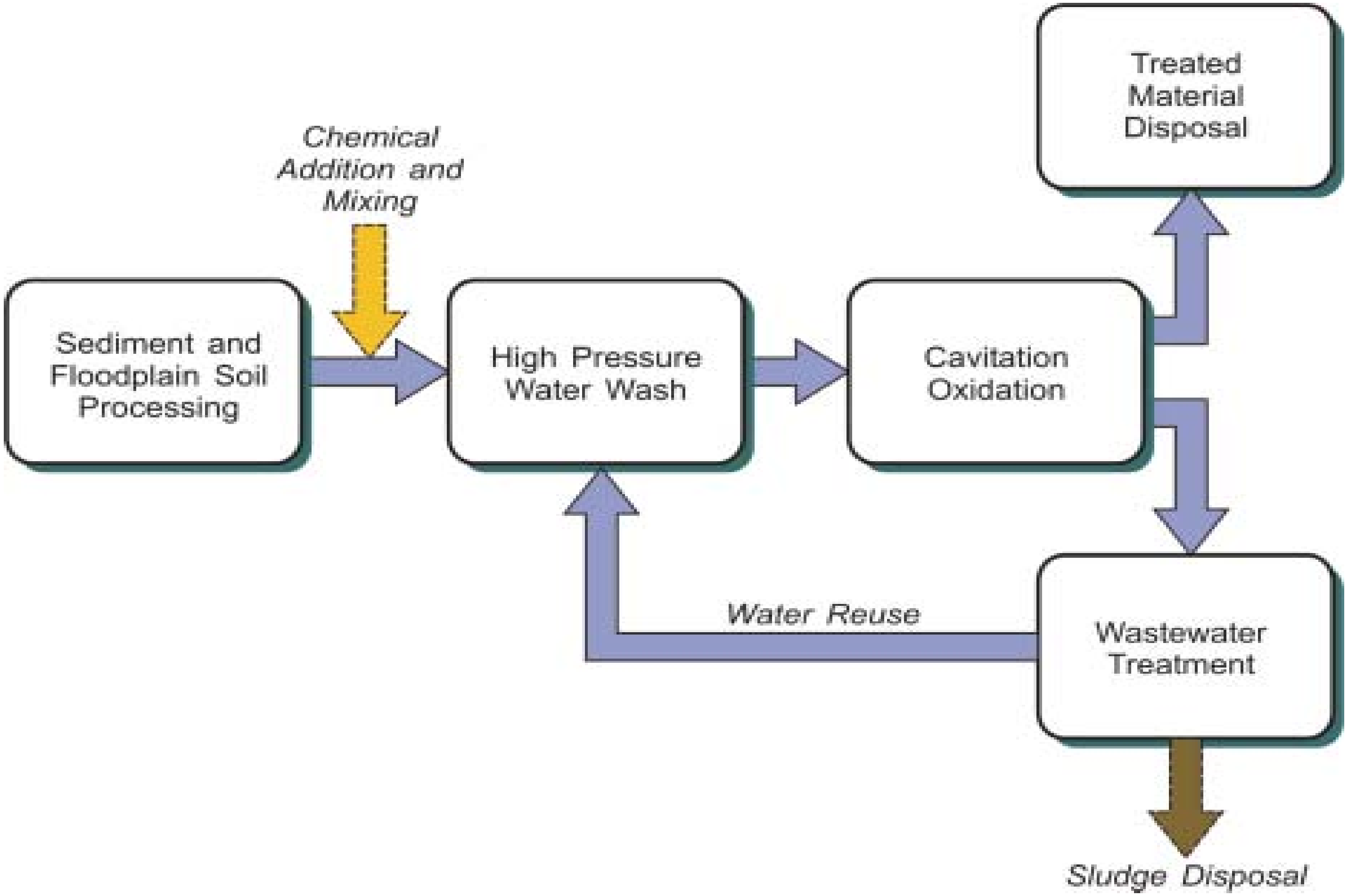
- Removed sediments and floodplain soils are transported to an Upland Disposal Facility that would be engineered and constructed in close proximity to the River, but outside the 100-year floodplain.
- Upland Disposal Facility would have an engineered impermeable liner/cover and a leachate collection system.

TD 3: DISPOSAL IN LOCAL UPLAND DISPOSAL FACILITY

- Process/assumptions:
  - Permanent access to suitable location is obtained.
  - Removed materials dewatered as necessary, loaded into trucks, and transported to an Upland Disposal Facility.
  - Volume range: 185,000 to 2,800,000 cy.
- Primary considerations:
  - Location and design effectively prevent future release/transport of those materials to the River or floodplain.
  - Constructed at other PCB sites: established design, operation, and monitoring requirements ensure long-term effectiveness and reliability.
  - Short- and long-term ecological and aesthetic impact could be minimized depending on location.
  - Potential short-term risks due to truck traffic minimized using local disposal.

TD 4: TREATMENT USING CHEMICAL EXTRACTION

- Extraction fluid/solvent(s) are mixed with removed sediment and soil, so that PCBs are preferentially transferred from the solid media into the extraction fluid. Resulting PCB-containing fluid is then treated or disposed.
- Site-specific bench-scale treatability study performed using the BioGenesis^{SM} process.



SUMMARY OF BIOGENESIS[SM] TREATABILITY STUDY

- Study conducted in accordance with EPA–approved Work Plan and EPA oversight.
- The study was conducted using 3 types of site-specific material:
  - Coarse-grained sediment representative of the upper reach.
  - Fine-grained sediment representative of areas like Woods Pond
  - Floodplain soil.
- Results:

Time Sampled	Average PCB Concentration (mg/kg)
Before treatment	45-177
After First Treatment Cycle	7-48
After Third Treatment Cycle	4-22

- PCB concentrations not reduced sufficiently to meet standards for unrestricted use.

TD 4: TREATMENT USING CHEMICAL EXTRACTION

- Process/Assumptions:
  - BioGenesis[SM] treatment facility constructed in close proximity to the River, but outside of the 100-year floodplain.
  - All treated solid materials would be disposed of in an off-site solid waste landfill.
  - Volume range: 185,000 to 2,800,000 cy.
- Primary Considerations:
  - Would reduce the toxicity, mobility, and volume of PCBs in treated material, but would still require disposal.
  - Uncertainties regarding effectiveness and reliability if applied full-scale:
    - No precedent for chemical extraction at other sites with similar volumes and PCB concentration.
    - Extent to which PCB levels in sediments and soils can be reduced and the effect this could have on disposal.
    - Long implementation time would result in periodic equipment failure and down time.
  - Potential short-term risks:
    - Up to 211,800 truck trips for SED 8/FP 7 with associated noise, emissions, truck traffic.
    - Releases/spills at treatment facility.

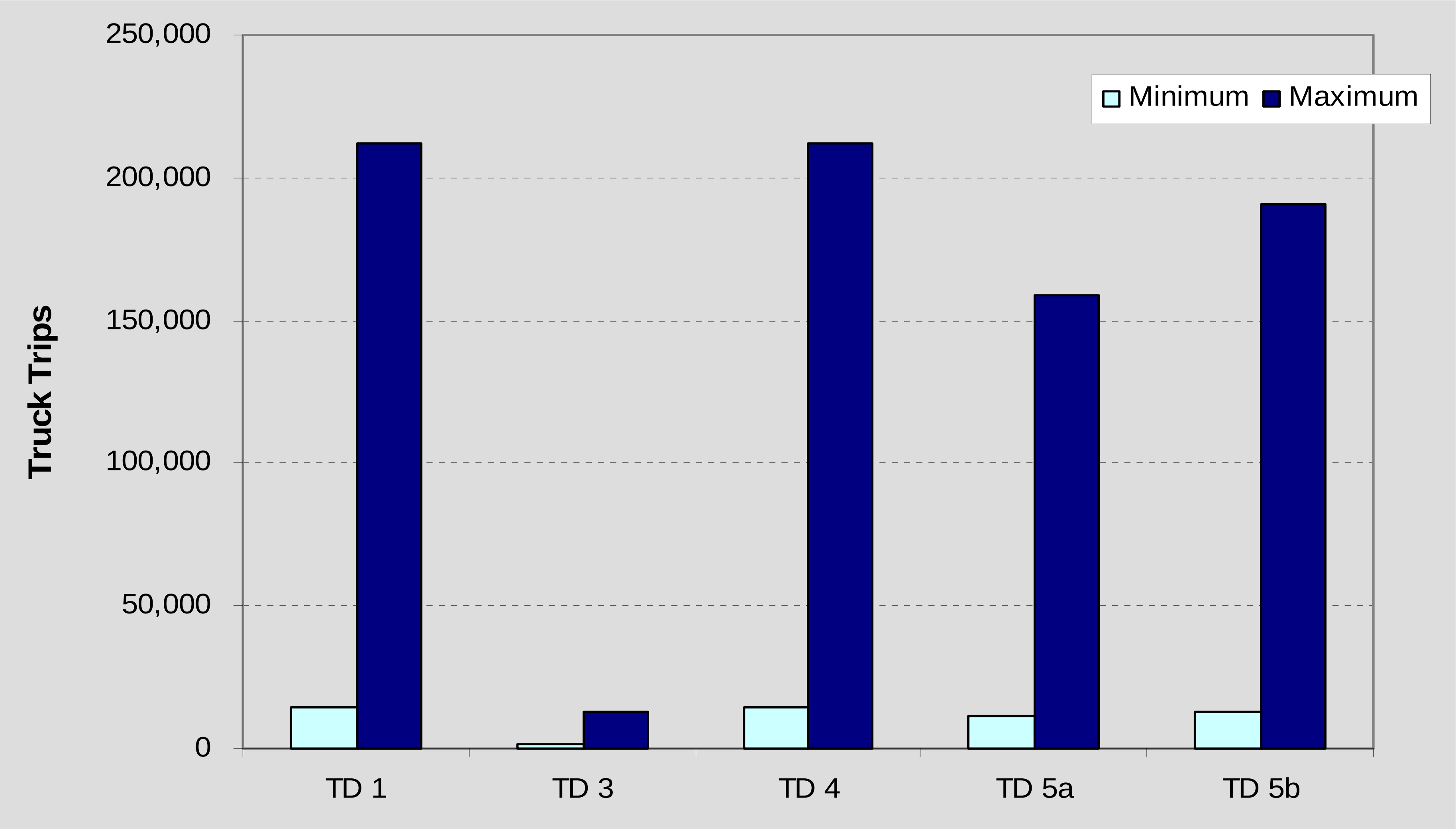
TD 5: TREATMENT USING THERMAL DESORPTION

- Heat is added to the removed sediments and soils to a sufficiently high temperature to volatize the PCBs into a gas stream.
- PCB-containing gas stream is subsequently condensed and the resulting liquids treated/disposed.

TD 5: TREATMENT USING THERMAL DESORPTION

- Process/assumptions:
  - Thermal desorption treatment facility constructed in close proximity to the River, but outside of the 100-year floodplain.
  - A portion of the treated soils could be re-used as backfill in the floodplain.
  - All treated solid materials could be disposed of at an off-site solid waste landfill.
  - Volume range: 185,000 to 2,800,000 cy.
- Primary considerations:
  - Would reduce the toxicity, mobility, and volume of PCBs in treated material, but sediments (and at least some soils) still require disposal.
  - Uncertainties regarding effectiveness and reliability:
    - No precedent at other sites for such large volumes and implementation time frames.
    - High organic content, high moisture content, and high percentage of fine-grained material all complicate treatment.
    - Thermal treatment could increase toxicity and mobility of metals, thus affecting ultimate reuse/disposal.
  - Potential short-term risks:
    - Up to 190,600 truck trips for with associated noise, emissions, truck traffic.
    - Releases/spills at treatment facility.

OFF-SITE TRUCK TRIPS FOR TREATMENT/DISPOSITION ALTERNATIVES



Note: Truck trips for TD 2 range from 11,200 to 22,900, but do not included off-site trips for disposal of materials not placed in CDFs.

OVERALL COMPARISON OF TREATMENT/DISPOSITION ALTERNATIVES

- TD 1 protects health and environment through **off-site disposal** of sediments and soils. But uncertainties exist regarding future off-site landfill capacity due to potential duration of implementation (8 to 51 years).
- TD 2 protects health and environment though placement of hydraulically dredged sediments in **local in-water CDF(s)**. But:
  - Would not provide for disposition of other sediments or floodplain soils.
  - Has some potential for releases to water during filling or after closure.
  - Would result in permanent loss of aquatic habitat in CDF areas.
  - Could result in loss of flood storage capacity.
- TD 3 protects health and environment though disposition of sediments/soils in **local engineered upland disposal facility** with liner, cover, and leachate collection system and long-term monitoring and maintenance. Effectively isolates the sediments/soils from people and wildlife.
- TD 4 protects health and environment through treatment of sediments/soils via **chemical extraction**, with off-site disposal of treated materials. But:
  - Process has not been demonstrated at full scale for sediments/soils like those here.
  - Treatability study indicates process could not reduce PCB levels sufficiently to allow reuse; uncertainties regarding off-site disposal options.
  - Could be operational challenges for large-scale, long-term operations.
  - Would require handling and treatment of large volumes of wastewater.

OVERALL COMPARISON OF T/D ALTERNATIVES (cont'd)

- TD 5 protects health and environment though treatment of sediments/soils via **thermal desorption**, with potential on-site reuse of some treated soils (with low levels) as backfill in floodplain and off-site disposal of rest of treated materials.
  - Very limited precedent for use on sediments, due in part to time and cost of removing moisture, which can present operational problems.
  - Use at other sites for soils has involved much smaller volumes and shorter durations than those here.
  - Reliability of process for long-term treatment of large volume of materials like sediments and soils from Rest of River is unknown.

OVERALL CONCLUSION

- GE believes that **TD 3, disposal in local upland disposal facility**, is "best suited" to meet the Permit evaluation criteria for the following main reasons:
  - Permanently isolates PCB-containing sediments/soils from humans and wildlife.
  - High degree of reliability and implementability compared to other alternatives.
  - No substantial long-term or short-term adverse impacts.
  - Most cost-effective of treatment/disposition alternatives.

COMBINED SEDIMENT AND TREATMENT/DISPOSITION COST ESTIMATES

Alternative	Cost Estimates for SED/TD Combinations				
	TD 1 Off-Site Disposal	TD 2 Confined Disposal Facility	TD 3 Upland Disposal Facility	TD 4 Chemical Extraction	TD 5 Thermal Desorption
SED 1	NA	NA	NA	NA	NA
SED 2	$10 M	NA	$10 M	$10 M	$10 M
SED 3	$195 M	NA	$154 M	$238 M	$216 M
SED 4	$304 M	NA	$232 M	$357 M	$324 M
SED 5	$372 M	NA	$273 M	$436 M	$399 M
SED 6	$482 M	$396 M	$334 M	$499 M	$502 M
SED 7	$614 M	$497 M	$399 M	$624 M	$629 M
SED 8	$1,260 M	$875 M	$695 M	$1,366 M	$1,385 M

COMBINED FLOODPLAIN SOIL AND TREATMENT/DISPOSITION COST ESTIMATES

Alternative	Cost Estimates for FP/TD Combinations					
	TD 1 Off-Site Disposal	TD 2 Confined Disposal Facility	TD 3 Upland Disposal Facility	TD 4 Chemical Extraction	TD 5A Thermal Desorption (w/ Reuse)	TD 5B Thermal Desorption (w/o Reuse)
FP 1	NA	NA	NA	NA	NA	NA
FP 2	$15 M	NA	$15 M	$34 M	$22 M	$23 M
FP 3	$46 M	NA	$30 M	$65 M	$42 M	$49 M
FP 4	$71 M	NA	$49 M	$92 M	$64 M	$75 M
FP 5	$82 M	NA	$47 M	$90 M	$62 M	$73 M
FP 6	$193 M	NA	$128 M	$242 M	$180 M	$215 M
FP 7	$310 M	NA	$202 M	$403 M	$311 M	$374 M

SUMMARY

- GE believes combination of SED 3 and FP 3 with local upland disposal is “best suited” to meet Permit criteria. Involves:
  - Removal of 167,000 cy (250,000 tons) of river sediments and bank soils over 42 acres from Reach 5A (and banks in Reach 5B) and placement of 6-inch cap over additional 97 acres in part of Reach 5C and in Woods Pond.
  - Removal of 60,000 cy (90,000 tons) of floodplain soil over 38 acres.
  - Disposition of removed materials in secure engineered landfill near River but outside 100-year floodplain.
  - Duration of 10 years and cost of ~ $184 million.
- SED 3 provides large reduction in PCBs flowing in River (94% at Woods Pond Dam) and in PCB levels in fish (72 to 99%). Achieves reductions in shortest time, with least adverse impact to environment and local communities and fewest implementability uncertainties.
- FP 3 achieves PCB levels in floodplain soil within EPA risk range for human health protection in all floodplain areas, significantly reduces wildlife exposure to PCBs, and results in less damage to environment and less disruption to use than FP 4 – FP 7.
- Disposal of removed materials in local engineered landfill would permanently isolate those materials from human and ecological exposure and has highest degree of reliability, with no significant adverse effects.
- This combination is most cost-effective.