Application of a Decision Making Framework for Sediment Contamination - Kingston Harbour and Sault Ste. Marie

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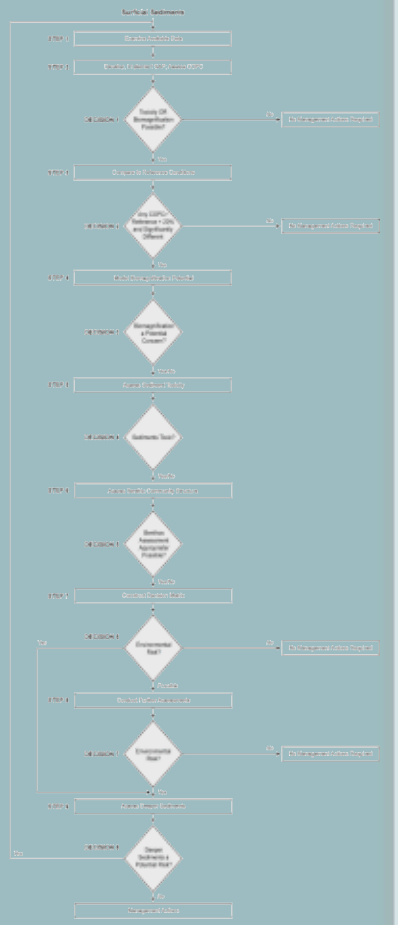
Introduction



- Sediment assessments typically integrate many types of data into an overall conclusion
  - Chemistry, toxicity, benthic community
  - Bioaccumulation, sediment stability, other
  - Sediment quality triads → weight of evidence assessments
- Wide-spread application:
  - Local → international
  - Menzie et al. (1996); Grapentine et al. (2002); Suter et al. (2002); Bay et al. (2007); Chapman and coauthors
- This presentation is not about new science; rather, it is about a specific framework

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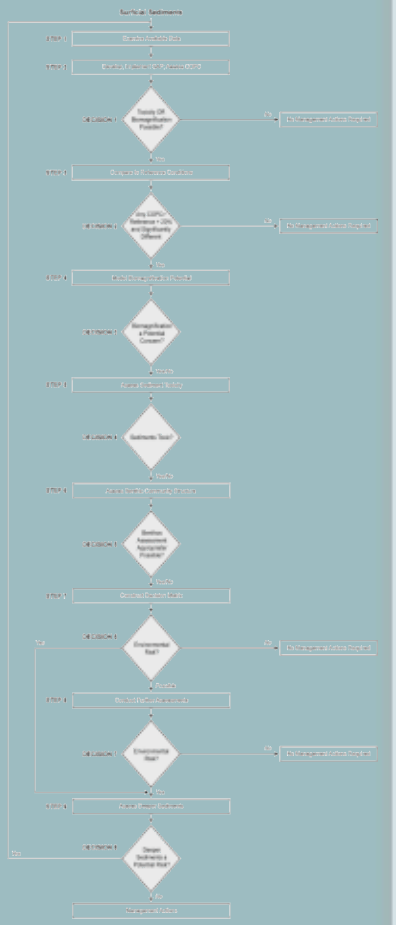
What's the value of a framework?



- Provides a transparent process that is scientifically-defensible
- Standardizes decision-making process without using a "cook book" approach which would
  - Ignore relevant site-specific issues
  - Prevent use of professional judgment
- Provides consistency to allow comparisons between sites and to build regional assessments where needed
- Builds consensus from different stakeholders

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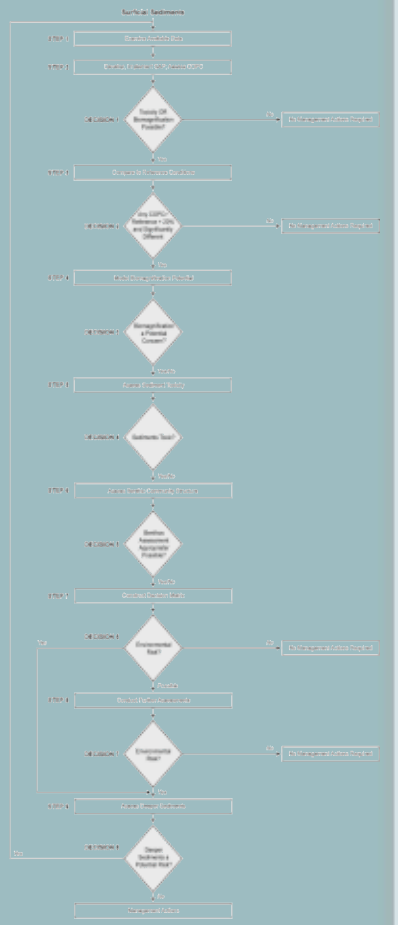
What does the Framework consist of?



- Peer-reviewed:
  - Chapman PM, Anderson J. 2005. *Integrated Environmental Assessment and Management* 1:163-173.
- Approved by Canada-Ontario Agreement Respecting the Great Lakes Ecosystem, March 2008
  - Facilitates consensus between jurisdictions
  - http://www.on.ec.gc.ca/greatlakes/

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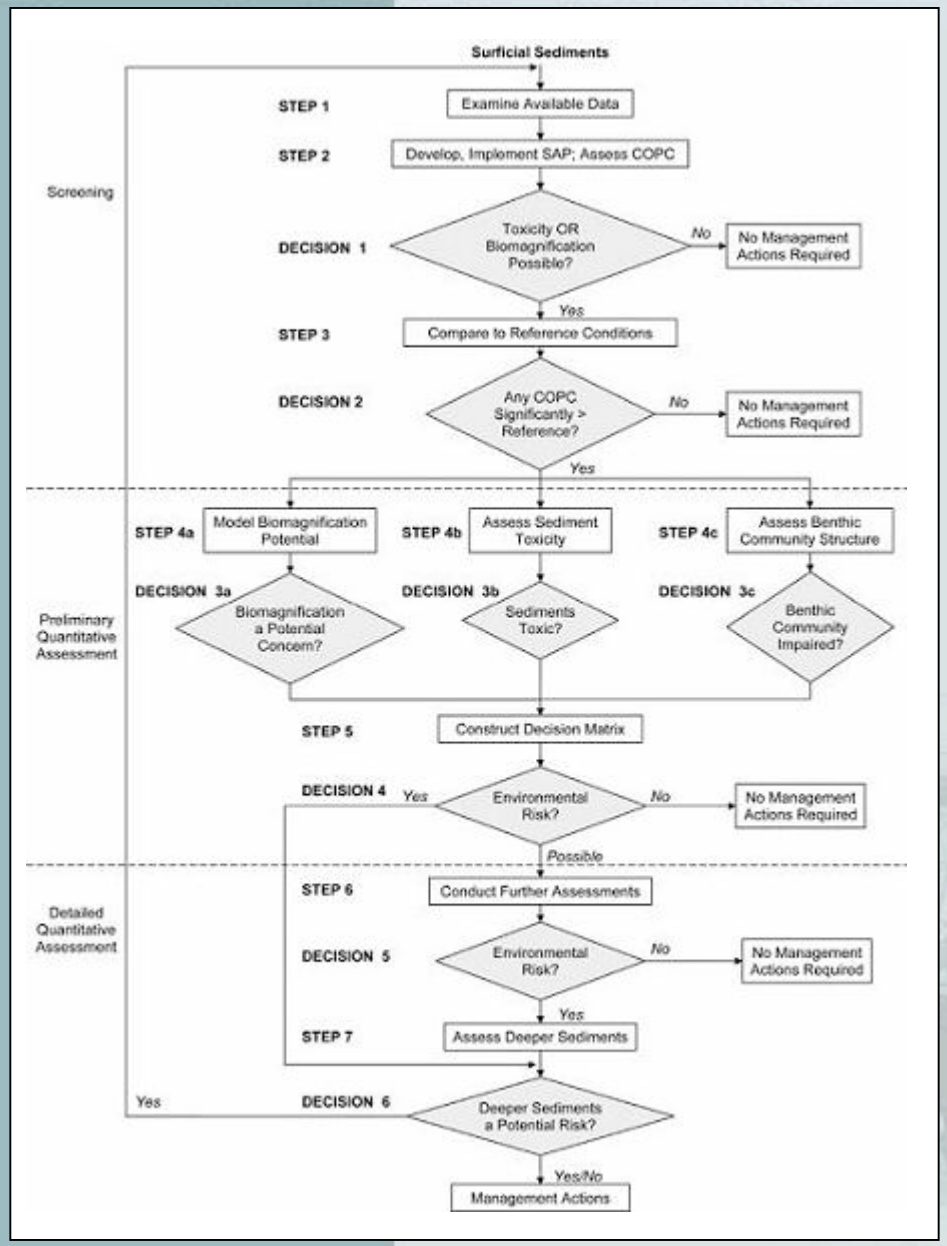
What does the Framework consist of?



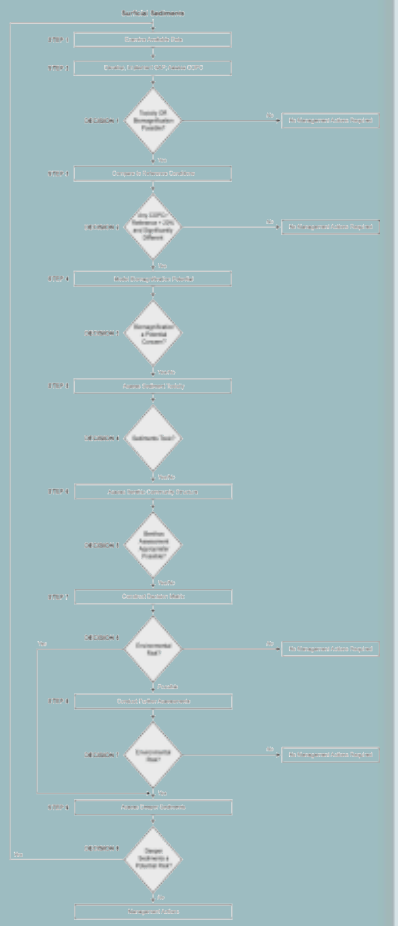
- Nine steps, eight decision points, four "off-ramps"
- Corresponds to federal ecological risk assessment approach
  - Problem Formulation / Screening; Preliminary Quantitative RA; Detailed Quantitative RA
- Consistent with WOE approaches from the literature

What does the Framework consist of?

	■	◘	□
Bulk Chemistry (compared to SQG)	**Adverse Effects Likely:** One or more exceedences of SQG-high	**Adverse Effects May or May not Occur:** One or more exceedences of SQG-low	**Adverse Effects Unlikely:** All contaminant concentrations below SQG-low
Toxicity Endpoints (relative to reference)	**Major:** Statistically significant reduction of more than 50% in one or more toxicological endpoints	**Minor:** Statistically significant reduction of more than 20% in one or more toxicological endpoints	**Negligible:** Reduction of 20% or less in all toxicological endpoints
Overall Toxicity	**Significant:** Multiple tests/endpoints exhibit major toxicological effects	**Potential:** Multiple tests/endpoints exhibit minor toxicological effects and/or one test/endpoint exhibits major effect	**Negligible:** Minor toxicological effects observed in no more than one endpoint
Benthos Alteration (multivariate assessment, e.g., ordination)	"different" or "very different" from reference stations	"possibly different" from reference stations	"equivalent" to reference stations
Biomagnification Potential (relative to reference)	**Significant:** Based on Step 6	**Possible:** Based on Step 4a	**Negligible:** Based on Steps 4a or 6
Overall WOE assessment	**Significant adverse effects:** elevated chemistry; greater than a 50% reduction in one or more toxicological endpoints; benthic community structure different (from reference) ; **and/or** significant potential for biomagnification	**Potential adverse effects:** elevated chemistry; greater than a 20% reduction in two or more toxicological endpoints; benthic community structure possibly different (from reference); **and/or** possible biomagnification potential	**No significant adverse effects:** minor reduction in no more than one toxicological endpoint; benthic community structure not different from reference; **and** negligible biomagnification potential

- Decision criteria for different lines of evidence are established
- Guidance on integrating multiple lines of evidence provided

Four guiding principles:



- Chemistry data alone will not be used for remediation decisions except for when:
  - Costs of further investigation outweigh remediation (i.e., small sites with a limited number of contaminants present at extremely elevated concentrations)
  - A regulatory order to remediate has been applied
- Remediation decisions will be based primarily on biology, not chemistry
- Data from properly conducted benthic surveys that show negligible impacts outweigh other types of data (e.g., toxicity testing)
- If the impacts of remediation will cause more environmental harm than leaving the contaminants in place, then remediation should not be implemented

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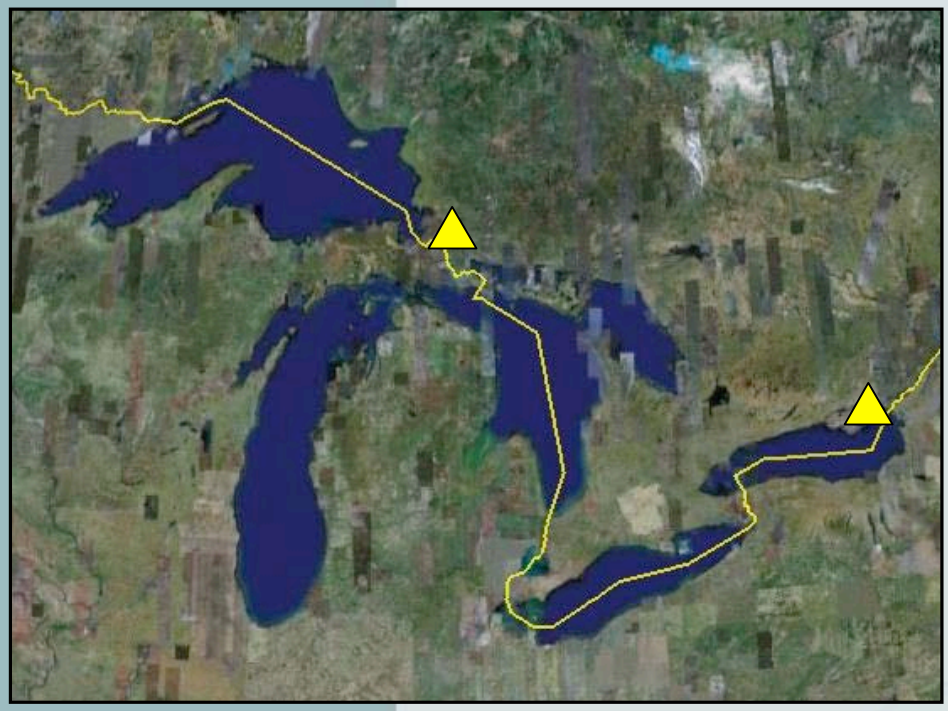
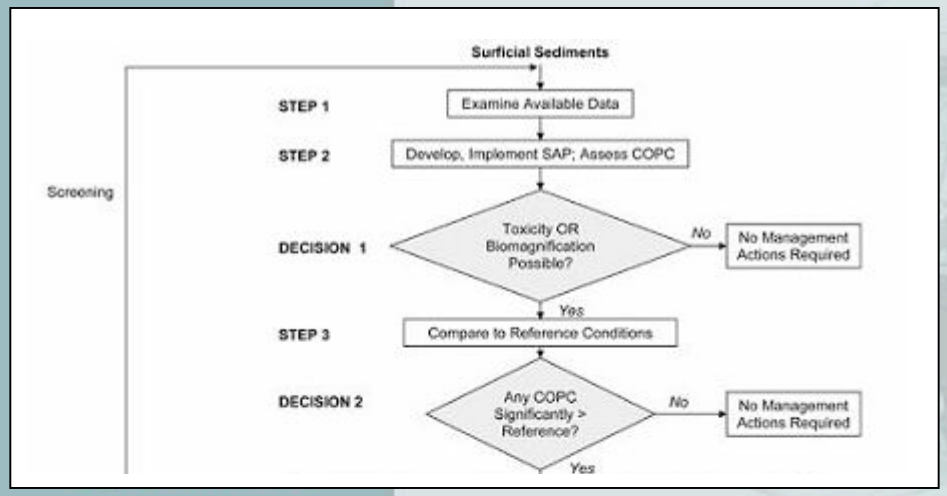
Examples





- First three steps of the Framework applied to Outer Kingston Harbour and Sault Ste Marie:
  - Step 1: Compile and examine all data
  - Step 2: Evaluate COPCs in terms of potential for toxicity and biomagnification
  - Step 3: Compare chemistry to reference conditions
  - Develop a sampling and analyses plan for future work

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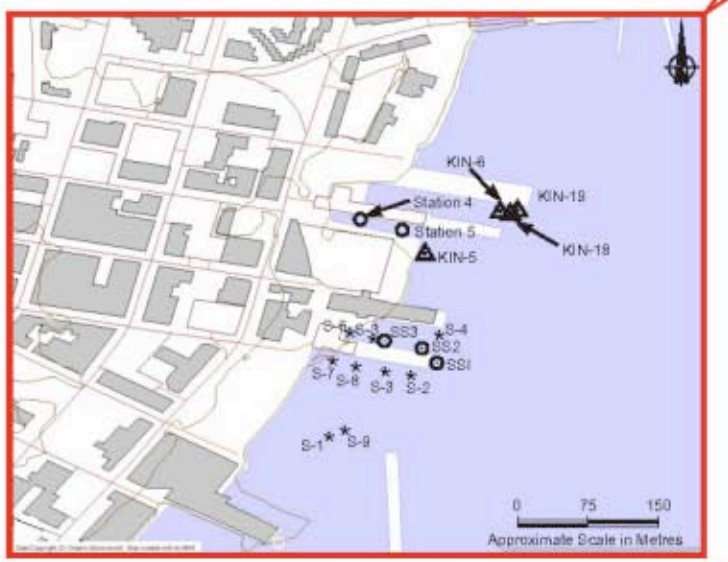
Outer Kingston Harbour



LEGEND

- Aqua Terre 2004
- Terrapex 2000
- UMA 1997
- Aqua Terre 1997
- Jaagumagi 1991
- Water Lot Boundary

PROJECT	PWGSC KINGSTON OUTER HARBOUR SEDIMENT MANAGEMENT FRAMEWORK (STEPS 1-3) KINGSTON, ON
TITLE	HISTORICAL SEDIMENT SAMPLING LOCATIONS

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PROJECT No. 07-1122-0009			FILE No.	
DESIGN	CT	16MAR07	SCALE AS SHOWN	REV.
CADD	MM	16MAR07	FIGURE 2	
CHECK				
REVIEW				

Outer Kingston Harbour

- Step 1: Data compilation
  - Reviewed five different reports
  - Three others were not available for review
- Step 2: Review available sediment chemistry data
  - Metals (As, Cd, Cr, Cu, Pb, Ni, Ag, Hg, Zn) and PAHs have the potential to cause toxicity based on exceedance of sediment quality guidelines
  - PCBs, organochlorine pesticides, TBT and methylmercury have the potential to cause unacceptable biomagnification
- Step 3: Insufficient data to support reference comparisons
- Completed a problem formulation (including conceptual exposure model) and developed a workplan for next steps

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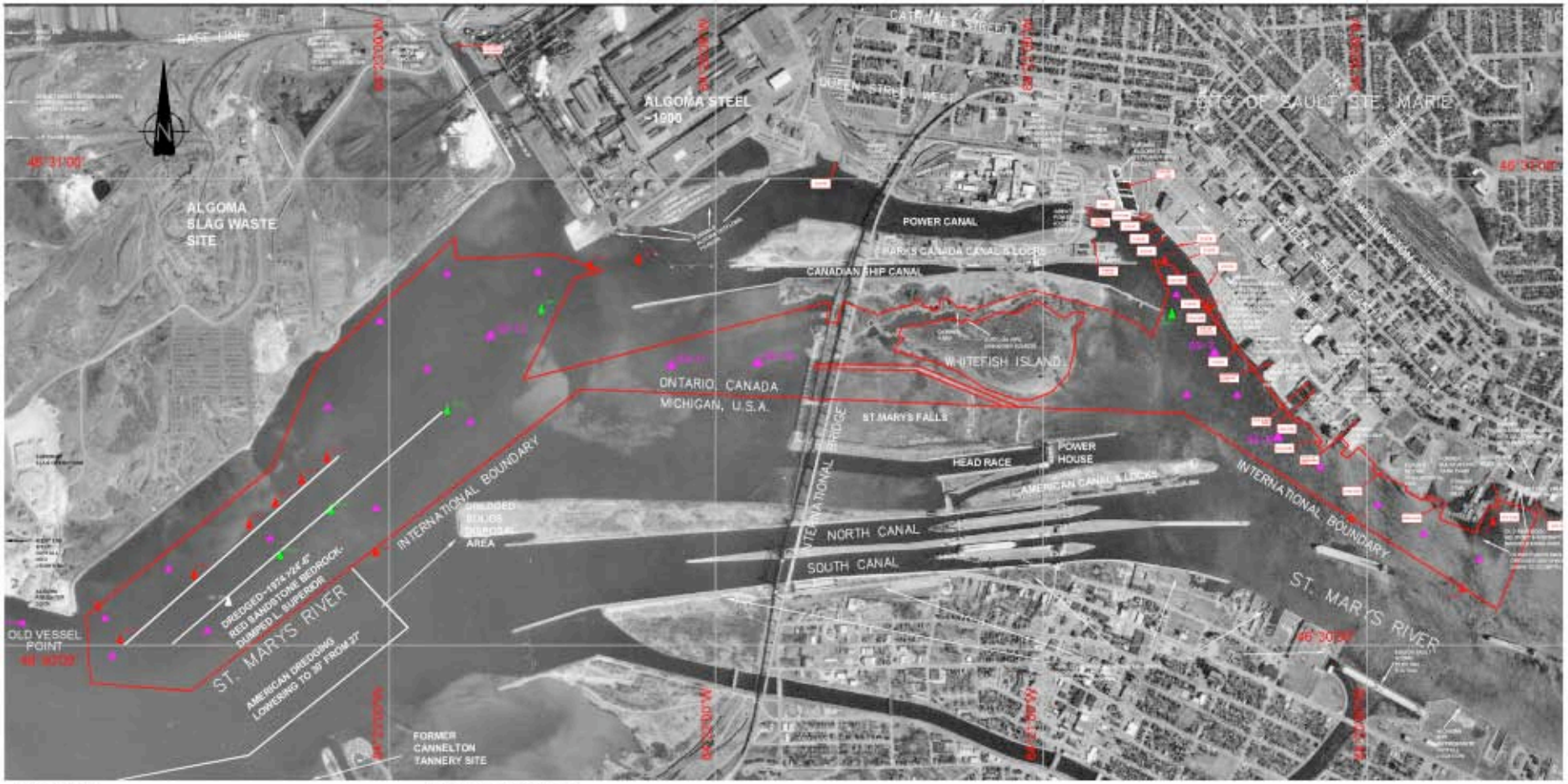
Sault Ste Marie



LEGEND

- BOUNDARY OF STUDY AREA
- DREDGED CHANNEL LIMITS
- SEDIMENT SAMPLING LOCATIONS 2003 SURVEY
- STORM/SANITARY SEWER OUTLET
- NAVIGATIONAL BOUYS (PORT)
- NAVIGATIONAL BOUYS (STARBOARD)

REFERENCES

1) DECOMMISSIONING CONSULTING SERVICES LIMITED REPORT MARCH 2004 "PWGSC/TC, SEDIMENT SAMPLING PROGRAM.

0 1600 3200 4800 6400 8000
Scale in Metres

PROJECT: PWGSC
SAULT STE. MARIE HARBOUR
SEDIMENT MANAGEMENT FRAMEWORK (STEPS 1-3)
SAULT STE. MARIE

TITLE: SAULT STE. MARIE HARBOUR ENHANCED PHASE 1 ESA SEDIMENT SAMPLING

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FIGURE3

Sault Ste Marie

- Step 1: Data compilation
  - One report with samples from water lot, but others available for adjacent sites (e.g., Algoma Steel)
  - Completed same reviews as Kingston
- Step 2: Review available sediment chemistry data
  - Metals (As, Cd, Cr, Cu, Fe, Pb, Ni, Hg, Zn) and PAHs have the potential to cause toxicity based on exceedance of sediment quality guidelines
  - Methylmercury has the potential to cause unacceptable biomagnification
  - Cyanide, TBT*, PCDD/F*, PCBs* were data gaps
- Step 3: Insufficient data to support reference comparisons
- Completed a problem formulation (including conceptual exposure model) and developed a workplan for next steps

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Similarities between the two sites

- Metals and PAHs are ubiquitous at both sites, which is common to nearly all urbanized/industrial sites

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Differences between the sites

Outer Kingston Harbour

- Relatively large waterlot subject to historic and ongoing point and non-point inputs
  - Supports a gradient approach
  - Typical COPCs
- Substrates consist of sand/silts
  - Supports standard toxicity tests
  - Unlikely to confound benthic community analysis
  - Standard sampling techniques
- Appropriate reference areas are likely available

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Differences between the sites

Sault Ste Marie

- Site consists of two areas of sediment and a waterfall.
  - Need to document areas without sediment
  - Grain size may confound toxicity and benthic community analyses
  - Grab penetration likely a challenge
- Significant adjacent point-sources should be considered
  - PAHs / cyanide from slag piles
    - Bioavailability of COPCs
  - Pulp and paper mill
- Source allocation is a key consideration
  - Focus on toxicity in depositional areas as an initial tier; consider TIE techniques

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Challenges in applying the Framework

- Reference site data were not readily available for either location
  - Consider establishing regional reference areas if multiple sites in the same area is being managed.
- Data were largely limited to chemistry; COPC selection not consistent
  - Consider implementing Steps 1 – 3 only at a larger number of sites to support future management
  - Consider limited toxicity testing from worst-case areas to provide context to the likely scale of investigation needed
- Difficult to compile data from historical reports
  - Require consultants to provide original electronic files
  - Consider in-house project archiving

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Conclusions and future next steps

- Applying Steps 1 – 3 of the Framework:
  - Provided a problem formulation to meet regulatory requirements
  - Outlined systematic way to manage sites with best possible use of existing data
  - Provides consistency in terms of integrating data into an overall risk estimate
  - Clarified when and how to implement additional investigation
- Next steps
  - Re-evaluate Step 3 with newly-collected reference site data
  - Implement toxicity, benthic community and biomagnification modelling
  - Scale investigation to outcome of Step 3; consider tiering strategies

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