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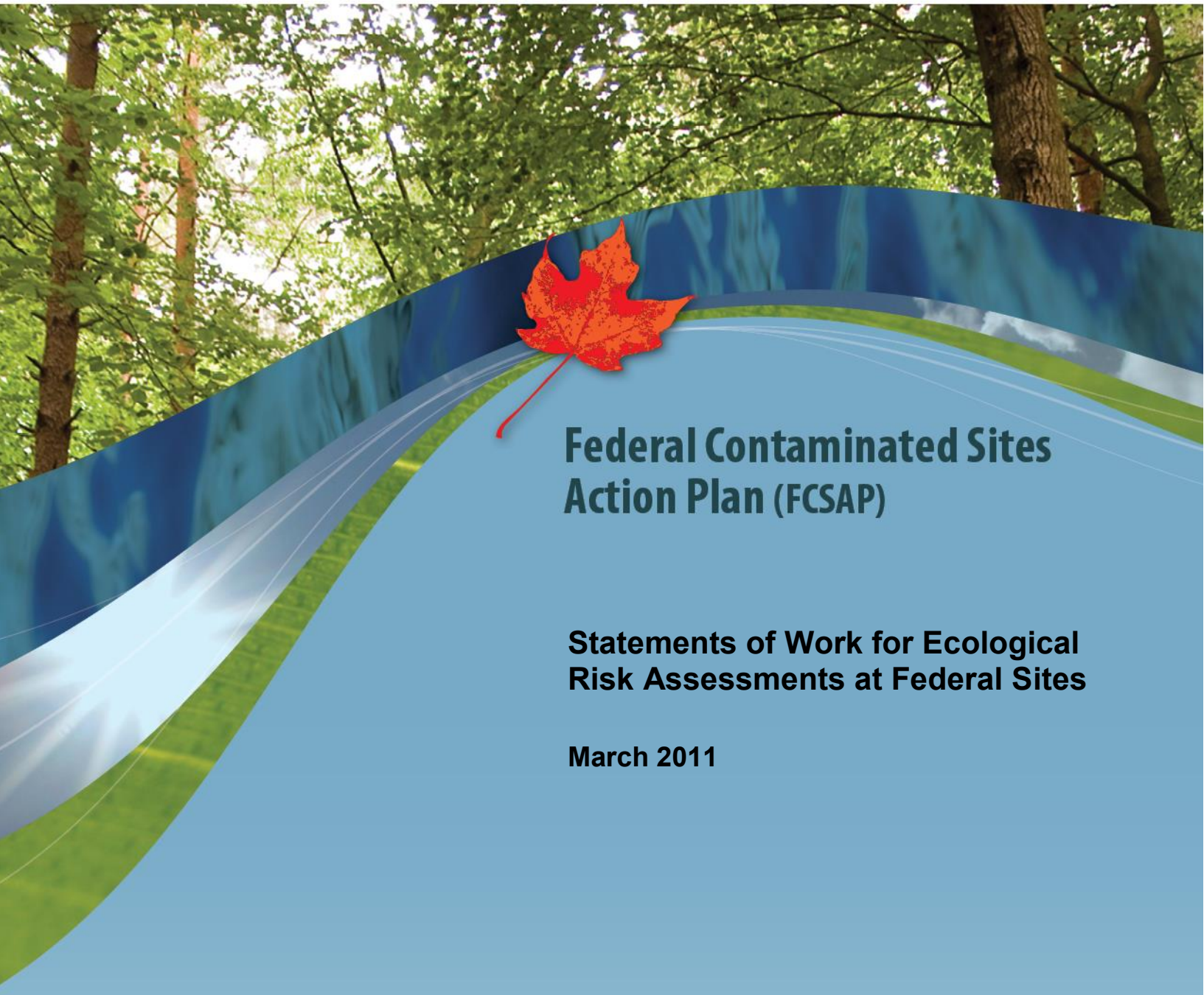

Federal Contaminated Sites Action Plan (FCSAP)

Statements of Work for Ecological Risk Assessments at Federal Sites

March 2011

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Federal Contaminated Sites Action Plan (FCSAP): Statements of Work for Ecological Risk Assessments at Federal Sites

Issued also in French under title:

Plan d'action pour les sites contaminés fédéraux (PASCF): Énoncé de travail concernant les évaluations des risques écotoxicologiques dans les sites fédéraux

ISBN no. 978-1-100-22283-7
Cat. no. En14-19/2-2013E-PDF

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1.0 INTRODUCTION

The Federal Contaminated Sites Action Plan (FCSAP) was developed to support federal departments, agencies and consolidated crown corporations in their efforts to reduce the risks to human health and the environment, as well as the financial liabilities associated with federal contaminated sites. Under FCSAP, ecological risk assessments (ERAs) are commonly used as a site management tool at federal contaminated sites. ERAs can also be driven by regulatory triggers, due diligence, or divestiture. This document provides guidance to custodians of federal contaminated sites on to the development of statements of work (SOWs) for ERAs, and provides examples of how the guidance can be applied to both terrestrial and aquatic ERAs.

1.1 Objectives

The FCSAP expert support departments that provide technical and scientific advice on ERAs include Environment Canada and Fisheries and Oceans Canada (DFO), whereas Public Works and Government Services Canada (PWGSC) has the mandate as an expert support department to develop enabling tools for project management to achieve consistent contaminated sites project delivery. One of the objectives of FCSAP guidance documents, including the Environment Canada (2011) technical guidance and this SOW guidance, is to increase the level of integrity and uniformity of ecological risk assessments performed under FCSAP. Another objective is to improve the focus of ERAs such that investigations target the potential risk pathways of greatest interest, and progress efficiently toward risk management.

The scope, level of effort, and objectives of an ERA vary among sites, and depend on a number of factors including data availability, site complexity, purpose of the study, and site management goals. The SOW guidance is designed to be sufficiently flexible to accommodate the anticipated range of site uses and complexity, while also providing a consistent framework for scoping environmental risk assessment needs. In practice, the SOW guidance should be used as a starting point and the additional site-specific details added to ensure that the expectations of the level of complexity of the ERA are clear.

The objectives of the SOW guidance are to:

- Provide custodians with a starting point for developing contractual documents for ERAs at federal contaminated sites;
- Outline the technical considerations that should be incorporated in scoping of ERAs; and,
- Promote a higher degree of consistency among ERAs performed at federal contaminated sites such that relative risks of sites can be evaluated more easily.

1.2 Structure of Guidance Document

The guidance document is structured in the following manner:

- **Section 2: Preparation of a Statement of Work** – Provides instructions on the preparation of an SOW and major elements that should be included in an SOW;
- **Section 3: Suggested Outline of an Ecological Risk Assessment** – Provides an outline of major sections and subsections that should be included in an ERA, plus a description of the expected content. Although not all subsections or content are necessarily applicable to all ERA deliverables, general use of a standardized table of contents would increase consistency among ERAs;
- **Section 4: References and Tools** – This section lists guidance documents that could be included in ERA SOWs as references. If specific technical approaches are recommended, these should be articulated in the ERA SOW;
- **Appendix A: Areas of Responsibility: Problem Formulation Checklist** – The FCSAP ERA Guidance document (Environment Canada 2012c) lists the major elements that should be included in the problem formulation. Appendix A outlines which of the major elements could be provided by the custodian in the SOW that would ensure that the objectives of the ERA and the level of detail expected are clearly articulated;
- **Appendix B: Strengthening the Statement of Work: Common Pitfalls** – Appendix B provides a list of issues encountered in developing SOWs that are common and that influence the utility and uniformity of ERAs. Where these issues are effectively framed in the SOW, the likelihood of achieving the desired study objectives increases;
- **Appendix C: Sample Statement of Work: Terrestrial Site** – Example statement of work for an ERA for a hypothetical terrestrial site;
- **Appendix D: Sample Statement of Work: Aquatic Site** – Example statement of work for an ERA for a hypothetical aquatic site; and,
- **Appendix E: Tool for Risk Assessment Validation Considerations** – Elements of the Tool for Risk Assessment Validation (TRAV) that are related to ERAs.

2.0 PREPARATION OF A STATEMENT OF WORK

2.1 General Considerations

In developing an SOW for ERA, the project authority should clearly identify project needs and provide sufficient detail and direction to the practitioner. The SOW should outline broader site management goals and articulate any specific goals of the ERA that have been identified. Although the specific methods and sampling design components are typically specified by the practitioner, a clear articulation of study purpose will help to frame the practitioner's approach. The SOW should also clearly establish the level of detail or complexity[1] expected from the analysis plus any other requirements or constraints.

The nature of the study deliverables should be described in the SOW, particularly where there are project-specific needs. In most cases, the preferred deliverable format is a stand-alone risk assessment document that meets the following core characteristics, all of which are meaningful to site custodians:

- **Transparency** – Articulation of approaches used, and rationale for important decisions;
- **Accuracy and Reproducibility** – The results are mathematically correct and can be reproduced based on the information contained in the report;
- **Defensibility** – The conclusions can be defended scientifically, are reasonable based on the application of standard risk assessment guidance, and follow a logical framework; and,
- **Comprehensiveness** – All relevant chemicals, receptors, pathways, and risks have been assessed, and key uncertainties described in terms of implications for site management.

2.2 Components of the SOW

The following subsections organize the information contained in the SOW. The organization of this chapter is aligned with the hypothetical SOW examples presented in Appendix C and Appendix D for terrestrial and aquatic sites respectively.

2.2.1 Project Title

Mandatory elements of a project title include:

- Specification of the type of assessment (ecological risks only, combined with human health assessment, or combined with other components);
- Level of Assessment (e.g., screening or detailed[1]); and,
- Site or Facility Identifier.

Other information may be incorporated in the title at the discretion of the custodian (e.g., Framework reference and relevant Steps).

2.2.2 Background

This section provides a brief summary of the drivers leading to the current stage of investigation. This includes discussion of the regulatory setting, stage of investigation, and impetus for further investigation. These factors

[1] The FCSAP ERA frameworks specify the general category of assessment (e.g., screening, preliminary, detailed); however, given the flexibility in tools and levels of detail within these categories, some context from the custodian is beneficial.

can influence how a program is designed, such as the degree to which tiering of investigations is conducted, level of detail required, or the pace of the study. Some questions for consideration include:

- Has a management Framework, such as the COA Framework or FCSAP Contaminated Sites Framework, been applied in previous investigations? If so, what stage of investigation has been completed to date?
- Is the current study linked to a contemplated management action, such as property divestiture?
- Is the current study linked to other regional investigations, such as identification as an Area of Concern, or a Remedial Action Plan developed as part of a broader scale of investigation? If so, what stakeholders have been engaged as part of these parallel investigations?

2.2.3 Site Context

The emphasis of the site context summary should be elements that relate to the overall site management strategy and project needs. These elements may not always be communicated in existing site documentation; technical reports such as environmental site assessments focus on characterization of site conditions rather than the procedural, policy, and strategic aspects of risk management.

The site context summary should provide the following information so contractors have an adequate knowledge of site issues and reporting requirements, such that they can adequately gauge level of effort and costs:

- **Site Description** – A brief description of the physical project setting, including clear identification of property or water lot boundaries, adjacent land uses, and land use classification.
- **Site Management Goals and Objectives** – This is probably the most important aspect of the SOW, because it contains strategic direction and context that must be provided by the custodian. For guidance on how to frame study needs, the custodian may consult Section 2.2.1.1 (Determining the Broad Assessment Goals) of the FCSAP ecological risk assessment technical guidance (Environment Canada 2012c). Some key questions to be addressed at this stage include:
  - Is the purpose of the investigation to evaluate current conditions only, or to extrapolate the risk assessment results to potential future conditions?
  - Is the purpose of the investigation to evaluate risks on a parcel by parcel basis, or to develop site-specific standards based on concentration-response relationships that can be extrapolated to non-sampled areas?
  - Has the desired level of protection to various receptor groups been evaluated, and has a policy decision been made by Expert Support or other regulatory input with respect to effect sizes or level of organization?

- Does the project require an assessment of causation to inform site management (e.g., are multiple parties responsible for contamination)?
- Are there known sources of disturbance (e.g., eutrophication, mechanical disturbance of sediments) that are unrelated to site contamination but that may confound assessment of site-related responses?

2.2.4 Objectives of Risk Assessment

In this section, summarize in plain language what the risk assessment is intended to achieve. Think of the key questions that should be answered in the conclusions section of the risk assessment deliverable, and use those questions to frame the risk assessment needs. If the assessment follows a federal framework, the decision points should be specifically referenced.

The practitioner will rely on this section for scoping the level of effort, so it is best to be clear regarding the need (or lack thereof) for:

- Collection of additional field data (biology/habitat, tissue, toxicity tests, or additional abiotic samples);
- Development of a formal work plan for custodian review prior to sampling;
- Risk characterization based on multiple future land use scenarios;
- Parcel-specific risk characterization;
- Site specific target levels (SSTLs); and/or
- Recommendations for future work.

2.2.5 Technical Resources

This component of the SOW describes the information repositories available to the practitioner. The SOW should list available reports and/or data compilations, and the expectations for incorporating these historical findings in the current assessment. For example:

- Are historical chemistry data to be incorporated in quantitative/geographical site contamination profiling (e.g., GIS representation), or merely to be used for screening of COPCs?
- Is additional literature review required to seek further information on site conditions, or may the practitioner rely on documentation provided from previous investigation steps? Note that site characterization information may be available from additional sources unrelated to the formal investigations led by the site custodian. Regional studies funded by Environment Canada, investigations by academic institutions or non-government organizations, and/or work by other landowners on adjacent properties may be considered.
- Are government contacts available to provide anecdotal or other information on site conditions, site history, habitat, etc.?

The primary goal of this component of the SOW is to maximize the value of previous findings (e.g., reduce the chance that important site knowledge is wasted).

2.2.6 Regulatory Framework

This component of the SOW identifies applicable protocols or guidance documents to which the ERA will adhere, such as:

- FCSAP Ecological Risk Assessment Guidance (Environment Canada 2012c);
- Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment (Chapman 2008);
- Framework for Addressing and Managing Aquatic Contaminated Sites under the Federal Contaminated Sites Action Plan (FCSAP) (Chapman 2011 e.g.); and,
- Provincial risk assessment guidance (BC CSR Guidance[2]), where appropriate (such as under specific circumstances of divestiture, off-site contaminant migration, etc.).

A listing of other references and tools is provided in Section 6 of this document. In addition to these general guidance documents, it may be useful to supply additional project-specific guidance concerning:

- Hierarchy (of identification of sources) of benchmarks (e.g., for substances that lack CCME guidelines for screening of COPCs); and,
- Role of FCSAP Expert Support staff in the conduct of the ERA. In most cases, Expert Support will provide advice, and defer to the custodian to make policy determinations (e.g., specification of protection goals). Therefore, the SOW need only indicate whether such determinations have already been made, or require review/consultation on a project-specific basis.

2.2.7 Scope

Established risk assessment frameworks have considerable flexibility in terms of the level of effort expended at each investigation stage, and in the use of tiered approaches. Therefore, the custodian must provide guidance to the practitioner in terms of the expected level of complexity and detail required. The hypothetical examples in Appendix C and Appendix D indicate common scope components.

The articulation of scope should be consistent with the investigation framework specified in Section 2.2.6 above. For example, if the current study entails application of a screening level assessment (SLA) under the FCSAP framework for aquatic sites (Chapman 2011), the scope summary should not specify application of tools that are intended for detailed level assessment.

Some guidance on the appropriate level of detail for ecological risk assessments is provided in Hill et al. (2000). The SOW should state the expectations with respect to:

- **Overall Level of Detail** – Is a screening level assessment using conservative and simplified assumptions appropriate, or should be practitioner plan for more detailed evaluations pending the outcome of the screening assessment?
- **Risk Assessment Toolbox** – The custodian should grant the practitioner some flexibility in terms of selecting specific measurement tools to suit the conditions of the site. However, some guidance on the level of complexity desired is helpful. For example, modeling studies, statistical analysis methods, and

[2] BC guidance is maintained at http://www.env.gov.bc.ca/epd/remediation/guidance/index.htm

biology/toxicology techniques all have a range of tools, each with their own combination of cost, uncertainty, and suitability for a specific site. Some examples include:

- Wildlife effects assessment – A simple assessment entails application of a generic dose- or concentration-based threshold (such as a CCME guideline developed for protection of piscivorous wildlife). A slightly more detailed approach entails customizing the guideline based on site specific receptor characteristics. A detailed assessment entails a formal assessment of effect sizes through literature review, followed by statistical dose-response assessment. A highly detailed assessment may incorporate probabilistic modeling, or in very rare circumstances, application of a feeding study using experimental animals and site-specific exposure media.

- Statistical analysis of benthic community data – A simple assessment entails calculation of summary univariate indices (abundance, richness, diversity). A slightly more detailed approach entails analysis of abundances of major taxonomic groups. A detailed assessment entails multivariate assessment of benthic community structure, evaluation of individual taxa and/or indicator organisms, and other advanced statistical tools.

- Toxicity testing – A simple assessment entails application of a single test, usually chosen based on evaluation of information from historical testing[3]. A more detailed assessment entails a battery of toxicity tests, preferably with chronic and sublethal endpoints, to support a weight-of-evidence evaluation of toxicity. A highly detailed investigation may apply sophisticated methods such as toxicity identification evaluation, modified test protocols, and/or *in situ* testing.

  The above examples provide a sense of the wide variation in the tools available, particularly at the detailed level assessment [DLA]) stage. In general, the cost of investigation increases with increasing level of detail and complexity in the tools applied, and the degree of uncertainty decreases with application of the more sophisticated tools. The custodian may not be able to recommend a precise level of sophistication along this continuum; however, if a qualitative indication can be provided (low, moderate, or high degree of complexity) this will assist the practitioner in selecting appropriate tools.

- **Potential for Iteration** – Whereas some risk assessment tools are best implemented concurrently, either for collecting synoptic data or for achieving economies of scale during sampling programs, there are many cases for which the most efficient approach is to tier the investigations. Therefore, the custodian should indicate whether a tiered approach is acceptable within the project timeline, what is expected in each iteration and specific constraints (or flexibility) for sequencing the work iteratively (e.g., schedule and fiscal factors).

- **Site-Specific Sampling Constraints** – For many risk assessments, the scope and design of a field investigation are influenced by project specific factors. Where the custodian is aware of specific constraints, they should be identified. For example:

  - Level of spatial resolution of sampling required – If the risk assessment is being used to frame potential remedial options, what density of sampling is needed to support a remedial design?

  - Site access – Are there limitations to the conditions of site access, either in terms of accessible areas or the timing of access? Private property concerns (especially for off-site sampling), potential interference with site operations, and presence of site infrastructure, may all affect study design.

[3] A single test should be applied only in situations for which the sensitivity and/or reliability of multiple tests has been previously assessed. Decision rules in common frameworks (such as Chapman 2008) assume that a test battery approach has been applied.

- Sampling at depth[4] – Is vertical characterization of contamination currently required to support assessment of potential liability and/or evaluation of remediation options? Alternatively, can characterization of contamination at depth be deferred pending an analysis of surface conditions (and sediment stability assessment for contaminated sediments)? The relevance of this issue depends on the stage of assessment, and the results from problem formulation findings (if conducted) including conceptual model and lines of evidence. For some sites, the timing of depth assessments (if needed) is a strategic issue because: (1) the decision has implications for schedule and investigation cost; and (2) the decision to refine the contaminant delineation, or apply other more detailed risk assessment tools to refine uncertainties, is partly based on risk management priorities.

2.2.8 Deliverables

This component of the SOW should articulate any special requirements or conditions for the subject work that would not be specified in contractual documents. Departures from standard guidance or protocols, if applicable, should be communicated here:

- Deliverable Requirements:
  - Problem Formulation;
  - Sampling and Analysis Plan (Work Plan);
  - Draft ERA Report; and,
  - Final ERA Report.

The custodian may append a deliverable template (see Section 3.0) to the SOW; this template will provide a clear and consistent structure to work products.

2.2.9 Project Delivery and Contracting

Schedule and Communications

The custodian should provide a high-level description of the anticipated stages of the project, including those stages where interaction/liaison or formal review is required. This information will assist the practitioner in terms of scoping meetings, windows for review, and consultation with stakeholders:

- Stages of Review by Project Authority:
  - Problem Formulation Report;
  - Sampling and Analysis Plan (Work Plan);
  - Draft ERA Report;
  - Final ERA Report;
- Communications, Site Visits, and Meetings; and,
- Project Timeline.

[4] Determination of the need for sampling at depth may not apply to the SOW, depending on the stage of investigation and the identification of relevant pathways. If the project is in earlier investigation stages, the problem formulation output may inform the relevance of depth assessment, and the custodian should await problem formulation results in these cases. In other cases (particularly for sediment assessments), the decision to conduct coring investigations (or assess stability of surface sediments) is often deferred to detailed stages of assessment, in which case the timing (or deferral) of the evaluation of deeper horizons is a decision requiring custodian input.

The level of detail to be specified under each of the subject areas itemized above is at the discretion of the Project authority or department commissioning the ERA. Greater detail will provide a basis for a more accurate estimate of time and cost on the part of bidding contractors.

Tiered Design

In general, it is desirable to sequence or tier major expenditures such that findings from one project milestone can be used to refine uncertainty in scope and costs of subsequent steps. This phased approach has the advantages of strong alignment with the tiered risk assessment framework, and allows the custodian to assess the quality/value of work products delivered before committing to additional funds. The primary drawback of this approach is that it does not provide cost certainty for the overall site investigation and risk assessment components. Accordingly, the SOW should be clear with respect to the acceptability of tiered cost proposals.

If the SOW includes supplemental data collection, the risk assessment contractor is typically provided wide discretion to review available data, identify data gaps, and make recommendations for additional data collection required to support the ERA and fulfill its stated objectives. These activities are typically conducted in conjunction with the problem formulation stage of the ERA, and therefore cannot be prescribed in detail in responding to the initial SOW. Similarly, the consultant may not be able to finalize the data collection program details when responding to an SOW, but instead may defer such details to the Work Plan stage.

Costing

Initial scoping of a supplemental data collection program (prior to Work Plan) can cause uncertainty in scope and cost; therefore, consultant submissions may vary. To assist practitioners in responding to the SOW, and to provide the custodian with the required budget information, the SOW should specify the basis for the contracted work. Some examples of contracting models are provided below.

- **Firm, Fixed Price Effort** – Where cost certainty is required, practitioners will invest more time in proposal stage and develop relatively detailed cost estimates. However, because risk of inflated scope accrues to the consultant, a contingency factor is typically incorporated. A disadvantage of this model for risk assessments is that the level of detail often cannot be predicted in advance; there could be a conflict whereby the custodian desires or requires more detailed evaluation that was not contemplated at proposal stage. This contract mechanism also discourages innovative or adaptive approaches because there is a desire to conduct the investigation according to the template used for costing purposes;

- **Partial Fixed Price, Field Program Separate** – This model requires the practitioner to provide a fixed cost for consulting and risk assessment tasks, with notional estimates provided for field and disbursement costs. As field disbursements are often a major component of overall study costs, this approach improves upon the inflexibility of the firm, fixed price approach;

- **Tiered Costing** – This model requires the practitioner to provide a fixed cost for the initial stages of assessment (e.g., Problem Formulation and Sampling and Analysis Plan), but defers costing of all supplemental data collections and risk assessment analysis/reporting stages. Once the problem formulation has been completed, the project understanding has improved, such that the envelope of potential project costs has been refined. An advantage of this approach is that the field programs can be carefully aligned with study objectives. The primary disadvantage is that the custodian may be uncomfortable with the uncertainty associated with the deferred field program costs; and,

- **Time and Effort** – This approach, generally preferred by consultants due to the limitation on financial risk, is less attractive to custodians for the same reason.

The choice of contracting model is at the discretion of the custodian; however, in specifying a contract model, he/she should be aware of the trade-off between cost certainty and the scientific value of information per dollar spent (cost efficiency).

3.0 TEMPLATE FOR AN ECOLOGICAL RISK ASSESSMENT REPORT

The following table provides a template for presentation of ecological risk assessment deliverables. In developing the SOW, the custodian may apply or modify this template, and provide to the practitioner as an attachment to the SOW. This template fulfills two objectives:

- Organize the deliverable in a clear and consistent manner; and,
- Assist the practitioner in understanding project requirements and developing the scope.

Differences in the structure and communication of ERA information can result in confusion or uncertainty on the part of the custodian. The outline below is sufficiently detailed to structure deliverables in a clear and consistent manner, while also allowing flexibility to different environments and site conditions.

Depending on the stage of investigation, some sections in this template may not be applicable, or may be simplified. For example, in a detailed ecological risk assessment it is not necessary to repeat the detailed derivation of receptor types, contaminant screening, or pathway analyses that were provided in the original problem formulation stage. However, it would be appropriate to provide a simplified summary of the problem formulation findings, with an emphasis on aspects of the conceptual model that may have changed over the course of the study.

Section No.	Report Subsections	Content
ES	**Executive Summary**	
	Executive Summary (lay friendly)	• Background and objectives • Site description • Scope • Summary of findings • Recommendations
1.0	**Introduction**	
1.1	Background and Objectives	• See *Problem Description* (Section 2.1 of this SOW guidance document, above) • Articulate framework and relevant steps • Describe site management goal(s)

Section No.	Report Subsections	Content
1.2	Site Description	• Site ownership and legal lot boundaries • Physical setting and surrounding land or water uses, including a brief description of aquatic habitats at and adjacent to the site • Current land use and, if applicable, potential future land use • Surface cover and infrastructure present • Character of surface substrate (soil, sediment) • Site history and operations (in sufficient detail with maps) • Summary of previous site investigations and remediation activities • Overview of site geology, hydrology, and hydrogeology • Identity of potential contaminants based on current and historical activities (or summarized from previous investigations)
1.3	Scope of Risk Assessment	• Overview of the scope as specified under the contract • Complexity of the risk assessment and rationale (e.g., role of tiering) • Project protocols and guidance applied
2.0	**Problem Formulation**	
2.1	Study Objectives	• Specific goal of the ERA (e.g., broad protection goals, linkage to Framework steps and decision points)
2.2	Regulatory Context	• Summary of regulatory context for site and the ERA

Section No.	Report Subsections	Content

2.3	Review of Existing Site Information (can be a standard-alone chapter, depending on complexity of ERA)	• List of relevant documentation
		• Review of previous environmental site assessments and findings, such as:
		  ○ Summary of contaminant concentrations (e.g., number of samples, detection limits, depth, media, location, date sampled, etc.)
		  ○ Screening procedures used to filter data for applicability to risk assessment (e.g., QA/QC measures, detection limits, date ranges)
		  ○ Identify data gaps and where additional information/data is required
		  ○ Delineation of high concentration areas (horizontal and vertical)
		  ○ Site map(s) of on-site buildings and infrastructure, depicting all sampling locations, measured contaminant concentrations and/or delineation of concentration gradients across the site
		  ○ Environmental sensitivity of site
		  ○ Potential contamination due to off-site sources
		• Review of previous risk-related data, if applicable, from other adjacent sites or studies:
		  ○ Receptors of potential concern
		  ○ Exposure pathways
		  ○ Other relevant information

2.4	Selection of Contaminants of Concern (or refinement if in Detailed Risk Assessment stage)	• Identification of sources of COCs
		• Identification of guideline sources (including other jurisdictions to fill gaps or provide context)
		• Summary of exposure values, as appropriate to risk assessment stage, for example:
		  ○ maximum concentration for each contaminant (for conservative screening stage or fixed receptor)
		  ○ 95^{th} upper confidence limit of the mean concentration (for mobile receptors, provided that sample size and type considerations satisfied)
		• Contaminant screening against relevant guidelines
		• Screening against local or regional background concentrations (if applicable)
		• Transport and fate characteristics
		• Additional considerations (e.g., substances with no guidelines; persistent, bioaccumulative or biomagnifying substances; degradation products)
		• Identification of contaminants of concern

Section No.	Report Subsections	Content
2.5	Selection of Receptors of Concern	Compile the following information • Habitat assessment (on-site and adjacent) • Species inventories • Species at risk assessment • Complete relevant tables from Environment Canada (2012c) guidance Identify and provide rationale for selection of receptor types, surrogate receptors and exclusion of receptor types
2.6	Exposure Pathway Identification	• Complete pathways, documenting link between source and receptor • Incomplete pathways with no documented or anticipated link between source and receptor • Complete relevant tables from Environment Canada (2012c) guidance
2.7	Conceptual Site Model	• Tabular, matrix, diagram, or pictorial representation, or combination thereof • Explanatory text to provide context to simplified conceptual model
2.8	ERA Design and Strategy	For each receptor group: • Protection goals and acceptable effect levels • Assessment endpoints • Measurement endpoints and rationale for selection of types of measurement endpoints • Lines of evidence, including rationale for selection of LOEs • *A priori* consideration of endpoint weighting (may be qualitative) in contemplation of WOE • Describe general strategy, providing overview of the approach to be used for the ERA • Describe reference areas, gradient design, or other sampling design components
2.9	Sampling and Analysis Plan (may be relegated to appendix depending on amount of detail)	• Description of how SAP is fulfilling information needs for each LOE • Field safety plan • Logistics • Sampling (chemical, biological, other) • Chain of custody • Laboratory analyses (methods, analytes, detection limits) • Quality assurance/quality control (QA/QC) • Data analyses and modelling

Section No.	Report Subsections	Content
3.0	**Exposure Assessment**	

3.1	COC Concentrations – Abiotic Media (e.g., soil, water, sediment)	• Source concentrations (direct measurement)
		• Statistical measures used to characterize media concentration and rationale
		• Consideration of spatial layout and density of samples
		• Description of ancillary parameters relevant to media (grain size, carbon content)
		• Description of biological or habitat factors that may influence contaminant fate/transport (e.g., bioturbation)
		• Evaluation of bioavailability or speciation (If applicable)
		• Description of fate and transport models used to estimate concentrations (if applicable):
		  ○ Rationale for model selection
		  ○ Summary of model assumptions and inputs
		  ○ Source concentrations
		  ○ Contaminant-specific parameters
		  ○ Relevant input parameters (geological, hydro-geological, etc.)
		  ○ Estimation of exposure concentrations (i.e., model output)

3.2	COC Concentrations – Tissues (If applicable)	• Source concentrations (direct measurement)
		• Description of method(s) used to estimate concentration(s):
		  ○ Uptake factors
		  ○ Bioaccumulation regression models
		  ○ Mechanistic bioaccumulation models

3.3	Estimation of Total Dose for Wildlife (If applicable)	• Present receptor characteristics (e.g., ingestion rates, body weights, diet proportions, etc.); consult Module C of Environment Canada (2012c) • Present moisture content and harmonize units considering dry weight or wet weight basis • Estimate home range size relative to size of the site or relevant portion of the site • Consider other dose adjustment factors (e.g., bioavailability) • Estimate dietary intake through food chain modeling
3.4	Categorical Measures of Exposure (If applicable)	• Describe comparative use of on-site versus reference conditions or spatial gradients • Develop scenarios based on assumed site fidelity • Adjust for habitat use as applicable

Section No.	Report Subsections	Content
4.0	**Effects Assessment**	

4.1	Effects Assessment Methods	For each line of evidence:
		• Describe type(s) of effects assessment measure (e.g., toxicity studies, biological studies, critical body burdens, etc.)
		• Select appropriate reference samples (or reference envelope) for statistical comparisons
		• Describe gradient design if applicable
		• Determine how contaminant mixtures will be considered
		  o Toxic equivalents
		  o Surrogate compounds
		  o Individual substance versus group totals

4.2	Observed Effects (Direct Contact Pathways) (if applicable)	• Categorize toxicity or community responses based on percent impairment relative to reference • Characterize responses based on gradient of distance-direction from source areas • Multivariate and graphical assessment of community structure (if applicable) • Results of field observations (transects, plots, underwater imagery)
4.3	Site-Specific Thresholds (Direct Contact Pathways) (if applicable)	• Derive chronic effects benchmarks for water, soil, sediment, or tissue • Account for site-specific conditions (pH, soil type, particle size, salinity, redox, hardness, etc.)
4.4	Toxicity Reference Values for Wildlife (if applicable)	• Present and describe TRV derived/adopted from literature; or • Develop continuous or discrete response profile for each COC/ROC combination Incorporate the following considerations: • Effect size associated with the study that drives the toxicity threshold • Steepness of the concentration-response • Degree to which the most sensitive study represents a larger number of experimental results or an outlying response • Concordance of sensitivity for different receptor groups • Concordance of short-term versus chronic test endpoints
5.0	**Risk Characterization**	
5.1	Relevance of Data	• List deviations that occurred during field or lab studies that could affect the relevance or weighting of the data • Confirm that ERA strategy as described in the problem formulation remains applicable, identify adjustments if required

Section No.	Report Subsections	Content

5.2	Interpretation of Lines of Evidence	• Interpret the results from the individual LOE
		• Combine exposure and effects profiles, for example:
		  ○ Concentration-response evaluation
		  ○ Hazard quotients for wildlife
		• Correlation analysis

5.3	Data Summary	• Provide simplified data summary (face value):
		  ○ New data collections
		  ○ Integrated data from recent and relevant historical collections

5.4	Weight of Evidence Evaluation	• Articulate selected WOE framework and rationale
		• Summarize each LOE based on :
		  1. Magnitude of response
		  2. Evidence for causality
		  3. Ecological relevance
		• Discuss uncertainty regarding magnitude and causality for each LOE
		• Coherence assessment linking LOE results
		• Integrate findings for all LOEs

5.5	Uncertainty Assessment	• Discuss uncertainties in:
		  ○ Site characterization
		  ○ Data collection
		  ○ Exposure assessment
		  ○ Effects assessment
		  ○ Risk characterization
		• Evaluate implications of uncertainties on risk estimates

5.6	Site-Specific Target Levels (as needed)	• Develop SSTLs • Discuss constraints/limitations to use • Include table
5.7	Discussion and Conclusions	• Clearly summarize results • Integrate all information, draw overall conclusions • Link to Framework decision rules and outcomes

Section No.	Report Subsections	Content
6.0	**Recommendations**	

6.1	Investigation Implications	• Requirements for additional assessment associated with a more detailed site-specific risk assessment
		  ○ New data collections?
		  ○ Desktop refinements (modelling, literature review)
		• Rank uncertainties in terms of importance and cost to resolve

6.2	Management Implications	• Recommended risk management/remediation measures
7.0	**References**	
Appendices		
A	Contaminant Concentration Data for Current and Previous Studies	• GIS plots, cross-sections, guideline screening tables
B	Biological Reports	• Reports for biological or toxicological studies
C	Exposure Assessment Models and Equations	• Trophic Transfer Equations
D	Contaminant Toxicity Review	• Details of TRV derivations, chronic effects benchmarks, critical body residues
E	NCSCS/ASCS Scoring (if requested by custodian)	• Updated NCSCS/ASCS worksheets • Optional item at discretion of custodian – generally is only required when applying for remediation or risk management funding under FCSAP
F	TRAV Worksheets (if requested by custodian at site closure stage)	• If further ERA iterations are planned the TRAV should only be completed when those are completed
G	Field Data	• Photos, field notes

4.0 REFERENCES AND TOOLS

For ERAs that are to be conducted strictly in accordance with available frameworks and technical guidance, little additional descriptive information on the ERA process will be required. However, technical guidance does not contemplate every scenario that may arise in the course of an ecological risk assessment, and specifics of any site could warrant the inclusion of additional or more detailed guidance.

When the project authority wants specific methods from the guidance to be applied, this should be explicitly stated in the SOW to avoid the practitioner using non-standard methods. Examples of issues that may warrant articulation of preferred guidance or protocols include:

- If the default weight of evidence framework from the FCSAP ERA guidance should be applied;
- If soil toxicity test endpoints must be from Environment Canada published test protocols;
- If non-detect value replacement assumptions in chemistry data must be harmonized with previous methods; or
- If benthic community assessments must follow Canadian Aquatic Biomonitoring Network (CABIN) (Environment Canada 2012a) bioassessment protocols.

For more complex ERAs, or where the conditions and/or requirements depart from standard procedures, the SOW should contain additional information to focus the scope and minimize variability among the submissions of bidding contractors. For example, the exclusion of exposure pathways, consideration of nonstandard receptors, compliance with provincial protocols, policy decisions, or guidelines, or completion of a detailed toxicity assessment for a given substance, would need to be specified in the SOW.

Key guidance documents and tools available for conducting ERAs at federal contaminated sites are listed below:

- *Framework for Ecological Risk Assessment: General Guidance* (CCME 1996).

  This guidance was developed to provide the general framework under which ERAs are conducted at federal contaminated sites. It provides a high level summary of the three main stages of risk assessment (screening, preliminary assessment, detailed assessment). The details of implementation are deferred to Environment Canada (2012c), although other guidance and framework documents use the general guidance as a starting point.

- *Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance* (Environment Canada 2012c).

  This guidance was developed to support federal custodians and risk assessment practitioners when conducting ERAs at federal contaminated sites. This guidance document provides a high level of technical detail on conducting many aspects of ERA and is applicable to both simple and complex sites. This guidance could be referred to in general, or specific portions therein could be prescribed for use in the SOW document. For example, the weight of evidence approach, the wildlife receptor characteristics, and other elements in the guidance document could be referenced to ensure that specific methods are used in the ERA. However, many aspects of this guidance are "principles based"; meaning that practitioners are required to consider the consequences of key technical decisions throughout the risk assessment process, but not directed to use a specific prescribed method for all situations.

  In addition to the main volume of technical guidance, detailed modules have been developed for the following components:

- Module A: Toxicity Test Selection and Interpretation (Available 2011);
- Module B: Selection and Development of Toxicity Reference Values (Available 2011);
- Module C: Standardization of Wildlife Receptor Characteristics (Available 2012); and,
- Module D: Causality Assessment (Available 2012 pending public review and translation).

- *Guidance Document: Framework for Addressing and Managing Aquatic Contaminated Sites under the Federal Contaminated Sites Action Plan (FCSAP)* (Chapman 2011).

  This risk-based framework describes the adaptive management of contaminated aquatic sites under federal custody. The framework was developed for the Aquatic Sites Working Group subcommittee of the inter-departmental Contaminated Sites Management Working Group (CSMWG), and is based on the CSMWG (1999) 10 step process for terrestrial contaminated sites (A Federal Approach to Contaminated Sites). The framework includes a four (4) tier and ten (10) step process, intended to identify sites: (1) Requiring risk management (e.g., remediation); (2) Requiring further assessment; or, (3) Eliminated from further consideration. The Framework also includes risk management and monitoring guidance.

  Aquatic sites entering the process can be eliminated from further consideration at three decision points or can be prioritized for management action(s). Contaminated aquatic sites where management action(s) are necessary remain within the process until successful remediation has been achieved and confirmed. Successful remediation is defined as a condition where there are negligible risks to human health or the environment.

- Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment (Chapman 2008).

  This guidance provides a decision-making framework for sites with contaminated sediments. Although the framework was developed for use in the Great Lakes and other water bodies in Ontario, the principles could be applied elsewhere. The framework provides a standardized approach for decision-making as it pertains to contaminated sediment. At most sites in Canada, the Chapman (2011) framework will be the default procedure for investigation of contaminated sediments. However, some programs have begun using the Chapman (2008) framework; furthermore, Chapman (2008) contains some technical details related to screening procedures and decision rules that are referenced in Chapman (2011).

- Tool for Risk Assessment Validation (Environment Canada 2012a).

  The TRAV is a quality assurance tool that forms part of the FCSAP site closure process. The tool evaluates if the risk assessment has been conducted according to prescribed guidance. Although the TRAV is not a mandatory tool, its use is strongly encouraged by the FCSAP Secretariat. Specifically, the TRAV can be used by federal custodians and the FCSAP Secretariat as a key mechanism to:

  - Document program accountability & quality assurance;
  - Set a benchmark for conducting risk assessments for FCSAP sites and promote standardization of investigations at federal contaminated sites;
  - As part of the Site Closure Tool, demonstrate that sites are meeting the FCSAP objective of reduced environmental health risk; and,

- As part of the Site Closure Tool, strengthen public confidence in the management of federal contaminated sites by verifying and documenting actions taken at federal contaminated sites.

If the project authority plans to use the TRAV (encouraged), this requirement should be included in the SOW for the consultant to complete the tool at the same time that the ERA is completed.

- Environment Canada CABIN Protocols (Environment Canada 2012b).

  The Canadian Aquatic Biomonitoring Network (CABIN) is the national biomonitoring program developed by Environment Canada that provides a standardized sampling protocol and a recommended assessment approach called the Reference Condition Approach (RCA) for assessing freshwater aquatic ecosystem condition. CABIN provides the tools necessary to conduct consistent, comparable, and scientifically credible biological assessments of streams.

- Other Provincial or Territorial Policies, Protocols or Guidance.

  Although federal guidance and policy decisions take priority, some technical matters have been explored in greater detail within provincial contaminated sites frameworks, and may assist custodians and practitioners where federal guidance is lacking. For example:

  - British Columbia Contaminated Sites – http://www.env.gov.bc.ca/epd/remediation/guidance/index.htm
  - British Columbia Science Advisory Board – http://www.sabcs.chem.uvic.ca/DERA2008.pdf
  - Ontario Brownfields Regulations –

  http://www.ene.gov.on.ca/environment/en/subject/brownfields/STDPROD_087096.html

  - Quebec Contaminated Lands – http://www.mddep.gouv.qc.ca/sol/terrains/politique/annexe_2.htm

  A caveat to the use of these sources is that they are evolving over time, and may conflict with other guidance (including federal policies and procedures).

- *FCSAP National Contaminated Sites Classification System (CCME 2008)*

  The Canadian Council for Ministers of the Environment (CCME) has developed an electronic ranking tool for federal sites called the National Contaminated Sites Classification System (NCSCS) (CCME 2008). CCME (2008) is an update of an earlier tool developed in 1992 to establish a rational and defensible system for comparable assessment of contaminated sites across Canada and is also used to prioritize the investigation and remediation of contaminated sites. There are five possible NCSCS outcomes that indicate the level of priority for action at the Site.

  For the NCSCS and the ASCS (discussed below), the ranking tools should not be applied as a default procedure at every project stage, but rather only where the custodian sees benefit in revised rankings and where rankings will meaningfully influence FCSAP funding and/or risk management decisions.

- *FCSAP Aquatic Sites Classification System (ASWG 2009).*

  The Aquatic Sites Classification System (ASCS) is similar to the NCSCS but it is designed for aquatic systems. The Aquatic Sites Working Group (ASWG) was established as a subcommittee under the Contaminated Sites Management Working Group (CSMWG) in order to develop guidance for classifying, assessing, and managing federal aquatic (marine and freshwater) sites. The ASCS is intended for aquatic sites which are defined as “a water lot or land/part of land that is completely, partially, or occasionally

submerged by water". This includes the zone where shallow groundwater and surface water mix but excludes deep groundwater and is intended to apply to both marine and freshwater sites. The classification system parallels that used by the NCSCS and incorporates a well-defined approach for applying numerical scores, particularly for qualitative considerations such as potential receptors and exposure pathways. Although the ASCS is intended to maximize consistency in scoring evaluations, it is not intended to provide a general or quantitative risk assessment, but rather is a tool for screening-level identification and prioritization of contaminated aquatic sites within the FCSAP program.

The SOW should state the stage of investigation (and deliverables) at which the above classifications should be applied (or revised).

5.0 CITATIONS

ASWG (Aquatic Sites Working Group). 2009. *Aquatic Site Classification System (ASCS)*. Developed by Franz Environmental Inc. in collaboration with the ASWG and the CSMWG (Contaminated Sites Management Working Group).

CCME (Canadian Council of Ministers of the Environment). 1996. A Framework for Ecological Risk Assessment: General Guidance. National Contaminated Sites Remediation Program. Canadian Council of Ministers of the Environment, Winnipeg MB.

CCME (Canadian Council of Ministers of the Environment). 2008. *National Classification System for Contaminated Sites: Guidance Document*. Canadian Council of Ministers of the Environment, Winnipeg MB.

Chapman PM. 2008. *Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment*. Prepared by Peter Chapman (Golder Associates Ltd.) with the COA Sediment Task Group on behalf of Environment Canada and the Ontario Ministry of the Environment under the Canada Ontario Agreement. March 2008.

Chapman PM. 2011. *Guidance Document: Framework for Addressing and Managing Aquatic Contaminated Sites under the Federal Contaminated Sites Action Plan (FCSAP)*. Revised Final Report. Prepared by Golder Associates Ltd., Burnaby BC, for the Aquatic Sites Working Group (ASWG), Contaminated Sites, Habitat Program Services Branch, Fisheries and Oceans Canada (DFO), Ottawa, ON. March 14, 2011.

Environment Canada. 2012a. Tool for Risk Assessment Validation. Prepared by Public Works and Government Services Canada and the Federal Contaminated Sites Action Plan (FCSAP) Secretariat at Environment Canada, supported by the science-based Expert Support Departments (Health Canada, Environment Canada, and Fisheries and Oceans Canada) in conjunction with the Site Closure Tool (SCT) within FCSAP.

Environment Canada. 2012b. Canadian Aquatic Biomonitoring Network (CABIN). Available at: http://www.ec.gc.ca/rcba-cabin/default.asp?lang=En&n=72AD8D96-1.

Environment Canada. 2012c. *Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance*. Prepared by Azimuth Consulting Group, Vancouver BC for Environment Canada, Pacific and Yukon, Environmental Stewardship Branch, Vancouver, B.C. February 2012.

Golder Associates Ltd. (2008). *Detailed Ecological Risk Assessment (DERA) In British Columbia – Technical Guidance*. Final – 2008 Revision. Submitted to Science Advisory Board (SAB) for Contaminated Sites in British Columbia. September 3, 2008.

Hill RA, Chapman PM, Mann GS, Lawrence GS. 2000. Level of Detail in Ecological Risk Assessments. *Marine Pollution Bulletin* 40(6): 471-477.

APPENDIX A

Areas of Responsibility – Problem Formulation Checklist

AREAS OF RESPONSIBILITY – PROBLEM FORMULATION CHECKLIST

One of the challenges of developing an SOW is distinguishing between:

- Responsibilities of the custodian in framing the issues and providing guidance; and,
- Responsibilities of the practitioner in implementing the planning and design components of an ERA.

The FCSAP risk assessment guidance (Section 1.4) acknowledges these roles and responsibilities, stating that "it is appropriate for site custodians, expert support departments and risk assessors to proactively encourage communication and early involvement of the various parties in the ERA process."

One way of improving the clarity of these interactions is to specifically consider each major component of a problem formulation. The problem formulation is the stage of an ERA where issues are framed, context is provided, and the general approach to conducting the technical aspects of an ERA is summarized. By "beginning with the end in mind," the custodian can step through each problem formulation element and confirm the following:

- Whether the element is discussed in the SOW;
- Whether the issue is sufficiently resolved/framed; and,
- Which party/parties are responsible for conducting further assessment of the element.

The following problem formulation elements are extracted directly from the FCSAP risk assessment guidance (Section 2). The following table (Table A-1) provides a checklist that can be used by custodians during SOW development; it may assist in identifying gaps in the SOW or uncertainties that the custodian wishes to engage the practitioner in resolving. Table A-1 also identifies the various levels of involvement of the custodian for each element, which are (in decreasing level of involvement):

- Lead – Mandatory for custodian to clarify, preferably in SOW;
- Initiator – Necessary for custodian to begin, but responsibility transitioning to practitioner; responsibilities should be clarified in SOW;
- Participant – Optional for custodian to be involved; there may be specific issues for which they can provide context, but otherwise practitioner is the lead; and,
- Reviewer – Involvement is generally limited to review of deliverables by the custodian, who may consult with Expert Support. Practitioner should always incorporate in-house senior review of each stage /element.

Table A-1 can serve as a checklist (optional) for the custodian during SOW development to determine whether the SOW effectively articulates roles and responsibilities, and whether important context for the project has been provided.

Table A-1: Problem Formulation Key Elements

Element (FCSAP Guidance Section)	Definition	Typical Responsibilities	SOW Considerations for Custodians
Site Management Goals (Section 2.2.1)	Description of the site management goal(s) and the specific assessment goal(s) of the ERA.	Custodian is lead	Very important that custodian articulate the management objectives in the SOW (overall purpose of ERA, type of assessment required, need to discern causality, need for extrapolating to future conditions).
Regulatory Context (Section 2.2.2)	Review of the regulatory context for the site and the ERA, including applicable legal instruments and policy.	Custodian is lead	Custodian must identify the regulatory framework, land use designations, and risk framework (e.g., COA Sediment Framework or FCSAP Aquatic Sites Framework).
Existing Site Information (Section 2.2.3)	Review of existing site information, including at a minimum a list of relevant documentation, a site description, and a summary of key findings from previous investigations.	Custodian initiates; Practitioner completes	Custodian must identify the information repositories that are mandatory to include in the ERA, and identify whether the practitioner is to conduct supporting reviews to identify additional sources. Custodian should specify who is responsible for obtaining copies of reports and/or contacting agencies for additional information.
Contaminants of Concern (Section 2.2.4)	Selections of contaminants of concern (COCs) and descriptions of their characteristics that are relevant to the ERA.	Custodian participates; Practitioner completes	Custodian should specify preferred sources of benchmarks where CCME guidelines are unavailable (i.e., hierarchy of jurisdictions) or recommend other sources of screening values. Practitioner responsible for formal screening of COCs.
Receptors of Concern (Section 2.2.5)	Selection of receptors of concern (ROCs) that could be affected by contamination and that will be evaluated in the ERA. Receptors can be identified at the level of individual organisms, species, populations, etc.	Custodian may participate; Practitioner completes	Custodian should communicate where there are known species of special interest based on previous stakeholder discussions (social, economic, or cultural importance). Practitioner selects remaining ROCs based on formal listed/endangered status, representative guilds, or specific risk pathways.
Exposure Pathways (Section 2.2.6)	Identification of the exposure pathways by which COCs may come into contact with the receptors of concern.	Custodian may participate; Practitioner completes	In most cases, this stage is led by the practitioner following technical ERA guidance. In special cases (e.g., dermal contact pathways to birds, inhalation pathways to burrowing mammals), consultation with regulators may be required, with custodian involvement.
Conceptual Site Model (Section 2.2.7)	Development of a conceptual site model (CSM) that shows the potential links between source of contaminants, exposure pathways, and receptors of concern.	Custodian may review; Practitioner completes	The details of CSM format and content are typically not specified in the SOW, but rather are left for the practitioner to prepare. The custodian may wish to specify in the SOW the type of CSM they prefer (e.g., pictorial, tabular).

Element (FCSAP Guidance Section)	Definition	Typical Responsibilities	SOW Considerations for Custodians
Protection Goals (Section 2.3.1)	Clarification of protection goals and associated acceptable effect levels (AELs). Typically, protection goals and AELs may vary by land use or by receptor (e.g., species at risk may be afforded a higher level of protection than common species).	Custodian may participate; Practitioner completes	Definitions of protection goals are a continuing area of development, particularly for Environment Canada. If policy decisions or regulatory liaison may provide context for the AELs or other protection goals, the custodian should communicate such in the SOW. Alternatively, the custodian may wish to assign the liaison role to the practitioner.
Assessment Endpoints (Section 2.3.2)	Identification of assessment endpoints, which are attributes of receptors (the entities that are to be protected), often with specific spatial and temporal components.	Custodian may participate and will review; Practitioner completes	If the custodian is aware of valued ecosystem components that should be framed as assessment endpoints, this context should be communicated to the practitioner. Otherwise, the custodian can defer involvement to the review of the problem formulation (a required review point) ensuring that assessment endpoints are in alignment with site management goals.
Measurement Endpoints (Section 2.3.2)	Identification of measurement endpoints, which are the tools used to measure exposure for, or effects on, a receptor, or to measure changes in attributes of assessment endpoints.	Custodian may review; Practitioner completes	Generally, the practitioner is responsible for translating the assessment endpoints into measurable attributes. If the custodian has interest in the level of organization, or the spatial scale of the local population, this input is typically provided during problem formulation discussions rather than in the SOW.
Lines of Evidence (Section 2.3.4)	Development of lines of evidence for each assessment endpoint, which specify how measurement endpoints will be used to evaluate potential risks.	Custodian may review; Practitioner completes	Generally, the practitioner is responsible for framing the individual lines of evidence. The custodian may provide input on the potential benefits/constraints of field studies or toxicology endpoints given their knowledge of the site conditions, but this is rarely specified in the SOW.
ERA Design/Strategy (Section 2.3.5)	Articulation of the general strategy for the ERA including how risk characterization will be conducted, and a sampling and analysis plan (SAP).	Custodian may participate; Practitioner completes	The custodian should provide input on the potential for phasing/sequencing of the study, or other scheduling/logistical constraints. Other aspects of study design are left to the practitioner.

APPENDIX B

Strengthening the Statement of Work – Common Pitfalls

STRENGTHENING THE STATEMENT OF WORK – COMMON PITFALLS

The following paragraphs summarize some common issues encountered in the framing of an ecological risk assessment. By considering these issues, it may be possible to customize the SOW to provide clarity and consistency in submissions.

1. Study Purpose

In ecological risk assessment, provision and consideration of context are important. The priorities for site management, when articulated well, will assist the practitioner in the development of a study design that meets custodian needs. Does the study need to determine whether observed responses are linked to a specific source or toxicant? Is the work driven by external factors such as schedule for divestiture, maintenance dredging, or regulatory triggers? Can the study be tiered for efficiency? These types of considerations are important, and should be highlighted in the SOW.

2. Site Definition

The definition of the site should include not only the legal lot boundaries, but also the spatial domain of the area of interest. The latter may include off-site areas for the purposes of assessing regional reference conditions, contributions from nearby sources, or comparisons to other studies. If contamination from the custodian's site has migrated off-site, the study will need to address this off-site contamination.

3. Degree of Prescription

The degree of discretion (professional judgement) that you wish to grant your practitioner should be considered. For example, weight-of-evidence frameworks vary widely in terms on the level of objectivity. In the SOW, it is possible to prescribe the degree to which you wish the ERA to conform to a specific format. It is also possible to specify the oversight and review process for key decision points in the study.

4. Historical Context

Listing resources in the SOW is a start, but it is common for important information to be skipped over in the problem formulation. Where important background research is available, you may want to require the practitioner to explain how each historical study informed their decisions, especially for selection of study tools.

5. Level of Detail/Uncertainty

For detailed risk assessments, there is a wide range of potential tools and levels of effort that can be applied at each stage. In general, as the level of investigation increases, the resolution of results increases and uncertainty decreases. If there are specific management needs or constraints (provide examples) that would inform the appropriate level of detail, these are best addressed up front.

6. Cut and Paste Approaches

Practitioners may have favourite tools that they have comfort with, either due to technical familiarity, or successful experience at other sites. When preparing an SOW and reviewing proposals, look for ways to guard against approaches being selected due to convenience, rather than site-specific merit.

7. Spatial Aggregations

The groupings of stations that make sense from a technical or scientific perspective may not be the best choices from an administrative or practical perspective. If there is a basis for partitioning the site based on known management needs (e.g., development plans), these should be specified as early as possible.

8. Reference Approach

In conducting ecological risk assessments, study designs can be based on comparisons to reference(s), gradient designs, or a hybrid of both. There is danger is relying solely on one method. You may want to think of contingencies in case suitable references are difficult to obtain (n.b., there should be a minimum of 2 reference stations, with 3 or more being more acceptable), or chemical gradients are not easy to predict.

9. Alteration versus Impairment

In articulating study goals, consider the distinction between an alteration (can be good, bad, or neutral) and an impairment (net loss of ecological function). For some stressors, particularly when there is organic enrichment or changes in habitat, it is common to identify changes in biological metrics but the ecological significance of these changes can be more challenging to discern. In developing your SOW and reviewing study design, consider how the potential tools may discriminate between these factors.

10. Non-scheduled Substances

Comparisons to guidelines and criteria are only one means of identifying contaminants of concern. There are far more substances without guidelines than with them. If your site contaminants potentially include uncommon or ‘emerging’ substances (phthalates, pharmaceuticals, etc.), or contaminants that can cause both physical and chemical impacts, such as wood waste, consider the procedure proposed to identify and evaluate these COCs.

APPENDIX C

Sample Statement of Work 1 – Terrestrial Site

1. Project Title

Ecological Screening Level Risk Assessment for *XYZ Maintenance Compound*

2. Background

The Federal Contaminated Sites Action Plan (FCSAP) represents a commitment by the federal government to remediate its highest risk sites. Determining the risk that these sites present to humans and the environment is not an exact science. However, standard approaches to ecological risk assessment (ERA) are very useful in providing transparent and scientifically based priorities for management action.

To provide a basis for potential remedial funding for the *XYZ Maintenance Compound*, *[Custodial Department]* is commissioning an ecological screening level risk assessment (SLRA) to quantify potential ecological risks from previously identified soil and groundwater contamination at the site. Human health risks are being evaluated under a separate contract.

3. Site Context

The site is a maintenance compound located approximately 2 km east of the town of *[Town Name*], located in rural British Columbia. The Site is currently abandoned and has been in disuse since 2004. A map showing the legal lot boundaries, rights of way, and ownership of neighbouring land parcels is provided in *[Drawing Reference]*.

Surrounding land use includes permanent and seasonal residences approximately 200 m to the south, and a highway to the north with a forested recreational area beyond the highway. A private campground is located to the west, and a provincial wildlife management area and Crown lands are located to the east of the site. A number of private and community wells exist in the area.

The land parcel and two adjacent lots owned by *ABC Corporation* are presently zoned as industrial land use. However, mixed residential and commercial land uses are found within 200 metres of the legal site boundary, and parkland use applies to the provincial wildlife management area north of the Site. No agricultural uses are known to occur within the *[Town Name*] limits.

The Site is a 10 ha area and includes numerous storage, workshop, office and garage buildings, an administration centre, outdoor parking, storage areas and approximately 4 ha of undeveloped forested land. Underground fuel storage tanks were previously located at the site, to the north of the garage building; these tanks were removed in 1989 and an underground waste oil tank was removed 1994. An environmental site assessment conducted in 1997 identified petroleum hydrocarbon contamination in soil and shallow groundwater in the vicinity of the former underground fuel storage tanks as well as metals contamination in soil around the active maintenance area.

The *[Custodial Department]* is seeking closure of the property, and is not currently contemplating divestiture or sale of the property. Nevertheless, the [Custodial Department] wishes to explore the contamination under both federal and provincial frameworks in the event that transferral of property rights is entertained in the future.

The current stage of site investigation is Phase II Environmental Site Investigation. These investigations have identified soil and groundwater contamination by total petroleum hydrocarbons and polycyclic aromatic hydrocarbons in excess of CCME generic soil quality guidelines for commercial/industrial use and Canada Wide Standards for Petroleum Hydrocarbons. Soil contamination above guidelines is restricted to the area adjacent to the garage building. In addition,

minor exceedances of federal interim groundwater criteria for two metals (lead and zinc) were observed throughout the property, including vegetated portions; these concentrations are found at similar levels across the site, and may reflect background levels in the mineralized zone of this region.

Because the *[Custodial Department]* is not actively using the Site, nor currently divesting the property, we wish to evaluate the Site contamination in a phased, efficient manner. Other key considerations include:

- The site has not been categorized according to the FCSAP Contaminated Sites Framework. We wish to rank the site contamination using the CCME (2008) National Classification System for Contaminated Sites, such that potential liability associated with this site can be compared to other sites in the region.

- The site has become overgrown since it was abandoned, and significant regrowth of weedy vegetation has occurred along previously developed areas including the access road and parking lot.

- We understand that the neighbouring ABC property was issued a Certificate of Compliance by the BC Ministry of Environment in 2009, following application of a risk assessment following the Contaminated Sites Regulation (CSR) process. Although there are differences in the federal and provincial regulatory frameworks, we wish to learn from the experiences at the neighbouring site.

- The issue of regional elevations of lead and zinc has been explored by DEF Mining Corporation as part of their regional Environmental Assessment for the proposed Fictional Project Expansion. Soil and surface water samples have been collected in the region, including within the provincial wildlife management area; these data may support the evaluation of the environmental significance of lead and zinc contamination, and natural background levels of these substances.

- Due to the potential future application of the provincial contaminated sites framework, we require a level of delineation and analysis that would support a detailed (DSI) level characterization and associated risk assessment under the provincial CSR. We understand that the technical guidance for the Province is more prescriptive in this regard; therefore, an important aspect of this study is the identification of gaps or additional information needs.

- With the exception of metals, the contaminants and industrial processes at the neighbouring ABC property are dissimilar to the contamination profile on the *XYZ Maintenance Compound*. Therefore, we do not require an assessment of adjacent sources of contamination, nor is a causal assessment required for any observed effects.

4. Objectives of Risk Assessment

The objectives of the SLRA for *XYZ Maintenance Compound* are to:

- determine whether unacceptable ecological risks may be present at the site;
- determine whether reclassification of the site (land use and/or divestiture) would affect the conclusions reached above; and,
- prioritize the site, and parcels therein, for potential remedial funding under FCSAP.

The SLRA is to be undertaken based on existing conditions at the site and future conditions associated with the following scenarios: (1) conversion to light commercial land use; and (2) continued light industrial land use.

Due to the heterogeneity of the site, we recommend identification of potential management units based on proximity to the Areas of Concern identified in the Phase II Environmental Site Investigations, specifically:

- AOC 1 (Garage Area) - Total hydrocarbons, PAHs, and metals;
- AOC 2 (Tank Removal Area) - Total hydrocarbons, PAHs, and metals;
- AOC 3 (Storage and Vehicle Area) - PAHs and metals; and
- AOC 4 Undeveloped lot (metals only).

Wildlife receptors that integrate exposure across all AOCs may be considered as a single local population.

Site specific target levels (SSTLs) should be derived for any contaminants where unacceptable risks are identified. However, it is not expected that SSTLs will be developed based on this SLRA. Rather, the SLRA should identify which, if any, of the four AOCs warrants a detailed quantitative level assessment (DQRA). Although the DQRA is not part of this scope, the SLRA should contemplate how subsequent risk assessment stages could support SSTL development.

5. Technical Resources

- *Phase I Environmental Site Investigation,* ABC Environmental Ltd., March 22, 1996
- *Phase II Environmental Site Investigation,* ABC Environmental Ltd., May 16, 1997
- First Consulting Company Ltd. Detailed Ecological Risk Assessment for ABC Industries Site, Town Name, BC. February 4, 2007.
- Second Consulting Company Ltd. Preliminary Quantitative Risk Assessment for DEF Industries Site, Town Name, BC. March 14, 2010.
- Another Consulting Company Ltd. Environmental Studies to Support Soil, Vegetation and Wildlife Assessment for Fictional Project Expansion. June 8, 2009.

Data from available reports should be incorporated in the SLRA.

6. Regulatory Framework

The SLRA will be conducted using the following protocols and guidance documents:

- *FCSAP ERA Guidance (Environment Canada 2012);*
- *Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil* (CCME 2008a, 2008b);
- *National Classification System for Contaminated Sites: Guidance Document* (CCME 2008c);
- *Detailed Ecological Risk Assessment (DERA) In British Columbia – Technical Guidance* (Golder 2008).

Data should be screened using CCME guidelines and supplemented with BC provincial standards for soil and groundwater. If CCME guidelines are not available, provincial values should be used preferentially. Non scheduled substances should be evaluated using comparisons to background data provided in *Another Consulting Company Ltd.* (2009).

Where discrepancies are found between the FCSAP ERA guidance framework and the BC ERA guidance framework, the former shall take precedence for preparation of the deliverable. This includes issues of receptor selection, and technical policy determinations (pathways, protection goals, etc.). However, such areas of departure shall be documented such that the custodian will be aware of potential issues for extension of ERA findings to the provincial framework.

Where weight of evidence (WOE) is required, the project shall apply the default federal framework (Environment Canada 2012) rather than the provincial framework, although we understand that the latter is sufficiently flexible to accommodate a range of approaches.

7. Scope

The project will consist of three main tasks:

1. **Historical data review –** The referenced reports will be reviewed together with publicly available information pertaining to surficial geology and hydrogeology, land and water use, and species at risk. A brief literature review should be conducted to evaluate the regional significance of metals contamination in the watershed.

2. **Site visit and data collection –** The contractor (using a qualified professional biologist) will conduct a site visit to ensure an understanding of ecological attributes of the site. These attributes should include basic site characteristics, habitat types and receptors common to the site. Observations should also be made regarding ecosystem health in areas of contamination and comparatively in areas with no impacts. These observations should be incorporated into the SLRA. Based on the outcomes of the problem formulation, an additional sampling program may be required to support the SLRA and resolve data gaps. The chemical characterization of the site must be adequate to support risk assessment under both the provincial and federal contaminated sites regimes.

   A formal Work Plan is not required for the initial site visit. However, should collection of environmental samples be identified as necessary, these sampling components should be considered under Task 3 (below) during problem formulation, and a sampling/analysis plan preparation for client review prior to data collection.

3. **Risk assessment** – An ecological SLRA will be conducted in compliance with FCSAP ERA guidance. The SLRA is intended to apply literature-based evaluation of effects (toxicity thresholds), applying a similar level of investigation as that used for the *Second Consulting Company Ltd.* (2010) assessment of the nearby DEF Industries Site. Specific phases of the risk assessment deliverable will include:

   - Problem Formulation – identification of chemicals of concern (COCs), potential ecological receptors, and exposure pathways. Discussion of information gaps and ERA design and strategy, including identification of measurement and assessment endpoints. A sampling and analysis plan (SAP) is to be prepared in conjunction with the Problem Formulation if additional environmental samples are proposed to be collected in support of the ERA.
   - Exposure Assessment – quantification of the estimated exposure of each ecological receptor to each COC, using conservative exposure scenario assumptions and, where appropriate, simple fate and transport models. Wildlife receptor characteristics provided in the FCSAP ERA guidance document should be used.

- Effects Assessment – determination of appropriate toxicological reference values consistent with FCSAP ERA guidance recommendations. Point estimate TRVs may be used for screening assessment (e.g., USEPA Eco-SSL screening values). Dose-response assessment shall be deferred to the detailed level investigation as needed.
- Risk Characterization – draw together exposure and effects information, incorporate hazard quotients, visual observations, and information on comparisons to reference. Conduct uncertainty analysis.
- Discussion and Conclusions – including weight of evidence determination for each receptor group.
- Recommendations – must be made separately for each AOC, with recommendations for the type and position of additional sampling required, plus recommendations for how to reduce uncertainty through application of detailed investigation tools.

8. Deliverables

The SLRA report and any accompanying material may be provided in the official language of choice of the contractor. As noted above, the report should be self contained, including all relevant supporting data, and should include the sections and content recommended in FCSAP guidance.

The deliverables will include:

- Problem formulation report (draft version for review, and final version with comments/concerns addressed);
- Sampling and analysis plan (may be combined with above);
- Draft ERA report; and
- Final ERA report.

The deliverables shall be submitted in editable digital format (MS Word™ and spreadsheets in MS Excel™). The final report will address all comments provided during the *[custodial department]* review of the draft. The *[custodial department]* will also engage the provincial Ministry of Environment to solicit input on harmonizing the federal and provincial risk frameworks; however, the *[custodial department]* will perform this liaison function and will provide a single set of consolidated comments that incorporate the views of FCSAP Expert Support and other stakeholders.

The contractor may be required to discuss the comments on the draft report in order to clarify or confirm any outstanding questions or comments. **Four (4)** bound hard copies of the final report are required, as well as a digital (MS Word™ or Adobe Acrobat™) copy. The final report should be signed.

A detailed report will be prepared documenting the input data, methods, and results of the ERA. The report should include and adequately address the sections provided in the suggested outline [*refer to an appendix with the suggested outline, for example the one in Section 3 of this guidance*] is this the final ERA report or a 5th report?

Bidders should refer to the FCSAP ERA guidance for further information and details concerning the expected content of each section of the risk assessment report.

The report should undergo an internal senior technical peer review to confirm that data from the environmental site investigation(s) are correct, that appropriate ecological-based screening guidelines are used, and calculations have been checked. The report should be reviewed by a professional editor. Unclear language or typographical mistakes that impair the understanding of the report will result in the report being rejected and returned to the consultant for correction at the consultant's

expense. No deadline extensions will be considered for this deficiency. The report should be self-contained, including all data necessary for a reviewer to evaluate the SLRA. The report should incorporate the following qualities:

- Transparency – Articulation of approaches used, and rationale for important decisions.
- Accuracy and Reproducibility – The results are mathematically correct and can be reproduced based on the information contained in the report.
- Defensibility – The conclusions can be defended scientifically, are reasonable based on the application of standard risk assessment guidance, and follow a logical framework.
- Comprehensiveness – All relevant chemicals, receptors, pathways, and risks have been assessed, and key uncertainties described in terms of implications for site management.

An appropriate professional limitations statement may be provided that is consistent with the standards of care for the practice of environmental risk assessment.

The report should clearly describe any aspects of the SLRA that deviate from the referenced protocols and guidance documents listed above, and should document important assumptions made by the contractor that influence risk estimates. The report should contain recommendations with respect to further work, such as further data collection (if required), more detailed risk assessment and recommendations for remediation and/or risk management proposals. In particular, the report should identify any issues representing significant risks to ecological health that may require immediate mitigative action.

Additional considerations:

a. Risk assessment reports must be accompanied by NCSCS scores; and
b. The TRAV worksheets must be completed.

9. Project Delivery and Contracting

Costing
Bidders must provide the following cost information in the proposal:

- Breakdown of costs by major task item and allocated staff; and,
- Estimated hours and fully loaded hourly rate for each assigned staff member.

The cost proposal must include a firm, fixed price for the preparation of a final problem formulation and sampling and analysis plan, and for the preparation of a draft and final SLRA report. Costs for field sampling, analytical costs, and field disbursements should be estimated, but can be provided as a separate cost from the fixed price consulting component.

Schedule
It is anticipated that the contract will be awarded by *[date]*. The timeline for the project is as follows:

- *[date]* – project kickoff meeting.
- *[date]* – all relevant reports and data to be forwarded to contractor.
- *[date]* – draft problem formulation report to be submitted to *[custodial department]* for review.
- *[date]* – draft sampling plan report to be submitted to *[custodial department]* for review.
- *[date]* – draft SLRA report to be submitted to *[custodial department]* for review.
- *[date]* – comments on the draft report to be forwarded to the contractor.

- *[date]* – final SLRA report to be submitted to *[custodial department]*.

Communications/Meetings

A kickoff meeting will be held upon contract award, in a manner and venue (e.g., face-to-face, teleconference) to be determined by the project authority. Travel costs for meetings, if necessary, will be negotiated as separate scope/cost items and should not be included in this proposal.

Progress meetings will be held upon submission of the problem formulation report and the draft report to discuss the direction of the SLRA and the findings.

The contractor shall remain in regular contact with the project authority either by telephone or e-mail to ensure that the project is progressing according to schedule and that any required information is made available.

The project authority for this project is *[name and contact details]*.

APPENDIX D

Sample Statement of Work 2 – Aquatic Site

1. Project Title

Ecological Detailed Quantitative Assessment for Sediments of *XYZ Ship Repair Facility*

2. Background

The Federal Contaminated Sites Action Plan (FCSAP) represents a commitment by the federal government to remediate its highest risk sites. Determining the risk that these sites present to humans and the environment is not an exact science. However, standard approaches to ecological risk assessment (ERA) are very useful in providing transparent and scientifically based priorities for management action.

To provide a basis for potential remedial funding for the *XYZ Ship Repair Facility*, *[Custodial Department]* is commissioning a detailed quantitative assessment (DQA) to further delineate contamination and quantify potential ecological risks from previously identified sediment contamination at the site. This work will build upon previous screening and preliminary level assessment for the affected property. Human health risks are being evaluated under a separate contract.

3. Site Context

The Site is a former ship maintenance and repair facility located on federal property located within the harbour of *[Town Name]*, located in the Great Lakes Region of Ontario. A map showing the legal water lot boundaries, rights of way, and ownership of neighbouring land parcels is provided in *[Drawing Reference]*.

The former shipyard has not been active since 1971, and there are no longer any buildings at the site. The historical uses that have been identified are:

- Shipyard operations dating back to World War II;
- Creosote and asphalt storage and use between 1973 and 1976; and
- Lumber mill operation 1978 until 1987.

Surrounding land use includes port facilities, a marina, and an industrial park located upgradient of the Site. These uses fall within a complex mosaic of urban site uses including industrial and commercial land use, transportation corridors, and a wastewater treatment plant. The bulkhead and water lot encompass 10 hectares in total area. The upland land parcel and adjacent lots are presently zoned as industrial land use; this designation is expected to remain for the foreseeable future given the highly industrialized nature of the water lot and adjacent harbour.

The water lot consists of rip-rap foreshore and bulkhead facilities grading to soft sediment throughout much of the water lot. The water lot sediment is similar to much of the harbour of *[Town Name]* with the exception that mechanical disturbance from prop scour has affected much of the Site, whereas macrophyte coverage is prevalent in other parts of the harbour.

The *[Custodial Department]* is seeking closure of the property, and is not currently contemplating divestiture or sale of the property. Nevertheless, the *[Custodial Department]* wishes to explore the contamination under the FCSAP framework to address legacy contamination from historical site use. The *[Custodial Department]* is applying the Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment (Chapman 2008) for assessing and managing contaminated sediments at the Site. This Framework was developed on behalf of Environment Canada and the Ontario Ministry of the Environment under the Canada Ontario Agreement.

Previous work at the Site under the COA Framework consisted of a Screening Evaluation (Steps 1 through 3), followed by a Preliminary Quantitative Assessment (PQA; Steps 4 and 5), and identified potential environmental risk (including potential risk due to biomagnifying substances) for much of the water lot. However, this PQA relied on conservative assumptions in the face of uncertainty, and applied a relatively coarse level of spatial analysis.

The *[Custodial Department]* wishes to advance the investigation to include Steps 6 and 7 and Decision Point 5 of the COA Framework. The following excerpt from the COA Framework shows the linkage between PQA and DQA components.

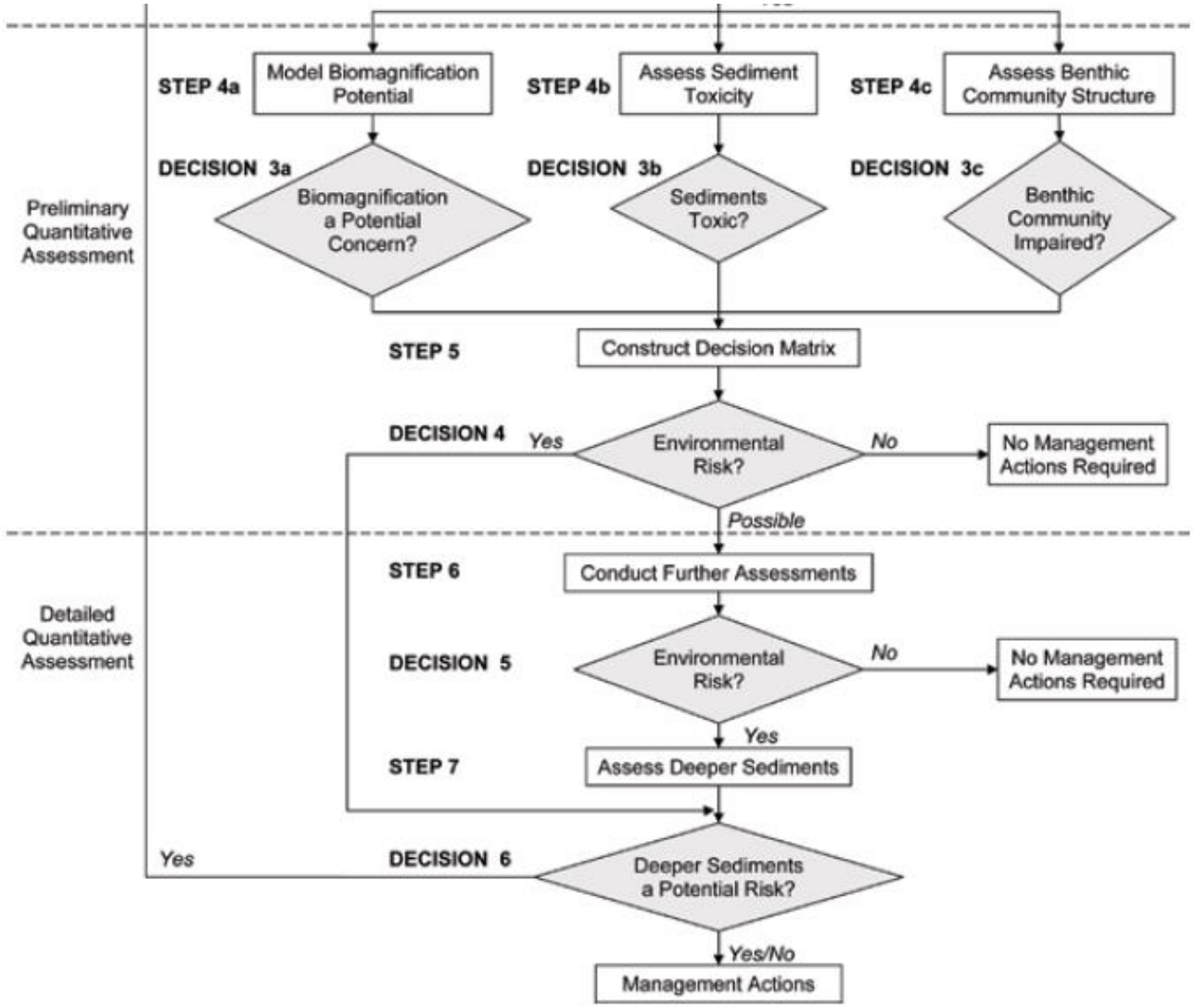

Figure excerpted from Chapman (2008)
The PQA identified several sediment management units (SMUs) and made the following determinations:

- SMU 1 (Ship Repair Zone) – sediment toxicity and biological alteration was observed in areas where concentrations of several metals, TBT, PAHs, and PCBs exceeded the CCME probable effect level (PEL) and the Ontario Provincial severe effect level (SEL). On this basis,

management actions were recommended, but uncertainty remained with respect to the spatial extent of significant contamination within this SMU.

- SMU 2 (Jetty Zone) – sediment toxicity was observed in a subset of samples, but assessment of biological alteration was inconclusive due to high variability and the confounding influence of mechanical disturbance. Concentrations of several metals, PAHs, and PCBs exceeded the CCME interim sediment quality guidelines, but most substances were below the probable effect level (PEL). On this basis, unacceptable environmental risk was considered to be possible, but detailed assessment was recommended to resolve uncertainty in the PQA.

- SMU 3 (Boundary Zone) – sediment toxicity was not observed in any samples, and assessment of biological communities, although indicative of generally healthy biota, were confounded by mechanical disturbance. Concentrations of most analytes met the CCME interim sediment quality guidelines, although marginal exceedances were observed for PCBs, copper and zinc. On this basis, environmental risk was considered to be negligible for direct contact pathways, but this SMU was retained for assessment of biomagnification potential.

Reference conditions were also evaluated as part of the PQA, and sediments of comparable grain size characteristics and organic carbon were identified. These sediments were located in distant portions of the harbour, where adjacent land use is primarily residential. The sediment chemistry of the reference areas resembled those of SMU 3, except that PCBs were non-detected.

Other key considerations include:

- The reference area, while containing substrate similar to the *XYZ Ship Repair Facility,* had increased prevalence of macrophytes, no evidence of mechanical disturbance, and different water depths.

- The entire harbour of *[Town Name]* is located in a watershed subject to eutrophication from nutrient loads (nitrogen, phosphorus) from upstream portions of the watershed. The biological communities found in the harbour are atypical of background Great Lakes conditions, and likely unsuited to comparisons to reference envelopes developed from non-eutrophic environments.

- To support preliminary remedial design for SMU 1, and to further characterize SMU 2, the *[Custodial Department]* requires step out sampling on the order of 25 m spacing between samples. SMU 3 does not require this sampling density, but should incorporate sufficient samples to support a gradient design.

- To support preliminary remedial design for SMU 1, and possibly SMU 2, the *[Custodial Department]* requires development of site-specific remediation standards, focusing on those substances that explain the pattern of biological effects observed. These standards are necessary to develop performance-based standards for remediation, and to determine the lateral extent of remediation that may be required beyond SMU 1.

- Sediment coring is not required as part of this project scope, as depth profiling is being conducted through a supplemental site investigation under a separate contract. However, once core chemistry data are available, screening of sediment data against site-specific standards will be required.

- The organic carbon content of sediments varies across the water lot. This requires evaluation of site-specific standards on a dry weight and OC-normalized basis.

- Issues of scale need to be explicitly considered for the biomagnification assessment. Considerations of biomagnification potential at a DQA level need to consider the feeding ranges (area use) and preferences of fish and waterfowl.

- The DQA will likely require determination of causation, specifically answering the question as to whether or not any observed biological effects are due to sediment contaminants and, if so, which contaminant(s) and at what concentration(s). The PQA recommendations included the application of toxicity identification evaluation (TIE) to discriminate among contaminant types; we require the contractor to clarify the role and methodology of TIE analysis to be applied in the DQA.

4. Objectives of Risk Assessment

The objectives of the DQA for *XYZ Ship Repair Facility* are to:

- improve spatial delineation of sediment contamination in SMU 1 and SMU 2;
- determine whether unacceptable ecological risks to the benthic community may be present within SMU 2;
- develop site-specific standards for sediments based on a linkage between contamination and observed biological/toxicological responses to the benthic community, over a gradient of contamination levels for primary contaminants of concern;
- refinement of the screening evaluation of wildlife risks from PCB exposure in SMUs 1, 2, and 3; and
- prioritize the site, and SMUs therein, for potential remedial funding under FCSAP.

The DQA is to be undertaken based on existing conditions at the site, assuming that future conditions will remain similar.

5. Technical Resources

- *Problem Formulation and Screening Level Assessment, XYZ Water Lots,* ABC Environmental Ltd., March 22, 1996
- *Preliminary Quantitative Assessment of XYZ Water Lots,* ABC Environmental Ltd., May 16, 1997
- *PCB Source Identification Report*, Greater *[Town]* Regional District. May 30, 2005.
- *Biological profiles of aquatic life in the Inner Harbour of [Town]*. Environment Canada Technical Report, Series X. September 12, 2010.
- Round robin testing of amphipod and polychaete species in natural sediments of *Inner Harbour of [Town]* Environment Canada Technical Report, Series Y. September 2, 2011.
- Allard P, Fairbrother A, Hope BK, Hull RN, Johnson MS, Kapustka L, Mann G, McDonald B, Sample BE. Recommendations for the development and application of wildlife toxicity reference values. *International Environmental Assessment and Management* 2009; 6:28–37.

Data from available reports should be incorporated in the DQA. These results of Environment Canada testing should be used to inform the selection of appropriate test organisms.

6. Regulatory Framework

The PQA will be conducted using the following protocols and guidance documents:

- *Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment (Chapman 2008).*
- *FCSAP ERA Guidance (Environment Canada 2012); particularly toxicity test selection guidance.*
- *Aquatic Site Classification System (ASCS) (Franz Environmental Inc and Aquatic Sites Working Group 2009)*
- *CCME guidance for development of site-specific tissue residue guidelines.*

Sediment data should be screened using CCME guidelines (ISQG/PEL), but also supplemented with Ontario provincial sediment guidelines (LEL, SEL). Additional guidelines from other jurisdictions (e.g., other Provinces or Territories, National Oceanic and Atmospheric Administration (NOAA), Washington Department of Ecology (WDOE) and Puget Sound Dredge and Disposal Analysis (PSDDA)) can also be included for additional context. Non-scheduled substances should be evaluated using comparisons to background data.

Where weight of evidence (WOE) is required, the project shall preferentially apply the default federal framework (Environment Canada 2012). Modifications to this approach will be considered only if supported by a clear rationale for the alternative approach.

7. Scope

The project will consist of three main tasks:

1. **Work Plan** – The contractor will design a sampling program to collect sediment, tissue, and/or biological specimens required to support a DQA. The work plan must include a health and safety plan, a Quality Assurance program, and details of logistics for sampling, processing, transport, and chain of custody.

2. **Detailed Quantitative Risk assessment** – An ecological DQA will be conducted in compliance with the COA Framework Steps 6 and 7, and will apply a weight of evidence framework to evaluate environment risks in each SMU within the water lot. Specific phases of the risk assessment deliverable will include:

    - Updated Problem Formulation – identification of chemicals of concern (COCs), potential ecological receptors, and exposure pathways, building on information already discussed in the PQA. Discussion of ERA design and strategy, including identification of measurement and assessment endpoints.
    - Exposure Assessment – quantification of the estimated exposure of wildlife to PCBs, using a trophic transfer model of bioaccumulation pathways. For direct contact pathways to sediment-associated organisms, GIS smoothed surfaces for primary COPCs should be developed.
    - Effects Assessment – determination of appropriate toxicological reference values consistent with FCSAP ERA guidance recommendations. Point estimate TRVs may not be used for screening assessment. Instead the guidance of Allard et al. (2009), which recommends development of dose-response profiles for wildlife TRVs, shall be the preferred method for TRV derivation. For benthic community and toxicity endpoints, decision rules from the COA Framework shall be applied.

- Risk Characterization – draw together information from exposure and effects assessments, incorporate hazard quotients for wildlife, and apply weight-of-evidence from sediment quality Triad tools. Conduct uncertainty analysis.
- Discussion and Conclusions – including weight of evidence determination for each receptor group.
- Recommendations – must be made separately for each SMU, with recommendations for the type and position of additional sampling required. Present draft recommended site-specific standard(s) for contaminant(s) driving biological responses in the water lot.

8. Deliverables

The DQA report and any accompanying material may be provided in the official language of choice of the contractor. As noted above, the report should be self contained, including all relevant supporting data, and should include the sections and content recommended in FCSAP guidance. Detailed information may be relegated to appendices to facilitate review of the main document text.

The deliverables will include:

- Sampling and analysis plan (draft for review; final with comments/concerns addressed prior to sampling);
- Draft DQA report; and,
- Final DQA report.

The deliverables shall be submitted in editable digital format (MS Word™ and spreadsheets in MS Excel™). The final report will address all comments provided during the *[custodial department]* review of the draft.

If required, the contractor may be required to discuss the comments on the draft report in order to clarify or confirm any outstanding questions or comments. **Four (4)** bound hard copies of the final report are required, as well as a digital (MS Word™, or Adobe Acrobat™) copy. The final report should be signed.

A detailed report will be prepared documenting the input data, methods, and results of the ERA. The report should include and adequately address the sections provided in the suggested outline [*see attached Template for an Ecological Risk Assessment Report].*

Bidders should refer to the FCSAP ERA guidance for further information and details concerning the expected content of each section of the risk assessment report.

The report should undergo an internal senior technical peer review to confirm that data from the environmental site investigation(s) are correct, that appropriate ecological-based screening guidelines are used, and calculations have been checked. The report should be reviewed by a professional editor. Unclear language or typographical mistakes that impair the understanding of the report will result in the report being rejected and returned to the consultant for correction at the consultant's expense. No deadline extensions will be considered for this deficiency. The report should be self-contained, including all data necessary for a reviewer to evaluate the DQA. The report should emphasize the following qualities:

- Transparency – Articulation of approaches used, and rationale for important decisions.
- Accuracy and Reproducibility – The results are mathematically correct and can be reproduced based on the information contained in the report.

- Defensibility – The conclusions can be defended scientifically, are reasonable based on the application of standard risk assessment guidance, and follow a logical framework.
- Comprehensiveness – All relevant chemicals, receptors, pathways, and risks have been assessed, and key uncertainties described in terms of implications for site management.

An appropriate professional limitations statement may be provided that is consistent with the standards of care for the practice of environmental risk assessment.

The report should clearly describe any aspects of the risk assessment that deviate from the referenced protocols and guidance documents listed above, and should document important assumptions made by the contractor that influence risk estimates. The report should contain recommendations with respect to further work, such as further data collection (if required), more detailed risk assessment and recommendations for remediation and/or risk management proposals. In particular, the report should identify any issues representing significant risks to ecological health that may require immediate mitigative action.

Additional considerations:

a. Risk assessment reports must be accompanied by revised ASCS scores; and
b. The TRAV worksheets must be completed.

9. Project Delivery and Contracting

Costing
Bidders must provide the following cost information in the proposal:

- Breakdown of costs by major task item and allocated staff; and
- Estimated hours and fully loaded hourly rate for each assigned staff member.

The cost proposal will must include a firm, fixed price for the preparation of a final work plan (sampling and analysis plan), and for the preparation of a draft and final DQA report, including completion of TRAV and ASCS. Costs for field sampling, analytical costs, and field disbursements should be estimated, but can provided as a separate cost from the fixed price consulting component.

Schedule
It is anticipated that the contract will be awarded by *[date]*.

The timeline for the project is as follows:

- *[date]* – project kickoff meeting.
- *[date]* – all relevant reports and data to be forwarded to contractor.
- *[date]* – draft work plan for supplemental sampling to be submitted to *[custodial department]* for review.
- *[date]* – draft DQA report to be submitted to *[custodial department]* for review.
- *[date]* – comments on the draft report to be forwarded to the contractor.
- *[date]* – final DQA report to be submitted to *[custodial department]*.

Communications/Meetings

A kickoff meeting will be held upon contract award, in a manner and venue (e.g., face-to-face, teleconference) to be determined by the project authority. Travel costs for meetings, if necessary, will be negotiated as separate scope/cost items and should not be included in this proposal.

Progress meetings will be held upon submission of the problem formulation report and the draft report to discuss the direction of the DQA and the findings.

The contractor shall remain in regular contact with the project authority either by telephone or e-mail to ensure that the project is progressing according to schedule and that any required information is made available.

The project authority for this project is *[name and contact details]*.

APPENDIX E

Tool for Risk Assessment Validation (TRAV) – ERA Related Questions

Table E.2: TRAV - Site data and ERA-related questions

Category	Question
Site Data Considerations	Have areas of environmental concern been delineated horizontally and vertically?
	Were sufficient samples collected from areas of environmental concern to reflect maximum concentrations?
	Have QA/QC program elements been incorporated to ensure the validity of the data and scientific approach? If the answer is No, does the lack of sufficient QA/QC measures compromise the results of the risk assessment?
	Is the site assessment testing program described, including methodology used to collect samples, number of testing locations and analytical program?
	Was rationale provided for the selection of samples for analytical testing?
	Are all sampling locations identified on site plans and in data tables?
Screening COCs	Were CCME guidelines used to screen COCs? If not, provide rationale.
	Were maximum concentrations used in the screening process?
	Were chemicals whose detection limit was greater than the screening guidelines retained as COCs?
	If chemicals were screened out because their concentrations fell within background levels, were background concentrations determined appropriately and used correctly?
	Was consideration given to the following:
	• Substances for which there are no guidelines?
	• Persistent, bioaccumulative or biomagnifying substances?
	• Degradation products?
Problem Formulation – Objectives	Are the study objectives clearly stated?
	• Is it clear how the ERA was used to support the study objectives?
	• Provide report reference where ERA objectives are stated.
	Have all assessment endpoints been identified clearly?
	Have all measurements endpoints been identified clearly and do they support the assessment endpoints?
Problem Formulation – Habitat Assessment	Was an on-site habitat assessment completed? Provide a brief description of on-site habitat in the rationale box.
	Was an adjacent habitat assessment completed? Provide a brief description of adjacent habitat in the rationale box.
	If there is more than one type of habitat in an area (e.g., riparian, aquatic, upland forested, prairie grassland etc.), were all habitat types on the site considered in the risk assessment?
	• Which habitats were excluded? Provide rationale.

Category	Question
	Were both on and offsite (occasional) receptors considered?
	Did the ERA include a comparison to reference sites, a gradient design or background conditions to establish that adverse effects are related to contamination?
Problem Formulation – Species at Risk	Was a Species at Risk (SAR) assessment, including identification of Critical Habitat conducted for the site?
	Were SAR identified as potential or actual ROCs?
	Were SAR carried through the assessment and specifically considered in the ERA?
Problem Formulation – Conceptual Site Model	Was a CSM included in the ERA?
	• Does the CSM identify the interactions between receptors and key stressors (usually COCs, but sometimes physical stressors)?
Exposure Assessment	Was a model or equations used to predict environmental concentrations?
	• If a model or equations were used to predict environmental concentrations, was their use appropriate, were all input parameters justified, were assumptions explained and were references provided?
	• Have model predicted values been calibrated to or compared against measurement data from the site? Do the comparisons of model predictions make sense?
	Was home range size incorporated into the assessment?
	• Was the source of the home range size documented?
	For higher order receptors, was receptor characteristic information presented and referenced? (e.g., ingestion rate, diet proportions, body weight, home range size, etc.)
	Was uptake through the food chain adequately addressed?
	Were contaminant hot spots or preferred habitat features considered as factors that could affect the level of exposure?

www.ec.gc.ca

Additional information can be obtained at:

Environment Canada
Inquiry Centre
10 Wellington Street, 23rd Floor
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800
Fax: 819-994-1412
TTY: 819-994-0736
Email: enviroinfo@ec.gc.ca