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Canada

Federal Contaminated Sites Action Plan (FCSAP)

Decision-Making Framework

May 22, 2013

Document change control

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Decision-Making Framework

What is the Decision-Making Framework (DMF)?

The Decision-Making Framework (DMF) for the Federal Contaminated Sites Action Plan (FCSAP) is a roadmap that outlines the specific activities and requirements for addressing federal contaminated sites in Canada. The DMF is based on *A Federal Approach to Contaminated Sites*, a 10-step process guiding federal custodians in all aspects of working with contaminated sites. The 10-step process was developed to provide a common approach to managing contaminated sites for which the federal government is responsible. The DMF does not replace the 10-step process; rather, it is a complementary guide to assist federal custodians in managing their contaminated sites.

The DMF is broken into individual segments that make it easier to understand each step. It enables custodians to consider the critical decisions they have to make at each step and helps them understand how and when the expert support departments can help them in decision making. By clarifying the rules to be followed under the FCSAP, this guide also increases consistency in the decision-making process and improves the effectiveness of site assessment and remediation activities.

How to use the DMF

To ensure consistency and ease of use, each of the 10 steps is described using the same page format:

- A general description of the step, including key decisions to be made by custodians
- A flowchart showing the main management options available at each step, allowing users to visualize the different avenues and decision points available
- An explanation of the services offered to the custodians by the expert support departments and FCSAP Secretariat
- All relevant supporting documentation and tools

Disclaimer

Although the guidance provided in the DMF is intended to meet the needs of most scenarios, professional judgment is required throughout the process.

The 10-step process

Supporting documents and tools useful throughout the 10-step process

- *A Federal Approach to Contaminated Sites*
- Eligible Costs Guidance
- Federal Contaminated Sites Inventory (FCSI)
- Federal Contaminated Sites Inventory (FCSI) Input Guide
- Framework for Addressing and Managing Aquatic Sites under the FCSAP
- *Guidance Document on the Management of Contaminated Sites in Canada*
- Performance-Based Contracting
- Project Management Tools for Federal Contaminated Sites Remediation and Risk Management Projects
- Treasury Board Policy on Management of Real Property
- Treasury Board Reporting Standard on Real Property
- Treasury Board Secretariat Guide to the Management of Real Property
- Waves: DFO Library
- Working Near Water: What You Need To Do

Step 1: Identify Suspect Site

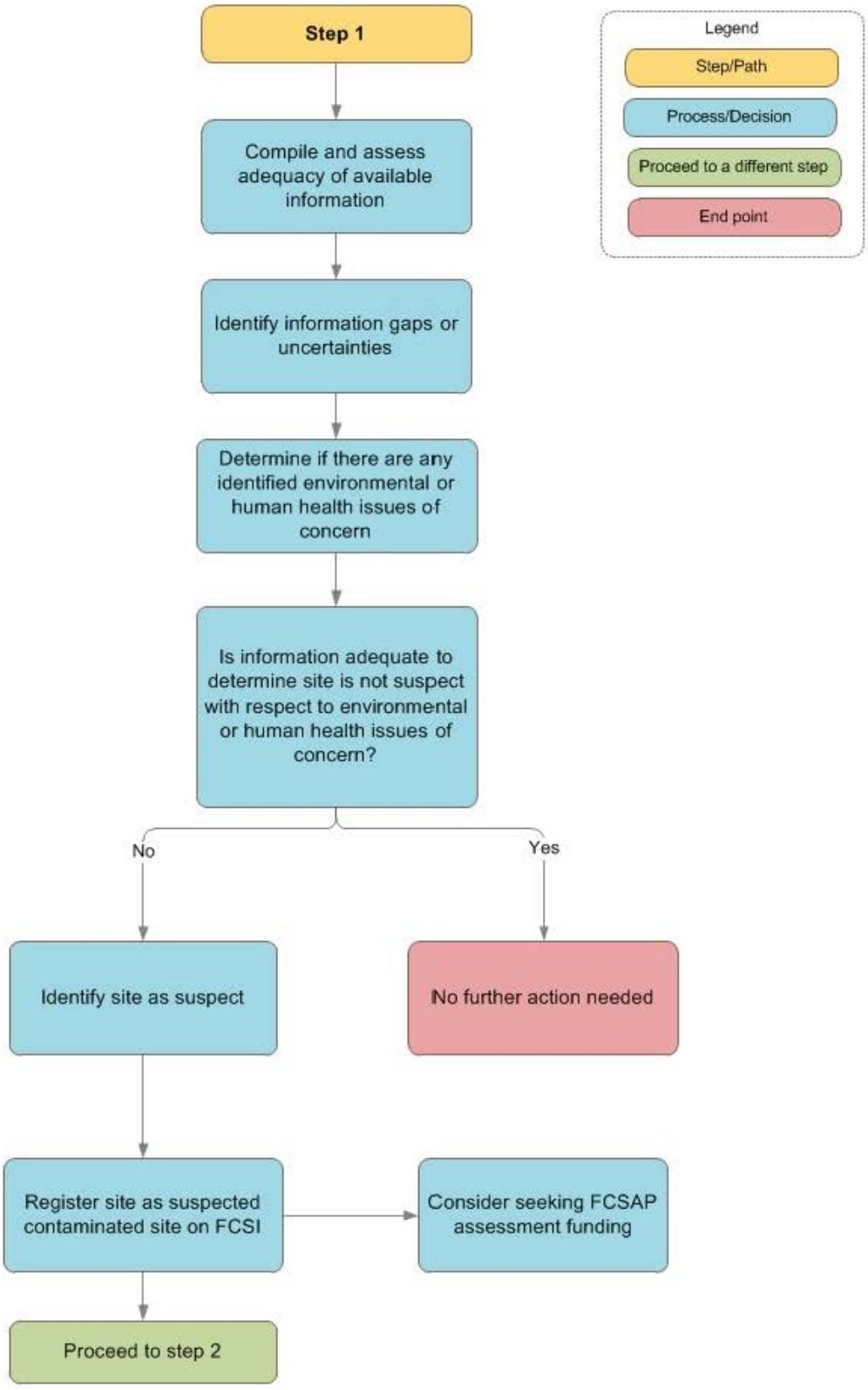
Step 1 is the identification of a potentially contaminated site, called a “suspected site,” based on past or current activities that have occurred on or near the site. This step involves compiling and reviewing past and current land uses, activities, and information about a site in order to determine whether there is a potential risk to human health and/or the environment that requires further investigation.

At this step, and throughout the 10-step process, custodians need to consider the interests of stakeholders—in other words, those interested in and affected by the site. Health Canada guidance documents for public involvement need to be reviewed at this step.

Key decision(s):

- Determine whether it is a suspected site or if no further action is required beyond Step 1
- Identify stakeholders and public involvement needs

Step 1: Identify Suspect Site



Consider seeking Federal Contaminated Sites Action Plan (FCSAP) assessment funding

At this step, custodians can use FCSAP assessment funding if the site is on federal lands, or on non-federal lands for which the federal government has accepted full responsibility, and there are documented reasons for suspecting that a site is contaminated from activities that occurred prior to April 1, 1998. FCSAP assessment funding amounts from 2011–2012 to 2015–2016 for each custodian were set in 2011–2012. Custodians are not required to submit assessment proposals to the FCSAP Secretariat for approval but are asked to prioritize assessment work in a risk-based manner using the Priority for Assessment Tool (PAT) or an equivalent system.

How Fisheries and Oceans Canada (DFO) expert support can assist

- Identify:
    - fish and fish habitat concerns on or near the site;
    - aquatic species listed under the *Species at Risk Act* (SARA);
    - additional information requirements.
- Provide information on past DFO involvement at the site (studies, *Fisheries Act* authorizations, letters of advice, etc.).
- Provide advice on DFO regulatory responsibilities and processes.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP.

How Environment Canada (EC) expert support can assist

- Provide advice on known risks to the environment in the site area and impacts that may have occurred from past operations conducted at the site.
- Provide advice on EC regulatory responsibilities and processes.

How Health Canada (HC) expert support can assist

Provide advice on identifying human health concerns on the site, or off-site issues related to contamination at the site based on historical activity, including on the identification of additional information required to delineate contamination and adequately assess human health risks.

- Provide training and/or guidance on public involvement (PI) and advice on the implementation of an effective PI strategy.

How Public Works and Government Services Canada (PWGSC) expert support can assist

- Provide advice on determining if site requires further investigation and what scope of further investigation may include, such as cost and time frame estimates.

How the FCSAP Secretariat can assist

- Provide advice on the FCSAP process and eligibility for funding.

Supporting documents and tools

Please also refer to the list of “Supporting documents and tools useful throughout the 10-step process” at the beginning of the document.

- A Guide to Involving Aboriginal Peoples in Contaminated Site Management
- Addressing Psychosocial Factors through Capacity Building: A Guide for Managers of Contaminated Sites
- *Canada Wildlife Act*
- *Fisheries Act*
- For Human Health Risk Assessment: Federal Contaminated Site Risk Assessment in Canada Part I, Part II, Part III, Part IV available on request from cs-sc@hcsc.gc.ca
- Guidance on Developing a Contract Statement of Work (SOW) for Human Health Preliminary Quantitative Risk Assessment (PQRA) and Detailed Quantitative Risk Assessment (DQRA)
- Improving Stakeholder Relationships: Public Involvement and the Federal Contaminated Sites Action Plan: A Guide for Site Managers
- *Migratory Birds Convention Act, 1994*
- Priority for Assessment Tool (PAT)
- Proponent's Guide to Information Requirements for Review Under the Fish Habitat Protection Provisions of the *Fisheries Act*
- *Species at Risk Act* (SARA)
- Species at Risk Public Registry

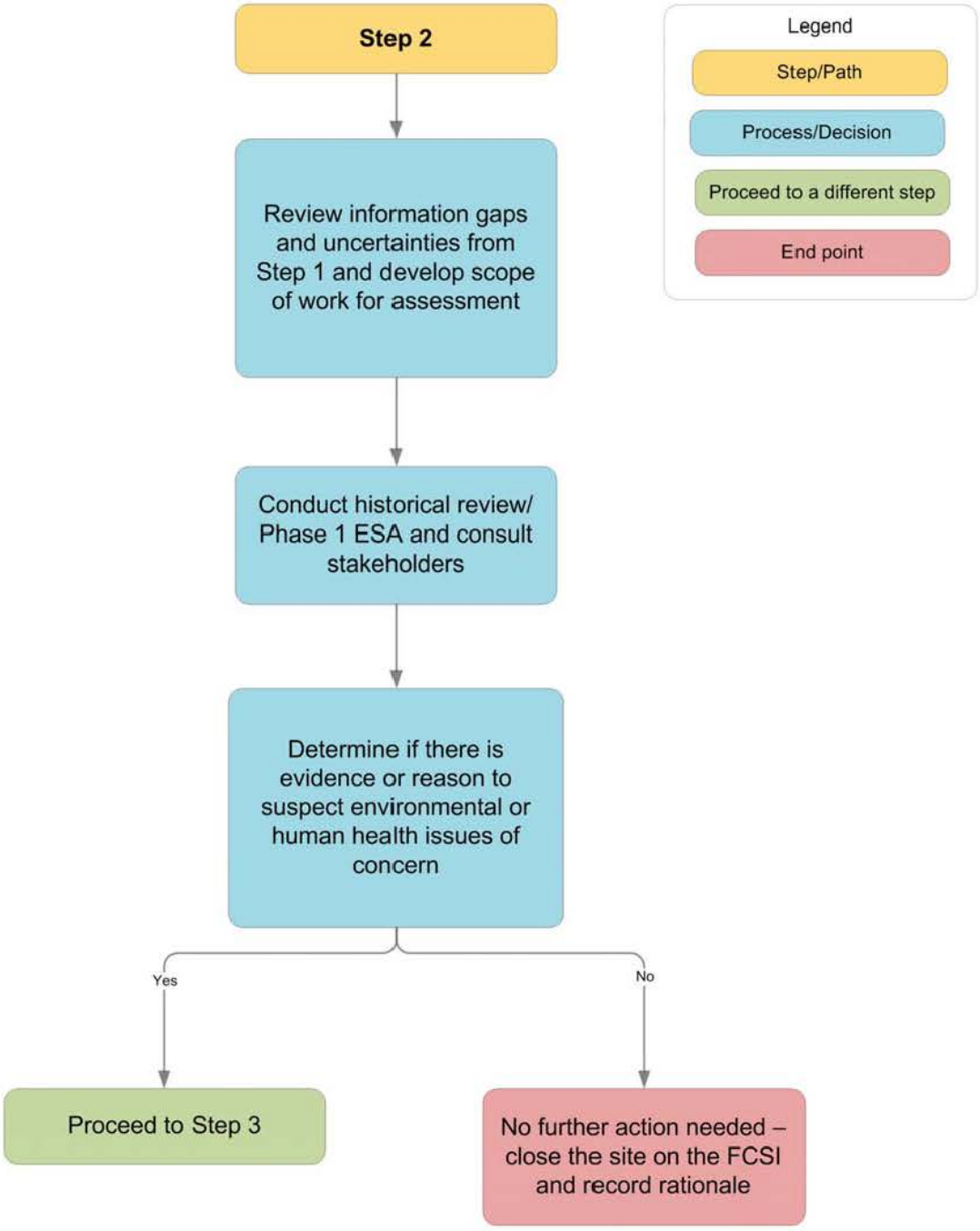
Step 2: Historical Review

In Step 2, a suspected site identified in Step 1 undergoes a review of historical information including a Phase I Environmental Site Assessment (ESA) and the custodial department accountable will consult with stakeholders. This information will provide insight into the types and locations of potential contaminants and the suspected pathways and receptors. Sites undergoing assessment are prioritized by the custodians using the Priority for Assessment Tool (PAT) or an equivalent system. Upon completion of every assessment step, the project manager should contact the custodial program lead to determine if further assessment work should be conducted based on the PAT. Sites that are not identified as a priority for assessment should be re-evaluated periodically according to a custodian's portfolio characteristics.

Key decision(s):

- Validate Step 1 conclusions that there is reason to suspect that the site is contaminated and that assessment should continue.
- Determine whether the site can be closed because no further action is required.

Step 2: Historical Review



How Fisheries and Oceans Canada (DFO) expert support can assist

- Provide fish, fish habitat and fisheries background information at or near the site, if available.
- Provide information on regulatory frameworks applicable to aquatic sites.
- Review the Phase I ESA and provide advice.
- Participate in site visit activities.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP.

How Environment Canada (EC) expert support can assist

- Provide regulatory advice concerning past operations conducted at the site.
- Provide advice on site assessment standards and best practices.
- Review the ESA, identify information gaps and provide advice on information gathering.
- Participate in site visit activities.

How Health Canada (HC) expert support can assist

- Provide advice on developing a site assessment that can be used for adequately characterizing chemicals of potential concern in site media based on historical land use, which is important for assessing risks to human health and future decision making.
- Review the Phase I ESA report and provide technical comments related to requirements for the Phase II ESA to identify potential human health exposure and information gaps that may require additional assessment in order to identify whether there are human health risks.
- Participate in site visit activities.

How Public Works and Government Services Canada (PWGSC) expert support can assist

- PWGSC can complete Step 2 on the custodian's behalf or provide advice on the Phase I ESA, including the historical review/assessment project, and determine if further work is required or no further action needs to be taken.

How the FCSAP Secretariat can assist

- Provide general FCSAP program information and support.
- Provide assistance in using the Prioritization for Assessment Tool and the Eligible Cost Guidance document as required.

Supporting documents and tools

Please also refer to the list of "Supporting documents and tools useful throughout the 10-step process" at the beginning of the document.

- Canadian Council of Ministers of the Environment (CCME) Site Characterization Guidance
- Canadian Standards Association (CSA) Standards for Phase I Environmental Site Assessments
- Priority for Assessment Tool (PAT)
- Site Characterization Training

Step 3: Initial Testing Program

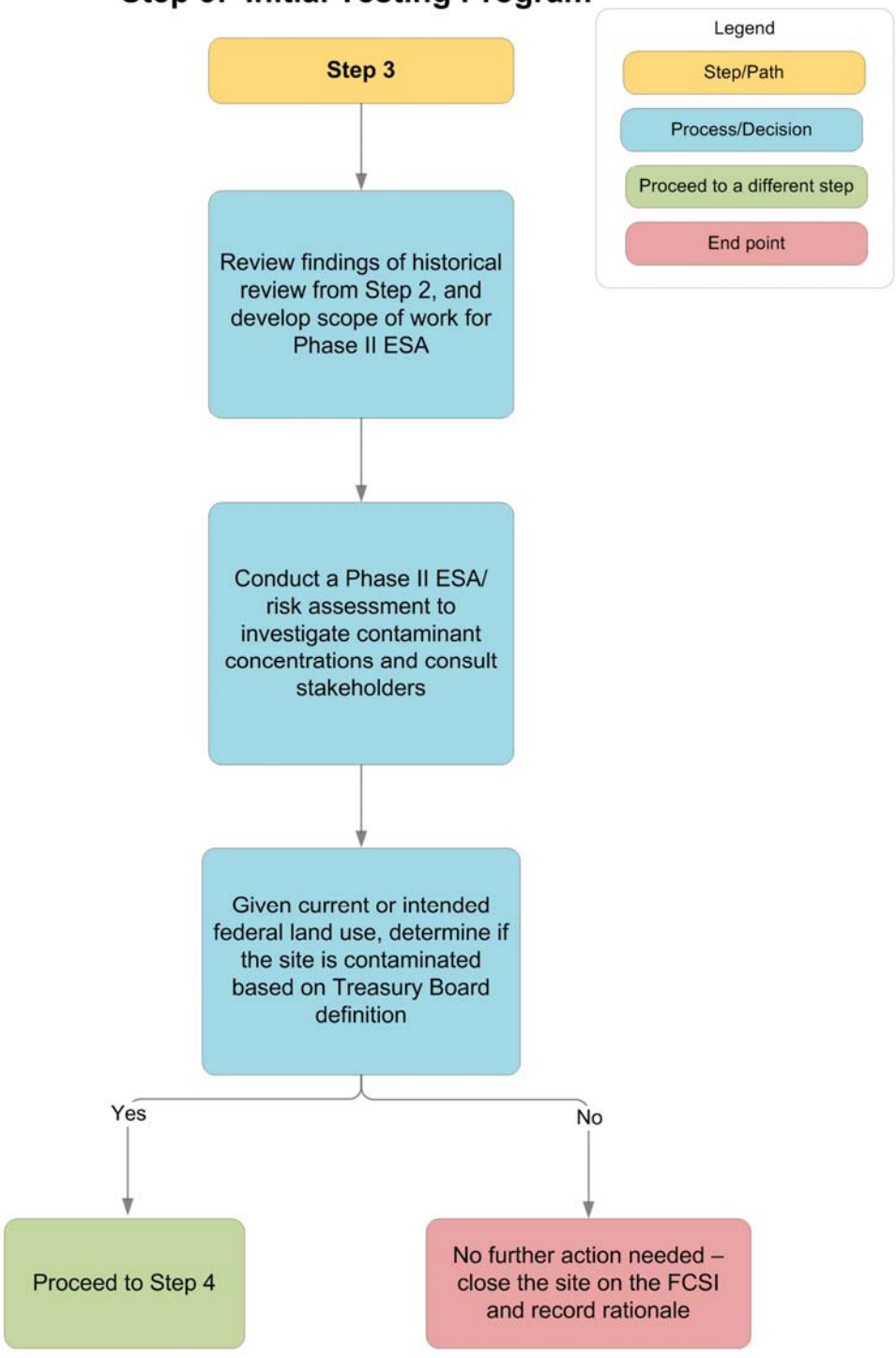
Step 3 involves focusing on the identified environmental issues and potential risks. A Phase II Environmental Site Assessment (ESA) is conducted to investigate actual site conditions, and stakeholders should be consulted. This step will provide a preliminary assessment of the degree, nature and extent of the contamination.

Sites undergoing assessment are prioritized according to the FCSAP Secretariat's Priority for Assessment Tool (PAT) or an equivalent system. Upon completion of every assessment step, the project manager should contact his or her custodial program lead to determine if further assessment work should be conducted based on the PAT.

Key decision(s):

- Define the appropriate current and intended federal land-use scenario according to the Canadian Council of Ministers of the Environment (CCME) guidelines for land use.
- Confirm if the site is contaminated according to the Treasury Board of Canada (TB) definition.
- Determine whether the site can be closed because no further action is required.
- Determine whether detailed testing is required (Step 5) based on results of the initial testing program.

Step 3: Initial Testing Program



Treasury Board of Canada definition

According to the TB definition, a contaminated site is "one at which substances occur at concentrations (1) above background (normally occurring) levels and pose or are likely to pose an immediate or long-term hazard to human health or the environment, or (2) exceeding levels specified in policies and regulations."

If there are no guidelines available, custodians should base their determination of a contaminated site on the background level, by looking at existing literature or undertaking additional sample analysis. Before moving to the next step, the custodian should be able to confirm whether or not the site is contaminated.

If the information is not adequate to determine that there are no human health or environmental issues of concern, go back to the start of Step 3.

Identify intended or future federal use for impacted area

Before remediation or risk management (R/RM) strategies are identified and evaluated, the intended or future federal land use of a site must be agreed upon to determine the appropriate standard for remediation. Whether the site is used for industrial, commercial, agricultural or residential/parkland purposes, each will have varying degrees of human health and ecological protection. The levels of protection provided by CCME standards ensure that the remediated land has the potential to support most activities associated with the intended land use.

- **Agricultural:** growing crops, raising livestock, natural areas including National Wildlife Areas and Migratory Bird Sanctuaries*
- **Residential/Parkland:** residential or recreational activities, buffer areas between residences, campgrounds
- **Commercial:**† public access, malls, cultivated lawns, flowerbeds* *,gas stations
- **Industrial:**† restricted access, production, manufacture or construction of goods

*Natural areas consist of natural wild land (including national parks) that would apply the same standards as agricultural land for remediation purposes.

**Cultivated lawns and flowerbeds must be part of the commercial property, and not used as a public area (i.e., picnic or park areas).

†Commercial and industrial land must still be under the responsibility of the federal government.

Under the TB Policy on *Management of Real Property*, remediation must be undertaken to the extent required for current or intended federal use. If a custodian plans to divest the property, he/she may remediate beyond federal standards, but the supplementary (above the current or intended federal land use) remediation will not be covered by Federal Contaminated Sites Action Plan (FCSAP) funds.

How Fisheries and Oceans Canada (DFO) expert support can assist

- Assist with identification of fish, fish habitat and fish/fisheries information.
- Provide advice on:
    - characterization of fish habitat or habitat mapping;

    - confirmation of aquatic species, including species listed under the Species at Risk Act (SARA); and
    - expectations associated with fish and fish habitat data collection.
- Document review (e.g., Phase II ESA report, conceptual site model) with respect to the risk(s) (including receptors, hazard and exposure) to fish and fish habitat.
- Review sampling plan to ensure that data collected will accurately represent the site and assess risks to fish and fish habitat.
- Participate in site visit activities with custodians and other stakeholders to address potential issues and become familiar with the site.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP.
- Provide advice on compliance requirements under the *Fisheries Act* and other environmental requirements.

How Environment Canada (EC) expert support can assist

- Provide advice on and/or review of the Phase II Environmental Site Assessment (ESA) report, with respect to ecological risks (including receptors, hazard and exposure).
- Provide advice on planning of the Phase III investigation (including providing advice on sampling plan, sampling techniques and technologies, QA/QC program, and conceptual site model).
- Provide advice on CCME Canadian Environmental Quality Guidelines (soil, water, sediment) or other applicable guidelines.
- Participate in site visit activities with custodians and other stakeholders to address potential issues and become familiar with the site.
- Provide advice on the analysis of data.

How Health Canada (HC) expert support can assist

- Provide advice on and/or review of the Phase I Environmental Site Assessment (ESA) report, with respect to human health risks, and identify whether there are data gaps associated with the Phase II ESA report in light of historical land use.
- Provide advice on and/or review of the conceptual site model.
- Provide advice on the characterization of the site and whether there are data gaps associated with site characterization that may impact assessment of human health risks.
- Provide advice and training on sampling techniques and technologies.
- Review sampling plan to ensure that data collected will accurately represent the site and assess human health risks.
- Provide advice on quality assurance/quality control (QA/QC) programs.
- Provide advice on CCME Canadian Environmental Quality Guidelines (soil, water, sediment) or other guidelines that are applicable to screening chemicals for potential human health risks.
- Participate in site visit activities with custodians and other stakeholders to address potential issues and become familiar with the site.
- Provide advice on the analysis of data from laboratories (adequate detection limits, etc.).
- Provide advice on CCME Canadian Environmental Quality Guidelines for the protection of human health and Canadian Drinking Water Guidelines, and/or on the adoption of standards from other jurisdictions.

- Provide advice, guidance and training on the characterization and delineation of contamination at a site in environmental site assessment reports so that custodians can better risk-manage sites and obtain adequate data for use in human health risk assessment, including:
    - advice on and/or review of conceptual site model with respect to human health;
    - advice on characterization of the site; and
    - advice on the sampling and analysis plan to ensure that data collected will accurately represent the site and supply sufficient data to allow for the assessment of potential human health risks.
- Participate in site visit activities with custodians and other stakeholders to address potential issues and become familiar with the site.

How Public Works and Government Services Canada (PWGSC) expert support can assist

- Provide advice on or develop statement of work (SOW), or complete the Phase II ESA on departments' behalf—including status reporting, scope verification, schedule and cost quality, communication and risk control, and lessons learned.
- Assist in determining whether further work is required or no further action is necessary.

How the FCSAP Secretariat can assist

- Provide assistance in using the Prioritization for Assessment Tool and the Eligible Cost Guidance document as required.

Supporting documents and tools

Please also refer to the list of "Supporting documents and tools useful throughout the 10-step process" at the beginning of the document.

- Canada-Wide Standard for Petroleum Hydrocarbons
- Canadian Council of Ministers of the Environment (CCME) Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume I: Main Report
- *CCME Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites* – Volume II: Analytical Method Summaries
- Canadian Council of Ministers of the Environment (CCME) Analytical Method Summaries
- Canadian Standards Association (CSA) Standards for Phase II Environmental Site Assessment
- CCME Canadian Environmental Quality Guidelines (Soil, Water, Sediment)
- FCSAP Ecological Risk Assessment Guidance
- FCSAP Ecological Risk Assessment Training
- Federal Interim Groundwater Guidelines
- For Human Health Risk Assessment: Federal Contaminated Site Risk Assessment in Canada Part I, Part II, Part III, Part IV available on request from cs-sc@hcsc.gc.ca
- Framework for Addressing and Managing Aquatic Contaminated Sites Under the Federal Contaminated Sites Action Plan (FCSAP)
- Guidance and Orientation for the Selection of Technologies (GOST)
- Guidance on Developing a Contract Statement of Work (SOW) for Human Health Preliminary Quantitative Risk Assessment (PQRA) and Detailed Quantitative Risk Assessment (DQRA)
- Guidelines for Canadian Drinking Water Quality

- Phase II ESA SOW incorporating Science-based Expert Support Input
- Priority for Assessment Tool (PAT)
- Site Characterization Training
- Subsurface Assessment Handbook for Contaminated Sites

Step 4: Classify Site (optional)

In Step 4, custodians can complete the Canadian Council of Ministers of the Environment (CCME) National Classification System for Contaminated Sites (NCSCS) and/or the Federal Contaminated Sites Action Plan (FCSAP) Aquatic Site Classification System (ASCS) worksheets if sufficient site information is available. Custodians should refer to the NCSCS Supplemental Guidance. Stakeholders can provide key information about the site history and condition, end use of the site, exposure pathways, receptors, contaminants of potential concern, and safe exposure limits. This exercise can help the custodians identify the priority of sites for further action (assessment or remediation).

Site classifications include Class 1, 2, 3, INS (insufficient information) or N (not a priority for action), with Class 1 having the highest priority for action. For the second phase of the FCSAP program (2011–2016), only Class 1 sites and ongoing Class 2 sites (with FCSAP remediation expenditures prior to April 1, 2011) are eligible for FCSAP remediation funding.

When further testing is not required and sufficient site information is available, and if the custodian wishes to have the site considered for FCSAP remediation/risk management funding, the site will be reviewed by the expert support departments and the FCSAP Secretariat to determine if the site meets the eligibility requirements for FCSAP remediation/risk management funding.

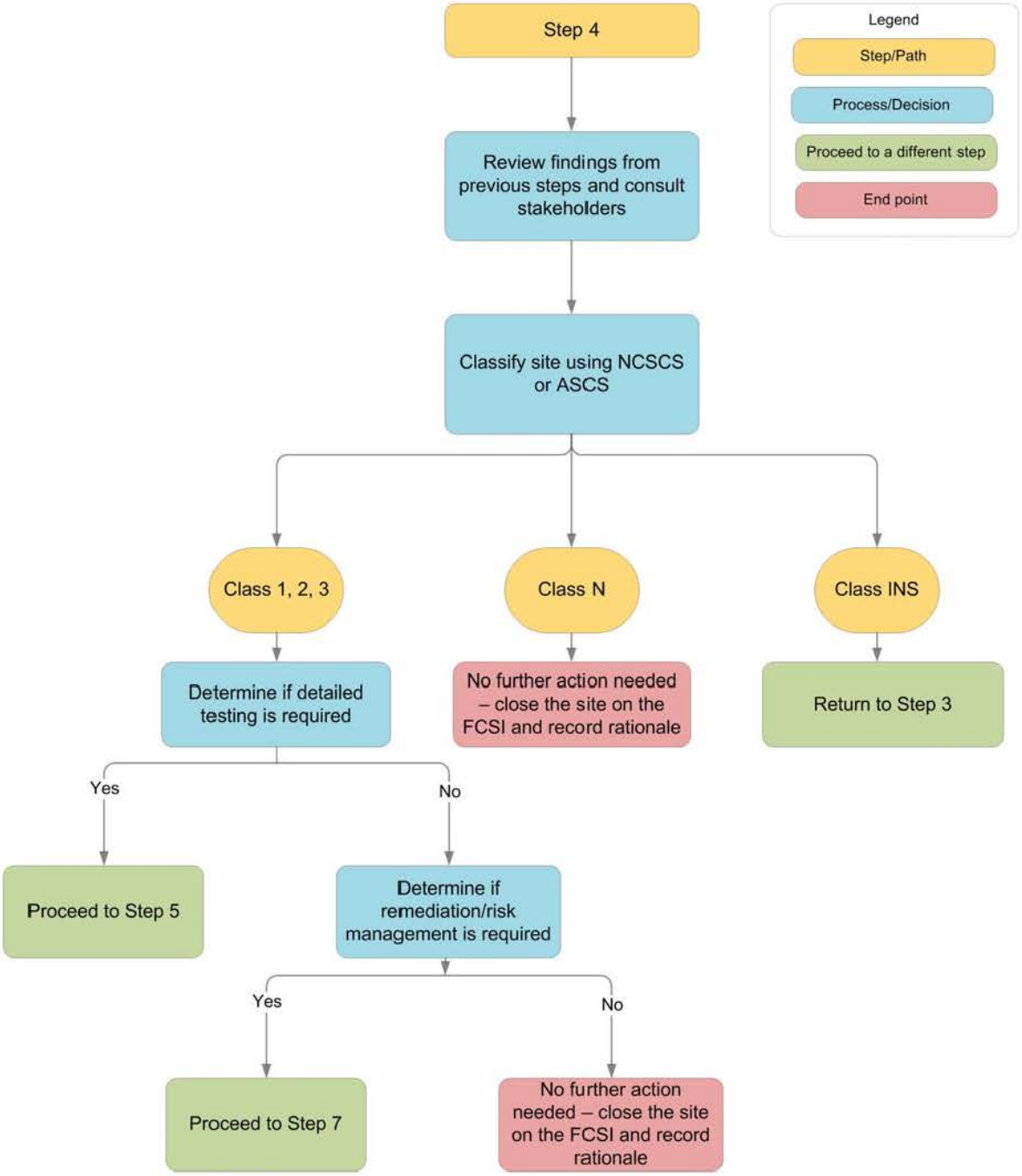
Sites undergoing assessment are prioritized according to the FCSAP Secretariat's Priority for Assessment Tool (PAT) or an equivalent system. Upon completion of every assessment step, the project manager should contact the custodial program lead to determine if further assessment work should be conducted based on the PAT.

Key decision(s):

- Determine if sufficient site information is available to classify the site or if further assessment work is required.
- Determine the classification of the site, if applicable.
- Based on the level of priority for action, determine if the site is eligible for FCSAP remediation/risk management funding (for details concerning eligibility, see Step 6).

Step 4: Classify Site (Optional*)

**If sufficient site information from Step 3 is available to suggest that detailed testing is required, custodians may consider proceeding directly to Step 5.*



How Fisheries and Oceans Canada (DFO) expert support can assist

- Review and provide advice on relevant (i.e., fish and fish habitat) components of the NCSCS or ASCS classification scores and associated background information.
- Provide access to training and resources for the ASCS (such as the FCSAP Aquatic Sites Classification System [2009] Detailed User Guidance Manual).
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP.

How Environment Canada (EC) expert support can assist

- Provide advice on the use and interpretation of NCSCS and ASCS worksheets.
- Review and provide advice on ecological concerns described by the NCSCS or the ASCS.
- Provide training and guidance on the use of NCSCS or ASCS worksheets.

How Health Canada (HC) expert support can assist

- Review and provide advice on relevant (i.e., human health) components of NCSCS and ASCS classification scores and associated background information, including interpretation of NCSCS and ASCS worksheets.
- Provide advice, guidance, training and/or peer review on conducting human health risk assessments and interpreting their results with respect to site classification.
- Provide advice and support in ranking and prioritizing sites from a human health risk perspective.

How Public Works and Government Services Canada (PWGSC) expert support can assist

- Provide advice throughout Step 4, including on determining whether risk management or remediation is required at a site.
- Assist in determining whether further work is required or whether no further action is necessary.

How the FCSAP Secretariat can assist

- Provide assistance in using the Prioritization for Assessment Tool and the Eligible Cost Guidance document as required.
- Provide support to custodians on the process for submitting a site to the FCSAP Priority List for remediation funding (navigating through the Interdepartmental Data Exchange Application [IDEA], mandatory documents, reports and other eligibility concerns) if sufficient information about the condition of the site is available at this step.

Supporting documents and tools

Please also refer to the list of "Supporting documents and tools useful throughout the 10-step process" at the beginning of the document.

- CCME National Classification System for Contaminated Sites (NCSCS) Guidance Document
- CCME National Classification System for Contaminated Sites Spreadsheet
- FCSAP Aquatic Site Classification System (ASCS) Guidance Document

- FCSAP Aquatic Sites Classification System/Spreadsheet
- NCSCS Supplemental Guidance
- Priority for Assessment Tool (PAT)
- Training on the CCME NCSCS
- Training on the FCSAP ASCS

Step 5: Detailed Testing Program

If the results of the initial testing program (Step 3) indicate that contaminant levels exceed guidelines or background levels and may pose a risk, a detailed testing program may be required in order to address outstanding issues.

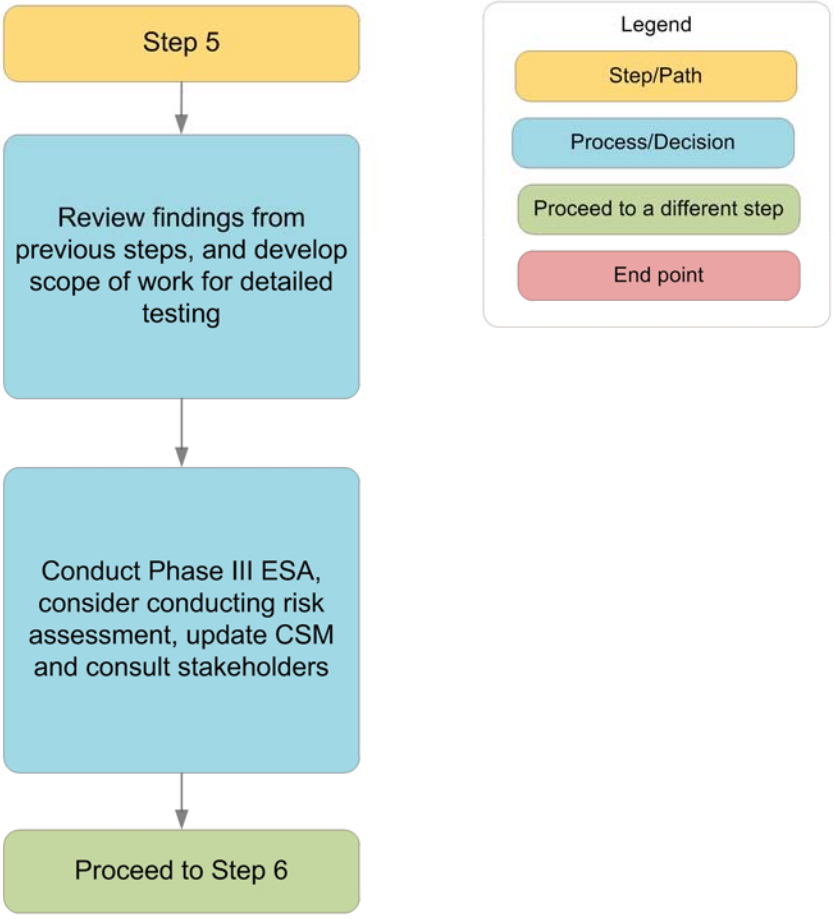
Step 5 involves investigating site conditions, characterizing the impacted media, further delineating the areas of concern identified during Step 3 (e.g., Phase III Environmental Site Assessment [ESA], updating the Conceptual Site Model [CSM]), and consulting stakeholders. A new risk assessment may be conducted at this step if none was conducted at Step 3, or the preliminary risk assessment that occurred at Step 3 may need to be refined. If potential effects are identified, a more detailed and accurate risk assessment will typically be conducted at Step 7. The type and scope of the risk assessment to be conducted at Step 5 depend on the site conditions and should aim to classify the site and/or determine if further management action is required. Custodians should refer to the Eligible Costs Guidance for eligibility related to risk assessment activities.

Sites undergoing assessment are prioritized according to the Priority for Assessment Tool (PAT) or an equivalent system. Upon completion of every assessment step, the project manager should contact the custodial program lead to determine if further assessment work should be conducted based on the PAT.

Key decision(s):

- Determine the need for a risk assessment.
- Determine if remediation or risk management is required at the site

Step 5: Detailed Testing Program



How Fisheries and Oceans Canada (DFO) expert support can assist

- Assist with determining level of impact to fish and fish habitat (e.g., contaminants-related impacts to fish habitat).
- Provide advice on physical processes (e.g., erosion/deposition, susceptibility to tides/currents/floods) that could affect fish and fish habitat.
- Review documents (e.g., draft site assessment, draft risk assessment) with respect to fish and fish habitat.
- Provide advice to custodians on the development of terms of reference for contracts to prevent or mitigate potential impacts to fish and fish habitat associated with testing.
- Review sampling plan to ensure that data collected will accurately represent the site and assess risks to fish and fish habitat.
- Participate in site visit activities.
- Assist with the identification of aquatic receptors and pathways to focus on during the assessment.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP.
- Provide advice on compliance requirements under the Fisheries Act and other environmental requirements.

How Environment Canada (EC) expert support can assist

- Review ESA reports and risk assessment and provide advice on treatment of data.
- Review sampling plan to ensure that data collected will accurately represent the site and assess ecological risks.
- Provide advice on sampling and analytical techniques and technologies.
- Provide advice on data requirements of an Ecological Risk Assessment (ERA) and future monitoring plans.
- Provide advice assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP.
- Provide advice on quality assurance/quality control (QA/QC) programs.
- Provide advice on applicable environmental quality guidelines.
- Participate in site visit activities.
- Provide advice on developing a site management strategy.
- Provide advice on compliance requirements under the Fisheries Act and other environmental requirements.

How Health Canada (HC) expert support can assist

- Review environmental site assessment (ESA) reports, preliminary quantitative risk assessment (PQRA) or risk assessment and CSM.
- Review sampling plan to ensure that data collected will accurately represent the site and provide input for the assessment of potential human health risks.
- Provide advice on sampling techniques and technologies.
- Provide advice on data requirements of a Human Health Risk Assessment (HHRA) and future monitoring plans.
- Provide advice on quality assurance/quality control (QA/QC) programs.
- Provide advice on applicable environmental quality guidelines.
- Participate in site visit activities.

- Provide advice on developing a site management strategy.
- Provide advice on the treatment of data.
- Review ESA reports, and where applicable, PQRA, and provide detailed technical comments regarding the data requirements necessary to adequately characterize contamination at the site.
- Review the sampling and analysis plan to ensure that data collected will be useful in delineating contamination at the site and that the data will be adequate to support the assessment of human health risks.
- Provide advice on the development of terms of reference for contracts for human health risk assessment.
- Provide advice on the selection and/or development of human-health-based remediation criteria and/or risk management.
- Provide advice, guidance and training on the characterization and delineation of contamination at a site so that custodians can adequately characterize their site for the purpose of risk management.
- Provide advice, guidance and training on human health risk assessment so that custodians can obtain adequate data for use in site management with the goal of risk reduction.
- Participate in site visit activities.
- Assist with developing a conceptual site model that includes the identification of human receptors and pathways, and that allows more targeted site investigation, which will allow for proper characterization of the contamination as it applies to human exposure.
- Provide advice on applicable human-health-based guidelines and standards and/or recommended interim values where guidelines and standards area not available (e.g., perfluorooctane sulfonate [PFOS]).

How Public Works and Government Services Canada (PWGSC) expert support can assist

- Provide advice throughout Step 5—including on the development of a statement of work, completion of the Phase III and preliminary liabilities estimates and the use of project management tools such as preliminary project planning and the project charter—or complete Step 5 on the custodian's behalf.
- Provide advice to custodians in the development of terms of reference for contracts.
- Assist in determining whether further work is required or no further action is necessary.

How the FCSAP Secretariat can assist

- Provide assistance in using the Prioritization for Assessment Tool and the Eligible Cost Guidance document as required.

Supporting documents and tools

Please also refer to the list of "Supporting documents and tools useful throughout the 10-step process" at the beginning of the document.

- Canada–Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment
- Canada-Wide Standard for Petroleum Hydrocarbons
- Canadian Council of Ministers of the Environment (CCME) Analytical Method Summaries

- Canadian Council of Ministers of the Environment (CCME) Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites – Volume I: Main Report
- CCME Canadian Environmental Quality Guidelines
  Soil, Water, Sediment
- *CCME Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites –* Volume II: Analytical Method Summaries
- Canadian Standards Association (CSA) Standards for Phase II Environmental Site Assessments
- FCSAP Ecological Risk Assessment Guidance
- FCSAP Ecological Risk Assessment Training
- Federal Interim Groundwater Guidelines
- For Human Health Risk Assessment: Federal Contaminated Site Risk Assessment in Canada
  Part I, Part II, Part III, Part IV available on request from cs-sc@hcsc.gc.ca, Part V, Part VI, Part VII
- Guidance on Developing a Contract Statement of Work (SOW) for Human Health Preliminary Quantitative Risk Assessment (PQRA) and Detailed Quantitative Risk Assessment (DQRA)
- Guidance on Human Health Risk Assessment for Country Foods (HHRAFoods)
- Guidelines for Canadian Drinking Water Quality
- Site Characterization Training
- Phase II ESA SOW incorporating Science-based Expert Support Input
- Priority for Assessment Tool (PAT)
- Subsurface Assessment Handbook for Contaminated Sites

Step 6: Re-Classify Site

At this step, the site may be classified for the first time, or it may be reclassified if new information leads to a different understanding of the site and a change in classification score is expected (i.e., from ineligible to eligible for funding). Custodians should complete the Canadian Council of Ministers of the Environment (CCME) National Classification System for Contaminated Sites (NCSCS) or the Federal Contaminated Sites Action Plan (FCSAP) Aquatic Site Classification System (ASCS) worksheets based on the results of the initial and detailed testing programs as detailed in the NCSCS Supplemental Guidance. Stakeholders can provide key information about the site history and condition, end use of the site, exposure pathways, receptors, contaminants of potential concern, and safe exposure limits.

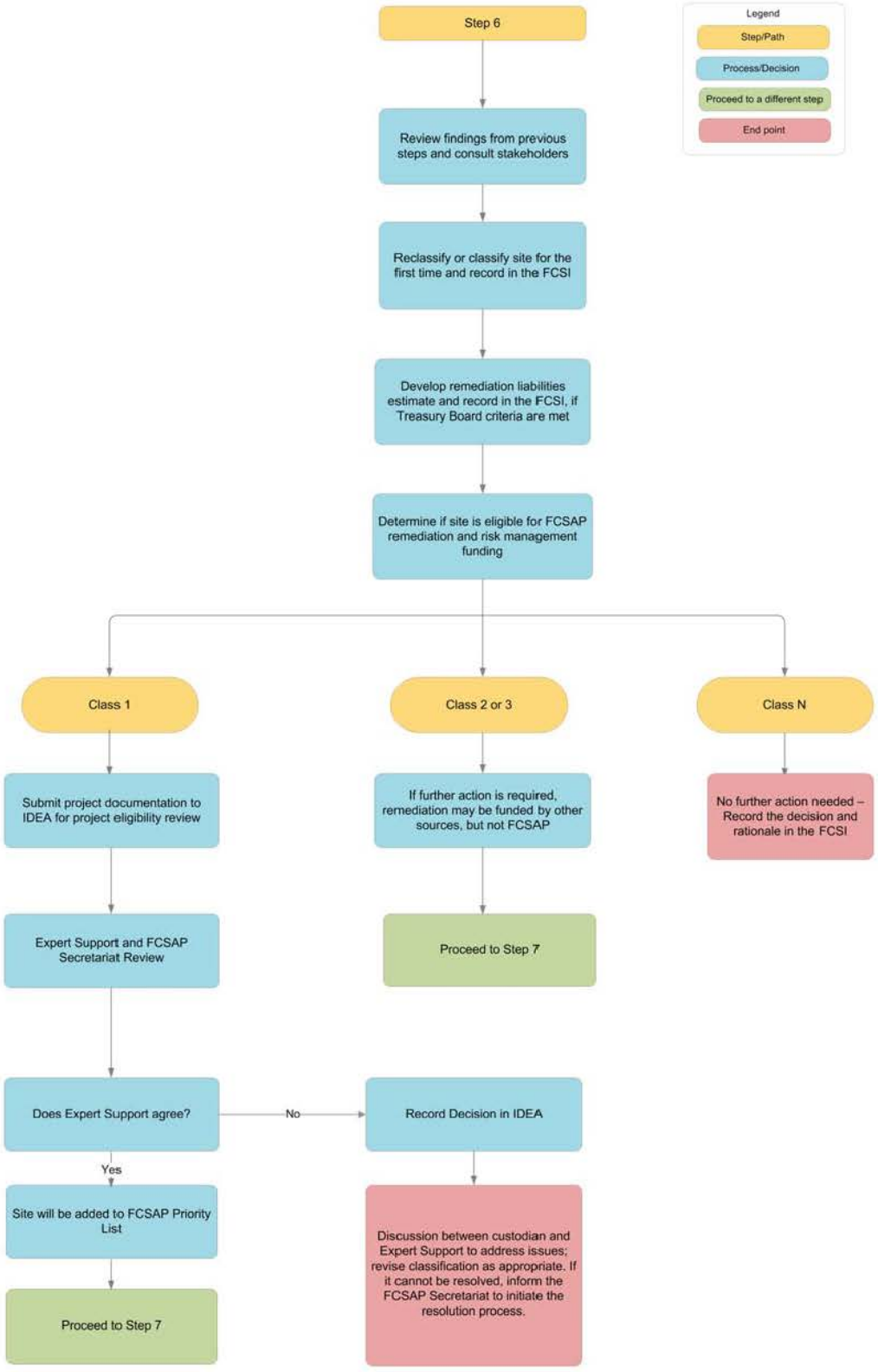
Site classifications include Class 1, 2, 3, INS (insufficient information) or N (not a priority for action), with Class 1 having the highest priority for action. For the second phase of the FCSAP (2011–2016), only Class 1 sites and ongoing Class 2 sites (with FCSAP remediation expenditures prior to April 1, 2011) are eligible for FCSAP funding.

After completion of Step 6, if the custodian wishes to have the site considered for FCSAP R/RM funding, the site will be reviewed by expert support to determine if it meets the eligibility requirements for FCSAP R/RM funding.

Key decision(s):

- Determine the site classification and FCSAP eligibility for funding.

Step 6: Re-Classify Site



How Fisheries and Oceans Canada (DFO) expert support can assist

- Review relevant components (e.g., fish and fish habitat) of the NCSCS or ASCS classification scores and associated reports.
- Provide training resources (such as the FCSAP Aquatic Sites Classification System [2009] Detailed User Guidance Manual) and provide advice on the submission score.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP.

How Environment Canada (EC) expert support can assist

- Review the NCSCS or ASCS score and associated reports to confirm the accuracy of the classification derived by the custodian (mandatory for sites that custodians are requesting be added to the FCSAP Priority List for remediation/risk management funding).
- Provide information on training resources.

How Health Canada (HC) expert support can assist

- Review human health components of the NCSCS and ASCS and associated reports to confirm the accuracy of the classification derived by the custodian.
- Provide advice on the use and interpretation of NCSCS and ASCS worksheets.
- Provide advice, guidance, training and/or peer review on conducting and interpreting human health risk assessment results as they apply to site classification.

How Public Works and Government Services Canada (PWGSC) expert support can assist

- Can complete or offer advice on the review and classification, and can liaise with other expert support departments.

How the FCSAP Secretariat can assist

- Provide clarification on the application of the Eligible Cost Guidance document and the NCSCS supplemental guidance as required.
- Communicate decision to custodians on the eligibility of new sites once reviewed, and add new eligible sites to the FCSAP Priority Site List.
- Provide information on how to access and operate the Interdepartmental Data Exchange Application (IDEA).

Supporting documents and tools

Please also refer to the list of "Supporting documents and tools useful throughout the 10-step process" at the beginning of the document.

- CCME National Classification System for Contaminated Sites (NCSCS) Guidance Document
- CCME National Classification System for Contaminated Sites Spreadsheet
- FCSAP Aquatic Site Classification System (ASCS) Guidance Document
- FCSAP Aquatic Sites Classification System Spreadsheet
- For Human Health Risk Assessment: Federal Contaminated Site Risk Assessment in Canada Part III

- Guidance: Checklist for Peer Review of Detailed Human Health Risk Assessment (HHRA)
- IDEA Data Guide
- NCSCS Supplemental Guidance
- Remediation Liabilities Related to Contaminated Sites: A Supplement to the Financial Information Strategy (FIS) Manual
- Training on the CCME NCSCS
- Training on the FCSAP ASCS

Is the site eligible for FCSAP remediation and risk management funding?

For federal contaminated sites to be eligible for remediation/risk management funding under the FCSAP Phase II (2011–2012 to 2015–2016), the following conditions must be met:

- The site must meet the Treasury Board of Canada (TB) definition of a contaminated site.
- Contamination must have occurred before April 1, 1998.
- The site must be classified as Class 1 using an appropriate site classification system identified in the FCSAP Guidance Manual. Class 2 sites are also eligible under FCSAP if remediation expenditures were incurred prior to April 1, 2011.
- The site must have an associated financial liability reported in the Public Accounts of Canada, in accordance with current Treasury Board of Canada (TB) guidance on recording remediation liabilities for contaminated sites.
    - In those circumstances where FCSAP funding is used for remediation expenditures but no liability can be recorded, custodians should provide a justification as part of the FCSAP Secretariat's review of priority sites.
    - An example is when a site with no opening liability for the fiscal year receives assessment and remediation funding in one field season.
- A complete and accurate site record, including annual expenditure and liability data, must be recorded in the TBS Federal Contaminated Sites Inventory (FCSI), in compliance with Treasury Board's Policy on Management of Real Property and the Reporting Standard on Real Property.

Treasury Board of Canada definition

According to the TB definition, a contaminated site is "one at which substances occur at concentrations (1) above background (normally occurring) levels and pose or are likely to pose an immediate or long-term hazard to human health or the environment, or (2) exceeding levels specified in policies and regulations".

Step 7: Develop Remediation/Risk Management Strategy

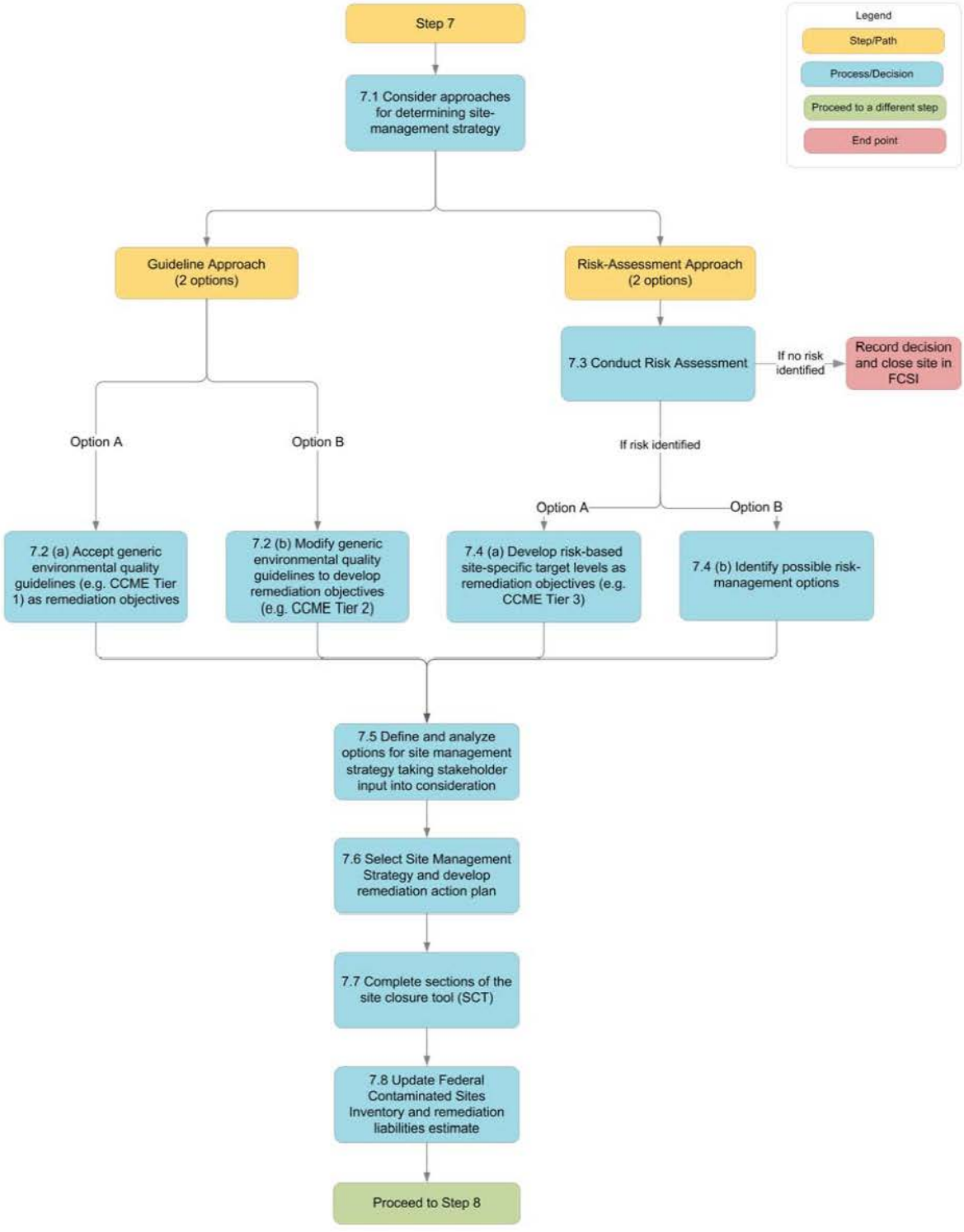
A remediation/risk management (R/RM) strategy is developed once the results of the preliminary (Step 3) and detailed (Step 5) testing have indicated that risks from contamination must be addressed. For the site to be funded under the Federal Contaminated Sites Action Plan (FCSAP) for R/RM activities, the site also needs to be scored and classified as either Class 1 or ongoing Class 2. Selection of the strategy is one of the most critical decisions in the 10-step process, since the outcome will largely determine the cost and effectiveness of the chosen remedy on the reduction of risk to human health and the environment, and on the reduction of financial liability. The financial liability for the site, based on the risk and the federal government's obligation to address it, should also be calculated by the end of Step 7. Careful consideration and evaluation of R/RM objectives, R/RM options and regulatory requirements will reduce the possibility of error and substantially increase the effectiveness of the proposed site management strategy.

At Step 7, it is recommended that custodians begin to fill in the FCSAP Site Closure Tool (SCT). It enables custodians to evaluate key decisions and document important information about the R/RM activities leading to the eventual closure or long-term monitoring/management of the site.

Key decision(s):

- Determine whether a guideline approach or a risk assessment approach to establish R/RM objectives will be applied.
- Establish corresponding R/RM objectives if a risk assessment approach is taken.
- Determine which R/RM options should be considered, and choose the most appropriate remedy.

Step 7: Develop Remediation/Risk Management Strategy



Step 7.1: Based on intended land use, consider approaches for developing a site management strategy

To develop their site management strategy, custodians will need to identify the remediation/risk management (R/RM) objectives and select the best options for attaining them. These two important decisions will be made in parallel, based on the intended or future federal use of the site, which was first identified at Step 3 but should be reconfirmed.

R/RM objectives may be developed for a site using a guideline approach—where generic or modified guidelines (e.g., Canadian Council of Ministers of the Environment [CCME] Tier 1 or Tier 2) are adopted—or using a risk assessment approach to derive site-specific target levels as remediation objectives (CCME Tier 3). Choosing between the guidelines or risk assessment approach depends on the circumstance. For instance, if the potential site management strategies based on the guideline approach are too costly or are unacceptable for other reasons (e.g., technical feasibility or unacceptable environmental damage caused by the remedy), it may be advantageous to perform a risk assessment. A risk assessment may help custodians to better understand and focus on the main drivers of risk at the site, which can optimize R/RM actions. There are many conditions under which one or both of these approaches may be implemented. Switching between the risk assessment and guideline approach is not prohibited; an iterative analysis of the alternatives is encouraged and works to optimize the final strategy.

Step 7.2a: Accept generic environmental quality guidelines (e.g., CCME Tier 1) as remediation objectives

Published guidelines such as the CCME Canadian Environmental Quality Guidelines (1999) are selected as the remediation objectives. These are conservative, generic numeric concentrations of residual contamination that are considered to be acceptable for a wide range of site conditions and receptors under defined land uses.

Step 7.2b: Modify generic environmental quality guidelines (e.g., CCME Tier 2) to develop remediation objectives

When site conditions, land use, receptors or exposure pathways differ slightly from those set out for the generic guidelines—and when adjustment of certain parameters in equations or pathway exposure assumptions is deemed acceptable based on jurisdictional approval and guidance—it is possible to apply limited modification of generic guidelines.

Step 7.3: Conduct risk assessment

When the environmental quality guideline approaches cannot be implemented, or if site conditions are unique or particularly sensitive and would limit the effectiveness of generic criteria, a risk assessment approach may be used to determine if the existing contamination/site conditions represent a risk. If generic environmental quality guidelines for the contaminant of concern do not exist in Canada or other jurisdictions, if costs of remediating to guideline levels are too high, if the site is particularly large and complex, if the environmental impacts of using available remediation techniques are unacceptable, or if little information is known about the contaminants of concern, risk assessment may be warranted.

Depending on the site and receptors present, both a human health and an ecological risk assessment will likely be necessary. Guidance for these assessments is published by the Canadian Council of Ministers of the Environment (CCME), Health Canada and Environment Canada. A risk assessment at Step 7 typically requires substantially more effort and detail than simpler risk assessments that may have been completed previously.

If there is no risk identified, no further action is required and the site should be closed in the Federal Contaminated Sites Inventory (FCSI). No further action should also be recorded in the mandatory site closure tool (SCT) and the recommended Tool for Risk Assessment Validation (TRAV). If risks are identified, they can either be managed through remediation up to site-specific target levels or by risk management of the contamination in such a way that no risk exists, despite any changes to contamination level.

Step 7.4a: Develop risk-based site-specific target levels as remediation objectives (e.g., CCME Tier 3)

Site-specific target levels (SSTLs) are established using risk assessment. SSTLs are concentrations at or below which no risk exists for this particular site (CCME Tier 3). Remediation should aim to attain those levels.

Step 7.4b: Identify possible risk management options

Options for risk management typically involve engineering or institutional controls that a) interrupt the exposure pathways (e.g., installing fencing, filtering drinking water, removing children's sandboxes, importing clean soil for raised garden beds); b) remove receptors (e.g., not allowing deep-rooted trees on site); or c) change the form of the contaminant to make it less accessible (e.g., liming soil to reduce metal mobilization, encapsulating metals in cement).

Step 7.5: Define and analyze options for site management strategy, taking stakeholders' input into consideration

A site management strategy may include one or a combination of remediation and risk management options to address a variety of site conditions. For example, it may be decided that remediation methods are appropriate for some areas of the site or impacted media, but that other site conditions are more appropriately addressed by engineering and/or institutional controls to prevent potential exposure by receptors. In this context, it is necessary to consider various options and to assess their relative advantages and disadvantages. See Appendix A for further guidance on how to assess available options.

Step 7.6: Select optimal site management strategy based on options developed

Once the preferred R/RM techniques are determined, a strategy is developed that may rely on a combination of remediation and risk management approaches. One of the main components of the strategy is the Remedial Action Plan (RAP) or Risk Management Plan (RMP), depending on the chosen route. Each plan should contain some key details about the project, including the following:

- A summary of all data from previous investigations, including identifying contaminants of concern, affected media and quantity of materials to be treated;
- A summary of the R/RM techniques that were evaluated and how the preferred strategy was chosen;
- A detailed plan for the R/RM processes to be used, as well as an implementation plan and control measures to minimize further risk; and
- A description of remedial verification and long-term monitoring plans.

Step 7.7: Complete sections of the Site Closure Tool (SCT) including the Tool for Risk Assessment Validation (TRAV)

The SCT is meant to provide custodians with consistent evaluation criteria for determining when it is appropriate to close sites remediated using FCSAP funding. It also provides a template for determining which critical information about site remediation decisions should be documented and summarized in a closure report. The TRAV is embedded within the SCT and acts as a quality assurance tool describing the expectations of Environment Canada, Fisheries and Oceans Canada, and Health Canada with respect to the proper procedure for conducting risk assessments. The TRAV is not a mandatory tool but is strongly recommended by the FCSAP Secretariat. Custodians will begin to fill out the sections of the site closure tool related to R/RM planning and the quality of site assessment data during Step 7. This will ensure that any deficiencies are identified early enough in the R/RM process that they can be corrected, rather than doing so at the end of the project.

Step 7.8: Update Federal Contaminated Sites Inventory (FCSI)

The Federal Contaminated Sites Inventory (FCSI) should be updated to include liability estimates, if the Treasury Board of Canada Secretariat liability recognition criteria are met.

A liability for remediation of contaminated sites should be recognized when, as of the financial reporting date, the following apply:

- An environmental standard exists.
- Contamination exceeds the environmental standard.
- The Government of Canada:
  - owns the land; or
  - is directly responsible; or
  - accepts responsibility (e.g., when there is little, if any, discretion to avoid the obligation).
- It is expected that future economic benefits will be given up.
- A reasonable estimate of the amount can be made.

How Fisheries and Oceans Canada (DFO) expert support can assist

- Provide input and advice on risk management options (including remediation and mitigation measures).
- Review and provide advice on the following points to ensure that activities on site are compliant with DFO's regulatory requirements and mandate to protect fish and fish habitat that support fisheries:
  - draft Remedial Action Plan (RAP) or Risk Management Plan (RMP);
  - remedial strategy to ensure coherence with broader DFO initiatives;

    - SARA recovery strategies, action plans and management plans to ensure compliance with the SARA-listed aquatic species or particular harvested aquatic species;
    - draft Environmental Assessment (EA) and supporting documentation;
    - draft Ecological Risk Assessment (ERA);
    - plans for physical works and undertakings; and
    - mitigation, monitoring and contingency plans.
- Participate in site visit activities (if specific issues arose).
- Identify appropriate contacts within DFO.
- Provide support to the public engagement process.
- Provide advice to custodians on the development of terms of reference for contracts to prevent or mitigate potential impacts to fish and fish habitat that would be associated with testing or remediation/risk management programs.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP.
- Provide advice on compliance requirements under the *Fisheries Act* and other environmental requirements.

How Environment Canada (EC) expert support can assist

- Provide advice on and/or review of ecological risk assessments, remediation objectives, risk-based site-specific target levels, remedial action plans or risk management plans.
- Provide advice on the accuracy of model assumptions made during the Ecological Risk Assessment (ERA) and the Risk Management Strategy.
- Provide advice to ensure that remediation or risk management activities on site are compliant with EC's regulatory requirements including the Fisheries Act and other environmental requirements.
- Provide advice on the development and comparison of remedial/risk management options.
- Provide advice to custodians in the development of terms of reference for contracts.
- Provide advice on mitigation activities and sustainable strategies to reduce impacts from remediation.
- Assist on the environmental assessment (EA) for remediation activities (e.g., excavation) as per the Canadian Environmental Assessment Act (CEAA) (Note: sending the EA to the FCSAP expert support department does not replace the formal EA process).
- Participate in site visit activities.

How Health Canada (HC) expert support can assist

- Provide advice, guidance, training and review on developing site-specific human health remediation objectives (risk-based remediation standards).
- For the Human Health Risk Assessment (HHRA), HC can review the statement of work, provide a technical review of the draft and final report, and provide advice on standard or more complicated aspects of human health risk assessment (including, but not limited to, how to incorporate bioavailability of substances in soil to reduce remediation costs, how to address short-term exposure in a fiscally responsible manner, and how to ensure protection of human health).
- Provide advice on and/or review of human health risk assessments and remedial action plans or risk management plans as they pertain to human health.
- Provide advice on human health impacts associated with remedial options and on mitigating human health impacts on a technology- and site-specific basis.

- Participate in site visit activities.
- Provide advice on mitigation options to reduce human health exposure as they relate to site contamination and/or remediation options.

How Public Works and Government Services Canada (PWGSC) expert support can assist

- Assist throughout Step 7 including the evaluation of remedial options, which may include the use of project management and database tools; innovative procurement; and awareness of innovative, green, sustainable remediation approaches.
- Assist in project planning, including developing scope of work, work breakdown structure, schedule development, cost estimating and budgeting, quality planning, communications planning, risk identification and response, and procurement planning.

How the FCSAP Secretariat can assist

- Provide clarification on the application of the Eligible Cost Guidance document as required.

Supporting documents and tools

Please also refer to the list of "Supporting documents and tools useful throughout the 10-step process" at the beginning of the document.

- *Canada-Wide Standard for Petroleum Hydrocarbons* and Spreadsheet Model
- Canadian Council of Ministers of the Environment (CCME) *Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites* – Volume I: Main Report
- *Canadian Environmental Assessment Act (CEAA) 1992*
  Canadian Environmental Assessment Act (CEAA) 2012
- *Canadian Environmental Protection Act, 1999*
  CCME Canadian Environmental Quality Guidelines and respective derivation protocols
- *CCME Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites* – Volume II: Analytical Method Summaries
- Contaminated Site Remediation Projects Roadmap
- DFO Pathways of Effects (PoE)
- FCSAP Ecological Risk Assessment Guidance
- FCSAP Guidance Document on Statements of Work for Ecological Risk Assessments at Federal Sites
- *Federal Guidelines for Landfarming Petroleum Hydrocarbons Contaminated Soils*
- Federal Interim Groundwater Guidelines
- For Human Health Risk Assessment: Federal Contaminated Site Risk Assessment in Canada Part I, Part II, Part III, Part IV available on request from cs-sc@hcsc.gc.ca, Part V, Part VI, Part VII
- Green Remediation Contract Specifications
- Guidance and Orientation for the Selection of Technologies (GOST)
- Guidance on Developing a Contract Statement of Work (SOW) for Human Health Preliminary Quantitative Risk Assessment (PQRA) and Detailed Quantitative Risk Assessment (DQRA)
- Guidance on Human Health Risk Assessment for Country Foods (HHRAFoods)
- *Guidelines for Canadian Drinking Water Quality*
- Interdepartmental Recovery Fund
- Interim Long-Term Monitoring Planning Guidance
- Objective (Performance) Based Contracting Training

- Probabilistic Sediment Costing Tool
- *Recommended Principles on Contaminated Sites Liability*
- *Remediation Liabilities Related to Contaminated Sites: A Supplement to the Financial Information Strategy (FIS) Manual*
- Site Closure Tool including the Tool for Risk Assessment Validation
- SuRF Canada
- Sustainable Decision Support Tool
- Treasury Board Accounting Standard 3.1 – Capital Assets
- Treasury Board Accounting Standard 3.6 – Contingencies
- Treasury Board of Canada Secretariat Directive on Contingencies

Step 8: Implement Remediation/Risk Management Strategy

Step 8, which is based on the analysis and planning outcomes from Step 7, involves carrying out the work to reduce the risk from contaminants at the site to acceptable levels. Other responsibilities include:

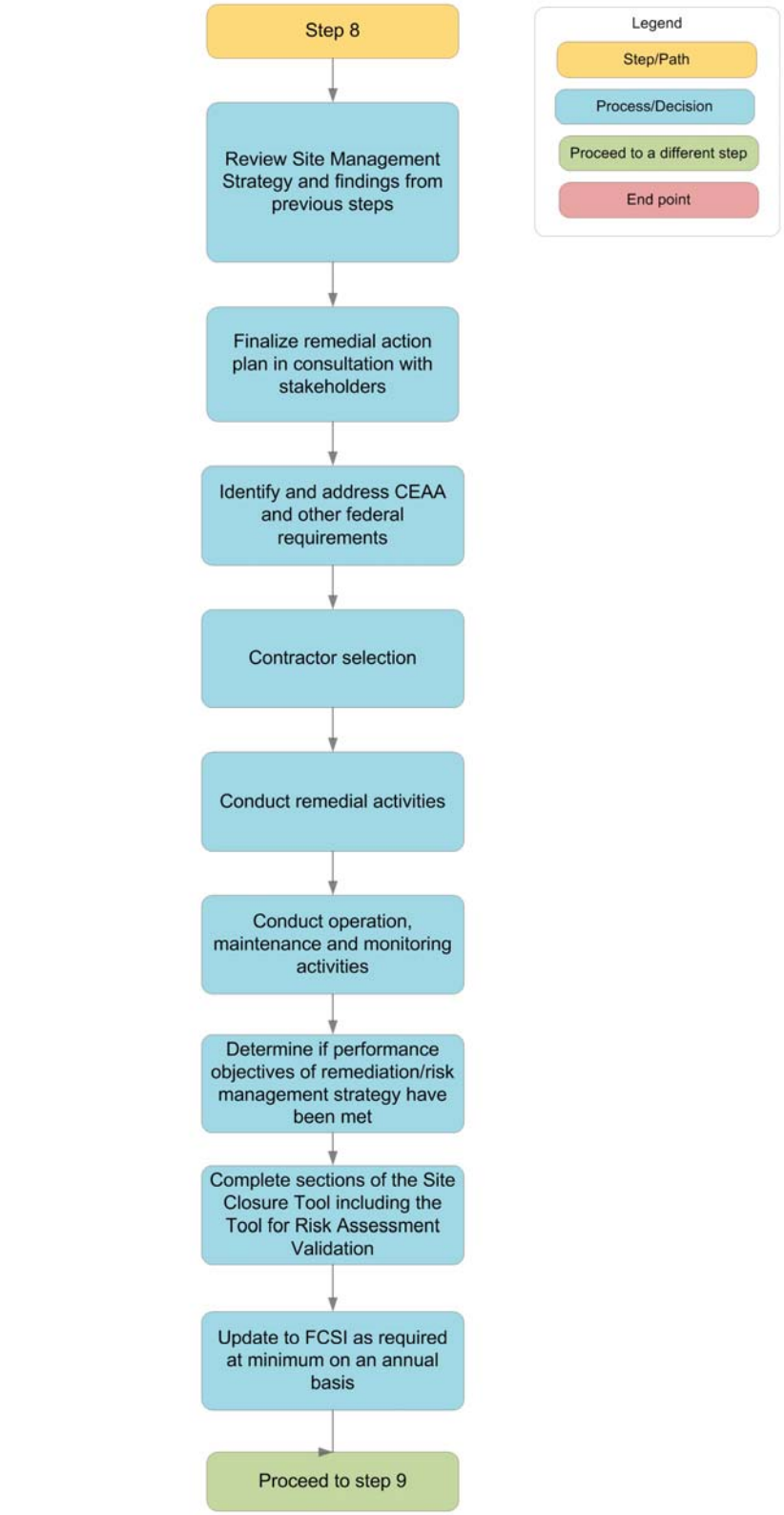
- meeting requirements under the Canadian Environmental Assessment Act (CEAA);
- obtaining all permits and approvals required to undertake any work at the site;
- selecting the contractor;
- conducting operations, maintenance and monitoring during implementation of the remediation during the Remedial Action Plan (RAP); and
- verifying the efficacy of the RAP.

This step should include strict documentation control and adherence to the remediation/risk management (R/RM) objectives, as any unanticipated occurrences will require modification of the RAP and potential re-evaluation of the technologies applied. Stakeholders should be consulted as appropriate. If it is determined that the remediation objectives will not be met, a full review of the Risk Management Strategy (RMS) and RAP for the site is required. It may be necessary to revisit earlier steps to determine what supplemental work is required or to determine if the site management strategy needs to be refined.

Key decision(s):

- Determine if the performance expectations of the R/RM project have been met.

Step 8: Implement Remediation/Risk Management Strategy



How Fisheries and Oceans Canada (DFO) expert support can assist

- Provide advice during implementation of the risk management strategy (RMS) related to:
    - mitigation measures and compliance requirements under the *Fisheries Act*;
    - effectiveness and compliance monitoring;
    - unforeseen issues; and
    - revisions to the sampling and monitoring plans, if required.
- Provide support to the public engagement process.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP.

How Environment Canada (EC) expert support can assist

- Provide advice related to the implementation of R/RM strategies (specific to potential environmental and human health impacts).
- Provide advice on compliance requirements under the Fisheries Act and other ecological requirements.
- Provide advice on revising the design, implementation and objectives for the long-term management plan.
- Provide advice on the preparation of the site closure report and assist with the Site Closure Tool (SCT) including the Tool for Risk Assessment Validation (TRAV), an optional component of the SCT.

How Health Canada (HC) expert support can assist

- Provide advice related to the implementation of remediation and RMS (specific to potential human health impacts).
- Provide advice and support in the determination of the project's significant environmental effects as defined under the Canadian Environmental Assessment Act, 2012 (CEAA 2012).
- Provide advice and support on risk communication to stakeholders (including the general public).

How Public Works and Government Services Canada (PWGSC) expert support can assist

- Provide advice on, among other things, finalizing the Remedial Action Plan, developing tender specifications, selecting contractors, providing oversight of remedial activities, and completing the Site Closure Tool; PWGSC can also complete these activities on behalf of custodians.
- Ensure that the monitoring and control of the project, such as the status, scope, schedule, communication, risk control and lessons learned, are complete.

How the FCSAP Secretariat can assist

- Provide clarification on the application of the Eligible Cost Guidance document as required.

Supporting documents and tools

Please also refer to the list of "Supporting documents and tools useful throughout the 10-step process" at the beginning of the document.

- *Canada Wildlife Act*
- *Canadian Environmental Assessment Act (CEAA) 1992, CEAA* 2012
- *Canadian Environmental Protection Act, 1999*
- Contaminated Site Remediation Projects Roadmap
- DFO Pathways of Effects (PoE)
- *Federal Guidelines for Landfarming Petroleum Hydrocarbons Contaminated Soils*
- *Fisheries Act*
- Green Remediation Contract Specifications
- Guidance and Orientation for the Selection of Technologies (GOST)
- *Habitat Compliance Decision Framework*
- *Migratory Birds Convention Act, 1994*
- PM Tools Handbook for Remediation/Risk Management Projects
- Remediation Checklist (internal, Health Canada)
- Site Closure Tool (SCT) and Tool for Risk Assessment Validation (TRAV)
- *Species at Risk Act* (SARA)
- SuRF Canada
- Sustainable Decision Support Tool (SDST)

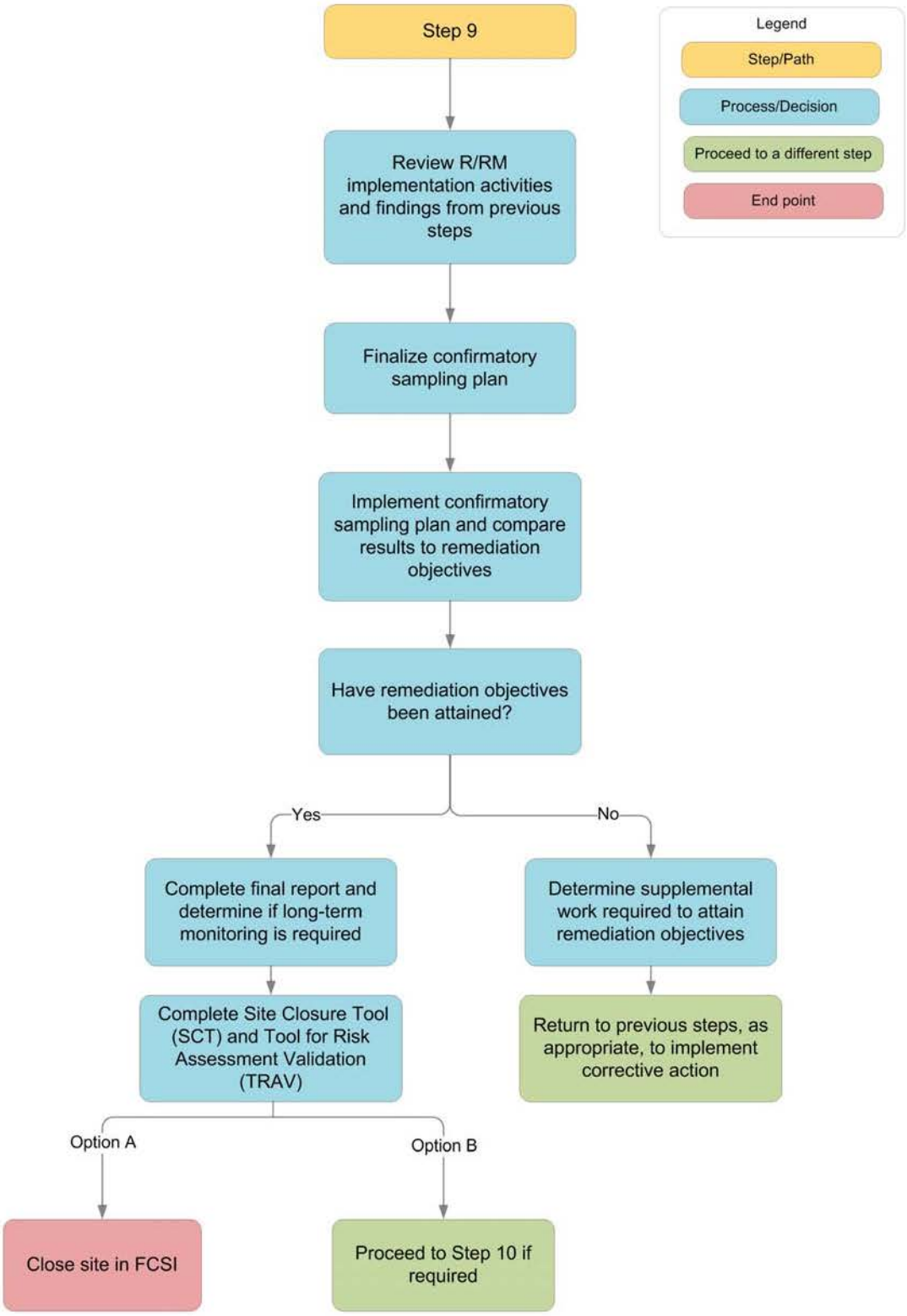
Step 9: Confirmatory Sampling and Final Reporting

Step 9 involves confirming the achievement of remediation/risk management (R/RM) objectives by implementing the confirmatory sampling plan. The sampling plan that will have been developed during Step 7 and refined in Step 8 will be finalized at this step. Closure reporting to document the reduction of risk to acceptable levels will be completed and submitted to the FCSAP Secretariat if it is determined that no further action is required. For sites that require additional R/RM activities or long-term monitoring, this information would also be recorded in the site closure report in preparation for closure in the future.

Key decision(s):

- Evaluate the success of the site management strategy implementation.
- Determine whether the site can be closed or whether additional work (e.g., continued R/RM or long-term monitoring) is required.

Step 9: Confirmatory Sampling and Final Reporting



How Fisheries and Oceans Canada (DFO) expert support can assist

- Review and provide advice on the results of the confirmatory sampling.
- Advise on the effectiveness of monitoring in protecting fish and fish habitat.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP.
- Provide advice on the design and expectations associated with the long-term monitoring plan.

How Environment Canada (EC) expert support can assist

- Provide advice on the design, implementation and results of confirmatory sampling.
- Provide advice on the preparation of the site closure report and assist with the Site Closure Tool (SCT) including the Tool for Risk Assessment Validation (TRAV), an optional component of the SCT.

How Health Canada (HC) expert support can assist

- Provide advice on the design and implementation of confirmatory sampling.
- Provide advice on the preparation of closure reporting and on the reporting of risk reduction.
- Provide advice on ongoing site work and long-term management.
- Provide assistance with interpreting long-term monitoring results and reports as they relate to human health.
- Provide advice on the accuracy of model and other assumptions made during the human health risk assessment and the Risk Management Strategy.

How Public Works and Government Services Canada (PWGSC) expert support can assist

- Can assist in confirming whether the remediation/risk management objectives were met, including the completion of the sampling plan; PWGSC can also complete this activity on behalf of custodians.
- Assist in confirming that no further action is necessary and in documenting completion through the Site Closure Tool.

How the FCSAP Secretariat can assist

- Offer support by providing clarification on the application of the Eligible Cost Guidance document as required, and assist in liability estimates and reporting on the Federal Contaminated Sites Inventory (FCSI).

Supporting documents and tools

Please also refer to the list of "Supporting documents and tools useful throughout the 10-step process" at the beginning of the document.

1. Canadian Council of Ministers of the Environment (CCME) *Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites* – Volume I: Main Report
2. CCME Canadian Environmental Quality Guidelines (Soil, Water, Sediment)
3. *CCME Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites* – Volume II: Analytical Method Summaries

4. *Federal Guidelines for Landfarming Petroleum Hydrocarbons Contaminated Soils*
5. Federal Interim Groundwater Guidelines
6. Guidelines for Canadian Drinking Water Quality
7. Interim Long Term Monitoring Planning Guidance
8. Remediation Checklist
9. Site Closure Tool, including the Tool for Risk Assessment Validation

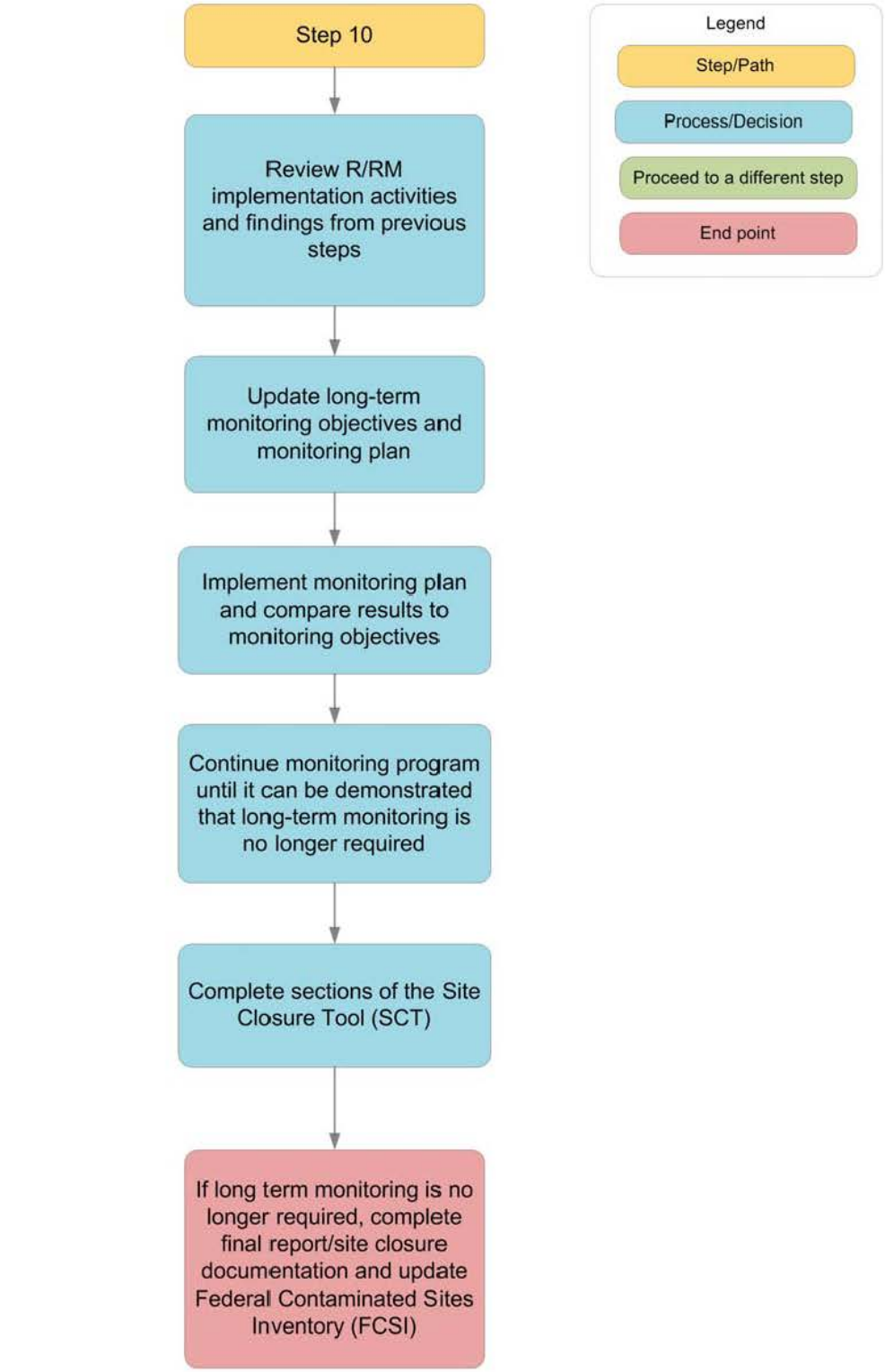
Step 10: Long-Term Monitoring (if required)

Step 10 involves implementing long-term monitoring (LTM) at a site, which may not be required at all sites. Stakeholders should be consulted as appropriate. LTM objectives must be achieved and verified before a site can be closed, unless perpetual monitoring is required.

Key decision(s):

- Decide whether the long-term monitoring plan (developed in Step 7) is still applicable.
- Decide when long-term monitoring is no longer required.

Step 10: Long-Term Monitoring (if required)



How Fisheries and Oceans Canada (DFO) expert support can assist

- Provide advice during the design and development of a long-term monitoring (LTM) program (e.g., selecting monitoring targets/endpoints and monitoring plans).
- Provide support for public engagement activities (e.g., help with the interpretation and communication of results).
- Assist with interpreting LTM results and reports.
- Provide advice on adaptive management and possible modifications to the monitoring plan.
- Provide assistance in applying the Framework for Addressing and Managing Aquatic Contaminated Sites under the FCSAP.
- Provide assistance with interpreting LTM results and reports.

How Environment Canada (EC) expert support can assist

- Provide advice during the design and development of a long-term monitoring plan.
- Provide advice on establishing procedures for identifying decision criteria prior to LTM data collection.
- Provide assistance with interpreting LTM results and reports.
- Provide advice on the need to continue monitoring.

How Health Canada (HC) expert support can assist

- Provide advice on the need for long-term monitoring and on the design of the monitoring plans, including the need for risk communication with stakeholders and those affected, for the duration of the monitoring program (if necessary).

How Public Works and Government Services Canada (PWGSC) expert support can assist

- Assist with the update of the long-term monitoring plan and with continual monitoring and the Site Closure Tool when applicable; PWGSC can also complete these activities on behalf of custodians.

How the FCSAP Secretariat can assist

- Provide clarification on the application of the Eligible Cost Guidance document as required.

Supporting documents and tools

Please also refer to the list of “Supporting documents and tools useful throughout the 10-step process” at the beginning of the document.

- Interim Long-Term Monitoring Planning Guidance
- Site Closure Tool, including the Tool for Risk Assessment Validation

Appendix A: Site Management Options Assessment

This appendix discusses methods for assessing the relative advantages and disadvantages of a variety of remediation or risk management options.

Part 1 – The Theory

Role of cost/benefit analysis

Cost/benefit analysis is a commonly accepted approach for determining the feasibility of various alternatives being considered to address a particular problem or project requirement. In the context of contaminated sites, this can be used as a basis to determine the optimum approach where a variety of alternatives exist to address site conditions, representing a range of effectiveness, implementability and cost considerations.

In order to conduct the cost/benefit analysis, it is typically necessary to determine the alternatives for consideration, identify the evaluation criteria to be applied, and then conduct the comparative evaluation using an appropriate method. This is discussed in more detail below.

Development of an alternatives array

The formulation of a range of alternatives can be illustrated in an array that identifies the technical options available for addressing the site conditions (identified prior to Step 7). This may include both remediation and risk management techniques, and a combination depending on the site-specific circumstances and the environmental media that need to be addressed.

For illustration purposes, an example alternatives array is included in Table 1. As shown in the table, a total of nine alternatives are included. Each alternative includes specific actions related to individual site-specific areas or units (e.g., equipment/storage vessels, waste disposal areas, impacted soil areas, impacted groundwater areas). The scope of the alternatives progress sequentially from “do nothing,” to limited action (waste material removal, access restrictions, monitoring), then containment, and finally to active remediation through treatment. The potential application of both risk management and remediation methods is an integral part of the array, and a variety of other combinations may be available beyond what is shown in this example. In carrying out the comparative assessment, it may ultimately be decided that the optimum alternative is a refinement of the alternatives initially included in the array. The evaluation process should provide flexibility for this type of decision making.

It is noted that Alternative 1 (no action) may appear inherently unacceptable at the outset. However, its inclusion in the array may be useful for representing a baseline condition to identify the consequences of “do nothing” and for assisting with the justification for selecting one of the other alternatives.

Table 1

Example Alternatives Array

Cost/benefit analysis for remediation/risk management alternatives for federal contaminated sites

Area/Unit	1	2	3	4	5	6	7	8	9
Drums/tanks/ piping	No action	Remove	Remove	Remove	Remove	Remove	Remove	Remove	Remove
Waste disposal pit	No action	Restrict access	Cap	Cap	Excavate /dispose	Excavate /dispose	Excavate /dispose	Excavate /dispose	Excavate /dispose
Soil impacted above industrial use guidelines	No action	Restrict access	Cap	Cap	Cap	Cap	Excavate /dispose /treat	Excavate /dispose /treat	Excavate /dispose /treat
Soil impacted above unrestricted use guidelines	No action	Restrict access	Restrict access	Restrict access	Restrict access	Restrict access	Restrict access	Cap	Excavate /dispose /treat
Groundwater at source area	No action	Monitor	Monitor	Treat-ment	Treat-ment	Treat-ment	Treat-ment	Treat-ment	Treat-ment
Groundwater plume	No action	Monitor	Monitor	MNA*	MNA	Treat-ment/ MNA	Treat-ment/ MNA	Treat-ment/ MNA	Treat-ment/ MNA

**MNA: monitored natural attenuation*

Potential evaluation criteria

In most situations, the comparative evaluation of alternatives relies on the use of criteria against which each alternative can be assessed relative to other alternatives. These criteria may be either qualitative or quantitative, and will generally consider factors relating to overall protection, effectiveness, implementability, cost, stakeholder considerations and regulatory compliance. A list of potential evaluation criteria is included in Table 2. As shown in the table, various criteria may be applicable under each category, and are further classified according to the type of criteria (threshold, balancing and acceptance).

Table 2

Potential Evaluation Metrics

Cost/benefit analysis for remediation/risk management alternatives for federal contaminated sites

CATEGORY/EVALUATION METRICS	METRIC TYPE		
Overall protection	**Threshold**	**Balancing**	**Acceptance**
Protection of human health	**X**		
Protection of the environment	**X**		
Effectiveness	**Threshold**	**Balancing**	**Acceptance**
Short-term effectiveness		**X**	

CATEGORY/EVALUATION METRICS	METRIC TYPE		
Long-term effectiveness and permanence		X	
Reduction of toxicity, mobility, volume		X	
Implementability	**Threshold**	**Balancing**	**Acceptance**
Use of proven technology		X	
Use of innovative technology		X	
Use of sustainable construction/remediation methods		X	
Permits and approvals required		X	
Time required for implementation		X	
Impacts and risks to the environment		X	
Impacts and risks to the public and workers		X	
Cost	**Threshold**	**Balancing**	**Acceptance**
Construction cost		X	
Operation and maintenance cost		X	
Decommissioning cost		X	
Present worth cost		X	
Stakeholder considerations	**Threshold**	**Balancing**	**Acceptance**
Federal government/custodian acceptance			X
Provincial government acceptance			X
Local government acceptance			X
Community/public acceptance			X
Regulatory compliance	**Threshold**	**Balancing**	**Acceptance**
Compliance with regulatory requirements – federal	X		
Compliance with regulatory requirements – provincial	X		
Compliance with regulatory requirements – local	X		
Other	**Threshold**	**Balancing**	**Acceptance**
Sustainable development		X	
Future development potential		X	
Long-term liability		X	
Impact on land value		X	
Impacts on future operations		X	

CATEGORY/EVALUATION METRICS	METRIC TYPE		
Compatibility with federal government policies			X
Socio-economic impacts		X	

Threshold criteria include minimum requirements that need to be met in order for the alternative to be considered for selection. Typically, this relates to protection of human health and the environment, and regulatory compliance. Alternatives that satisfy these threshold criteria will be suitable for passing an initial screening and then short-listed for more detailed consideration.

Balancing (or modifying) criteria are those which are used to compare the relative merits of the various alternatives and associated trade-offs. For example, Alternative A might be expected to achieve a permanent solution and unrestricted future site use, whereas other alternatives may achieve an acceptable cleanup level for commercial or industrial site use at a much lower cost.

Acceptance criteria are those that relate to meeting the expectations of various stakeholder groups, including various levels of government and the local community. Acceptance considerations may ultimately be used to make a final selection from a list of several otherwise suitable alternatives, or as a basis for refinement of a preferred alternative.

An alternative that is preferable based on balancing criteria considerations may not ultimately be selected for implementation if it is not acceptable to stakeholders. In some cases (e.g., large/complicated sites), stakeholder input will probably have already been considered in developing the list of alternatives.

The list shown in Table 2 represents potential criteria for consideration. The selection of relevant criteria may be affected by site-specific factors, and it may be decided that some should be deleted, or others added, as necessary and appropriate.

Options for comparative evaluation of alternatives

A variety of methods are available for conducting a comparative evaluation of alternatives in order to identify the most suitable alternative (and hence site management strategy) for implementation. This includes the following examples described herein: ad hoc methods, checklist methods, economic methods, pairwise comparison methods and matrix methods.

Ad hoc methods compare alternatives in narrative terms without using any explicitly stated methods to order the preferences, based on professional judgment. Typically, the use of ad hoc methods, as the name implies, does not necessarily follow an explicit set of evaluation criteria. This approach can be applied to situations in which the scope of the problem is narrow and well defined, and the rationale for selection of the proposed alternative can be readily communicated. However, in more complex situations this method is subject to potential problems such as assuring that each alternative is evaluated in a consistent manner.

Checklist methods compare and evaluate alternatives against a specified set of criteria with no compensatory rules or tradeoffs. Typically, this involves posing a series of questions related to the

individual criteria that require a yes or no response, such as:

- Is the alternative protective of human health and the environment?
- Is the alternative effective in the long term?
- Does the alternative use proven methods or technology?
- Is the estimated cost below a defined threshold?

This approach may be useful for identifying dominant alternatives for screening purposes. For example, if Alternative A is better than Alternative B in at least one respect and no worse than Alternative B in any other respect, Alternative A may be considered dominant.

Economic methods use economic procedures and principles to translate non-commensurable units into monetary units. This methodology relies largely on determining an individual's willingness-to-pay (the amount that individuals affected by the project would be willing to pay for the defined benefits), and the availability of market prices that relate to the benefits. By their nature, many of the benefits associated with environmental improvements cannot be readily determined based on market prices; however, this type of method may have application in situations where the property is being considered for sale and/or redevelopment. In this case, it may be possible to directly relate the cost of implementing an alternative to the beneficial value of land improvement.

Pairwise comparison methods use the sequential comparison of alternatives in pairs as a basis for subsequent ordering of preferences. In its simplest form, the procedure develops a measure of how frequently one alternative is superior to another based on the various evaluation criteria. This is improved using **fuzzy set procedures**, which is based on subjective interpolation, and is used to identify inefficient alternatives (those that are dominated by other alternatives). In this case, each alternative is numerically ranked for each evaluation criteria. Initially, two alternatives are compared to determine dominance, i.e., which of the two alternatives has the greater number of occasions of dominance. The dominant alternative is then compared to the next alternative, and so on, until one dominant alternative is identified. The method can be based on either a non-parametric or parametric ranking; however, in both cases, the assignment of the ranking values may be subjective. Also, the relative importance of each criterion is not reflected in the procedure unless the criteria are ranked into groups.

Matrix methods use a matrix for the summary, comparison and evaluation of criteria and alternatives, based on professional judgment (as an extension of ad hoc methods). In this case, weight factors are applied to each evaluation criterion to reflect its overall importance, and ranking factors are applied to each alternative (for each criterion). These are multiplied and summed to develop an overall score. In this manner, alternatives that score well can be considered to be superior to other alternatives. This method relies on subjective assignment of the weight and ranking factors, and therefore would need to be supported by the assessor's justification for assigning the factors. It is an improvement over ad hoc methods in that all evaluation criteria need to be considered for each alternative, and it is amenable to sensitivity analysis by examining the effects of changes in the factors. Both the pairwise comparison and the matrix methods are transparent in the identification of the preferred alternative and hence potentially very useful in public consultation.

Expert support tools that may assist the custodian in completing the preceding evaluation include the **Guidance and Orientation for the Selection of Technologies (GOST)** and the **Sustainable Development Tool (SDT)**. GOST is a technology database that contains individual fact sheets on a host of treatment technologies/approaches. The user is prompted for a series of inputs regarding contaminant and site data (e.g., hydro-geologic conditions), which results in the identification of a number of technically

feasible remediation/risk management options. Custodians could consider the use of GOST as early as Step 5 and during Step 7 of the 10-step federal process, primarily to identify potential candidate technologies/approaches for management of their sites. A secondary benefit of GOST is that it provides assistance to the custodian in confirming the necessary data to be collected during the environmental site assessment, via the required inputs to the model, to support this evaluation.

Once the custodian has identified a suite of potential technologies/approaches using GOST, a secondary evaluation can be conducted using SDT to evaluate and compare up to five separate treatment options from the perspective of the three pillars of sustainability: economic, social and environmental. Custodians can choose from a suite of parameters for all three elements—and further, use weightings for each parameter—to reflect their specific site situation. The output from the model is both graphical and numerical, such that it serves as a communication as well as an analytical tool. This approach allows for stakeholder engagement and incorporation of multi-stakeholder requirements. The intent is that custodians will select the most balanced alternative with the cost in mind; SDT will help them to incorporate sustainability aspects into their evaluation process when identifying the preferred alternative.

Part 2 – Example Alternatives Assessment

An example of alternatives assessment using the pairwise comparison and matrix methods based on a contaminated site scenario is presented below.

Use of evaluation metrics to select the preferred R/RM alternative

Table 2 includes the potential evaluation metrics within various categories that can be used as part of the process for identifying the preferred R/RM alternative. Although Table 2 lists a number of evaluation metrics associated with each category, not all evaluation metrics will be employed in an actual evaluation. In practice, it is only necessary to employ the evaluation metrics that are relevant to discriminating between the R/RM alternatives. Hence, only a subset of the potential evaluation metrics will be employed in any particular evaluation.

As apparent from the list of potential evaluation metrics, individual metrics are not measured using the same units, and hence they are not additive. As a result, they cannot be combined in a simple manner. Instead, a means of combining the value of an alternative must be made relative to the various evaluation metrics, to determine which of the alternatives is preferred.

An additional dimension of the evaluation criteria must also be acknowledged; if an alternative does not attain a threshold (e.g., with respect to human health and the environment), that alternative is not acceptable and is not considered beyond the first level of analysis.

Example problem definition

The following example demonstrates how the methodology is applied. Please note that this problem situation has been kept fairly simple in order to focus on the methodology rather than on precise complexities that may arise in practice. Furthermore, the exact details of the preferred strategy are not supplied but are assumed to be consistent with good practice, specifically for a remote site.

Consider the following situation:

A waste disposal pit and an underlying groundwater plume have been identified at a site. The

alternatives for the remediation of the disposal pit were identified as capping the pit, or excavation and disposal of the waste.

For the underlying groundwater plume, the alternatives that will be considered are monitored natural attenuation (MNA) and groundwater treatment with MNA combined (treatment/MNA). The duration of these options will vary, since treatment will promote a more rapid reduction in contaminant concentrations. The status quo ("do nothing") option associated with the groundwater plume should also be considered, as there may be no need to undertake action, and it will provide a baseline for comparison of this scenario.

The individual alternatives, as classified into vertical sets of options, are illustrated in Table 3. Other options may be available, for example cap and treatment/MNA, but are not included in this example in order to maintain simplicity.

Table 3
List of Alternatives

Area/Unit	***EXC****	***1***	***2***	***3***
Waste disposal pit	No action	Cap	Excavate/dispose	Excavate/dispose
Groundwater plume	No action	MNA	MNA	Treatment/MNA

**EXC: excluded as a viable alternative as it does not attain the necessary threshold levels.*
**MNA: monitored natural attenuation*

These alternatives include elements related to both risk management (i.e., cap and MNA) and remediation (i.e., excavate/dispose and groundwater treatment/MNA). We are now interested in selecting the preferred alternative, where the preferences between the options regarding long-term effectiveness may be different, for example, than cost considerations.

To proceed to the next step, each of the alternatives needs to be considered with respect to each of the evaluation criteria within the categories. This step is accomplished in the following sub-tables, as follows:

(i) The alternative is judged to be unacceptable or excluded in terms of threshold levels and, hence, is no longer considered.
(ii) Table 4(a) summarizes the attributes of each of the alternatives relevant to effectiveness. It should be noted that the only relevant effectiveness evaluation criteria are the long-term effectiveness and the reduction of toxicity, mobility or volume.

Table 4(a)

Description of attributes of alternatives related to effectiveness criteria

Alternative	*Long-term effectiveness*	*Reduction of toxicity, mobility or volume*
1. Capping and MNA	Capping not necessarily effective in the long term, and attenuation of groundwater contamination will occur but will take some time.	There will be no reduction of toxicity, mobility or volume of chemicals within the waste disposal pit contents, and reduction of groundwater contamination will occur over time.
2. Excavation/disposal and MNA	This represents a permanent solution for in situ wastes, and attenuation of groundwater contamination will occur but will take some time.	This will reduce/eliminate the waste disposal pit contents, and will result in attenuation of the groundwater contamination over time.
3. Excavation/disposal and treatment/MNA	This represents a permanent solution for in situ wastes, and will result in attenuation of groundwater contamination more rapidly than MNA alone.	This will reduce the toxicity of waste pit contents, and will result in attenuation of groundwater contamination more rapidly than MNA alone.

**MNA: monitored natural attenuation*

(iii) Table 4(b) summarizes the attributes of each of the alternatives relevant to "implementability." All of the alternatives involve the application of proven technologies, none is innovative, all involve the necessity to obtain permits, etc. This means that the discriminating factor between the alternatives is the time required for implementation (e.g., MNA requires a lengthy period for site remediation whereas capping is implemented relatively quickly). Impacts and risks to the environment during implementation must also be a consideration (i.e., consider the risks associated with the transport and disposal of theexcavated material).

Table 4(b)

Description of attributes of alternatives related to implementability criteria

Alternative	*Time required for implementation*	*Impacts and risks to environment*
1. Capping and MNA	Rapid to construct cap. MNA will take time to be totally effective.	Technology of capping is understood, and risks to environment by MNA are small, although the possible ongoing source of contamination must be considered.
2. Excavation/disposal and MNA	Excavation/disposal relatively rapid. MNA will take time to be totally effective.	May be issues in relation to contaminant release during excavation as well as at the disposal site. MNA risks are small.

Alternative	*Time required for implementation*	*Impacts and risks to environment*
3. Excavation/disposal and treatment/MNA	Excavation/disposal relatively rapid. Treatment/MNA will be more rapid than MNA alone.	May be issues in relation to contaminant release during excavation. Treatment/MNA risks are small and less than MNA alone.

(iv) Table 4(c) describes the attributes of the various alternatives in terms of costs. In this application, the costs are determined in terms of present worth (or net present value) and therefore show the combination effect of construction costs, operation and maintenance costs, and discount rate.

Table 4(c)

Description of attributes of alternatives related to cost criteria

Alternative	*Magnitudes of costs of each alternative*
1. Capping and MNA	2 million + 1 million = 3 million
2. Excavation/disposal and MNA	10 million + 1 million = 11 million
3. Excavation/disposal and treatment/MNA	10 million + 2 million + 0.5 million = 12.5 million

(v) Table 4(d) describes the attributes for different alternatives in terms of the "Other" category. This may be a relevant consideration in selecting between the alternatives in that there is long-term liability for ensuring that MNA functions as intended, as opposed to, for example, the excavation and destruction of the wastes. For MNA, there is some degree of long-term liability associated with the site. Also, the potential impacts on future site operations may be a consideration.

Table 4(d)

Description of attributes of alternatives related to other evaluation criteria

Alternative	*Magnitudes of long-term liability*	*Impacts on future operations*
1. Capping and MNA	***Liability*** exists since capping does not destroy the contaminants, and the time for MNA to be effective is potentially long.	***Operations:*** Capping will limit certain land-use activities on site.
2. Excavation/disposal and MNA	Reduced long-term liability since the remediation removes the contaminants, although time for MNA to be effective may still be prolonged.	Excavation/disposal will allow future land uses depending on residual contaminant concentrations.
3. Excavation/disposal and treatment/MNA	Minimum long-term liability since the remediation removes the contaminants and time for treatment/MNA is shorter.	Excavation/disposal will allow future land uses depending on residual contaminant Concentrations.

The set of Tables 4(a) through 4(d) summarizes how the alternatives are measured with respect to each of the evaluation criteria. The next stage is to identify which of the alternatives is/are the preferred alternative(s). This will be accomplished using the two separate procedures designed for this identification, namely (i) the pairwise comparison method and (ii) matrix weighting procedures.

Identification of preferred alternative

Using the pairwise comparison method

Table 5

Comparison of Alternatives 1 and 2

Category/Evaluation Criteria	*Preferred Alternative*	*Rationale*
Effectiveness		
Long-term effectiveness	2	Alternative 2 is more effective since it removes the waste material.
Reduction of toxicity, mobility or volume	2	Alternative 2 is more effective since it removes the waste material.
Implementability		
Time required for implementation	1	Alternative 1 requires less time for implementation and avoids potential impacts
Impacts and risks to the environment	1	Alternative 1 requires less time for implementation and avoids potential impacts
Costs	1	Alternative 1 involves lower cost.
Other		
Long-term liability	2	Alternative 2 reduces long-term liability associated with leaving the waste in place.
Impacts on future operations	2	Alternative 2 reduces long-term liability associated with leaving the waste in place.

Alternative 2 has four evaluation criteria in which it is preferred to Alternative 1, and there are three criteria in which Alternative 1 is preferred to Alternative 2. In this situation, Alternative 2 moves on to be compared with Alternative 3. It is noted that this comparison suggests that there is little difference between Alternatives 1 and 2.

In a more complete assessment of impacts, other considerations such as off-site impacts like transportation of excavated material and liability/risk associated with disposal might also be evaluated with regard to each alternative. Please note this type of evaluation does not give weight to the evaluation criteria; it only allows a preference for one alternative method or another. A weighted matrix example is explained later in this appendix.

Table 6

Comparison of Alternatives 2 and 3

Category/Evaluation Criteria	*Preferred Alternative*	*Rationale*
Effectiveness		
Long-term effectiveness	3	Alternative 3 is more effective since it reduces the contaminant mass through treatment.
Reduction of toxicity, mobility, or volume	3	Alternative 3 is more effective since it reduces the contaminant mass through treatment.
Implementability		
Time required for implementation	3	Alternative 3 requires less time to reach acceptable contaminant levels because it
Impacts and risks to the environment	3	Alternative 3 requires less time to reach acceptable contaminant levels because it
Costs	2	Alternative 2 involves lower cost.
Other		
Long-term liability	3	Alternative 3 shortens the time that groundwater contamination persists.
Impacts on future operations	No Difference	--

In this comparison, Alternative 3 is preferred to Alternative 2 with regard to five evaluation criteria, whereas Alternative 2 is preferred to Alternative 3 in only one criterion. This indicates that Alternative 3 is the preferred alternative remediation option.

Based on the above, it could be concluded that Alternative 3 is the preferred alternative, if all evaluation criteria were considered to have equal weight (or importance), as is the case with this method. Weightings are applied in the matrix method discussed below.

Using Matrix Weighting Procedures

Two sets of weighting factors are required:

- The factor weights for the evaluation criteria within each category, where the sum of the factor weights equals one. For example, within the effectiveness category there are two evaluation criteria (long-term effectiveness and reduction of toxicity, mobility or volume), each of which is assigned a factor weight.
- The priority group weights, to reflect the relative importance of each category and assign values such that the sum of the priority group weights equals one. In this case, each of the four categories (effectiveness, implementability, cost, other) is assigned a priority group weight.

The selection of the weighting factors needs to consider the viewpoints of the interested parties, recognizing that different stakeholders may be more sensitive to specific evaluation criteria than others. However, the procedure does allow sensitivity testing to determine differences in the analysis resulting from changes in the weight factors.

Ranking of one alternative relative to another

In the example matrix, each of the alternatives is ranked relative to the others using non-parametric means, such that the best of the three alternatives associated with each of the evaluation criteria receives a 3, the second-best gets a 2, and the third-best gets a 1. In the event of a tie, the average of the two is assigned to both.

Simple matrix weighting calculations are summarized in the table below, which shows that Alternative 3 is the preferred alternative of the three (i.e., has the highest score).

Table 7

Scoring calculation for alternatives using matrix weighting procedure

Category/Evaluation Criteria	*Factor Weight*	*Ranking Score Alternative (1, 2, 3)*			*Weighted Factor*			*Priority Group Weight*	*Weighted Factor Alternative (1, 2, 3)*		
Effectiveness											
Long-term effectiveness	0.7	1	2	3	0.7	1.4	2.1				
Reduction in toxicity	0.3	1	2	3	0.3	0.6	0.9				
				Total Weighted Factor	1	2	3	x 0.2	0.2	0.4	0.6
Implementability											
Time required	0.5	3	1	2	1.5	0.5	1				
Impacts of risks	0.5	1	2	3	0.5	1	1.5				
				Total Weighted Factor	2	1.5	2.5	x 0.3	0.6	0.45	0.75
Cost											
Present worth	1	3	2	1	3	2	1				
				Total Weighted Factor	3	2	1	x 0.3	0.9	0.6	0.3
Other											
Long-term liability	0.7	1	2	3	0.7	1.4	2.1				
Impacts on future operation	0.3	1	3	2	0.3	0.9	0.6				
				Total Weighted Factor	1	2.3	2.7	x 0.2	0.2	0.46	0.54
							Final Alternative Score		1.9	1.91	2.19

**Note: red numbers refer to Alternative 1; blue numbers refer to Alternative 2; and purple number refers to Alternative 3.*

Ranking of each alternative on a scale of one to ten

Another option is to rank the values on a scale from one to ten using parametric means. This allows the assessor to determine, for example, the magnitude of the differences between the alternatives for individual evaluation criteria.

Additional considerations

The example problem was kept very simple to allow the primary focus to be on the selection procedure for the preferred alternative. However, it should be clear that the process may be considerably more

complex in a real situation. Examples of the challenges that could arise include the following:

- There may be more than one evaluation criteria necessary to discriminate between the preferred alternatives in a particular application. For example, there could be both long- and short-term differences in the effectiveness of different alternatives. In this situation, and if both long- and short-term ramifications are better for Alternative A in comparison with B, the approach is relatively simple in that both could be combined into a single metric by which the alternatives can be compared. The challenge will be where Alternative A is better than B with respect to short-term effectiveness, and B is better than A with respect to long-term effectiveness. In this situation, it may be necessary to employ the preferred alternative within an individual category first, and then proceed to the next level of assessment.

- The procedures are readily transparent and are apparent to reviewers. Hence, discussion on the assignments can be focused on points of controversy, should they exist.

The procedures are straightforward to apply and test the sensitivity of the selection by allowing different methods to arrive at the same conclusion.

There is merit in completing evaluations using one or more procedures, for example pairwise comparison or matrix weighting comparisons; if the results are the same, it demonstrates that the findings are robust.

List of Abbreviations

Abbreviation	Definition
ASCS	Aquatic Site Classification System
CCME	Canadian Council of Ministers of the Environment
CEAA	*Canadian Environmental Assessment Act*
CEPA 1999	*Canadian Environmental Protection Act, 1999*
CSA	Canadian Standards Association
CSM	Conceptual Site Model
DFO	Fisheries and Oceans Canada
DMF	Decision-Making Framework
DQRA	Detailed Quantitative Risk Assessment
EC	Environment Canada
EA	Environmental Assessment
ERA	Ecological Risk Assessment
ESA	Environmental Site Assessment
ESD	Expert Support Department
FCSAP	Federal Contaminated Sites Action Plan
FCSI	Federal Contaminated Sites Inventory
GOST	Guidance and Orientation for the Selection of Technologies
HC	Health Canada
HHRA	Human Health Risk Assessment
IDEA	Interdepartmental Data Exchange Application
INS	Insufficient information
LTM	Long-term monitoring
MNA	Monitored natural attenuation
NCSCS	National Classification System for Contaminated Sites

Abbreviation	Definition
PAT	Priority for Assessment Tool
PoE	Pathways of Effects
PQRA	Preliminary Quantitative Risk Assessment
PWGSC	Public Works and Government Services Canada
QA/QC	Quality assurance/quality control
R/RM	Remediation/risk management
RAP	Remedial Action Plan
RMP	Risk Management Plan
RMS	Risk Management Strategy
SARA	*Species at Risk Act*
SCT	Site Closure Tool
SDST	Sustainable Decision Support Tool
SDT	Sustainable Development Tool
SOW	Statement of Work
SSTL	Site-specific target levels
SURF	Sustainable Remediation Forum
TB	Treasury Board of Canada
TBS	Treasury Board of Canada Secretariat
TRAV	Tool for Risk Assessment Validation

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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