



Technology and  
Environment

# ***Petroleum Contaminated Site Remediation Guidelines***



**1999**

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Government of Prince Edward Island  
[www.gov.pe.ca](http://www.gov.pe.ca)

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Atlantic Risk Based Corrective Action  
[www.atlanticrbca.com](http://www.atlanticrbca.com)

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## ***Introduction***

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The Prince Edward Island Department of Technology & Environment (PEIDOTE) has set the following guidelines for petroleum contaminated site remediation. These guidelines reflect the desire of PEIDOTE to move the remediation of contaminated sites into a risk-based management approach rather than sole dependence on generic clean-up values. A tiered approach allows the selection of different levels of site investigations, permitting the use of Risk Based Screening Levels (RBSLs) based on a number of default assumptions chosen to be protective of human health and the environment for most site conditions, to the use of Site-Specific Target Levels (SSTLs) based on site specific conditions. The progression from the generic Tier I Look Up Tables Criteria (Appendix B) to simple site-specific and more detailed site-specific SSTLs usually involves an increase in investigation costs and, generally a decrease in the stringency of the screening levels because conservative assumptions can be replaced with less conservative site-specific information. Generally, the decision of which method to use involves balancing the increased investigation costs with the potential saving associated with higher generic RBSLs.

Formerly, the standard approach for the remediation of petroleum contaminated sites was that the responsible party would go in and cleanup the site to conservative pre-set criteria. The advantage was that it allowed the remediation to proceed without the added cost of performing site assessments. Its

disadvantages were that at one end of the spectrum, excessive remedial actions were taken in some cases because site-specific environmental conditions were not known, while at the other end of the spectrum clean-up criteria were impossible to meet. This is commonly seen where the contaminant plume has migrated into an aquifer, and the objective of the remedial efforts was to return groundwater quality to a pre-contamination level.

The risk-based approach recognizes the potentially significant differences in the environmental sensitivities from site to site. It allows the regulatory agency the flexibility to require the level of remediation that is best suited to the situation under consideration. The risk-based approach outlined in the American Society for Testing and Materials (ASTM) Standard E-1739-95, entitled "Risk-Based Corrective Action (RBCA) Applies at Petroleum Release Sites" applies the principles of risk assessment and risk management to contaminated sites. The Atlantic Partnership in the RBCA Implementation (PIRI) Committee has developed a modified version of the ASTM RBCA for use in Prince Edward Island and the other Atlantic Provinces. The Atlantic RBCA process is intended to be the primary technical approach used when managing petroleum impacted sites. Details of the technical approach and requirements are provided in a separate document entitled "The Atlantic PIRI Group Reference Documentation", and are intended to be used in conjunction with this ASTM Standard E-

1739-95 document. Other risk-based formats may be used, however the Department may require peer review by an independent third party professional.

Once a petroleum contaminant plume has migrated any distance into an aquifer, corrective action is far from simple. In short the aquifer may be contaminated for a very long period of time regardless of the effort put into remediation. The only real solution to this problem is the prevention of contaminant releases from leaking petroleum storage tank systems. PEIDOTE remains committed to getting tank owners to upgrade their storage tank systems before they leak, through an on-going comprehensive public education program, and enforcement of the *Petroleum Storage Tanks Regulations under the Environmental Protection Act*. This is the most cost-effective approach and has the greatest probability of achieving the desired level of environmental and human health protection possible.

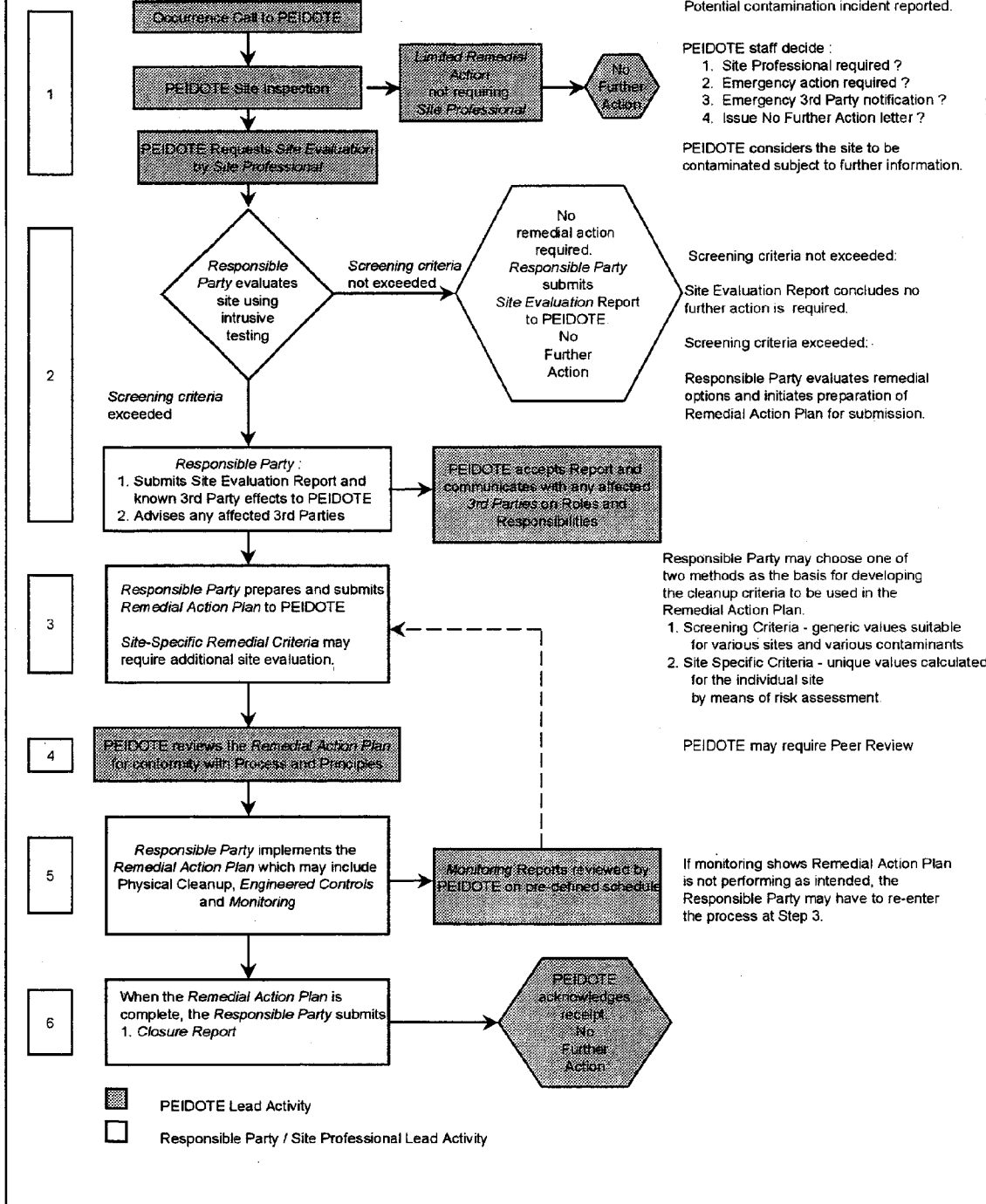
Prince Edward Island is blessed with sufficient good quality groundwater, therefore, remedial options must be taken to arrest the further migration of contaminated water into uncontaminated regions. Protection of groundwater quality in the vicinity of a petroleum contaminated site requires careful monitoring. The risk assessment must consider the transport and fate of the contaminants in groundwater.

PEIDOTE recognizes that after a period of time the contaminant plume may no longer be increasing in size, and therefore, groundwater plume containment actions may not be warranted. However, in instances of recent releases, plume containment actions may be required to mitigate the movement of the groundwater contaminant plume. To verify that the plume is not migrating from the source area into uncontaminated regions, the level of contaminant at a compliance point may be determined from sample data, or by the Atlantic RBCA software model when insufficient sample data is available. The compliance point is defined as the monitoring point at the source area where the source area target groundwater concentration must be met. At least one compliance point must be located directly downgradient of the source area or along the center line of the contamination plume.

### **Contaminated Site Management Process**

The Department's Management Process is summarized in the accompanying graphic.

**Prince Edward Island Department of Technology &  
Environment  
Contaminated Site Management Process**



## Step 1 Initial Notification

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This step covers the initial time period following discovery of the contamination occurrence and represents the normal initial notification to the Department. Occurrence may be the result of spills, accidents, investigations completed for the sale or refinancing of a property, or other situations that identify contamination impacts to the environment.

The Department will assess the significance of the reported discovery of the contamination by either a site visit by a Departmental Inspector or reviewing site assessment findings. The PEIDOTE Inspector may conduct a limited risk assessment prior to the initiation of site remediation to establish target remediation concentration. This limited risk assessment evaluates the likelihood of receptor and groundwater impacts, and compares it to applicable screening criteria. Tier I Look Up Tables Criteria (Appendix B) established within the Atlantic RBCA process are to be used in the evaluation of applicable petroleum impacted sites. The physical characterization of the site is assessed to determine site sensitivity with respect to likelihood of impact. Factors to be considered include (1) depth or distance from contamination to each receptor, (2) soil type, (3) depth to groundwater which has a demonstrated use or beneficial use as a drinking water source, (4) depth to groundwater with no reasonable potential beneficial use as a drinking water source, and (5) vapour generation in buildings and underground utilities.

Should the Departmental Inspector determine that the contaminant plume presently, or in the future, poses a risk to human health or the environment, the inspector will require remedial action to be taken to rectify the situation, and the Inspector will instruct the Responsible Party to carry out such action. The Responsible Party may be required to complete such work in a specified time frame. PEIDOTE will consult with the Environmental Health Division of the Queens Region Health Authority when exposures to indoor air contaminants originating from the release area are of concern. At such time as the Inspector is satisfied that the required actions have been completed, the Department will issue a letter advising that no further remedial action is required.

If the Inspector decides that the problem cannot be solved with limited remedial action, PEIDOTE will instruct the Responsible Party to obtain the services of a Site Professional. If evidence of extensive groundwater contamination or explosive vapours is present, or if a third party property is affected, the services of a Site Professional are mandatory. The Department will then consider the site a "contaminated site" until the Management Process has been completed. The need for site professionals to be trained in the practice and principles of contaminant fate and transport, exposure and risk assessment, and in hydrogeology are essential.

In all cases, the Responsible Party will be required to inform any affected Third Parties about the contamination event and provide proof of such disclosure to the Department. Any issues not related to health and/or the environment that arise between Responsible Parties and Third Parties are considered by the Department to be civil matters to be settled by the two parties outside of this Management Process.

## **Step 2** Initial Site Evaluation

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During this step the Site Professional conducts a site evaluation to collect necessary technical information. Soil and groundwater effects must be evaluated as well as potential effects on the surrounding population. The methodology used in this step is the responsibility of the Site Professional (see Phase I, II, III Environmental Site Assessment, Appendix A). Consideration of the possible requirements for ecological based studies should begin at this stage of the process. A critical factor in a site evaluation is that the extent of the contamination in both soil and groundwater must be completely defined and delineated, even if it has crossed the source property boundary. Once the plume is defined, it must remain defined. If monitoring data indicates that the plume is migrating beyond monitoring wells, then additional wells shall be installed.

Once the environmental condition of the site has been evaluated, the Site

Professional will compare it to applicable screening criteria. Tier I Look Up Tables Criteria (Appendix B) established within the Atlantic RBCA process are to be used in the evaluation of applicable petroleum impacted sites. Non-petroleum impacted sites are to be evaluated by means of an appropriate environmental guideline established by the Canadian Council of Ministers of the Environment (CCME) or other provincial jurisdictions. If these criteria are not exceeded, the Site Professional may conclude that no further action is required and submit the evaluation report to the Department.

If the site conditions exceed the applicable screening criteria, the Responsible Party must submit the evaluation report to the Department and advise any affected Third Parties. The Department will contact any affected Third Parties and advise them of the Management Process and the responsibilities of the various parties.



### **Step 3** Preparation of a Remedial Action Plan (RAP)

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At this point the Responsible Party and the Site Professional will review the results of the site evaluation and determine whether to remediate the site to the screening criteria levels or complete further scientific work to develop site specific remedial criteria using a risk assessment approach.

If a risk assessment approach is proposed, additional information may have to be collected to permit the Site Professional to calculate site-specific remedial criteria (see Phase III ESA, Appendix A). Once the remedial criteria have been determined for the site, the Site Professional must prepare

a Remedial Action Plan (RAP) detailing the methodology for achieving these criteria as well as the proposed remedial action.

A critical component of a RAP is the monitoring program (Appendix C). The purpose of a monitoring program is to evaluate the performance of a RAP and/or to evaluate the condition of the environment during ongoing site management.

The final action in this step is to submit the RAP to the Department for review and approval.

### **Step 4** Remedial Action Plan Review

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At this stage, the Department will review the RAP to ensure relevant issues are addressed. In cases where the Atlantic RBCA process has been utilized on impacted sites, the Department will review the RAP for conformity with the endorsed approach. A peer review by a qualified,

independent Site Professional will be required in those instances where the proponent utilizes an approach other than the Atlantic RBCA approach. The peer review will be completed at the expense of the Responsible Party.

## **Step 5 Remedial Action Plan (RAP) Implementation**

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The Responsible Party and the Site Professional shall proceed with the RAP and submit monitoring reports to the Department on the pre-determined schedule. Minimum monitoring requirements are described in Appendix C.

The Responsible Party must advise the Department if activities deviate from the approved RAP. The Department will assess the significance of such deviations and respond accordingly. In situations where predictions included in the RAP fail to be achieved, the Responsible Party may be required to revisit Step 3 and enhance the RAP.

## **Step 6 Site Closure**

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When the Responsible Party and the Site Professional are satisfied that all the requirements of the RAP have been met, a Closure Report will be forwarded to the Department.

Upon receipt and acceptance of the Closure Report, the Department will conclude the Management Process by issuing a letter advising that no further remedial action is required.

## Definitions

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### Closure Report

is a final report prepared by the Site Professional and provided to the PEIDOTE following successful implementation of the Remedial Action Plan including all required monitoring in the monitoring program (Appendix C).

### Commercial Site Activities

means a site, property or location associated with the presence of, or predominant use by commercial human receptors similar to those indicated as such in the Atlantic RBCA spreadsheet and/or Atlantic PIRI documentation. This terminology may not be consistent with applicable zoning requirements, and as such, the Responsible Party should review these requirements.

### Contaminated Site (or Site)

is a property or collection of properties where the concentration of specified chemicals in air, soil, or groundwater exceed levels considered acceptable by the PEIDOTE. The contaminated site may consist of a property or properties where the contamination originated (source property) and other properties which have been chemically altered by the source property (third party properties).

### Emergency Action

means initial response activities to protect the environment and/or human health from the immediate or future impacts related to the release of the contaminant(s) of concern into the environment.

### Engineered Controls

are modifications to a site or facility (which are part of the Remedial Action Plan) to reduce or eliminate the potential for exposure to chemical substances.

### Inspector

means a government employee so designated or appointed by the Department.

### Limited Remedial Action

means the remediation of a site without the use of a Site Professional. The limited remedial action shall be approved by the PEIDOTE.

### Monitoring

is the scientific assessment of air, soil and groundwater conditions at a contaminated site at specific points in time and may also include assessment of processes and equipment used as well as significant occurrences related to the Remedial Action Plan. (see Appendix C).

### Peer Review

means a technical review of a Remedial Action Plan by an independent Site Professional. A peer review is completed at the expense of the Responsible Party and is separate from a PEIDOTE review.

### Phase I Environmental Site Assessment (ESA)

A systematic process to review all available information relating to the site. The objective of a Phase I ESA is to assess whether current and/or past practices on the site may have resulted in environmental contamination or unsafe conditions. A Phase I ESA does not involve the intrusive investigative procedures of sampling, analyzing and measuring.

### Phase II ESA

A more extensive evaluation, including intrusive investigation, to confirm and delineate, or demonstrate the absence of contamination in the various media on a site identified through the Phase I procedure. This information will indicate whether more detailed

testing is required in specific areas, and provide the inputs required to develop appropriate site cleanup criteria. It is not essential that a Phase I ESA be completed prior to conducting a Phase II ESA. In some instances, sufficient information exists regarding potential contamination to proceed directly to a Phase II ESA.

### Phase III ESA

A complete evaluation, (including further intrusive investigation if necessary), sufficient to fully characterize the extent and degree of contamination. The data collected should be sufficiently representative of the site conditions to provide further assessment of site specific remedial objectives using a risk assessment approach, to investigate the feasibility of various cleanup options and to input to the development of the various components of the Remedial Action Plan.

### RBCA

means Risk-Based Corrective Action using a process originating with the American Society for Testing and Materials (ASTM) but modified and endorsed by the environment departments of the Atlantic Provinces.

### Receptor

means the person or organism, including plants, subjected to chemical exposure.

### Remedial Action Plan (RAP)

a report which provides rationale for the selected remedial criteria, includes risk assessment and management documentation, identifies remedial options and objectives with a conceptual remediation plan, identifies the feasibility of the remedial options, includes a monitoring plan and if required, an on-going site management plan.

### Remediation

is the improvement of a contaminated site to prevent, minimize, or mitigate damage to the environment and human health.

### Residential Site Activities

means a site, property or location associated with the presence of, or predominant use by residential human receptors similar to those indicated as such in the Atlantic RBCA spreadsheet and/or Atlantic PIRI documentation. This terminology may not be consistent with applicable zoning requirements, and as such, the Responsible Party should review these requirements.

### Responsible Party

in most cases, the Responsible Party is a person whose conduct or failure to act has caused or contributed to the contamination of property and who, in the opinion of the Minister, is responsible for remediation of a contaminated site. However, in some cases, the persons among whom the Minister may choose to remediate the site are specifically listed in an Act or regulation, and may include, for example, the owners or the person having the charge of a storage tank system.

### Risk Assessment

is the scientific examination of the nature and magnitude of risk to define the effects on humans and/or ecological receptors due to exposure to contaminants.

### Risk Based Screening Level Criteria

are the screening criteria derived by means of the Atlantic RBCA process which constitute the Tier I Look Up Tables.

### Risk Management

is the implementation of a strategy or measures to control or reduce the level of risk estimated by a risk assessment.

### Screening Criteria

are environmental criteria developed with the intention of being protective of human and/or ecological *receptors* which are exposed to various contaminants in various scenarios (residential, commercial, industrial). Examples would be the Atlantic RBCA Tier I Look Up Tables, Guidelines for Canadian Drinking

### Site Evaluation

is the process of obtaining, compiling, analyzing, and drawing conclusions from all appropriate environmental information related to a contaminated site with respect to potential impacts or risks to define the type and extent of the contamination, the soil and groundwater characteristics and man-made structures which affect how the contaminant will move, and the receptors in the area (human and ecological) which may be affected. The type of work may include soil vapour analysis, geophysical testing, test pits, boreholes, monitoring wells, and air, soil, and water analysis at varying levels of complexity. Work may be done in successive stages as additional information is required for subsequent steps. (see Phase I, II, III ESA)

### Site-Specific Remedial Criteria

are risk-based remedial criteria which are derived using site specific conditions and accepted risk assessment / management procedures.

### Source Property

means the property at which the contaminant(s) of concern was released into the environment.

### Third Party

the owner, occupier or tenant of a property which is contiguous or which could possibly be affected by the contamination of a source property.

## Tier I Look Up Tables

TABLE 1A: SURFACE SOILS (mg/kg)

RECEPTOR	GROUND WATER USE	SOIL TYPE	COMPOUND OF CONCERN						
			Benzene	Toluene	Ethyl Benzene	Xylenes	Gas	Modified TPH Diesel/#2	#6 Oil
Residential	Potable	Sand	0.01	0.10	0.02	2.4	55	110	840
		Clay	0.005	0.06	0.015	1.8	45	60	240
	Non-potable	Sand	50	1,960	980	1,380	1,300	720	1,120
		Clay	50	1,960	980	1,380	1,300	720	1,140
Commercial	Potable	Sand	0.01	0.10	0.02	2.4	80	185	2,800
		Clay	0.005	0.06	0.015	1.8	60	90	380
	Non-potable	Sand	120	4,800	2,400	3,200	3,200	1,740	2,800
		Clay	120	4,800	2,400	3,400	3,200	1,740	2,800

**Tier I criteria were developed by the following sequential process:**

- Human health, risk-based criteria were developed using the Atlantic RBCA default values.
- Soil and groundwater criteria driven by the Canadian Drinking Water Quality Guidelines were looked with no further adjustment.
- All other threshold (non-carcinogenic) compound concentrations were then divided by a Management Adjustment Factor (MAF) of 5.
- Where the Atlantic RBCA model returned a value of ">RES" of ">SOL", the Residual and Solubility concentrations were divided by a MAF of 5.
- Upper limit values of 10,000 mg/kg and 20 mg/L were applied as necessary.
- The "Modified TPH" criteria noted in this table do not include BTEX compounds or carcinogenic PAHs.

**To apply the Tier I values in this table, the following mandatory criteria must also be satisfied:**

- Non-aqueous phase liquids (NAPL) must not be present in the groundwater.
- Potable water must be free of objectionable hydrocarbon odour and taste.
- Soils must not contain liquid and/or free petroleum product.
- Residual hydrocarbons in soil must be at concentrations that do not cause objectionable odours or explosive conditions in indoor or outdoor air.
- Surface soils must not be stained.
- The site characteristics and exposure scenarios must be compatible with the Atlantic PIRI default values.

TABLE 1B: SUB-SURFACE SOILS (mg/kg)

RECEPTOR	GROUND WATER USE	SOIL TYPE	COMPOUND OF CONCERN						
			Benzene	Toluene	Ethyl Benzene	Xylenes	Gas	Diesel/#2	Modified TPH
Residential	Potable	Sand	0.01	0.10	0.02	2.4	45	110	840
		Clay	0.005	0.06	0.015	1.8	45	60	240
	Non-potable	Sand	0.30	34	20	19	45	175	10,000
		Clay	0.80	260	165	165	135	560	5,400
Commercial	Potable	Sand	0.01	0.10	0.02	2.4	80	185	10,000
		Clay	0.005	0.06	0.015	1.8	60	90	380
	Non-potable	Sand	1.4	34	20	25	360	10,000	10,000
		Clay	3.8	260	165	260	2,800	10,000	10,000

**Tier I criteria were developed by the following sequential process:**

1. Human health, risk-based criteria were developed using the Atlantic RBCA default values.
2. Soil and groundwater criteria driven by the Canadian Drinking Water Quality Guidelines were locked with no further adjustment.
3. All other threshold (non-carcinogenic) compound concentrations were then divided by a Management Adjustment Factor (MAF) of 5.
4. Where the Atlantic RBCA model returned a value of ">RES" of ">SOL", the Residual and Solubility concentrations were divided by a MAF of 5.
5. Upper limit values of 10,000 mg/kg and 20 mg/L were applied as necessary.
6. The "Modified TPH" criteria noted in this table do not include BTEX compounds or carcinogenic PAHs.

**To apply the Tier I values in this table, the following mandatory criteria must also be satisfied:**

1. Non-aqueous phase liquids (NAPL) must not be present in the groundwater.
2. Potable water must be free of objectionable hydrocarbon odour and taste.
3. Soils must not contain liquid and/or free petroleum product.
4. Residual hydrocarbons in soil must be at concentrations that do not cause objectionable odours or explosive conditions in indoor or outdoor air.
5. Surface soils must not be stained.
6. The site characteristics and exposure scenarios must be compatible with the Atlantic PIRI default values.

TABLE 1C: GROUNDWATER (mg/L)

RECEPTOR	GROUND WATER USE	SOIL TYPE	COMPOUND OF CONCERN								
			Benzene	Toluene	Ethyl Benzene	Xylenes	Gas	Modified TPH Diesel / #2	#6 Oil		
Residential	Potable	Sand	0.005	0.024	0.0024	0.30	1.8	1.1	4.6		
		Clay	0.005	0.024	0.0024	0.30	1.8	1.1	4.6		
		Non-potable	1.0	20	20	20	3.1	20	20		
		Clay	1.5	20	20	20	14.2	20	20		
Commercial	Potable	Sand	0.005	0.024	0.0024	0.30	2.8	1.8	8.4		
		Clay	0.005	0.024	0.0024	0.30	2.8	1.8	8.4		
		Non-potable	4.7	20	20	20	20	20	20		
		Clay	7.0	20	20	20	20	20			

**Tier I criteria were developed by the following sequential process:**

1. Human health, risk-based criteria were developed using the Atlantic RBCA default values.
2. Soil and groundwater criteria driven by the Canadian Drinking Water Quality Guidelines were locked with no further adjustment.
3. All other threshold (non-carcinogenic) compound concentrations were then divided by a Management Adjustment Factor (MAF) of 5.
4. Where the Atlantic RBCA model returned a value of ">RES" of ">SOL", the Residual and Solubility concentrations were divided by a MAF of 5.
5. Upper limit values of 10,000 mg/kg and 20 mg/L were applied as necessary.
6. The "Modified TPH" criteria noted in this table do not include BTEX compounds or carcinogenic PAHs.

**To apply the Tier I values in this table, the following mandatory criteria must also be satisfied:**

1. Non-aqueous phase liquids (NAPL) must not be present in the groundwater.
2. Potable water must be free of objectionable hydrocarbon odour and taste.
3. Soils must not contain liquid and/or free petroleum product.
4. Residual hydrocarbons in soil must be at concentrations that do not cause objectionable odours or explosive conditions in indoor or outdoor air.
5. Surface soils must not be stained.
6. The site characteristics and exposure scenarios must be compatible with the Atlantic PIRI default values.



## Minimum Monitoring Requirements

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### Closure Monitoring

The following shall be used as a guideline (minimum requirements) when developing a monitoring program in situations where a RAP has been implemented and requires further evaluation through monitoring. This type of monitoring can be considered closure monitoring since it is the verification process required to determine if the RAP has been successful.

1. A clear restatement of the remedial criteria and objectives from the (RAP).
2. A restatement of the monitoring program prepared before the RAP implementation which includes the following:
  - parameters to be monitored and measured
  - when, where and how data is to be collected, analyzed and reported
  - how satisfactory RAP performance will be confirmed during operation
  - how the meeting of remedial criteria will be reported.
3. A detailed description of work carried out in accordance with the plan. A detailed comparison and interpretation of results against the remedial criteria.

**Note:** The data collected to evaluate the RAP performance should be sufficient to allow characterization of the extent and degree of contamination to an accuracy similar to that used during preparation of the RAP.

### On Going Site Management Monitoring:

The following shall be used as a guideline (minimum requirements) when developing a monitoring program when on-going site management is required. This type of monitoring can be considered to be part of a site or risk management plan.

1. Clear definition of the site management objectives.
2. Clear definition of the monitoring objectives.
3. Definition of parameters to be monitored or measured.
4. When, where and how data is to be collected, analyzed and reported.
5. Clear definition of data quality objectives.
6. How acceptable and unacceptable results will be determined.
7. Procedures that will be followed if unsatisfactory results are obtained.

**Note:** The data collected to evaluate the site management performance should be sufficient to allow the extent and degree of any contamination and resulting impacts to be estimated to an accuracy similar to that used during the initial evaluation of those impacts.