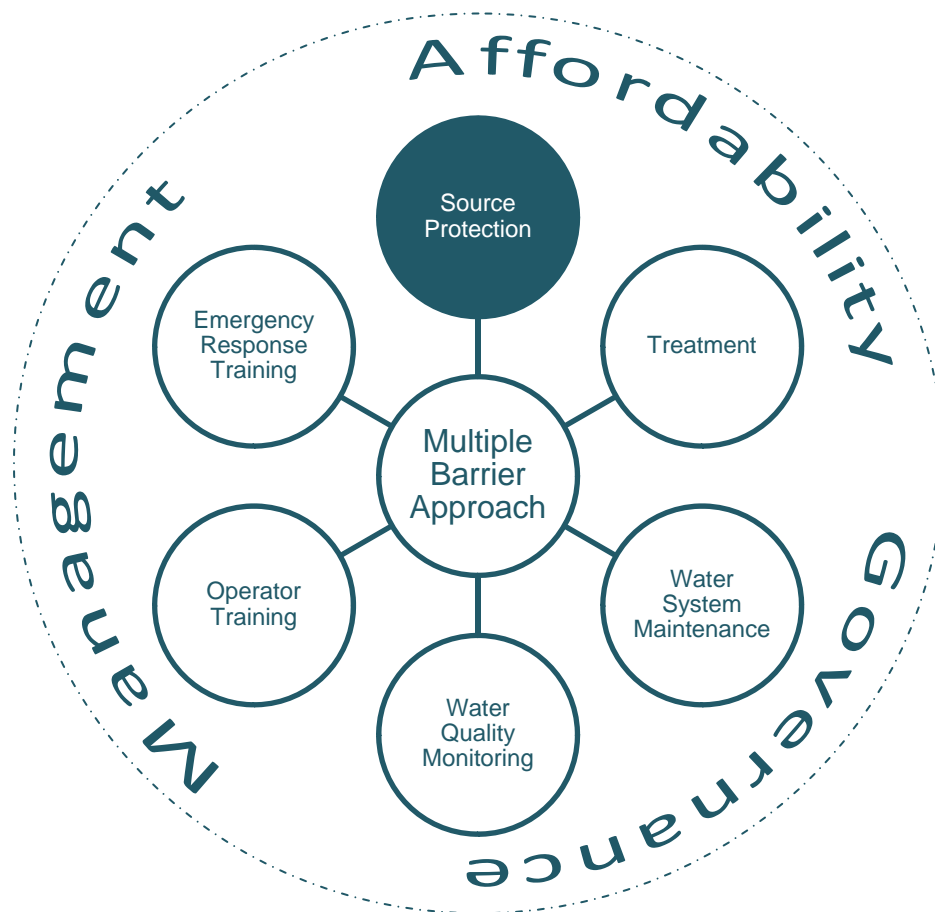


COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

MODULE 2

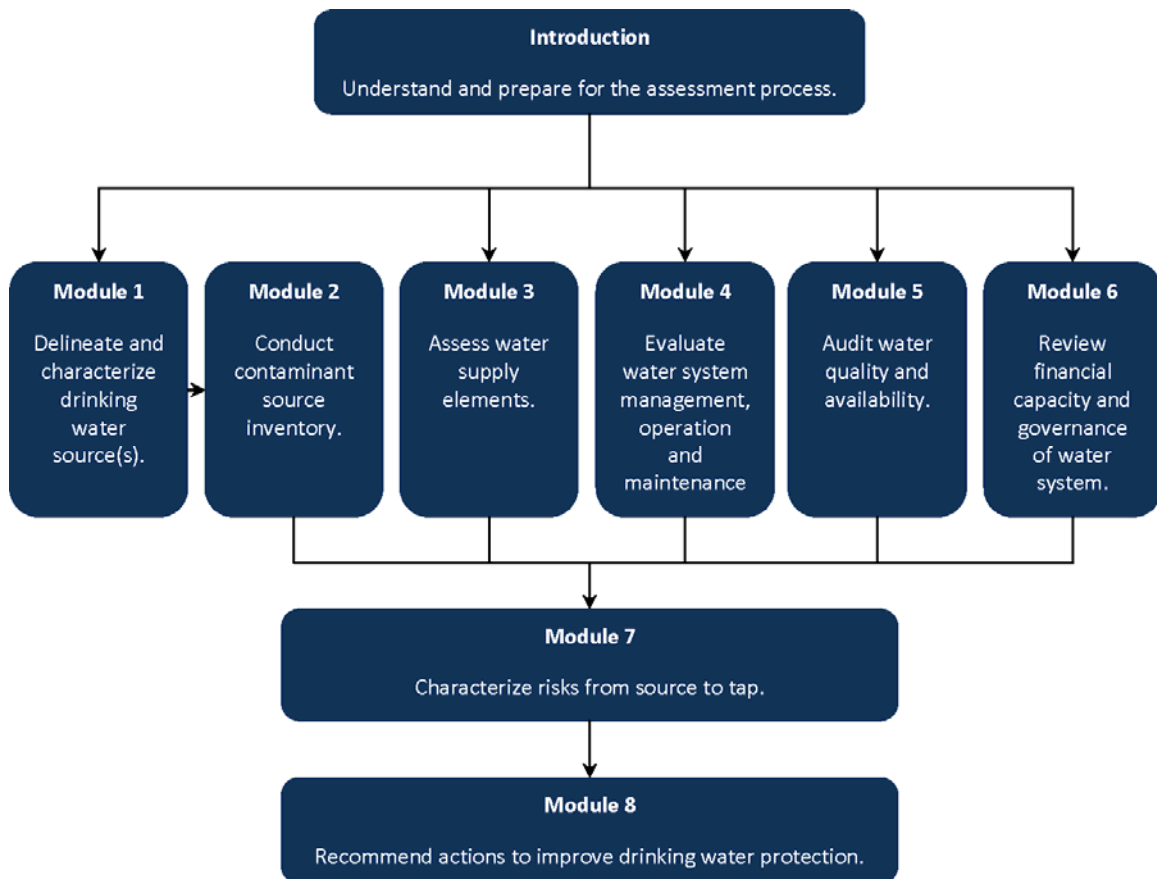
CONDUCT CONTAMINANT SOURCE INVENTORY



2010

Ministry of Healthy Living and Sport

Comprehensive Drinking Water Source-to-Tap Assessment Guideline Process



Here are the steps in the source-to-tap assessment process, through the Introduction and eight modules. Note that the Introduction should be read prior to undertaking any assessment.

TABLE OF CONTENTS

1.	INTRODUCTION.....	5
1.1	HAZARD AND VULNERABILITY IDENTIFICATION	6
1.2	MODULE 2 ASSESSMENT TEAM.....	7
2.	ASSESSMENT COMPONENTS	7
2.1	IDENTIFY POTENTIAL CONTAMINANT SOURCES.....	7
2.2	CONDUCT A CONTAMINANT SOURCE SURVEY.....	8
3.	ASSESSMENT DOCUMENTATION AND REPORTING	9
3.1	ASSESSMENT REPORT	9
3.2	CONTAMINANT SOURCE INVENTORY TABLE	10
3.3	HAZARD IDENTIFICATION TABLE	11
	APPENDIX 2A: MODULE 2 ASSESSMENT AT A GLANCE.....	12
	APPENDIX 2B: RECOMMENDED RESOURCES	13
	APPENDIX 2C: LIST OF POTENTIAL SOURCES OF CONTAMINATION FOR GROUNDWATER AND SURFACE WATER SOURCES.....	15
	APPENDIX 2D: POTENTIAL CONTAMINANT SOURCE INVENTORY METHODS.....	29

LIST OF TABLES

2-1. ASSESSMENT AREAS FOR DRINKING WATER SOURCE TYPES	6
2-2. SAMPLE CONTAMINANT SOURCE INVENTORY TABLES.....	11
2-3. SAMPLE MODULE 2 HAZARD IDENTIFICATION TABLE	11
2-4. POTENTIAL CONTAMINANT SOURCES AND THE CONTAMINANTS COMMONLY ASSOCIATED WITH THEM.....	15
2-5. ADVANTAGES AND DISADVANTAGES OF DIFFERENT TYPES OF POTENTIAL CONTAMINANT SOURCE SURVEYS	30

LIST OF BOXES

2-1. COMMON MICROBIOLOGICAL HAZARDS IN DRINKING WATER SOURCES	7
2-2. FACTORS INFLUENCING SUSCEPTIBILITY TO CONTAMINATION IN SOURCE AREA	8
2-3. CONTAMINANT TRANSPORT PATHWAYS.....	9

1. INTRODUCTION

Characterization of the drinking water source area in Module 1 involves the description and assessment of intrinsic, natural features of the water source and source area of a water supply.

Module 2 of the drinking water source-to-tap assessment presents a methodology for conducting a contaminant source inventory in the assessment area as defined in Module 1; therefore, Module 1 always precedes Module 2.

A contaminant source inventory identifies and describes land uses, human activities and other potential contaminant sources¹ that could affect source water quality. First, existing information sources such as aerial photographs, zoning or land use maps, and B.C. Ministry of Environment waste management databases (e.g., WASTE, SITE) are consulted to identify possible contaminant sources. This is followed up by a survey or field inspection to verify or reveal other actual or potential sources of contamination. For the purposes of this assessment, contaminant sources are considered drinking water hazards and are to be included in the Module 2 hazard identification table (see Table 2-3) as appropriate.

Contaminant sources include general land uses, as well as specific activities or facilities. Information on land uses can provide an indication of the type and extent of nonpoint source pollution (e.g., application of pesticides, urban runoff). Knowledge of specific activities may identify possible point sources of contaminants (e.g., industrial discharges, landfills and abandoned wells).

Line sources such as sewer lines, fuel pipelines, highways and power lines are other important potential contaminant sources. Knowledge of population density, spatial distribution and settlement trends will assist in determining the anthropogenic magnitude of influence on source water in the present, and projected into the future.

A list of potential contaminant sources (Appendix 2C) can be used as a guide for both surface and groundwater sources. However, it should be noted that some contaminant sources are more relevant for one source type than the other. For example, sediment sources in a watershed present a hazard to surface water, but not generally to groundwater.

The contaminant source inventory provides the information to enable water monitoring and risk management approaches to focus on the contaminants of greatest risk. Module 2 of the source-to-tap assessment employs a practical approach to the contaminant source inventory, in which land uses and activities are identified and then potential contaminants of concern inferred.

¹ The term "contaminant source" will be used in this document to mean both actual/existing or potential sources of contamination unless specified otherwise.

Appendix 2C provides a general cross-reference of land use activities with their commonly associated contaminants. Where the inventory of activities or land uses has identified particular contaminants of concern, more detailed monitoring and source protection planning efforts can be initiated.

Methods used for identifying the existing or potential contaminant sources are essentially the same for both surface water and groundwater source assessment areas. The methodology presented here is a summary of the approach used in the *Well Protection Toolkit*, but adapted for both surface and groundwater sources. See Step Three of the *Well Protection Toolkit*

(http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/wells/well_protection/acrobat.html) (Province of British Columbia, 2000) for more detailed information.

Contaminant source inventories should be conducted in the entire assessment area for each drinking water source. To review, the assessment areas are as follows, in Table 2-1, by source type:

Table 2-1. Assessment Areas for Drinking Water Source Types

Source Type	Assessment Area
All watersheds	Contributing watershed + intake protection zone (min. 100 m radius around intake)
Streams with watersheds >500 km ²	Portion of contributing watershed (e.g., time of travel, corridor zones, fixed radius) + intake protection zone (min. 100 m radius around intake)
Lakes with watersheds >500 km ²	Portion of contributing watershed (e.g., time of travel, corridor zones, fixed radius) + intake protection zone (min. 100 m radius around intake)
Springs	Spring source area + intake protection zone (min. 100 m radius around spring)
Wells	Capture zone + well protection zone (min. 100 m radius around well)

1.1. Hazard and Vulnerability Identification

Throughout the process of evaluating water supply elements in the source-to-tap system, assessors identify and describe hazards that pose a threat to drinking water safety or sustainability, and vulnerabilities in the multiple barrier system or other protective systems (e.g., security).

Hazards are recorded in the hazard identification table (see Table 2-3) used to document hazards in a consistent way throughout the source-to-tap assessment process. Information on strengths and vulnerabilities in the drinking water supply system identified throughout

the assessment is recorded, compiled from each module, and used to inform the multiple barrier system evaluation in Module 7.

1.2. Module 2 Assessment Team

A broad range of issues can exist in a water supply system from source to tap. As a result, comprehensive drinking water assessments require a multidisciplinary assessment team rather than a single assessor. Each module of the comprehensive drinking water source-to-tap assessment guideline requires some specialized skills and a unique spectrum of knowledge related to water sources and systems.

Collectively, the assessment team for Module 2 should have knowledge and experience related to:

- Hydrology/hydrogeology.
- Water chemistry, and contaminant fate and transport in surface and groundwater systems.
- Potential contaminant sources.
- Spatial analysis and mapping.
- Public health issues related to drinking water.
- Legislation relating to drinking water, surface water and groundwater.
- Microbiology and microbes commonly found in drinking water.
- Risk assessment and risk management.

Box 2-1. Common Microbiological Hazards in Drinking Water Sources

Common microbiologic hazards are:

- Grazing animals/feedlots
- Sewage discharges
- Wildlife populations
- Recreational activities
- Unrestricted human access to source
- Land applications of biosolids or manure
- Irrigation with wastewater effluent
- Areas of channel erosion and sediment sources in or adjacent to streams
- Inadequate riparian area
- Failing roads

2. ASSESSMENT COMPONENTS

2.1. Identify Potential Contaminant Sources

A contaminant source inventory involves identifying and describing contaminant sources in the designated assessment area from Module 1. Because the emphasis of the source-to-tap assessment is on public health, particular attention should be paid to microbiological contaminants or hazards that have immediate acute effects on health. Box 2-1 lists the most common microbial hazards.

Identifying contaminant sources is a simplified approach to understanding the risk potential that contaminant sources pose. Several factors can

significantly influence how susceptible the water source is to contamination (see Box 2-2). Understanding how these factors affect the possibility of contamination will help the water supplier select appropriate management options.

An analysis of these factors may or may not be part of the Module 2 assessment, depending on the perceived level of risk associated with potential contaminant sources and available resources.

The first step in the contaminant source inventory is to review existing sources of information to identify possible contaminant sources. Common information sources include:

- Interviews with the water supplier and other knowledgeable individuals.
- Recent and historical aerial photographs.
- Waste management databases of all levels of government.
- Zoning and land use maps.
- Regional health authorities for locations of septic systems.
- Municipal or regional governments for maps, business licenses, construction permits.

In addition to examining present activities and land uses, it may be important to collect information about an area's historical land uses.

Contaminants released years ago may still have the potential to affect water quality. Historical land use information can be obtained by reviewing old air photos, through the many resources available at public libraries or archives, or by consulting with knowledgeable residents.

2.2. Conduct a Contaminant Source Survey

Once existing information sources are reviewed, conduct a survey to verify and obtain more specific information on contaminant sources using one or more of the following inventory methods, described in Appendix 2D (B.C. Ministry of Environment, Lands and Parks and Ministry of Health, 2000):

- Personal interviews.
- Mail survey.
- Phone survey.
- Windshield survey.
- Door-to-door survey.
- Field inspections.

Box 2-2. Factors Influencing Susceptibility to Contamination in Source Area

- Physical integrity of works supplying water
- Physical, geologic, hydrologic, chemical, and biological characteristics that influence source water and contaminant flow to the supply point
- Type, number and locations of potential contaminant sources and land use within the assessment area of a water supply
- Nature and quantity of contaminants that have been or potentially could be released within a source area; the measures in place to prevent such releases

Some inventory methods require more effort and resources than others, and recognizing that capacities of water systems vary, the approach to the contaminant source survey can be scaled accordingly. As a guiding principle, assessments of water systems should include as comprehensive an inventory as resources allow. Having a knowledgeable local resource person involved in the survey can be very helpful. GIS information is also readily available and can be used to identify land uses and contaminated sites (<http://webmaps.gov.bc.ca/imfx/imf.jsp?site=imapbc>).

The contaminant source survey in the intake or well protection zone of a drinking water source (100-metre radius) should be the most intensive, as the risk of contamination is greatest close to the source intake. Pumphouses for wells and infiltration galleries offer protection for the source, but they may also be used as storage areas for contaminants such as gasoline, oil, paint and pesticides. Ensure pumphouses and areas immediately surrounding a well or intake are investigated for contaminant sources due to their proximity to the water supply.

For each contaminant source identified, there are several parameters i the magnitude of the contamination at the drinking water intake point (Rogers and Johnson, 2002):

Box 2-3. Contaminant Transport Pathways (Rogers and Johnson, 2002)

- Upgradient direct discharge or injection to water source
- Overland flow
- Sub-surface soil diffusion
- Geological strata: fractures, faults, fissures and other forms of secondary porosity in aquifers
- Direct entry to well or intake

- Time of travel from release point to intake:
 - Release location.
 - Stream velocity, discharge.
- Type and characteristics of contaminant(s).
- Release type: instantaneous or continuous.
- Concentration of contaminant at intake point.
- Contaminant transport mechanism (see Box 2-3).
- Physical, chemical and biochemical processes that may lower the concentration of a contaminant in water.

It may or may not be possible to examine all the factors influencing the magnitude of a contamination event for every contaminant source identified, but assessors may want to investigate further certain activities or land uses that may pose a serious threat to the water source. These factors should be considered when assigning risk levels to hazards in Module 7.

3. ASSESSMENT DOCUMENTATION AND REPORTING

3.1. Assessment Report

The assessment report should contain, at a minimum, the following components from Module 2 for each water source:

- **Contaminant source inventory table** (see Table 2-2), including:
 - A brief description of each land use, activity or facility.
 - The geographic location, using an address, UTM coordinates or legal property description.
 - The location relative to the water source.
 - Possible contaminants of concern.
 - Contaminant transport mechanisms.
 - Any additional comments, such as management practices or other observations.

Highlight any contaminant sources that may pose a present or imminent threat to source water.

- **Map of potential contaminant sources** depicted on an aerial photograph or a base map (e.g., a TRIM map) showing the source area and assessment area. In addition to mapping the possible contaminant sources, it may be useful to map areas of intrinsic vulnerability (e.g., unconfined aquifer, unstable slopes) to assist in prioritizing the contaminant sources.
- **Discussion of factors influencing susceptibility and magnitude of contamination (where applicable)** (see Boxes 2-2 and 2-3).
- **Completed hazard identification table for Module 2** (see Table 2-3 for an example).

3.2. Contaminant Source Inventory Table

Information on contaminant sources can be recorded in the contaminant source inventory table (Table 2-2). In this table the contaminant source is described briefly and its location documented as an address, UTM coordinates obtained from a map of appropriate scale or GPS unit, or legal property description. Also recorded in the table are distance and direction of the potential contaminant source with respect to the relevant water body, well, or intake; potential contaminants of concern; contaminant transport mechanisms; and where possible, landowner name or jurisdiction accountable for the land use, activity or facility. Comments can include contamination mitigation or prevention strategies, history of any previous discharges or spills, or any other information relevant to the potential contaminant source.

3.3 Hazard Identification Table

Enter existing or potential contaminant sources identified in Module 2 into the hazard identification table (Table 2-3). Similar to the hazard numbering system explained in Module 1 for multiple drinking water sources, small letters can be used to distinguish between contaminant sources associated with different sources. In the example below, the letter “a” has been assigned to a stream source, and “b” to a well.

Table 2-2. Sample Contaminant Source Inventory Table

Hazard No. (Hazard ID Table)	Contaminant Source Type and Description	Owner/Jurisdiction	Location (address / UTM coordinates)	Distance/Direction to the Source	Possible Contaminants of Concern	Contaminant Transport Mechanism	Comments
2-1a	Cattle ranch	John and Kate Sullivan	625 Valley Road	Cattle graze as close as 100 metres to the stream, 1.5 km upstream from intake.	Manure (pathogens)	Overland flow	Cattle cannot access stream.
2-2b	Gas station	Mike Smith, owner	105 Main Street	300 m NW	Gasoline, antifreeze, oils, solvents	Overland flow, subsurface soil diffusion	New underground storage tanks three years ago
2-3b	Roads	Municipal jurisdiction	All through capture zone	Surrounding	Automotive wastes, road salt, herbicides	Overland flow, subsurface soil diffusion	No stormwater collection

Table 2-3. Sample Module 2 Hazard Identification Table

Hazard No.	Drinking Water Hazard	Possible Effects	Existing Preventative Measures	Associated Barrier
2-1a	Cattle ranch	Pathogens, such as <i>E.coli</i> , present in water source	Chlorine disinfection	Source protection
2-2b	Gas station	Aquifer contamination from gasoline, oil, or other pollutants	Double-walled underground fuel storage tanks	Source protection
2-3b	Roads	Aquifer contamination from automotive wastes, road salt, or herbicides	None identified	Source protection

**APPENDIX 2A:
MODULE 2 ASSESSMENT AT A GLANCE**

Components	Recommended Methods	Scope	Documentation and Reporting
<p>1. Review information on historical, existing and potential contaminant sources in the water-source assessment area.</p>	<ul style="list-style-type: none"> • Common information sources include: <ul style="list-style-type: none"> ○ Interview with water supplier or other knowledgeable individuals ○ Recent and historic aerial photographs ○ Government waste management databases (e.g., WASTE, SITE) ○ Zoning and land use maps ○ Regional health authorities (septic systems) ○ Local government (maps, construction permits, business licences) 	<ul style="list-style-type: none"> • Geographic area: the water source assessment area defined in Module 1 (includes pumphouses) • Contaminant source types: <ul style="list-style-type: none"> ○ Historic, existing and potential ○ Land uses, nonpoint sources ○ Individual facilities, point sources, line sources • Contaminant types: <ul style="list-style-type: none"> ○ Microbiological ○ Chemical ○ Physical 	<ul style="list-style-type: none"> • Draft of contaminant source inventory table • Draft of map showing contaminant sources in assessment area • Draft of hazard identification table with contaminant sources shown as hazards (to be verified and completed in Task 2)
<p>2. Conduct a contaminant source survey</p>	<ul style="list-style-type: none"> • Use one or more of the following survey methods: <ul style="list-style-type: none"> ○ Personal interviews ○ Mail survey ○ Phone survey ○ Windshield survey ○ Door-to-door survey ○ Field inspections • Evaluate the factors that influence the susceptibility and magnitude of contamination (see Boxes 2-2 and 2-3). 	<ul style="list-style-type: none"> • Geographic area: the water source assessment area defined in Module 1. • Contaminant source types: <ul style="list-style-type: none"> ○ Historic, existing and potential ○ Land uses, nonpoint sources ○ Individual facilities, point sources, line sources • Contaminant types: <ul style="list-style-type: none"> ○ Microbiological ○ Chemical ○ Physical 	<ul style="list-style-type: none"> • Completed contaminant source inventory table • Map showing contaminant sources in assessment area • Discussion of factors influencing susceptibility and magnitude of contamination • Hazard identification table with contaminant sources included as hazards • Highlight any contaminant sources that may pose a present or imminent threat to source water.

APPENDIX 2B: RECOMMENDED RESOURCES

Source Assessment Guidelines and Information

Canadian Council of Ministers of the Environment (CCME). 2004. *From source to tap: Guidance on the multi-barrier approach to safe drinking water*. Produced jointly by the Federal-Provincial-Territorial Committee on Drinking Water and the CCME Water Quality Task Group. <http://www.ccme.ca/sourcetotap/mba.html>.

FORREX. Water Management Links. <http://www.forrex.org/programs/wmlinks.asp>.

US Environmental Protection Agency. Source Water Assessments. <http://cfpub.epa.gov/safewater/sourcewater/sourcewater.cfm?action=Assessments>

Groundwater

Province of British Columbia. 2000. *Well Protection Toolkit*. Victoria: Province of British Columbia. http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/wells/well_protection/acrobat.html.

Groundwater Foundation. *Using Technology to Conduct a Contaminant Source Inventory: A Primer for Small Communities*. http://www.groundwater.org/gi/actt_primer.html

B.C. Source Water Data and Monitoring

Groundwater

Water Well Data Query <https://a100.gov.bc.ca/pub/wells/public/indexreports.jsp>

Observation Well Network

http://www.env.gov.bc.ca/wsd/data_searches/obswell/index.html

Aquifer Classification Database

https://a100.gov.bc.ca/pub/wells/public/common/aquifer_report.jsp

Surface water

Community Watershed Data Query

http://www.env.gov.bc.ca/wsd/data_searches/comm_watersheds/index.html

Water License Query http://a100.gov.bc.ca/pub/wtrwhse/water_licences.input

River Forecast & Snow Survey <http://www.env.gov.bc.ca/rfc/>

Floodplain Mapping http://www.env.gov.bc.ca/wsd/data_searches/fpm/

Other

EcoCat <http://www.env.gov.bc.ca/ecocat/>

Water Quality Objective Reports http://www.env.gov.bc.ca/wat/wq/wq_objectives.html

Working Water Quality Guidelines for B.C.
<http://www.env.gov.bc.ca/wat/wq/BCguidelines/working.html>

Approved Water Quality Guidelines
http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved

Water & Sediment Quality Monitoring Reports
http://www.env.gov.bc.ca/wat/wq/wq_sediment.html

iMapBC <http://webmaps.gov.bc.ca/imfx/imf.jsp?site=imapbc>

BC Water Resource Atlas http://www.env.gov.bc.ca/wsd/data_searches/wrbc/index.html

**APPENDIX 2C:
LIST OF POTENTIAL SOURCES OF CONTAMINATION FOR
GROUNDWATER AND SURFACE WATER SOURCES**

What follows is a list of potential contaminant source activities and the contaminants commonly associated with those activities, modified from Appendix 3.1 of the *Well Protection Toolkit*. It should be noted that this list is not complete and it is not meant to be used as a checklist. There are many other activities that could potentially contaminate a drinking water source and the contaminants listed as associated with a particular activity may not be complete. Any activity or land use in the source area that has the potential to contaminate water should be considered and incorporated into the contaminant source inventory.

Table 2-4: Potential Contaminant Sources and the Contaminants Commonly Associated with Them

Naturally Occurring Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Rocks and soils	<ul style="list-style-type: none"> • Aesthetic contaminants: iron and iron bacteria; manganese; calcium and magnesium (hardness) • Health and environmental contaminants: Arsenic; asbestos; metals; chlorides; fluorides; sulphates; sulphate-reducing bacteria and other microorganisms
Contaminated water	<ul style="list-style-type: none"> • Excessive sodium; bacteria; viruses; low pH (acid) water
Sediment sources	<ul style="list-style-type: none"> • Increases turbidity
Wildlife	<ul style="list-style-type: none"> • Pathogens including <i>E. coli</i>; <i>Cryptosporidium parvum</i>; <i>Giardia lamblia</i>; <i>Toxoplasma gondii</i>
Decaying organic matter	<ul style="list-style-type: none"> • Bacteria; odour; colour, taste
Geological radioactive gas	<ul style="list-style-type: none"> • Uranium deposits; radon gas
100-year floodplain	<ul style="list-style-type: none"> • Surface water contamination of well; sediment, bacteria
Upstream reservoirs (surface water only)	<ul style="list-style-type: none"> • Sediment during and after a storm
Natural hydrogeological events and formations	<ul style="list-style-type: none"> • Salt-water/brackish water intrusion (or intrusion of other poor quality water); contamination by a variety of substances through sink-hole infiltration in limestone terrains

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Agricultural Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Animal feedlots and burial areas Manure treatment (composting) Manure spreading areas Manure storage areas and lagoons Animal waste disposal areas	<ul style="list-style-type: none"> • Viruses; bacteria (coliform and noncoliform) and other pathogens • Coliform bacteria can indicate the possible presence of pathogenic (disease-causing) microorganisms that may be transmitted in human or animal feces. • Eutrophication increasing algal biomass • Nitrates; phosphates, chloride; colour; taste; odour • Chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests on livestock
Animal grazing areas	<ul style="list-style-type: none"> • Livestock sewage wastes; nitrates; pathogens
Crop areas and irrigation sites	<ul style="list-style-type: none"> • Pesticides² including herbicides, insecticides, rodenticides, fungicides, and avicides; fertilizers³; nitrates; gasoline and motor oils from chemical applicators
Chemical storage areas and containers	<ul style="list-style-type: none"> • Pesticides²; fertilizers³; residues
Farm machinery areas	<ul style="list-style-type: none"> • Automotive wastes⁴: gasoline; antifreeze; automatic transmission fluid; battery acid; engine and radiator flushes; engine and metal degreasers; hydraulic brake fluid; and motor oils • Welding wastes
Agricultural drainage wells	<ul style="list-style-type: none"> • Pesticides²; fertilizers³; bacteria
Abandoned wells	<ul style="list-style-type: none"> • Contamination of aquifer from surface
Nurseries	<ul style="list-style-type: none"> • Pesticides², fertilizers³

² Pesticides include herbicides; insecticides; rodenticides; fungicides and avicides. Many pesticides are highly toxic and quite mobile in the subsurface.

³ The EPA National Pesticides Survey found that the use of fertilizers correlates to nitrate contamination of groundwater supplies.

⁴ Automotive wastes can include gasoline; antifreeze; automatic transmission fluid; battery acid; engine and radiator flushes; engine and metal degreasers; hydraulic (brake) fluid; and motor oils.

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Forestry-Related Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Landslides connected to water source	<ul style="list-style-type: none"> • Suspended sediment; turbidity
Log sorts	<ul style="list-style-type: none"> • Leachate from decomposing wood waste
Logging camps	<ul style="list-style-type: none"> • Fecal coliform; motor fuel; oil
Logging roads	<ul style="list-style-type: none"> • Suspended sediment; turbidity
Cutblocks	<ul style="list-style-type: none"> • Elevated concentrations of nitrate; decrease in pH (small watersheds most susceptible)
Channels in logged areas	<ul style="list-style-type: none"> • Turbidity due to increased channel scour and destabilization

Municipal Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Schools and government offices and grounds	Solvents; pesticides; acids; alkalis; residues from cleaning products that may contain chemicals such as xylene, glycol esters, isopropanol, 1,1,1-trichloroethane, sulphonates, chlorinated phenols and cresols Machinery/vehicle servicing wastes; gasoline and heating oil from storage tanks; waste oils General building wastes ⁵ Pesticides ² ; herbicides; fertilizers ³
Park lands, public and residential areas infested with mosquitoes, gypsy moths, ticks, ants or other pests	Fertilizers ³ ; pesticides ² ; herbicides; insecticides
Roads	Runoff; herbicides; accidental spills

⁵ Common wastes from public and commercial buildings include automotive wastes; rock salt; and residues from cleaning products that may contain chemicals such as xylenes, glycol esters, isopropanol, 1,1,1, trichloroethane, sulfonates, chlorinated phenols, and cresols.

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Municipal Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Highways, road maintenance depots, and de-icing operations	<ul style="list-style-type: none"> • Automotive wastes: gasoline; antifreeze; automatic transmission fluid; battery acid; engine and radiator flushes; engine and metal degreasers; hydraulic brake fluid; and motor oils⁴ • Herbicides in highway rights-of-way • Road salt (sodium and calcium chloride); road salt anticaking additives (ferric ferrocyanide, sodium ferrocyanide) • Anticorrosives (phosphate and chromate)
Municipal sewage treatment plants	<ul style="list-style-type: none"> • Municipal wastewater sludge⁶; treatment chemicals⁷; and sewer lines
Storage, treatment and disposal of waste from municipal treatment plants	<ul style="list-style-type: none"> • Sewage wastewater; biosolids; nitrates; other liquid wastes; microbiological contaminant ponds, lagoons, and other surface impoundments
Land areas applied with wastewater	<ul style="list-style-type: none"> • Organic matter; nitrates; inorganic salts; heavy metals; coliform and noncoliform or wastewater byproducts, bacteria; viruses; sludge; nonhazardous wastes
Storm water drains and basins	<ul style="list-style-type: none"> • Storm water; urban runoff; gasoline; oil; other petroleum products; road salt; microbiological contaminants
Combined sewer overflows (municipal sewers and storm water drains)	<ul style="list-style-type: none"> • Municipal wastewater sludge and treatment chemicals; urban runoff; gasoline; oil; other petroleum products; road salt • Microbial contaminants
Recycling/reduction/composting facilities	<ul style="list-style-type: none"> • Residential and commercial solid waste residues; nitrates; tannins
Municipal waste landfills	<ul style="list-style-type: none"> • Leachate; organic and inorganic chemical contaminants; wastes from households and businesses; nitrates; oils; metals • Biomedical and related waste
Open dumping and burning sites, closed dumps	<ul style="list-style-type: none"> • Organic and inorganic chemicals; metals; oils; wastes from households and businesses

⁶Municipal wastewater treatment sludge can contain organic matter; nitrates; inorganic salts; heavy metals; coliform and noncoliform bacteria; and viruses.

⁷Municipal wastewater treatment chemicals include calcium oxide; alum; activated alum, carbon, and lilyca; polymers; ion exchange resins; sodium hydroxide; chlorine; ozone; and corrosion inhibitors

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Municipal Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Municipal incinerators	<ul style="list-style-type: none"> • Heavy metals; hydrocarbons; formaldehyde; methane; ethane; ethylene; acetylene; sulphur and nitrogen compounds
Fire Stations, fire-training facilities, fire retardant recharge facilities.	<ul style="list-style-type: none"> • Fire retardant; spilled liquids, gasoline, oil
Water supply wells, monitoring wells, older wells, domestic and livestock wells, unsealed and abandoned wells, and test hole wells	<ul style="list-style-type: none"> • Surface runoff; effluents from barnyards, feedlots, septic tanks or cesspools; gasoline; used motor oil; road salt; fertilizers and pesticides
Sumps and dry wells	<ul style="list-style-type: none"> • Storm water runoff; spilled liquids; used oil; antifreeze; gasoline; other petroleum products; road salt; pesticides² and a wide variety of other substances
Drainage wells	<ul style="list-style-type: none"> • Pesticides²; bacteria
Well pumping that causes interaquifer leakage, induced filtration, landward migration of sea water in coastal areas; etc.	<ul style="list-style-type: none"> • Saltwater; excessively mineralized water
Artificial groundwater recharge	<ul style="list-style-type: none"> • Storm water runoff; excess irrigation water; stream flow; cooling water; treated sewage effluent; other substances that may contain contaminants, such as nitrates, metals, detergents, synthetic organic compounds, bacteria and viruses

Commercial Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Airports, abandoned airfields	Jet fuels; de-icers; diesel fuel; chlorinated solvents; automotive wastes; heating oil; building wastes
Auto repair shops	Waste oils; solvents; acids; paints; automotive wastes ⁴ ; miscellaneous cutting oils
Barber and beauty shops	Perm solutions; dyes; miscellaneous chemicals contained in hair rinses
Boat yards and marinas	Diesel fuels; oil; septage from boat waste disposal areas; wood preservative and treatment chemicals; paints; waxes; varnishes; automotive wastes

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Commercial Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Bowling alleys	Epoxy; urethane-based floor finish
Car dealerships (especially those with service departments)	Automotive wastes; waste oils; solvents; miscellaneous wastes
Car washes	<ul style="list-style-type: none"> • Soaps; detergents; waxes; miscellaneous chemicals
Campgrounds	<ul style="list-style-type: none"> • Septage; gasoline; diesel fuel from boats; pesticides for controlling mosquitoes, ants, ticks, gypsy moths, and other pests; household hazardous wastes from recreational vehicles (RVs)
Carpet stores	<ul style="list-style-type: none"> • Glues and other adhesives; fuel from storage tanks if forklifts are used
Cemeteries	<ul style="list-style-type: none"> • Leachate; lawn and garden maintenance chemicals
Construction trade areas and materials (plumbing, heating and air conditioning, painting, paper hanging, decorating, drywall and plastering, acoustical insulation, carpentry, flooring, roofing and sheet metal, wrecking and demolition, etc.)	<ul style="list-style-type: none"> • Solvents; asbestos; paints; glues and other adhesives; waste tars; insulation; lacquers; sealants; epoxy waste; miscellaneous chemical wastes
Country clubs	<ul style="list-style-type: none"> • Fertilizers; herbicides; pesticides; swimming pool chemicals; automotive wastes
Dry cleaners	<ul style="list-style-type: none"> • Solvents (perchloroethylene, petroleum solvents, Freon); • Spotting chemicals (trichloroethane, methylchloroform, ammonia, peroxides, hydrochloric acid, rust removers, amyl acetate)
Firing ranges	<ul style="list-style-type: none"> • Lead
Funeral services and crematories	<ul style="list-style-type: none"> • Formaldehyde; wetting agents; fumigants; solvents
Furniture repair and finishing shops	<ul style="list-style-type: none"> • Paints; solvents; degreasing and solvent recovery sludges
Gasoline services stations	<ul style="list-style-type: none"> • Oils; solvents; gasoline; miscellaneous wastes
Golf courses	<ul style="list-style-type: none"> • Fertilizers; herbicides; pesticides for controlling mosquitoes, ticks, ants, gypsy moths, and other pests; shop wastes
Hardware/lumber/parts stores	<ul style="list-style-type: none"> • Hazardous chemical products in inventories; heating oil

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Commercial Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
	and forklift fuel from storage tanks; wood staining and treating products such as creosote
Heating oil companies	<ul style="list-style-type: none"> • Heating oil; wastes from truck maintenance areas, underground storage tanks
Horticultural practices, garden nurseries, florists	<ul style="list-style-type: none"> • Herbicides; insecticides; fungicides and other pesticides
Jewellery/metal plating shops	<ul style="list-style-type: none"> • Sodium and hydrogen cyanide; metallic salts
Laundromats	<ul style="list-style-type: none"> • Detergents; bleaches; fabric dyes
Medical institutions	<ul style="list-style-type: none"> • X-ray developers and fixers;⁸ infectious wastes; radiological wastes; biological wastes; disinfectants; asbestos; beryllium; dental acids; miscellaneous chemicals
Office buildings and office complexes	<ul style="list-style-type: none"> • Building wastes; lawn and garden maintenance chemicals; gasoline; motor oil
Paint stores	<ul style="list-style-type: none"> • Paints; paint thinners; lacquers; varnishes; other wood treatments
Pharmacies	<ul style="list-style-type: none"> • Spilled and returned products
Photography shops, photo processing laboratories	<ul style="list-style-type: none"> • Biosludges; silver sludges; cyanides; miscellaneous sludges
Print shops	<ul style="list-style-type: none"> • Solvents; inks; dyes; oils; photographic chemicals
Railroad tracks and yards	<ul style="list-style-type: none"> • Diesel fuel; herbicides for rights-of-way; creosote for preserving wood ties
Research laboratories	<ul style="list-style-type: none"> • X-ray developers and fixers; infectious wastes; radiological wastes; biological wastes; disinfectants; asbestos; beryllium; solvents; infectious materials; drugs; disinfectants (quaternary ammonia, hexachlorophene, peroxides, chlornexade, bleach); miscellaneous chemicals
Scrap, tire, and junk yards	<ul style="list-style-type: none"> • Any wastes from businesses and households; oils

⁸ X-ray developers and fixers may contain reclaimable silver, glutaldehyde, hydroquinone, phenedone, potassium bromide, sodium sulfite, sodium carbonate, thiosulfates, and potassium alum.

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Commercial Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Ski resorts	<ul style="list-style-type: none"> Automotive and machinery wastes; salt; heavy metals; wastewater; turbidity
Sports and hobby shops	<ul style="list-style-type: none"> Gunpowder and ammunition; rocket engine fuel; model aeroplane glue
Above-ground and underground storage tanks	<ul style="list-style-type: none"> Heating oil; diesel fuel; gasoline; other petroleum products; other commercially used chemicals
Transportation services for passenger transit (local and interurban)	<ul style="list-style-type: none"> Waste oil; solvents; gasoline and diesel fuel from vehicles and storage tanks; fuel oil; other automotive wastes
Veterinary services	<ul style="list-style-type: none"> Solvents; infectious materials; vaccines; drugs; disinfectants (quaternary ammonia, hexachlorophene, peroxides, chlornexade, bleach); X-ray developers and fixers
X-Ray clinics and devices	<ul style="list-style-type: none"> X-ray developers and fixers may contain reclaimable silver, glutaldehyde; hydroquinone; phenedone; potassium bromide; sodium sulphite; sodium carbonates; thiosulphates; potassium alum

Industrial Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Material stockpiles (coal, metallic ores, phosphates, gypsum)	<ul style="list-style-type: none"> Acid drainage; other hazardous and nonhazardous wastes
Waste tailing ponds (commonly for the disposal of mining wastes)	<ul style="list-style-type: none"> Acids; metals; dissolved solids; radioactive ores; other hazardous and nonhazardous wastes
Transport and transfer stations (trucking terminals and rail yards)	<ul style="list-style-type: none"> Fuel tanks; repair shop wastes; other hazardous and nonhazardous wastes
Above-ground and underground storage tanks and containers	<ul style="list-style-type: none"> Heating oil; diesel and gasoline fuel; other petroleum products; hazardous and nonhazardous materials and wastes
Storage, treatment, and disposal ponds, lagoons, and other surface impoundments	<ul style="list-style-type: none"> Hazardous and nonhazardous liquid wastes; septage; sludge
Chemical landfills	<ul style="list-style-type: none"> Leachate; hazardous and nonhazardous wastes; nitrates

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Industrial Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Radioactive waste disposal materials	<ul style="list-style-type: none"> • Radioactive wastes from medical facilities • Radionuclides (uranium, plutonium)
Unattended wet and dry excavation sites (unregulated dumps)	<ul style="list-style-type: none"> • A wide range of substances; solid and liquid wastes; oil-field brines; spent acids from steel mill operations; snow removal piles containing large amounts of salt
Operating and abandoned production and exploratory wells (for gas, oil, coal, geothermal, coal bed methane and heat recovery); test hole wells; monitoring and excavation wells	<ul style="list-style-type: none"> • Metals; acids; minerals; sulphides; other hazardous and nonhazardous chemicals
Dry wells	<ul style="list-style-type: none"> • Saline water from wells pumped to keep them dry
Injection wells	<ul style="list-style-type: none"> • Highly toxic wastes; hazardous and nonhazardous industrial wastes; oil-field brines
Well drilling operations	<ul style="list-style-type: none"> • Brines associated with oil and gas operations

Industrial Processes (Currently Operated or Torn-Down Facilities)	
Source	Health, Environmental or Aesthetic Contaminant(s)
Asphalt plants	<ul style="list-style-type: none"> • Petroleum derivatives
Communications equipment	<ul style="list-style-type: none"> • Nitric, hydrochloric, and sulphuric acid wastes; heavy metal sludges;
Copper manufacturers	<ul style="list-style-type: none"> • Contaminated etchant (e.g., ammonium persulfate); cutting oil and degreasing solvent (trichloroethane, Freon, or trichloroethylene); waste oils; corrosive soldering flux; paint sludge; waste plating solution

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Industrial Processes (Currently Operated or Torn-Down Facilities)	
Source	Health, Environmental or Aesthetic Contaminant(s)
Electric and electronic equipment	<ul style="list-style-type: none"> • Cyanides; metal sludges; caustics (chromic acid); solvents; oils; manufacturers and storage facilities alkalis; acids; paints and paint sludges; calcium fluoride sludges; methylene chloride; perchloroethylene; trichloroethane; acetone; methanol; toluene; PCBs
Electroplaters	<ul style="list-style-type: none"> • Boric, hydrochloric, hydrofluoric, and sulphuric acids; sodium and potassium hydroxide; chromic acid; sodium and hydrogen cyanide; metallic salts
Foundries and metal fabricators	<ul style="list-style-type: none"> • Paint wastes; acids; heavy metals; metal sludges; plating wastes; oils; solvents; explosive wastes
Furniture and fixtures manufacturers	<ul style="list-style-type: none"> • Paints; solvents; degreasing sludges; solvent recovery sludges
Machine and metal working shops	<ul style="list-style-type: none"> • Solvents; metals; miscellaneous organics; sludges; oily metal shavings; lubricant and cutting oils; degreasers (tetrachloroethylene); metal marking fluids; mould-release agents
Mining operations (surface and underground), underground storage mines	<ul style="list-style-type: none"> • Mine spoils or tailings that often contain metals; acids; highly corrosive mineralized waters; metal sulphides
Unsealed abandoned mines used as waste pits	<ul style="list-style-type: none"> • Metals; acids; minerals; sulphides; other hazardous and nonhazardous wastes
Paper mills	<ul style="list-style-type: none"> • Metals; acids; minerals; sulphides; other hazardous and nonhazardous chemicals; organic sludges; sodium hydroxide; chlorine; hypochlorite; chlorine dioxide; hydrogen peroxide
Petroleum production and storage companies, secondary recovery of petroleum	<ul style="list-style-type: none"> • Hydrocarbons; oil-field brines (highly mineralized salt solutions)
Industrial pipelines	<ul style="list-style-type: none"> • Corrosive fluids; hydrocarbons; other hazardous and nonhazardous materials and wastes
Photo processing laboratories	<ul style="list-style-type: none"> • Cyanides; biosludges; silver sludges; miscellaneous sludges
Plastic materials and synthetics producers	<ul style="list-style-type: none"> • Solvents; oils; miscellaneous organics and inorganics (phenols, resins); paint wastes; cyanides; acids; alkalis; wastewater treatment sludges; cellulose esters; surfactant; glycols; phenols; formaldehyde; peroxides; etc.

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Industrial Processes (Currently Operated or Torn-Down Facilities)	
Source	Health, Environmental or Aesthetic Contaminant(s)
Primary metal industries (blast furnaces, steel works and rolling mills)	<ul style="list-style-type: none"> Heavy metal wastewater treatment sludge; pickling liquor; waste oil; ammonia scrubber liquor; acid tar sludge; alkaline cleaners; degreasing solvents; slag; metal dust
Publishers, printers, and allied industries	<ul style="list-style-type: none"> Solvents; inks; dyes; oils; miscellaneous organics; photographic chemicals
Public utilities (phone, electric power, gas)	<ul style="list-style-type: none"> PCBs from transformers and capacitors; oils; solvents; sludges; acid solution; metal plating solutions (chromium, nickel, cadmium); herbicides from utility rights-of-way
Sawmills and planers	<ul style="list-style-type: none"> Treated wood residue (copper quinolate, mercury, sodium azide); tanner gas; paint sludges; solvents; creosote; coating and gluing wastes
Stone, clay, and glass manufacturers	<ul style="list-style-type: none"> Solvents; oils and grease; alkalis; acetic wastes; asbestos; heavy metal sludges; phenolic solids or sludges; metal finishing sludge
Welders	<ul style="list-style-type: none"> Oxygen, acetylene, ozone
Wood preserving facilities	<ul style="list-style-type: none"> Wood preservatives; creosote

Residential Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Abandoned wells	<ul style="list-style-type: none"> Contamination of aquifer from surface
Asphalt and roofing tar	<ul style="list-style-type: none"> Hydrocarbons
Bug and tar removers	<ul style="list-style-type: none"> Xylene; petroleum distillates
Cesspool cleaners	<ul style="list-style-type: none"> Tetrachloroethylene; dichlorobenzene; methylene chloride
Cleaners (household, oven)	<ul style="list-style-type: none"> Xylenes; glycol esters; isopropanol
Disinfectants	<ul style="list-style-type: none"> Disinfectants (quaternary ammonia, hexachlorophene, peroxides, chlorhexide, bleach); cresol; xylenols
Drain cleaners	<ul style="list-style-type: none"> 1,1,1-trichloroethylene; caustic soda
Heating oil, diesel fuel, kerosene	<ul style="list-style-type: none"> Hydrocarbons

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Residential Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
Jewellery cleaners	<ul style="list-style-type: none"> • Sodium cyanide
Junk cars and debris in yards	<ul style="list-style-type: none"> • Gasoline; antifreeze; automatic transmission fluid; battery acid; engine and radiator flushes; engine and metal degreasers; hydraulic (brake) fluid; motor oils
Laundry soil and stain removers, spot removers	<ul style="list-style-type: none"> • Hydrocarbons; trichloroethylene; 1,1,1-trichloroethane
Lye or caustic soda	<ul style="list-style-type: none"> • Sodium hydroxide
Metal polishes	<ul style="list-style-type: none"> • Petroleum distillates; isopropanol; petroleum naphtha
Pesticides (household - all types)	<ul style="list-style-type: none"> • Common household pesticides for controlling pests such as ants, termites, bees, wasps, flies, cockroaches, silverfish, mites, ticks, fleas, worms, rats, and mice can contain ingredients including naphthalene, phosphorus, xylene, chloroform, heavy metals, chlorinated hydrocarbons, arsenic, strychnine, kerosene, nitrosamines, and dioxins.
Pets/animals	<ul style="list-style-type: none"> • Coliform bacteria and other microbes such as toxoplasmosis in cats
Photochemicals (photofinishing chemicals)	<ul style="list-style-type: none"> • Phenols; sodium sulphite; cyanide; silver halide; potassium bromide.
Printing ink	<ul style="list-style-type: none"> • Heavy metals; phenol-formaldehyde
Refrigerants	<ul style="list-style-type: none"> • Trichlorofluoroethane
Rustproofers	<ul style="list-style-type: none"> • Phenols; heavy metals
Septic systems, cesspools, and sewer lines	<ul style="list-style-type: none"> • Septage; coliform and noncoliform bacteria; viruses; nitrates; heavy metals; synthetic detergents; cooking and motor oils; bleach; pesticides; paints; paint thinners; photographic chemicals; swimming pool chemicals; septic tank/cesspool cleaner chemicals⁹; elevated levels of chloride, sulphate, calcium, magnesium, potassium and phosphate
Solvents	<ul style="list-style-type: none"> • Acetone; benzene; xylene
Swimming pool disinfection and maintenance chemicals	<ul style="list-style-type: none"> • Free and combined chlorine; bromine, iodine • Copper-based and quarternary algicides

⁹ Septic tank/cesspool cleaners include synthetic organic chemicals such as 1,1,1 trichloroethane, tetrachloroethylene, carbon tetrachloride, and methylene chloride

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Residential Sources	
Source	Health, Environmental or Aesthetic Contaminant(s)
	<ul style="list-style-type: none"> • Cyanuric acid • Calcium or sodium hypochlorite • Muriatic acid • Sodium carbonate
Toilet cleaners	<ul style="list-style-type: none"> • Xylene; sulphonates; chlorinated phenols
Underground storage tanks	<ul style="list-style-type: none"> • Home heating oil

Mechanical Repair and Other Maintenance Products	
Source	Health, Environmental or Aesthetic Contaminant(s)
Antifreeze (gasoline or coolant systems)	<ul style="list-style-type: none"> • Methanol; ethylene glycol
Automatic transmission fluid	<ul style="list-style-type: none"> • Petroleum distillates; xylene
Battery acid (electrolyte)	<ul style="list-style-type: none"> • Sulphuric acid; bromide
Car wash detergents	<ul style="list-style-type: none"> • Alkyl benzene sulphonates
Car waxes and polishes	<ul style="list-style-type: none"> • Petroleum distillates; hydrocarbons
Degreasers for driveways and garages	<ul style="list-style-type: none"> • Petroleum solvents; alcohols; glycol ether
Degreasers for engines and metal	<ul style="list-style-type: none"> • Chlorinated hydrocarbons; toluene; phenols; dichloroperchloroethylene
Engine and radiator flushes	<ul style="list-style-type: none"> • Petroleum solvents; ketones, butanol; glycol ether
Gasoline and jet fuel	<ul style="list-style-type: none"> • Hydrocarbons
Grease, lubricants	<ul style="list-style-type: none"> • Hydrocarbons
Hydraulic fluid (brake fluid)	<ul style="list-style-type: none"> • Hydrocarbons; fluorocarbons
Motor oils and waste oils	<ul style="list-style-type: none"> • Hydrocarbons; heavy metals

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Lawn and Gardens	
Source	Health, Environmental or Aesthetic Contaminant(s)
Fertilizers	<ul style="list-style-type: none"> • Nitrogen
Herbicides and other pesticides	<ul style="list-style-type: none"> • Common pesticides used for lawn and garden maintenance (i.e., weed killers, and mite, grub and aphid controls) include such chemicals as 2,4,-D, chlorpyrifos, diazinon, benomyl, captan, dicofol and methoxychlor.
Wood preservatives	<ul style="list-style-type: none"> • Pentachlorophenols; creosote; copper; arsenic; metam sodium

Wall, Furniture and Floor Treatment	
Source	Health, Environmental or Aesthetic Contaminant(s)
Floor and furniture strippers	<ul style="list-style-type: none"> • Xylene
Paint and lacquer thinner	<ul style="list-style-type: none"> • Acetone; benzene; butyl acetate; methyl ketones
Paint and varnish removers, de-glossers	<ul style="list-style-type: none"> • Methylene chloride; toluene; acetone; methanol; glycol ethers; methyl ethyl ketones
Paint brush cleaners	<ul style="list-style-type: none"> • Hydrocarbons; toluene; acetone; methanol; glycol ethers; methyl ethyl ketones
Paints, varnishes, stains, dyes	<ul style="list-style-type: none"> • Heavy metals; toluene

APPENDIX 2D: POTENTIAL CONTAMINANT SOURCE INVENTORY METHODS¹⁰

Personal Interviews

Personal interviews are a valuable way to find out about sources of potential contamination. These can be a “jumping-off point” for information gathering, as they can bring forward information that will help the planning team set priorities for other information gathering activities.

Local officials can often supply names of appropriate contacts. Contacts may include long-term residents, operators or staff with a wealth of knowledge about present and past operations and practices. Personal interviews with key individuals, such as a facility operator, often provide information that may not be available from other sources.

Results from the survey techniques can direct you to other community members who have valuable information. You may need to conduct a second round of personal interviews.

Mail and Phone Surveys

Mail and phone surveys are a good way to contact a large number of residents and businesses at a relatively low cost. Mailing lists can be obtained from a number of sources such as:

- Property owner names from the tax assessment authority.
- Voter registration lists.
- Chamber of Commerce rosters.
- Utility records.
- Phone directories.

Once the surveys are completed, they must be collected and the results summarized. The collection effort may be as simple as enclosing a self-addressed, stamped envelope with a mailed survey, or as labour intensive as a door-to-door collection. For telephone surveys, information is collected by filling out survey sheets during the interviews.

Windshield Survey

A windshield survey is used when more information is needed about potential or existing sources of contamination, and maps or aerial photographs do not provide

¹⁰ Contaminant source inventory method descriptions are excerpted from: Ministry of Environment, Lands and Parks & Ministry of Health. (2000). *Well Protection Toolkit*. Victoria: Province of British Columbia.
http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/wells/well_protection/wellprotect.html

enough information. A windshield survey requires access to a vehicle and one or two people, who drive through the area taking notes. A two-person survey is better, so that one person can drive while the other takes down the information. This information is later added to the database.

Windshield surveys work well in most communities and may provide a large amount of useful information. They work best in areas where most of the sources can be located from the road, but may be less effective in forested or mountainous areas where many sources are not visible from the road.

iMapBC

The Province of British Columbia provides a useful web mapping application to provide information on the natural resources, administrative boundaries and monitoring sites across the province. The iMapBC application can be accessed at <http://webmaps.gov.bc.ca/imfx/imf.jsp?site=imapbc>.

Table 2-5. Advantages and Disadvantages of Different Types of Potential Contaminant Source Surveys

Survey Type	Description	Advantages	Disadvantages
Personal Interviews	One-on-one interviews with individuals who may have information not available through other sources. Contacts may include long-time residents, water system operators or staff.	<ul style="list-style-type: none"> • Obtain useful information and insight not available through any other source • Efficient 	<ul style="list-style-type: none"> • Potential for response bias
Mail survey	A survey distributed by mail to a mailing list	<ul style="list-style-type: none"> • Low cost to contact a large number of people • Low time requirements • Promotes public awareness and participation 	<ul style="list-style-type: none"> • Usually a low response rate • Variable quality of response • Potential for bias
Phone survey	Survey conducted verbally over the telephone	<ul style="list-style-type: none"> • Low cost to contact a large number of people • Respondents a "captive" audience; higher response rates 	<ul style="list-style-type: none"> • May require a significant labour and time requirement (costs may be reduced by using volunteers) • Potential for response bias

COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

Survey Type	Description	Advantages	Disadvantages
		<ul style="list-style-type: none"> • Can be used selectively to fill in the gaps of a mail survey • Promotes public awareness and participation 	
Windshield survey	Conducted by one or two people driving through the well protection area and recording where potential sources of contaminants are	<ul style="list-style-type: none"> • Requires less time for survey staff • Effective in identifying obvious potential sources covering a large area • Effective in screening sites for future investigation • Access not a problem • Direct observations 	<ul style="list-style-type: none"> • Not easy to conduct in rough or forested terrain, where sources are not visible from road • No personal contact
Door-to-door survey	Involves canvassing the businesses and residents in the well protection area to identify the potential contaminant sources	<ul style="list-style-type: none"> • Increased accuracy and uniformity of the data collected • Increased likelihood of identifying previously unknown sources • More public interaction • Direct observations 	<ul style="list-style-type: none"> • Recruiting and training workers can be costly and labour intensive • Time consuming
Field Inspections	Consist of an extensive walking survey of an area and may be used to provide a detailed inspection of land uses	<ul style="list-style-type: none"> • Good for small areas with easy access • More accurate survey method • More public interaction • Direct observations 	<ul style="list-style-type: none"> • Costly and labour intensive in large areas • Need to get owner approval

Door-to-Door Surveys

Door-to-door surveys involve canvassing the residences and businesses within the well protection area to identify the activities and materials that may pose a hazard to the water supply. This method allows for first-hand observations, which mail and phone surveys do not.

When survey staff is properly trained, the answers to the door-to-door survey will be more concise, complete and uniform than those of mailed surveys. This type of survey can gather a wide range of detailed information and should be tailored for the potential contamination sources expected in the survey area.

Door-to-door surveys should not be conducted during holiday periods. Also, if survey staff is made up of volunteers, avoid sending them out in bad weather!

Field Inspections

Field inspections consist of an extensive walking survey of an area, and may be used to provide a detailed inspection of specific land uses. Field inspections allow survey staff to look at the area first-hand, without relying on landowners to identify and provide information about sources. It is also an opportunity to see actual management practices.

Select an Appropriate Survey Method

The choice of survey method will depend on:

- The nature of human activities in the well protection area.
What type of activity are you trying to document? How much detail do you require? For instance, assessing a farm might require an interview with the farmer. For a gas station, a site inspection might be appropriate, while for a trailer park a door-to-door or mail survey might be used.
- Availability and skills of labour force.
How many people will you need to conduct the surveys? Who will do the work? If you can't afford to hire labour, look at options such as using students or other volunteers. Who will train the survey staff?
- Cost.
Cost may influence your choice of survey technique. Do you need the level of detail provided by a field inspection, or would a phone survey be sufficient?

Conduct the most complete inventory possible. This may involve conducting more than one type of survey, such as mail, phone surveys or personal interviews in conjunction with historic records, door-to-door surveys or field inspections.