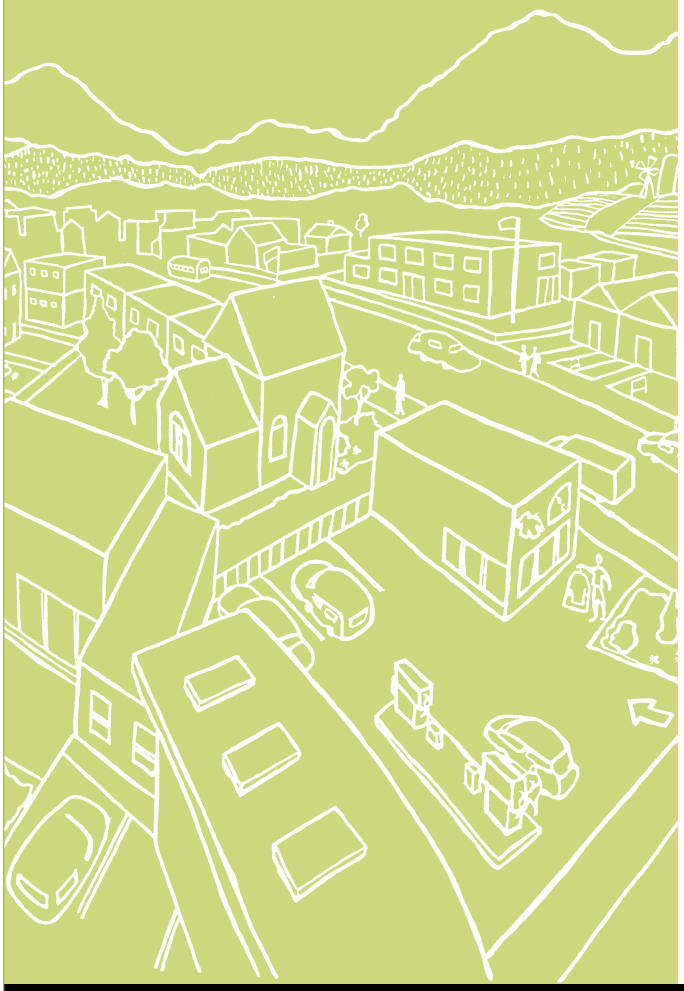

Step Three

IDENTIFY POTENTIAL CONTAMINANTS

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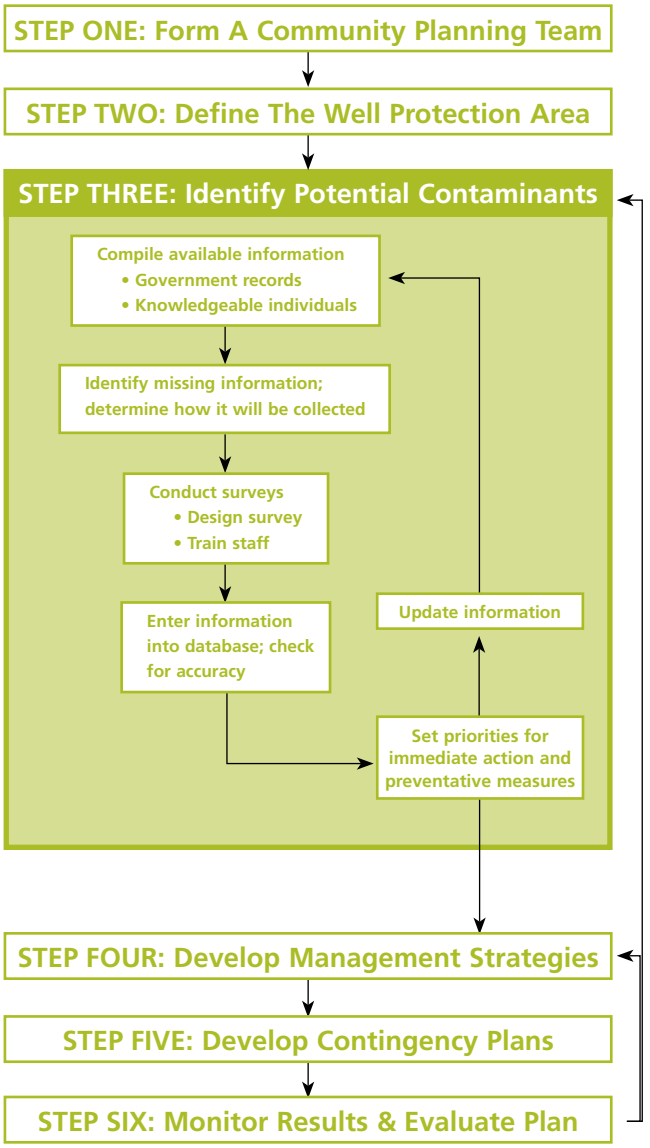
SUMMARY

Figure 3.1



More than 1,000,000 British Columbians rely on groundwater as their source of drinking water, and there are thousands of community well systems in British Columbia. A well protection plan allows communities to identify land use activities that may threaten the quality of their well water, and to develop a strategy to avoid or minimize these threats.

There are six steps to follow in developing a well protection plan:

1. Form a community planning team
2. Define the well protection area
3. Identify potential contaminants
4. Develop and implement management strategies
5. Develop contingency plans
6. Monitor results and evaluate the plan

These steps are described in the six booklets that make up the *Well Protection Toolkit*. Each booklet describes activities that lead to the development and implementation of a well protection plan. In each step, a fictional case study of the town of Pumphandle shows how one community took on this challenge.

Step Three: Identify Potential Contaminants

The third step is to find out what **sources** of potential contaminants are found within the well protection area, **where** they are located and what **type** of contaminants they are. Some of this information can be found using existing files and documents and by talking to knowledgeable individuals. Where information is not easily available, surveys may be needed to collect the missing data.

This data will need to be recorded and organized using some form of database. Once this is done, the resulting information can be used to identify which contaminants and their sources are the greatest and most immediate threat to the water supply. The data and the information will need to be reviewed and updated from time to time.

Figure 3.1 shows the stages of Step Three.

Identify Potential Contaminants

OBJECTIVES

- To obtain information about past, present and potential sources of contamination
- To document current management practices for activities in the well protection area
- To record this information in a format that can be easily viewed and used
- To set priorities for implementing protection measures
- To update the inventory of potential contaminants on a regular basis

3.1 Compile Available Information

Once you have defined the well protection area (Step Two), the next task is to locate and identify all the potential sources of contamination in this area. It may be necessary to undertake a "reconnaissance-level" inventory, to understand what types of contaminants may be in the capture zone. A great deal of information can be obtained from existing sources, such as zoning and land use maps.

[1] Pesticides and fertilizers are of concern when their use is excessive. There may also be a concern depending on what time of year they are applied.

Contaminant sources are often described according to three main categories:

- *Point sources* are those that release contaminants from a specific, known location, such as underground storage tanks, abandoned wells, small commercial/industrial facilities and landfills.
- *Non-point sources* are more extensive in area and diffuse in nature, making it difficult to trace contaminants back to their point of origin. Application of pesticides and fertilizers in gardens and farms,[1] septic systems, storm drains carrying urban runoff, and atmospheric deposition are all potential non-point contaminant sources.
- *Line sources* generally follow a line or corridor, and include sewer lines, gas/petroleum pipelines, and highways (especially those used for transporting dangerous goods). Contamination may occur anywhere along the line source, for example, hydro power-line corridors may use pesticides to control weeds.

The inventory will need to identify the **type of source**, **location** and **nature** of potential contaminants at each site. Non-point and underground sources are harder to identify but must also be included to get a complete picture of the possible threats to the water supply.

Appendix 3.1 is a list of some potential contaminant sources, which can be used as a checklist when setting up your inventory. It includes a list of the potentially harmful components from common household products, which could pollute the groundwater if they are not used according to the label instructions, or are disposed of improperly. This is one area where

WORTH ITS SALT?

In a small community north of Kamloops, B.C., a stockpile of road salt contaminated the groundwater supply.

The cost of responding to contamination was more than two million dollars. Costs included drilling replacement wells, buying property for the new well sites, cleaning contaminated soils, paying damage claims, conducting groundwater studies, replacing corroded pipes, supplying bottled water, holding public meetings, legal fees, and relocating and containing the salt pile. Settling claims alone cost more than $500,000.

A well protection plan would have identified the salt pile as a potential contaminant source. Constructing a suitable storage facility at a cost of about $250,000 could have prevented the incident.

community education can help to reduce the number of potential contaminants.

In general, groundwater contamination stems from:

- *misuse and improper disposal* of liquid and solid wastes;
- *illegal dumping or abandonment* of household, commercial, or industrial chemicals;
- *accidental spilling* of chemicals from trucks, railways, aircraft, handling facilities, and storage tanks; or
- *improper siting, design, construction, operation, or maintenance* of agricultural, residential, municipal (liquid and solid waste), commercial, and industrial facilities.

Contaminants also can stem from atmospheric pollutants, such as airborne sulfur and nitrogen compounds, which are created by smoke, stack emissions, aerosols, and automobile emissions, fall as acid rain, and percolate through the soil. When the sources listed in Table 3.1 are used and managed properly, groundwater contamination is not likely to occur.

Contaminants can reach groundwater from activities occurring on the land surface, such as industrial waste storage; from sources below the land surface but above the water table, such as septic systems; from structures beneath the water table, such as wells; or from contaminated recharge water.

The list of potential contaminants in the capture zone will be very specific to the activities in the area. If your time and financial resources are limited, start by collecting data on activities that are more likely to contaminate your groundwater. For example, data on animal manure stockpiles and septic tanks are much more important than data on the use of antifreeze and car washing detergents, particularly if there are high nitrate levels in the drinking water.

Check Existing Information Sources

It is easiest to start compiling the inventory by checking for data that has already been collected (see sidebar).

SOURCE OF INFORMATION	LOCATION OF INFORMATION
Recent and historical aerial photographs	Maps BC
Telephone directories	Telephone companies
Business licenses	Municipal or regional government
Federal, provincial and local data bases dealing with commercial permits	Federal and provincial government
Zoning regulations and zoning maps	Municipal or regional government
Information on domestic septic systems and adjacent community wells	Regional Health Authority
Construction permits	Municipal or regional government
MOE[2] contaminated sites and waste databases	Regional MOE offices
Real estate title searches	Municipal or regional government, land titles office
Purveyor or well driller reports	Purveyor or well drillers, MOE
Location of septic systems	Regional Health Authority
Density of septic systems	Municipal or regional government, Regional Health Authority
Gas pipelines	Municipal or regional government, utility companies
Agricultural Land Use	Ministry of Agriculture and Lands; B.C. Federation of Agriculture, municipal or regional governments
Sewer lines	Municipal or regional government

Government Databases

Federal, provincial and local governments[3] maintain a variety of databases on businesses and other activities that require a permit to operate, and on contaminated sites. These range from computerized systems to papers in file drawers. For example, the Ministry of Environment, maintains databases on permitted discharges (WASTE), and on Crown Contaminated Sites and spills through their CCSP database[4]. The information from these databases may help to identify the activity as a potential contaminant source.

The listings from these databases only identify those activities that require a permit to operate. Business licences, field surveys, zoning maps and air photos should be used to identify potential contaminant activities or sources that do not require a permit.

[2] Ministry of Environment

[3] "Local government" includes regional districts and municipalities

[4] A nominal fee is charged for most database searches

TABLE 3.1 SOURCES OF CONTAMINATION

Source activities	Sources and Quantity of Potential Contaminants	Chemical Category
INDUSTRIAL	**MAJOR:** Chemical manufacturing, electronics, petroleum refining and storage, metal treating, food processing, wood and pulp processing, textile manufacturing.	Organic solvents, petroleum, other organics, metals
	MODERATE/SMALL: Gravel pits.	
COMMERCIAL	**MAJOR:** Gas stations, furniture strippers, drum cleaning.	Petroleum, organics
	MODERATE: Dry cleaners, junk yards auto repair and body shops, pest control companies, photographic processing, machine shops, auto part stores, lawn and garden/farm stores, paint stores, hardware stores, medical facilities.	Organic solvents, petroleum, pesticides, metals, nitrates, other organics
	SMALL: Grocery stores, department stores, office buildings, laundromats, food service, shoe repair, barber and beauty shop.	Organics, petroleum
AGRICULTURAL	**MODERATE:** Heavy chemical use agricultural (fruits and vegetables), abandoned wells, manure storage (lagoons, stockpiles).	Nitrates, pesticides pathogens, chloride
	SMALL: Low chemical use agriculture (forage crops).	Nitrates
RESIDENTIAL	**MODERATE:** Urban housing, high density (>5 dwelling units per hectare) using septic systems, trailer parks, abandoned wells, sewer mains.	Nitrates, pesticides, petroleum, other organics, pathogens
	SMALL: Moderate and low density (<5 dwelling units per hectare) using septic systems.	Nitrates, pesticides, petroleum, other organics, pathogens
TRANSPORTATION CORRIDORS	**MAJOR TO SMALL:** Highways, roads, underground pipelines.	Spill events, fuel, road salt

Source: adapted from *Groundwater Supply Source Protection, A Guide for Localities in Upstate New York* (1994). Prepared by the Schenectady County Planning Department in cooperation with the Capital Regional Planning Commission and the New York State Department of the Environment Cooperative.

Other inventory approaches such as interviews, site inspections or a review of monitoring data might be necessary to confirm that documented sources still exist.

Zoning Maps

Local governments create zones (industrial, residential, commercial etc.) for different land use within a community. Zoning maps may help the search for potential contaminants, as you can identify potential sources associated with specific land uses (see Table 3.1). Zoning maps can be used to set priorities for investigating each area, by identifying some parts of the community that will need a more thorough investigation.

Aerial Photographs

Aerial photographs can be useful for surveying large areas to identify sites where follow-up investigations will be required. They can also identify potential contaminant sources on private lands where the owners do not permit access.

Interpretations from aerial photographs should always be followed by an on-site inspection. Certain practices, such as storing pesticides in the well pumphouse and over-fertilizing fields or gardens, can only be identified through ground inspections and interviews with landowners.

Historical Data

It is easier to identify contamination from present-day activities than it is to locate long-forgotten sources such as abandoned wells and old waste disposal sites. However, some of these sources still have the potential to contaminate the water supply. Include past land use practices when preparing the inventory:

- Interview long time residents of the area who can provide valuable historical information. Check this anecdotal evidence, where possible, using old air photos and government records;
- Look at maps and other documentation on past human activity. Old zoning maps, local registries of commercial and industrial activities, and property transfer records, titles and deeds may provide clues;
- Compare historical aerial photographs with more recent air photos. These "before and after" comparisons give an historical perspective of the changes in land use and can reveal the location of past sources or activities.

3.2 Conduct Surveys

Once you have assembled all the available data, decide what additional information is needed and how it will be collected. Surveys are also used to identify non-point sources, unregulated sources and previously unknown sources.

Local government staff such as tax assessors, property assessors or health unit workers who have a good working knowledge of the area can help to focus survey efforts, for example by suggesting critical sites for field surveys.

Survey Methods

Some advantages and disadvantages of the various survey methods are shown in Table 3.2.

Personal Interviews

Personal interviews are a valuable way to find out about sources of potential contamination. This can be a "jumping-off point" for information gathering, as these interviews 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 can direct you to other community members who have valuable information. You may then 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; and
- Phone directories.

Once the mail 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 enough information. A windshield survey requires a vehicle and one or two people, who drive through the area taking notes. A two-person survey is better, so that one 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

TABLE 3.2 ADVANTAGES AND DISADVANTAGES OF DIFFERENT TYPES OF SURVEY

Type of Survey	Advantages	Disadvantages
PERSONAL INTERVIEWS	Obtain useful information and insight not available from any other source Efficient	Potential for response bias
MAIL SURVEY	Low cost to contact a large number of people Low time requirements Promotes public awareness & participation	Usually a low response rate Variable quality of response Potential for bias
PHONE SURVEY	Low cost to contact a large number of people Respondents are a "captive audience" – response rates higher Can be used selectively to fill in the gaps from mail survey Promotes public awareness & participation	May be a significant labour and time requirement (costs may be reduced by using volunteers) Potential for response bias
WINDSHIELD SURVEY	Require less time for survey staff Effective in identifying obvious potential sources covering a large area Effective in screening sites for future investigation Access is not a problem Direct observations	Not easy to conduct in rough or forested terrain, where sources are not visible from road No personal contact
DOOR-TO-DOOR SURVEY	Increased accuracy and uniformity of the data collected Increased likelihood of identifying previously unknown sources More public interaction Direct observations	Recruiting and training workers can be costly and labour intensive Time consuming
FIELD INSPECTIONS	Good for small areas with easy access Most accurate survey method More public interaction Direct observations	Costly and labour intensive in large areas Need to get owner approval

the sources can be seen from the road, but may be less effective in forested or mountainous areas where many sources are not visible from the road.

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 are 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. And if survey staff are 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 firsthand, without relying on landowners to identify and provide information about sources. It is also an opportunity to see actual management practices and confirm potential sources identified from other survey techniques.

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**

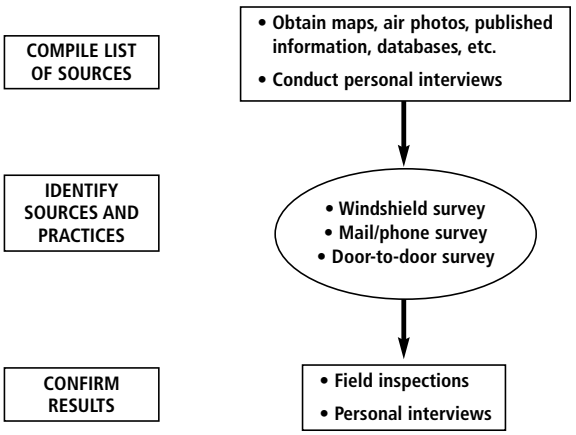
  How many people will you need to conduct the surveys? Who will do the work? If you can't afford to hire labour, look at options such as using students or other volunteers. Who will train the survey staff?

- **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, for example mail, phone surveys or personal interviews in conjunction with historic records, door-to-door surveys or field inspections. Figure 3.2 illustrates the steps involved in conducting a survey.

Figure 3.2 Selecting A Survey Method



Find and Train Survey Staff

Finding skilled labour at low cost can be difficult, but there are many options available:

- Local service organizations or citizens' groups may be willing to volunteer their efforts;
- Senior citizens who have observed the development of their community over a number of years can bring a valuable historical perspective;
- High school students could assist with the inventory as part of a school science project;
- Local government staff or consultants may be able to help with training;
- Retired professionals such as engineers or others with technical backgrounds have the expertise needed to identify sources and conduct the survey, and they bring the added advantage of their own knowledge of the area.

Members of the public will likely ask many questions during the survey. Survey staff should be able to provide accurate information and raise people's awareness about the well protection efforts in the community. Make sure that survey staff have good communication skills and solid understanding of

both the well protection planning process and the survey itself. Someone with experience in conducting surveys should provide training for volunteers.

Survey staff will need detailed maps of the survey area, lists of "hot-spots" (potential sources of contamination for more in-depth examination), and survey forms to be completed. Develop a numbering system so that survey staff can assign each source a unique identification number. (For example: "1" for the gas station with the leaky tank at Fourth and Elm; "2" for the potato field on Lot 4, DL78.)

To avoid problems with access and liability, get permission for access to the study area from the property owners or operators before going on-site. Survey staff should wear nametags identifying their affiliation with the community planning team.

Work with the Media

If you need the public's help in gathering information (e.g. phone, mail, or door-to-door surveys) it is a good idea to make people aware of the survey and its purpose in advance. Work with the media (radio, community television, and newspapers) to inform the public about the survey process, and conduct the survey once people know about it.

Design and Conduct the Survey

Decide how you will record and use the information gathered (see Section 3.3) before designing and conducting surveys, as this will influence the level of detail and types of information to be collected.

Table 3.3 shows the types of information that could be gathered through the survey. The type of information included will vary with the choice of survey method and the level of information required. It is important to record all the different potential contaminant sources at a given site. For example, a service station may have an underground storage tank and an abandoned well, in addition to an on-site septic system – and all are of potential concern.

Develop a form for survey staff to complete, and make sure they understand all the information that it requires. It is essential to "field test" the survey at a few sites, and then re-evaluate whether all the necessary information is being collected.

3.3 Record and Store Information

The inventory will generate a considerable amount of data that needs to be organized and stored properly, for example in some form of database. The database allows the planning team to analyze the data to show relationships and patterns.

There are many ways to record the data, from simple paper records and maps to complex computerized systems. Will you be gathering a large amount of information? Perhaps a computerized database would be better. Are hand-drawn overlay maps sufficient for your needs? This will avoid the expense of a Geographic Information System (GIS) format.

Remember that evaluating the various protection measures (Step Six) will also generate a great deal of data. Select a data management system that can store and process the data collected in both Steps Three and Six.

Land uses in the well protection area should be mapped. Detailed maps allow the planning team to see the number, location, nature and distribution of potential contaminant sources that exist in the well protection area, and their relationship to other information such as the vulnerable and non-vulnerable areas of the aquifer, the flow direction and the time of travel sub-areas.

Check for Data Accuracy

The information should be accurate, or it will not be as useful or defensible. Use Quality Assurance/Quality Control (QA/QC) measures during the survey and while entering data into the database. This could include training for survey staff, random checks during data collection, and doing cross-references when information on a site comes from more than one survey method.

Develop the Database

Databases can be in a manual, computerized or GIS format. The advantages and disadvantages of manual and other database systems are shown in Table 3.4.

TABLE 3.3 SURVEY INFORMATION

Type of Information	Categories	Comments
SITE	Unique identifier (e.g. site 001) Location (UTM coordinates) Street address Legal property description	Also plot or identify on base map
LANDOWNER	Site Name Address Phone number Contact information (name, address, phone) for renters or lease holders	May need to keep confidential
LAND USE	Types of activity (e.g. farm, gas station)	A land use classification system helps standardize land use descriptions[5]
SITE CHARACTERISTICS	Distance and direction to well Location within well protection area (e.g. "within one-year TOT," "aquifer highly vulnerable at this point")	
SOURCES OF POTENTIAL CONTAMINANTS	Description Chemicals (type and quantity), chemical composition Status (active or inactive)	Spatial distribution of chemical use and disposal practices
HISTORY	Any previous discharges	
SPILL RESPONSE EQUIPMENT	Describe existing management practices of contaminant sources List equipment/materials for spills	Written emergency response plan
SURVEY STAFF	Name and phone number Date of visit	
PHOTOGRAPHS	List and attach	
COMMENTS	Concerns, e.g. improper storage of chemicals, improper irrigation practices, and areas that could not be checked	

Manual Systems

Before the age of the computer, most data were managed through manual filing systems. Data sheets, index cards, maps and aerial photographs were stored in file folders and filing cabinets.

In a manual filing system, data records are generally organized according to some specific criteria, such as land use categories or by geographic areas. For a given category of land use activity, it is then easy to find all land parcels that are associated with that category.

A manual inventory system based on papers, files and paper maps may be perfectly adequate for a small well protection area with limited land use activities. Data collected from the surveys can be

[5] Example: Sawicki, J. and G. Runka, 1986. *Land Use Classification in British Columbia.* Manual 8, Ministry of Agriculture and Food and Ministry of Environment. 31pp.

TABLE 3.4 ADVANTAGES AND DISADVANTAGES OF DIFFERENT DATABASE SYSTEMS

Type of Database System	Advantages	Disadvantages
MANUAL SYSTEMS	Adequate for a limited amount of data Inexpensive to set up No special equipment or training	Inflexible Hard to deal with large amounts of files Hard to do complicated data retrievals Information cannot be easily shared by other programs High degree of redundancy depending on how the system is indexed Very limited data analysis and processing capabilities Labour intensive to maintain Difficult to update and backup
COMPUTERIZED DATABASE MANAGEMENT SYSTEMS	Greater flexibility Less restricted data usage Centralized control of data ensures integrity of database Easy to conduct unique database searches Less data redundancy Increased control and data security and accessibility	Costs of hardware and software acquisition and maintenance Additional training of users Risk of losing or corrupting the data due to insufficient backup and recovery procedures Set up requires technical assistance and can be expensive Risk of untrained user affecting the integrity of the database
GEOGRAPHIC INFORMATION SYSTEMS (GIS)	Extremely useful tool Easy to scan areas for potential sources of contamination Useful for managing and organizing information from a variety of sources GIS can be shared with other programs Effective spatial data query and analysis	Very expensive to implement High level of user training essential

entered on data sheets and organized according to land use categories or parcel identification numbers. Index files should be developed so that it is easy to find information, and to reduce duplication. Make sure you have a system to keep the data and files up to date.

Computerized Database Management Systems

Database Management Systems (DBMS) were developed to manage large quantities of data in an orderly manner, and to perform data analysis. Data from many sources can be combined and presented in reports that are concise and understandable. Typical database programs include Access and FoxPro.

Spreadsheets programs such as Excel can also be useful for decision-making, however they are not as good for analyzing data.

Setting up a DBMS can be complicated and expensive, and a skilled database staff person is needed to set up and maintain the system. However, the long-term benefits of using DBMS technologies

frequently outweigh the costs. These systems provide a much better basis for complex data processing, decision making support and integrating information among different agencies.

Geographic Information Systems

A Geographic Information System (GIS) is a computerized method that records data and shows it on a series of map layers. It is a very effective way to capture, store, update, manipulate, analyze and display all forms of spatial information.[6] This could include water supply wells, water distribution lines, soil/vegetation types, vulnerability of the aquifer, and direction of groundwater flow. It can be linked to a database (such as FoxPro or Access) that contains detailed information about each site.

GIS is a powerful analytical tool, but can be complex and expensive to set up. It is a good option for larger purveyors (such as local governments) that have staff trained in GIS. If the planning team is considering this option, you should speak to a GIS specialist. More information about setting up a GIS is provided in Appendix 3.2.

Maintain the Database

All data management systems require periodic maintenance. The changing nature of land use activities means that the database has to be updated regularly, perhaps repeating the inventory every few years. The data must be securely stored to minimize any chances of accidental destruction or gradual degradation over time. Only authorized individuals should be able to change the information in the database.

You will need to ensure that new users are trained to use the database, and to update the skills of current users whenever modifications are made to the system. Make sure there is a system for backup and recovery of data in case there is an error or malfunction.

[6] Spatial data is any data that contains information about their geographic location (e.g. a well with geographic coordinates such as latitude and longitude)

3.4 Analyze the Data and Set Priorities

Examine the data to identify the sites and sources of greatest priority for immediate attention. Don't forget to include underground and non-point sources. Consider the following questions when settings priorities:

1. **How vulnerable is the aquifer?**

   Where the aquifer is protected by clay or till layers, surface water and any contaminants are less likely to reach the groundwater supply. Such areas might be given a lower priority for protection measures.

   Where the aquifer is unconfined, it is more vulnerable to contamination by pollutants and should be a higher priority for protection. Standard methods are available to determine the vulnerability of different parts of the aquifer (see Step Two).

2. **How far is the source of potential contamination from the well?**

   Sources closest to the well (e.g. within the one-year time of travel area) should be the highest priority. Where time of travel is not known, distance to well can be used to establish priority (everything else being equal). (See Step Two.)

3. **How great is the potential for contamination?**

   Certain types of operations usually pose a threat to the groundwater. For example, activities that use hazardous materials, sites that are known to be polluting, or sites where poor management practices are used might be considered as having a greater potential to contaminate. A leaky underground storage tank in a gas station would be given greater priority than a gas station with a new double-lined tank.

The consequences of contamination should also be considered: the nature of the contaminant, the volume of contaminant, toxicity, and the risk.

By the end of this process, the planning team will have a list of potential contaminant sources for which management strategies will be developed (Step Four).

This is one possible method for a priority assessment. More complicated methodologies may be required, in which case you may wish to hire a consultant.

3.5 Update Information

Information gathered from the inventory needs to be updated regularly – every six months to two years. The timing depends on how fast the community is growing and changing, and how much water use is increasing.

The inventory should be updated any time there are changes in the community. For example when a new business opens in a well protection area, this information it could be immediately entered into the inventory and the owner provided with information on what it means to be in a well protection area.

CHECKLIST FOR STEP THREE

The following is a basic checklist for action items to be completed during Step Three of the well protection planning process:

ACTION ITEM	COMMENTS	COMPLETED
Decide who is responsible for these activities	Enlist technical and volunteer assistance if required.	☐
Compile available information	Check government records, talk to knowledgeable individuals.	☐
Decide what other information needs to be gathered	Determine appropriate method(s) for collecting this information.	☐
Conduct Surveys	Train staff, think how you will compile and use the information collected.	☐
Enter data into a database	Check for data accuracy.	☐
Review the data and determine the priority	Set priorities for each potential contaminant source.	☐
Update information	Determine how often information will be reviewed.	☐

Appendix 3.1 Potential Sources of Groundwater Contamination[7]

This list of potential contaminant sources is meant as a reference. The actual list of potential contaminants in the capture zone will be very specific to your area and the activities in the area.

This list is not exhaustive – there may be sources not included. As well, not all sources will be present in your community.

NATURALLY OCCURRING SOURCES	
Source	**Health, Environmental, or Aesthetic contaminant**
Rocks and soils	Aesthetic Contaminants: iron, iron bacteria, manganese, calcium and magnesium (hardness) Health and Environmental Contaminants: arsenic; asbestos; metals; chlorides; fluorides; sulfates; sulfate-reducing bacteria and other microorganisms
Contaminated Water	Excessive sodium; bacteria; viruses; low pH (acidic) water
Decaying organic matter	Bacteria, odour, colour, taste
Geological radioactivity	Uranium deposits Radon gas
Natural hydrogeological events and formations	Salt water or other poor quality water

AGRICULTURAL SOURCES	
Source	**Health, Environmental, or Aesthetic contaminant**
Animal feedlots and burial areas Manure treatment (composting) Manure spreading areas Manure storage areas and lagoons Animal waste disposal areas	Viruses, bacteria (coliform and non-coliform) and other pathogens Coliform bacteria can indicate the possible presence of pathogenic (disease-causing) microorganisms that may be transmitted in human or animal feces. Diseases such as typhoid fever, hepatitis, diarrhea, and dysentery can result from fecal contamination of water supplies Nitrates; phosphates; chloride; colour, taste and odour Chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests on livestock
Crop areas and irrigation sites	Pesticides including herbicides, insecticides, rodenticides, fungicides, and avicides. Many pesticides are highly toxic and quite mobile in the subsurface Fertilizers: The USEPA National Pesticides Survey found that the use of fertilizers correlates to nitrate contamination of groundwater supplies Pesticide and fertilizer residues Gasoline and motor oils from chemical applicators
Chemical storage areas and containers	Pesticides Fertilizers Chemical residues (residuals) Left-over product containers
Farm machinery areas	Automotive wastes: 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	Pesticide Fertilizers Bacteria

[7] This table is adapted from: U.S. Environmental Protection Agency, 1993. *Wellhead Protection: A Guide for Small Communities.* Office of Research and Development, US Environmental Protection Agency, Washington, DC. 144pp; and *Natural Resources Facts: Household Hazardous Wastes,* Fact Sheet No. 88-3, Department of Natural Science, University of Rhode Island, August 1988.

MUNICIPAL SOURCES

Source	Health, Environmental, or Aesthetic contaminant
Schools and government offices and grounds	Solvents, acids; alkalis, residues from cleaning products that may contain chemicals such as xylenes, glycol esters, isopropanol, 1,1,1 trichloroethane, sulfonates, chlorinated phenols and cresols Machinery/vehicle servicing wastes; gasoline and heating oil from storage tanks; waste oils General building wastes Pesticides, herbicides and fertilizers
Parklands, public and residential areas infested with mosquitoes, gypsy moths, ticks, ants, or other pests	Fertilizers Pesticides, herbicides, insecticides
Highways, road maintenance depots, and deicing operations	Automotive waste: gasoline; antifreeze; automatic transmission fluid; battery acid; engine and radiator flushes; engine and metal degreasers; hydraulic (brake) fluid; and motor oils Herbicides in highway rights-of-way Road salt (sodium and calcium chloride) and anti-caking additives (ferric ferrocyanide, sodium ferrocyanide) Anti-corrosives (phosphate and chromate)
Municipal sewage treatment plants	Municipal wastewater sludge: may contain organic matter; nitrates; inorganic salts; heavy metals; coliform and non-coliform bacteria; and viruses Wastewater treatment chemicals: may include calcium oxide; alum; activated alum, carbon, and silica; polymers; ion exchange resins; sodium hydroxide; chlorine; ozone; and corrosion inhibitors
Storage, treatment, and disposal of waste from municipal treatment plants	Sewage wastewater; lagoons, and other surface impoundments Nitrates; other liquid wastes; microbiological contaminants
Land areas applied with wastewater	Organic matter; nitrates; inorganic salts; heavy metals; coliform and non-coliform or wastewater byproducts, bacteria; viruses; sludge; non-hazardous wastes
Storm water drains and basins	Urban runoff; gasoline; oil; other petroleum products; road salt; microbiological contaminants
Combined sewer overflows (municipal sewers and storm water drains)	Municipal wastewater sludge and treatment chemicals Urban runoff; gasoline; oil; other petroleum products; road salt Microbiological contaminants
Recycling/reduction facilities	Residential and commercial solid waste residues
Municipal waste landfills	Leachate; organic and inorganic chemical contaminants; wastes from households and businesses; nitrates; oils; metals Biomedical and related waste. For example, in areas where there are hospitals with nuclear medicine departments, soiled diapers from patients undergoing nuclear medicine procedures may be landfilled
Open dumping and burning sites, closed dumps	Organic and inorganic chemicals; metals; oils; wastes from households and businesses
Municipal incinerators	Heavy metals; hydrocarbons; formaldehyde; methane; ethane; ethylene; acetylene; sulfur and nitrogen compounds
Water supply wells, monitoring wells, older wells, domestic and livestock wells, unsealed and abandoned wells, and test hole wells	Surface runoff; effluents from barnyards, feedlots, septic tanks or cesspools; gasoline; used motor oil; road salt; fertilizers and pesticides
Sumps and dry wells	Storm water runoff; spilled liquids; used oil; antifreeze; gasoline; other petroleum products; road salt; pesticides; and a wide variety of other substances
Drainage wells	Pesticides; bacteria
Well pumping that causes inter aquifer leakage, induced filtration, landward migration of sea water in coastal area; etc	Saltwater; excessively mineralized water
Artificial groundwater recharge	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
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; 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 boast waste disposal areas; wood preservative and treatment chemicals; paints; waxes; varnishes; automotive wastes
Bowling alleys	Epoxy; urethane-based floor finish
Car dealerships (especially those with service departments)	Automotive wastes, waste oils; solvents; miscellaneous wastes
Car washes	Soaps; detergents; waxes; miscellaneous chemicals
Campgrounds	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	Glues and other adhesives; fuel from storage tanks if forklifts are used
Cemeteries	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.)	Solvents; asbestos; paints; glues and other adhesives; waste tars Insulation; lacquers; sealants; epoxy waste; miscellaneous chemical wastes
Country clubs	Fertilizers; herbicides; pesticides; swimming pool chemicals; automotive wastes
Dry cleaners	Solvents (perchloroethylene, petroleum solvents, Freon) Spotting chemicals (trichloroethane, methylchloroform, ammonia, peroxides, hydrochloric acid, rust removers, amyl acetate)
Funeral services and crematories	Formaldehyde; wetting agents; fumigants; solvents
Furniture repair and finishing shops	Paints; solvents; degreasing and solvent recovery sludges
Gasoline services stations	Oils; solvents; gasoline; miscellaneous wastes
Golf courses	Fertilizers; herbicides; pesticides for controlling mosquitoes, ticks, ants, and other pests; shop wastes
Hardware/lumber/parts stores	Hazardous chemical products in inventories; heating oil and fork lift fuel from storage tanks; wood-staining and treating products such as creosote
Heating oil companies	Heating oil; wastes from truck maintenance areas, underground storage tanks
Horticultural practices, garden nurseries, florists	Herbicides, insecticides, fungicides, and other pesticides
Jewellery/metal plating shops	Sodium and hydrogen cyanide; metallic salts
Laundromats	Detergents; bleaches; fabric dyes
Medical institutions	X-ray developers and fixers; infectious wastes; radiological wastes; biological wastes; disinfectants; asbestos; beryllium; dental acids; miscellaneous chemicals
Office buildings and office complexes	Building wastes; lawn and garden maintenance chemicals; gasoline; motor oil

COMMERCIAL SOURCES continued	
Source	**Health, Environmental, or Aesthetic contaminant**
Paint stores	Paints; paint thinners; lacquers; varnishes; other wood treatments
Pharmacies	Spilled and returned products
Photography shops, photo processing laboratories	Biosludges; silver sludges; cyanides; miscellaneous sludges
Print shops	Solvents; inks; dyes; oils; photographic chemicals
Railroad tracks and yards	Diesel fuel; herbicides for rights-of-way; creosote for preserving wood ties
Research laboratories	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 and junk yards	Any wastes from businesses and households; oils
Sports and hobby shops	Gunpowder and ammunition; rocket engine fuel; model aeroplane glue
Storage tanks (above-ground and underground)	Heating oil; diesel fuel; gasoline; other petroleum products; other commercially; used chemicals
Transportation services for passenger transit (local and interurban)	Waste oil; solvents; gasoline and diesel fuel from vehicles and storage tanks; fuel oil; other automotive wastes
Veterinary services	Solvents; infectious materials; vaccines; drugs; disinfectants (quaternary ammonia, hexachlorophene, peroxides, chlornexade, bleach); x-ray developers and fixers
X-Ray clinics and devices	X-ray developers and fixers may contain reclaimable silver, glutaldehyde, hydroquinone, phenedone, potassium bromide, sodium sulfite, sodium carbonate, thiosulfates and potassium alum

INDUSTRIAL SOURCES	
Source	**Health, Environmental, or Aesthetic contaminant**
Material stockpiles (coal, metallic ores, phosphates, gypsum)	Acid drainage; other hazardous and non-hazardous wastes
Waste tailing ponds (commonly for the disposal of mining wastes)	Acids; metals; dissolved solids; radioactive ores; other hazardous and non-hazardous wastes
Transport and transfer stations (Trucking terminals and rail yards	Fuel tanks; repair shop wastes, other hazardous and non-hazardous wastes
Above-ground and underground storage tanks and containers	Heating oil; diesel and gasoline fuel; other petroleum products; hazardous and non-hazardous materials and wastes
Storage, treatment, and disposal ponds, lagoons, and other surface impoundments	Hazardous and non-hazardous liquid wastes; septage; sludge
Chemical landfills	Leachate; hazardous and non-hazardous wastes; nitrates
Radioactive waste disposal materials	Radioactive wastes from medical facilities Radionuclides (uranium, plutonium)
Unattended wet and dry excavation sites (unregulated dumps)	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, and heat recovery); test hole wells; monitoring and excavation wells	Metals; acids; minerals; sulfides; other hazardous and non-hazardous chemicals
Dry wells	Saline water from wells pumped to keep them dry
Injection wells	Highly toxic wastes; hazardous and non-hazardous industrial wastes; oil-field brines
Well drilling operations	Brines associated with oil and gas operations

INDUSTRIAL SOURCES: PRESENTLY OPERATED OR TORN-DOWN FACILITIES

Source	Health, Environmental, or Aesthetic contaminant
Asphalt plants	Petroleum derivatives
Communications equipment	Nitric, hydrochloric, and sulfuric acid wastes; heavy metal sludges
Copper Manufacturers	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
Electric and electronic equipment	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	Boric, hydrochloric, hydrofluoric, and sulfuric acids; sodium and potassium hydroxide; chromic acid; sodium and hydrogen cyanide; metallic salts
Foundries and metal fabricators	Paint wastes; acids; heavy metals; metal sludges; plating wastes; oils; solvents; explosive wastes
Furniture and fixtures manufacturers	Paints; solvents; degreasing sludges; solvent recovery sludges
Machine and metal working shops	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	Mine spoils or tailings that often contain metals; acids; highly corrosive mineralized waters; metal sulfides
Unsealed abandoned mines used as waste pits	Metals; acids; minerals; sulfides; other hazardous and non-hazardous wastes
Paper mills	Metals; acids; minerals; sulfides; other hazardous and non-hazardous chemicals; organic sludges; sodium hydroxide; chlorine; hypochlorite; chlorine dioxide; hydrogen peroxide
Petroleum production and storage companies, secondary recovery of petroleum	Hydrocarbons; oil-field brines (highly mineralized salt solutions)
Industrial pipelines	Corrosive fluids; hydrocarbons; other hazardous and non-hazardous materials and wastes
Photo processing laboratories	Cyanides; biosludges; silver sludges; miscellaneous sludges
Plastic materials and synthetics producers	Solvents; oils; miscellaneous organics and inorganics (phenols, resins); paint wastes; cyanides; acids; alkalis; wastewater treatment sludges; cellulose esters; surfactant; glycols; phenols; formaldehyde; peroxides; etc.
Primary metal industries (blast furnaces, steel works, and rolling mills)	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	Solvents; inks; dyes; oils; miscellaneous organics; photographic chemicals
Public utilities (phone, electric power, gas)	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	Treated wood residue (copper quinolate, mercury, sodium azide); tanner gas; paint sludges; solvents; creosote; coating and gluing wastes
Stone, clay, and glass manufacturers	Solvents; oils and grease; alkalis; acetic wastes; asbestos; heavy metal sludges; phenolic solids or sludges; metal finishing sludge
Welders	Oxygen, acetylene, ozone
Wood preserving facilities	Wood preservatives; creosote

RESIDENTIAL SOURCES	
Source	**Health, Environmental, or Aesthetic contaminant**
Asphalt and roofing tar	Hydrocarbons
Bug and tar removers	Xylene, petroleum distillates
Cesspool cleansers	Tetrachloroethylene, dichlorobenzene, methylene chloride
Cleaners (household, oven)	xylenes, glycol ethers, isopropanol
Disinfectants	disinfectants (quaternary ammonia, hexachlorophene, peroxides, chlornexade, bleach); cresol, xylenols
Drain cleaners	1,1,1-trichloroethane, caustic soda
Heating oil, diesel fuel, kerosene	Hydrocarbons
Jewellery cleaners	Sodium cyanide
Laundry soil and stain removers, spot removers	Hydrocarbons, trichloroethylene, 1,1,1-trichloroethane
Lye or caustic soda	Sodium hydroxide
Metal polishes	Petroleum distillates, isopropanol, petroleum naphtha
Pesticides (household - all types)	Common household pesticides for controlling pests such as ants, termites, bees, wasps, flies, cockroaches, silverfish, mites, ticks, fleas, worms, rates, and mice can contain active ingredients including naphthalene, phosphorus, xylene, chloroform, heavy metals, chlorinated hydrocarbons, arsenic, strychnine, kerosene, nitrosamines, and dioxins
Photochemicals (photofinishing chemicals)	Phenols, sodium sulfite, cyanide, silver halide, potassium bromide
Printing ink	Heavy metals, phenol-formaldehyde
Refrigerants	Trichlorofluoroethane
Rustproofers	Phenols, heavy metals
Septic systems, cesspools, and sewer lines; cleaners	Septage; coliform and non-coliform bacteria; viruses; nitrates; heavy metals; synthetic detergents; cooking and motor oils; bleach; pesticides; paints; paint thinner; photographic chemicals; swimming pool chemicals; septic tank/cesspool cleaner chemicals elevated levels of chloride, sulfate, calcium, magnesium, potassium, and phosphate Septic tank/cesspool cleaners include synthetic organic chemicals such as 1,1,1 trichloroethane, tetrachloroethylene, carbon tetrachloride, and methylene chloride
Solvents	Acetone, benzene, xylene
Swimming pool disinfection and maintenance chemicals	Free and combined chlorine; bromine; iodine Copper-based, and quaternary algicides Cyanuric acid Calcium or sodium hypochlorite Muriatic acid Sodium carbonate
Toilet cleaners	Xylene, sulfonates, chlorinated phenols
Underground storage tanks	Home heating oil

MECHANICAL REPAIR AND OTHER MAINTENANCE PRODUCTS

Source	Health, Environmental, or Aesthetic contaminant
Antifreeze	Methanol, ethylene glycol
Antifreeze (gasoline or coolants systems)	Methanol, ethylene glycol
Automatic transmission fluid	Petroleum distillates, xylene
Battery acid (electrolyte)	Sulfuric acid, bromide
Car wash detergents	Alkyl benzene sulfonates
Car waxes and polishes	Petroleum distillates, hydrocarbons
Degreasers for driveways and garages	Petroleum solvents, alcohols, glycol ether
Degreasers for engines and metal	Chlorinated hydrocarbons, toluene, phenols, dichloroperchloroethylene
Engine and radiator flushes	Petroleum solvents, ketones, butanol, glycol ether
Gasoline and jet fuel	Hydrocarbons
Grease, lubricants	Hydrocarbons
Hydraulic fluid (brake fluid)	Hydrocarbons, fluorocarbons
Motor oils and waste oils	Hydrocarbons, heavy metals

LAWN AND GARDENS

Source	Health, Environmental, or Aesthetic contaminant
Fertilizers	Nitrogen
Herbicides and other pesticides	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	Pentachlorophenols, creosote, copper, arsenic, metam sodium

WALL, FURNITURE AND FLOOR TREATMENT

Source	Health, Environmental, or Aesthetic contaminant
Floor and furniture strippers	Xylene
Paint and lacquer thinner	Acetone, benzene, toluene, butyl acetate, methyl ketones
Paint and varnish removers, deglossers	Methylene chloride, toluene, acetone, methanol, glycol ethers, methyl ethyl ether
Paint brush cleaners	Hydrocarbons, toluene, acetone, methanol, glycol ethers, methyl ethyl ketones
Paints, varnishes, stains, dyes	Heavy metals, toluene

Appendix 3.2 Setting up a GIS Database

A Geographic Information System (GIS) is capable of performing input, storage, retrieval, analysis, output, and display of geographically or spatially indexed data. An operational GIS allows users to encode, analyze and display data layers from a variety of sources, such as field notes, land use and zoning maps, topographic maps, aerial photographs and satellite images.

The first step in implementing a GIS project is to obtain digital spatial data of the area(s) of concern. It is important to evaluate this data based on the following criteria:

- scale
- accuracy
- level of detail
- date produced
- consistency with other data sets.

Once selected, spatial data can be encoded based on a commonly used coordinate system such as geographic coordinates (latitude/longitude) or UTM[8] coordinates. However, a large volume of data without proper geo-referencing[9] is available in paper format, and this data will need to be geo-referenced. Information on contaminant sources may also vary greatly in quality, depending on whether the information comes from anecdotal sources or has been field-checked. Once a GIS database is completed, data verification must be carried out to determine if the data are accurate, true and free of data entry errors.

The establishment of a GIS is a major undertaking. For most GIS applications, the gathering of the data is often the most resource intensive part of the exercise. A high level of staff training is required to make the GIS functional, but the benefits can outweigh the costs because it provides a visual representation of complex data sets. Professional assistance will be needed to set up a GIS system.

[8] UTM: Universal Transverse Mercator

[9] In other words, the location has not been linked to its geographic coordinates

STEP THREE: Documenting Potential Sources of Contaminants

Ian Rutherford (Valley District Engineer), Anne Jones (Drinking Water Officer), and Devon Alexander (Pumphandle Valley Conservation Society) approached the Valley District High School to help with the contaminant survey.

Gather Available Information

Students and instructors from the Valley District High School agreed to conduct a contaminant inventory as a year-long science project. Cadastral maps (1:2,000) for the well protection area were obtained from the Regional District and given to the students.

The students' first task was to gather information on potential contaminant sources. They obtained air photos and soil maps of the area from Maps BC, and zoning maps from the Regional District. They also called staff from the Ministry of Environment, and Pumphandle Health Authority to determine current and past activities or facilities that had been given permits. Anne Jones identified all the areas with septic systems in the well protection area and helped the students to map them out. Ministry of Environment staff searched their databases to check for permitted discharges, the existence of contaminated sites and reported spills in the protection area. Funding for the search was provided by the community planning team.

Conduct Surveys

The students chose to conduct different types of surveys for different source activities. The land use on agricultural lands was mapped from a windshield survey (with the teacher driving). The students then contacted and interviewed the farmers. They found that Simon Lee, the farmer who owned and maintained the hay (A-4) and corn (A-5) fields (see Figure CS 3.1), did not use fertilizer on his hay fields but did use manure, inorganic fertilizer and a small amount of atrazine (pesticide) on his cornfields. Simon is a member of the Pumphandle team and has already implemented Best Management Practices on his farm. Interviews and field visits to a neighbouring farmer revealed that there is an abandoned well in a hay field (A-3) next to the poultry barn. This abandoned well is a concern because it provides a potential route for contaminants to enter the aquifer.

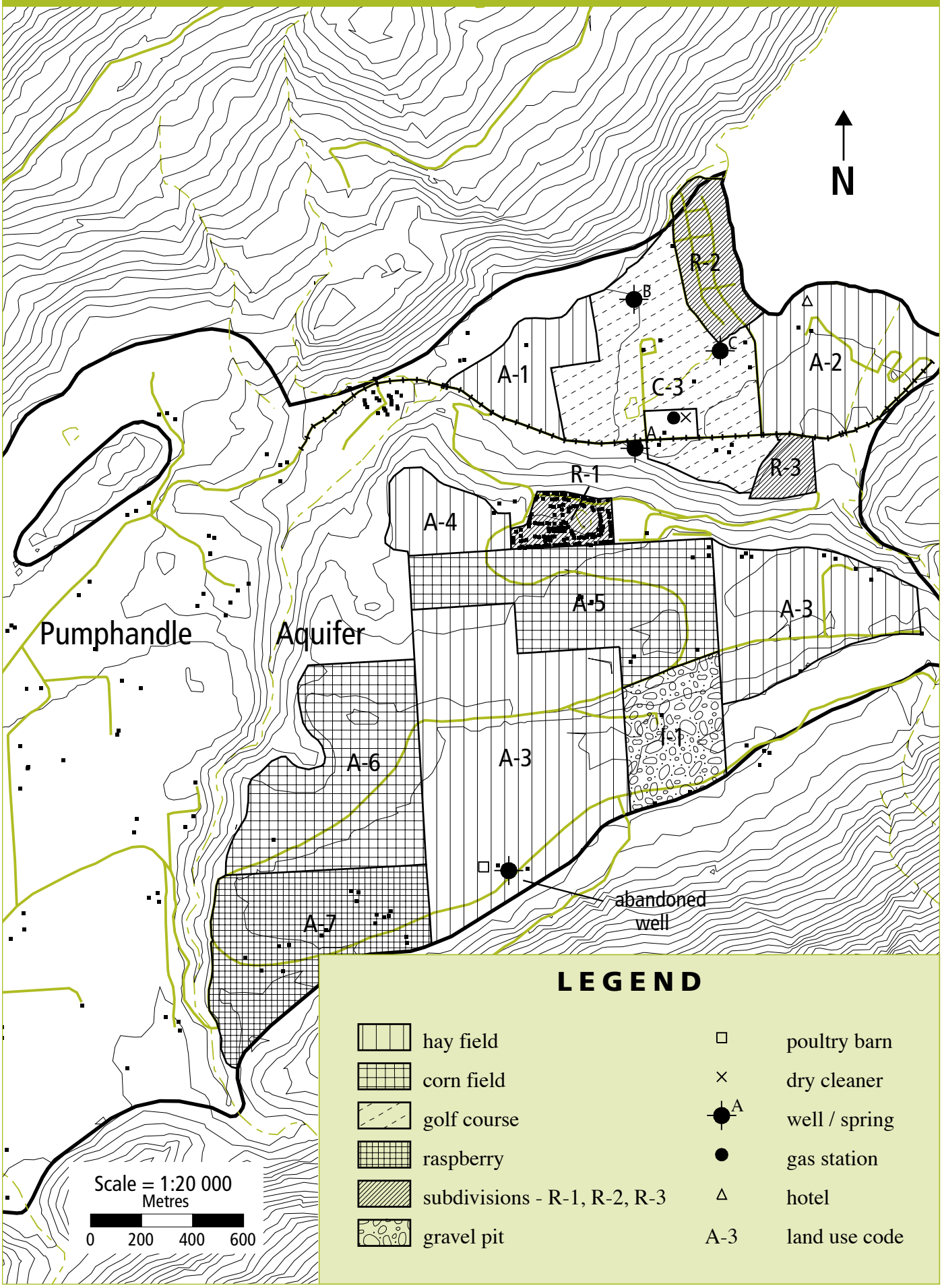
At the subdivisions, (R-1, 2, and 3), the students conducted door-to-door surveys to determine residents' household waste and gardening practices. Results of the surveys indicate that the use of fertilizers and pesticides is relatively high. Major household chemicals are paints and solvents stored in garages and sheds. Some residents did not know about the Regional District recycling programs and where or how they can properly store and dispose of household hazardous wastes.

A site inspection of the gas station yielded information on existing management practices and an inventory of on-site potential contaminants. The gas station has a tank that is 20 years old, which has not been tested for leaks for over ten years. A site inspection of the golf course (C-3) revealed that substantial amounts of both pesticides and inorganic fertilizers are applied to the greens and fairways from April to November. A site visit to the gravel pit (I-1) indicated that there is no gravel processing on site and the main activity is hauling gravel away.

Record Information

All the potential sources were mapped on a 1:20,000 TRIM map overlay (Figure CS 3.1). Information on the potential contaminant sources was entered onto a spreadsheet. The potential contaminant sources identified by the students are shown in Table CS 3.1. Once the survey was completed, the community planning team verified the results through field inspections of specified sites.

FIGURE CS 3.1 INVENTORY OF CONTAMINANT SOURCES



Set Priorities

The Pumphandle team met to establish priorities for the potential contaminant sources. They suggested:

1. **The highest priority sources include the golf course (C-3), gas station (C-1), dry cleaner (C-4), subdivision (R-1 and R-2), a corn field (A-5), hayfields (A-1 and A-4) and the main road (T-1).**

   These sites are all within the one-year time of travel zone for at least one of the wells, or are close to one of the wells. All have multiple sources of contamination such as septic fields, pesticide and fertilizer applications, solvents and gasoline storage or where the consequence of contamination would be severe.

2. **The lower priority sources include the other corn/hay fields (A-2, A-3, A-6) and gravel pit (I-1), hotel (C-2), poultry barn (A-3) and abandoned well (A-3).**

The corn/hay fields and gravel pit were given a lower priority since they are located further from the well sources. The team could consider dealing with these sites earlier in the process by letting the owners know about Best Management Practices. The abandoned well and poultry barn are located beyond the one-year time of travel distance from the community wells.

Update Information

The planning team agreed to review the land uses and practices and update the database and the land use map annually. Data from the contaminant survey were initially entered and stored in a spreadsheet in MS-Excel. The data were eventually uploaded to the Valley Regional District geographic information system (GIS).

TABLE CS3.1 SOURCE ACTIVITIES AND POTENTIAL CONTAMINANTS

SOURCE ACTIVITY (AREA IN HA)	OWNER	<1-YR TIME OF TRAVEL	1-5 YR TIME OF TRAVEL	5-10 YR TIME OF TRAVEL	IN CAPTURE ZONE BUT NO TIME OF TRAVEL SPECIFIED	JUST OUTSIDE CAPTURE ZONE
1st Priority A-1 hay field (15.4)	Ed Kotischyn	Blackwater Well				
2nd Priority A-2 hay field (34.1)	Janis Lobey		Charlie's Well			
2nd Priority A-3 hay field (114.4)	Jim Summer		Blackwater Well		Aiken's Well	
2nd Priority A-3 manure storage at poultry farm	Jim Summer		Blackwater Well			
2nd Priority A-3 abandoned well	Jim Summer		Blackwater Well			
1st Priority A-4 hay field (12.3)	Simon Lee	Blackwater Well				
1st Priority A-5 corn field (44.3)	Simon Lee		Blackwater Well		Aiken's Well	
2nd Priority A-6 corn field (46.7)	Manjit Dhaliwal					Blackwater Well

FOR PUMPHANDLE WELLS

POTENTIAL CONTAMINANTS	LAND USE PRACTICE	STORAGE OF CHEMICALS	OTHER OBSERVATIONS
NO_3 from fertilizers	Grows hay for feed; broadcasts fertilizers (15-15-10) three times a year from spring to fall	Fertilizers stored on pallets on cement floor in shed; shed is 30 m from pumphandle Creek	Septic system
NO_3 from fertilizers NO_3 from former corn field?	Grows hay for grazing; broadcasts fertilizers (15-15-10) once a year from spring to fall (60 Kg/ha)	Fertilizers stored on pallets on cement floor in shed; private well is 30 m uphill (south) of shed	Septic system
NO_3 from mixing fertilizer chemicals	Grows hay for feed; broadcasts fertilizers (15-15-10) three times a year from spring to fall (55-80 Kg/ha), also uses poultry manure	Fertilizers stored on pallets on cement floor in shed; well is 10 m from shed	Septic system
NO_3 from manure leachate	15,000 leghorns; follows Code of Practice, cleans out poultry barn every spring, uses some of the manure for hayfield, sells rest to other farmers in the area	Manure stockpiled in spring but covered with tarp	
A potential pathway for contaminants dumped down the well	Well is not used, the wellhead is covered with a 5-gal pail	N/A	
NO_3 from fertilizers	Grows hay for grazing; uses poultry manure once a year (2 truckloads/ha or 50 Kg N/ha)		
Pesticides, NO_3 from fertilizers	Grows Terrific and Supersweet Jubilee variety of corn; uses poultry manure from A-3 and elsewhere (1 truckload/ha or 25 Kg N/ha) and inorganic fertilizer (15-20-25), applied in spring before and after seeding (10 Kg N/ha); uses atrazine 500 for weed control (3.5 L/ha); fertilizer application not based soil testing	Fertilizers and pesticides are stored in the shed behind the house; fertilizers on pallets and pesticides in cabinets; the private well is located 200 m to the northeast	Septic System
Pesticides, NO_3 from fertilizers	Grows Supersweet Jubilee variety of corn; uses poultry manure from A-3 and elsewhere (1 truckload/ha) and inorganic fertilizer (15-20-25), applied in spring before and after seeding (20 kg N/ha); uses atrazine 500 for weed control (3.5 to 4.5 L/ha); fertilizer application not based on soil testing	Fertilizers and pesticides are stored in the shed behind the house; fertilizers on pallets on concrete floor and pesticides on shelves; the privates well are located 200 and 350 m to the northeast	Septic system

TABLE CS3.1 SOURCE ACTIVITIES AND POTENTIAL CONTAMINANTS

SOURCE ACTIVITY (AREA IN HA)	OWNER	<1-YR TIME OF TRAVEL	1-5 YR TIME OF TRAVEL	5-10 YR TIME OF TRAVEL	IN CAPTURE ZONE BUT NO TIME OF TRAVEL SPECIFIED	JUST OUTSIDE CAPTURE ZONE
2nd Priority A-7 raspberry farm (40.7)	Manjit Dhaliwal					Blackwater Well
1st Priority C-1 gas station	Fred Kobeck			Charlie's Well	Aiken's Well	
2nd Priority C-2-hotel	Tim & Judy Sonoff					Charlie's Well
1st Priority C-3 golf course (46.4)	Jack Sonoff	Blackwater Well and Charlie's Well			Aiken's Well	
1st Priority C-4 dry cleaner	Linda and Andrew Winters			Charlie's Well	Aiken's Well	
2nd Priority I-1-gravel pit (19.3)	Joe Mielo				Aiken's Well	
1st Priority R-1 subdivision (7.2)	Jenny Lowden strata president				Aiken's Well	
1st Priority R-2 subdivision and campground (13.5)	Jocelyne Dufour campground owner and operator	Charlie's Well				

POTENTIAL CONTAMINANTS	LAND USE PRACTICE	STORAGE OF CHEMICALS	OTHER OBSERVATIONS
Pesticides, NO_3 from fertilizers	Grows Chilliwack variety of raspberry; uses poultry manure as a soil conditioner/fertilizer (1 truckload/ha) and inorganic fertilizers (10-16-18), applied in the spring (30 Kg N/ha); uses minor amounts of simazine and diazinon for weed and pest control (amounts not known); fertilizer application not based on soil testing	Fertilizers and pesticides are stored in the shed behind the house; fertilizers on pallets and pesticides on shelves; the private well is located 100 m to the north	Septic system
Gasoline, pathogens & NO_3 from septic system, oils, chemicals	The tank is 20 years old and was tested for leaks in 1987 (none were found at the time); oils and solvents were stored in 45 gallon drums and taken to the regional landfill every week for disposal	Motor oil displayed in cashier area that is indoors and contained	Septic system is 35 m from Aiken's well
Pathogens & NO_3 from septic system	Uses cleaners and some solvents; uses garden fertilizers and lime for the lawn and Round-Up on the flower beds for weed control	Cleaners and solvents are stored in the janitorial room; wash water with cleaners are poured down the drains	Septic system is 40 m from Pumphandle Lake
Pesticides, NO_3 from fertilizers, pathogens & NO_3 from septic system	Uses fertilizers (20-20-10) and pesticides; light application of slow release fertilizer in late fall (amounts not reported); application of rapid release fertilizer in spring; application based on soil testing	Fertilizers and pesticides stored in physical plant shed, shed has a concrete floor; the shed is located 100 m south of Blackwater well and 150 m west of Charlie's well	Septic system
Solvents	Uses dry cleaning chemicals	Chemicals stored in locked cabinet	Septic system
None	Extract gravel and truck off-site; no processing	Motor oil stored in office	Septic system
Pesticides, NO_3 from fertilizers, pathogens & NO_3 from septic system, degreasers	Fertilizers and pesticides (commercial products such as Round-Up) used in various amounts; amounts unknown and undocumented	Some latex paints and motor oil stored in garden shed, along with the fertilizers and pesticides	Septic system density is high (28/ha)
Pesticides, NO_3 from fertilizers, pathogens & NO_3 from septic system, degreasers	Fertilizers and pesticides (commercial products such as Round-Up) used in various amounts; amounts unknown and undocumented	Latex and oil-based paints, thinners and motor oil stored in residential garages, along with the fertilizers and pesticides;	Septic system density is moderate (2-3/ha)

TABLE CS3.1 SOURCE ACTIVITIES AND POTENTIAL CONTAMINANTS

SOURCE ACTIVITY (AREA IN HA)	OWNER	<1-YR TIME OF TRAVEL	1-5 YR TIME OF TRAVEL	5-10 YR TIME OF TRAVEL	IN CAPTURE ZONE BUT NO TIME OF TRAVEL SPECIFIED	JUST OUTSIDE CAPTURE ZONE	
2nd Priority R-3 subdivision (4.9)	Eric Kowski strata president					Charlie's Well	
1st Priority T-1 main road	Valley Regional District	Blackwater Well		Charlie's Well	Aiken's Well		

	POTENTIAL CONTAMINANTS	LAND USE PRACTICE	STORAGE OF CHEMICALS	OTHER OBSERVATIONS
	Pesticides, NO_3 from fertilizers, pathogens & NO_3 from septic system, degreasers	Fertilizers and pesticides (commercial products such as Round-Up) used in various amounts; amounts unknown and undocumented	Some latex paints and motor oil stored in garden shed, along with the fertilizers and pesticides	Septic system density is moderate (3/ha)
	De-icing chemicals	Uses de-icing chemicals during freezing conditions (up to 20 times a year between Nov-Feb)	Chemicals stored in works yard 4 Km out of town	

NOTES