

# Step Six

**MONITOR RESULTS AND EVALUATE THE PLAN**

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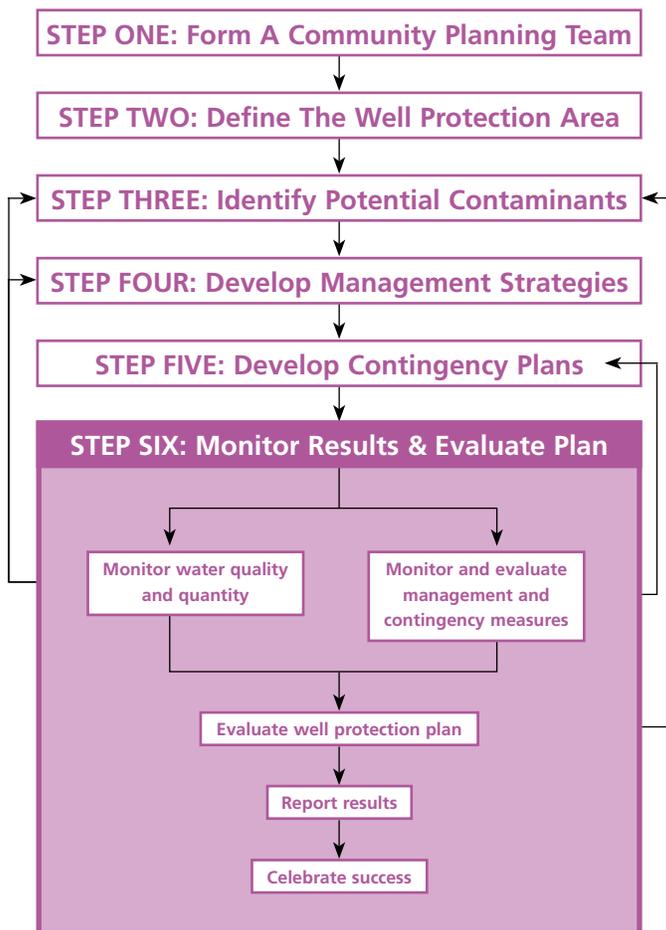
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Figure 6.1



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 Six: Monitor Results and Evaluate the Plan

The sixth step is to make sure that the well protection plan is working. By setting up a system to monitor water quality, the team will be alerted if there are contaminants in the groundwater supply, and will know if the groundwater quality is improving. It is also important to evaluate the well protection plan itself. Are you meeting your goals and objectives? Have all the proposed action items been completed? If there was a contamination event, did your contingency plan work? It may be necessary to adjust the plan to cope with new land-use activities.

The results of the monitoring and evaluation should be made available to members of the community so that they can see the plan is working, and can make comments on its progress.

Figure 6.1 shows the stages of Step Six.

# Monitor Results and Evaluate the Plan

## OBJECTIVES

- To monitor and evaluate water quality and quantity
- To evaluate the protection and contingency activities
- To report the results of the monitoring and evaluation
- To evaluate and update on the well protection plan

It is important to monitor the various protection activities, compare the results with the goals set out in the plan, and to evaluate how well the goals were met, so that the planning team can assess the success or failure of these efforts.

### 6.1 Monitor Water Quality and Quantity

You will need a system for monitoring water quality in the well protection area and in the community. The results will tell you whether you are meeting your main objective of safeguarding the community water supply, and will help you to detect any contamination. However, if water quality is monitored only at the well(s) or in the distribution system, there is no time to detect contamination before it reaches the well.

Water purveyors are responsible for collecting data and monitoring water quality in their water system and this data can be useful to the planning team. Water quality monitoring should therefore include the surrounding capture zone. Monitoring wells placed at strategic locations in the well protection area

<sup>1</sup> Monitoring wells are typically 5 cm to 15 cm (2-inch to 6-inch) in diameter.

<sup>2</sup> Location and information on domestic wells can be obtained through a field survey and/or the Ministry of Environment's water well database <http://aardvark.gov.bc.ca/apps/wells/>

<sup>3</sup> A list of groundwater consultants in B.C. can be found at [www.env.gov.bc.ca/wsd/plan\\_protect\\_sustain/groundwater/library/consultants.html](http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/library/consultants.html)

<sup>4</sup> Measured from the water levels in monitoring wells.

(for example between known or suspected sources of contamination and the community well) will provide advance warning of problems.

The planning team can arrange to have monitoring wells installed,<sup>1</sup> or may be able to use domestic wells that are suitably located, including the right depth, provided the well owners' permission has been obtained.<sup>2</sup> The frequency and intensity of monitoring within the well protection area will be based on factors such as distance to the community well, vulnerability of the aquifer, degree of pollution threat, and expected consequences. You should also have a Quality Assurance/Quality Control (QA/QC) procedure for sampling.

Design of the monitoring well network is complex and requires the help of a professional hydrogeologist.<sup>3</sup> A hydrogeologist can develop, implement and assess the results of the groundwater monitoring program. Draft terms of reference for hiring a hydrogeologist to do this work are included in Appendix 6.1.

Information on the quantity of the water supply is equally important. Data on the well water level (pumping and non-pumping), the volume pumped, as well as water levels in the aquifer<sup>4</sup> are critical for on-going operation of the well supply. This information is also valuable for planning the development of additional groundwater supplies for the community.

Interpreting the water quality monitoring data will require some effort. Keep the data up-to-date and review it on a regular basis, so that you can detect any contamination events quickly and respond appropriately to emergencies.

### 6.2 Evaluate Management Activities

Have the management activities (Step Four) been implemented properly? Are they helping to reduce the risk of contamination? Community groups and professional associations can help in evaluating these activities. For example, agricultural producer groups or other farmers could evaluate whether farmers in the protection area are adopting Best Management Practices for the handling and storage of manure. Appendix 6.2 provides a list of common activities and suggests who should monitor them and how.

The results of the evaluation surveys and other monitoring tools provide the planning team with information as to whether individual protection efforts are working. This is an opportunity to re-visit some of the management options outlined in Step Four. Should some other options be implemented? Should current measures be stopped or changed? Some of the management activities may have had a phased approach – are these still on time and on-track? Use this information to update your well protection plan.

## 6.3 Evaluate the Well Protection Plan

In addition to evaluating the individual actions, you should also look at the well protection plan itself. Ask yourself:

- Is it achieving its objectives? (If not, why?)
- Is there more or new information that can be added to the plan?
- Do contact lists need to be updated?
- What worked? What didn't? How can improvements be made?
- What were the costs of implementing the plan?

Much of this information will come from the results of sections 6.1 and 6.2. The review should focus on the plan's overall effectiveness as well as the merits of the individual components of the plan.

The well protection plan should be reviewed every year. Review of the plan will lead to decisions regarding any plan revisions and the development of next year's action plan.

## 6.4 Report the Results

Keep the public informed of the progress of the well protection activities. Publish an annual report on the plan and its activities. An example outline for an annual report on the well protection plan is shown in Appendix 6.3. This should include report on the water quality results and a summary of the protection activities underway. This will help build support for the protection efforts, and provides an opportunity for public input.

Results can be reported to the public in a variety of ways. For example:

- Prepare written reports and have them available on request;
- Include fact sheets and information bulletins with the water bill and post this information on water purveyor's, municipality's or regional district's website. To allow feedback, comment forms and/or a contact phone number should be included;
- Set up information display booths at trade fairs and shopping centres;
- Prepare press releases for the local media, and suggest they interview members of the planning team;
- Hold public meetings at which the planning team reports on results, and use this opportunity to seek public input into changes required to the well protection plan.

Prepare reports and information in a form that can be easily understood by the intended audience.

A written report is appropriate to formally communicate successes/failures of the plan at year-end, while fact sheets and press releases may be suitable as interim reports. Make a list of all of the key individuals who should receive this information, such as the Medical Health Officer, the Board of Directors of the community waterworks system, the municipality and regional district, and local conservation groups.

## 6.5 Celebrate Success

Don't forget to celebrate your successes! The planning team should take the time to reflect on what it has achieved.

Developing a well protection plan is a dynamic and exciting process. You will certainly learn a great deal about your community water supply – and the community itself. There will be frustrations – when you can't get information you need, or the planning team cannot agree on priorities. But there will also be a great sense of achievement. You have contributed to the protection of one of the community's greatest assets (and vital requirements)—your drinking water.

## CHECKLIST FOR STEP SIX

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

ACTION ITEM	COMMENTS	COMPLETED
Decide who is responsible for this action	Enlist technical and volunteer assistance if required.	<input type="checkbox"/>
Monitor water quality and quantity	Set up a system of monitoring wells.	<input type="checkbox"/>
Evaluate individual management and contingency measures	Design a system for evaluation when implementing the measures.	<input type="checkbox"/>
Evaluate the well protection plan	Evaluate annually Make adjustments to the plan as necessary.	<input type="checkbox"/>
Report results	Seek public input.	<input type="checkbox"/>
Celebrate success	Take the time to reflect on what the planning team has achieved.	<input type="checkbox"/>

## Appendix 6.1 Terms of Reference for Developing and Implementing a Groundwater Monitoring Program

Only general terms of reference are provided here. Specific terms of reference depend on site-specific conditions and factors and can only be developed after these are adequately known. It may be useful to contact the Groundwater Section of the Ministry of Environment, Lands and Parks for advice in drafting specific terms of reference.

- Review available information to identify critical areas to achieve the following objectives: 1) monitoring water quality to protect the quality of the community well supply and 2) detecting contamination in the aquifer before it reaches the community well.
- Outline locations of monitoring sites, monitoring depths, sampling procedures, parameters to monitor, frequency and schedule of monitoring, and a QA/QC program for collection of monitoring data. Include costs for establishment of monitoring sites, data collection, and QA/QC of monitoring data.
- Provide training to sampling staff: including sample collection and preservation protocols; QA/QC procedures; documentation; sample handling and shipping procedures; analyzing water quality results. Include a training manual.
- Sample monitoring sites, track sample collection, and QA/QC samples.
- Store monitoring data in the data management system that allows data to be readily manipulated, retrieved, displayed, and plotted.
- Conduct brief analysis of monitoring data after every sampling round to check for trends, substances that exceed drinking water guidelines, make recommendations, and write a brief progress report.
- Write annual report on results of water quality monitoring, including discussion on results, causes of observed trend, whether monitoring objectives are being achieved, and recommendations.

Appendix 6.2 Summary of Typical Well Protection Monitoring Activities

APPENDIX 6.2 SUMMARY OF TYPICAL WELL PROTECTION MONITORING ACTIVITIES				
General Categories	Purpose of monitoring	Some typical examples	Responsibility	How to evaluate
Water quality	Detect any changes in quality Assess the effectiveness of land use and protection strategies on water quality	Quality of the well water Ambient water quality in the aquifer	Water purveyor MOH <sup>5</sup> MOE <sup>6</sup> Industry	Compare water quality to drinking water and other guidelines Assess water quality trend over time
Water level	Detect any changes in water levels from water/land use which may adversely affect supply	Water levels in the community well Water levels in observation wells in the aquifer	Water purveyor MOE	Assess water level trend over time Determine/interpret causes of water level fluctuation from the hydrograph
Well use practices	Unused wells MUST be abandoned according to the Groundwater Regulation and wastes MUST NOT be disposed of in the well Ensure community well is being properly maintained and operating properly Update knowledge of water use in the area which may affect water quality or capture zone boundary Stick up Well Identification Plates	Quantities pumped from the community and other major wells The type of water use The number of new wells and construction practices The number of wells abandoned and abandonment practices	Water purveyor Well owners Local government Drillers (BCGWA) <sup>7</sup>  MOE	Compare actual practice against recommended practices and provincial guidelines Compare the specific capacity of the well over time to check if efficiency is maintained
Agricultural land use practices	Ensure that proper practices are being implemented	Agricultural manure storage and handling practices Fertilizer and pesticide use practices	Farmers, ranchers, and local residents Producer groups	Compare actual practices against recommended practices and
		Irrigation practices Enforcement of Code of Agricultural Practice for Waste Management Implementation of Integrated Pest Management Plans (IPMs) and Nutrient Management Plans (NMPs)	MAL <sup>8</sup> MOE	requirements specified in the operating permits
Industrial and commercial land use practices	Ensure that proper practices are being implemented Ensure pollution sources are being removed Assess water quality impact and compliance monitoring at regulated waste disposal activities	The number of leaky underground storage tanks removed Compliance monitoring around permitted waste disposal sites and contaminated sites Illegal dumping in gravel pits and gravel extraction practices	Local government MEMPR <sup>9</sup> MOE	Compare actual practices against recommended practices and monitoring requirements specified in the operating/discharge permits
Residential land use practices	Ensure that proper practices are being implemented	Septic system maintenance Fertilizer and pesticide use Disposal of household toxic wastes	Local government Local residents	Compare actual practices against recommended practices, requirements specified in by-laws and covenants
Public educational activities	Assess impact of activities on raising public awareness and stewardship	Questionnaires, surveys, and opinion polls	Water purveyor Local and provincial governments Local residents	Compare against baseline and/or previous data

<sup>5</sup> MOH: Ministry of Health, <sup>6</sup> MOE: Ministry of Environment, <sup>7</sup> BCGWA: B.C. Ground Water Association  
<sup>8</sup> MAL: Ministry of Agriculture and Lands, <sup>9</sup> MEMPR: Ministry of Energy, Mines and Petroleum Resources

## Appendix 6.3 Outline for an Annual Report on the Well Protection Plan

### Executive Summary

- Usually one page or less describing concisely what was done, the results, and any major recommendations.

### Introduction

- Background on the well protection plan (e.g. history, objectives, justification, etc.);
- Terms of reference for the plan;
- Outline what the report will address.

### Well Protection Plan

- Outline of annual plan (i.e. what was planned for the year).

### Plan Activities

- Report on plan activities (i.e. what was done for the year);
- Report results of monitoring;
- Include costs of the various activities.

### Discussion

- Discuss results, including what worked and what didn't work for the activities and for the plan on the whole;
- Discuss implementation for continued work.

### Conclusions and Recommendations

- Summarize plan activities and discussion;
- List recommendations for next year's operating plan.

### Appendices

- Include more detailed and technical information which may not be included in the main body of the report;
- Include statement of financial accounts for the various well protection plan activities.

## STEP SIX: Monitor Results and Evaluate the Plan

The Pumphandle Well Protection Plan spans a two-year period from spring 1999 to spring 2001. Monitoring and evaluation activities apply to the first year only – these too will be re-evaluated at the end of year one.

### Monitor Protection Activities

At the end of the first year, the planning team conducted a questionnaire survey in the community and held interviews with selected landowners and residents. The evaluation looked at the Best Management Practices (BMPs) and Integrated Pest Management (IPM) approaches, using information gathered by team members.

### Farmers

The results indicated that all farmers except one (the owner of the cornfield at A-6) had begun to adopt BMPs and IPM. The farmers started by properly storing their fertilizers, pesticides and fuels in covered areas away from watercourses and wells. They had consulted *Watershed Stewardship: A Guide for Agriculture*,<sup>10</sup> and jointly hired a consultant to advise them on developing IPM and water-wise irrigation methods to minimize leaching of agricultural chemicals into the aquifer.

### Golf Course Owner

The golf course owner had also initiated BMPs/IPM by properly storing fertilizers, pesticides and fuels in their maintenance area. He also began consulting experts on better ways to irrigate and manage the golf course according to the guidelines in *Greening Your Golf Course: A Guide to Environmental Management*.<sup>11</sup> The administrative staff had posted information about their protection efforts on the club bulletin board.

<sup>10</sup> Nener, J. (1977). *Watershed Stewardship: A Guide for Agriculture*. Co-produced by the Government of British Columbia and the Government of Canada. 60pp.

<sup>11</sup> UMA Engineering Ltd. (1996). *Greening Your Golf Course: A Guide to Environmental Management*. Produced by Environment Canada and the Department of Fisheries and Oceans. 44pp.

### Gas Station Owner

The gas station owner had tested the tanks and did not find any leaks. He therefore decided not to install new tanks at this time.

### Owner of Abandoned Well

The owner of the abandoned well did not grout off the well due to lack of funds despite being required to do so under the Groundwater Protection Regulation.

### Dry Cleaner Operator

The dry cleaner operator did not attend a spill response course due to a lack of funds.

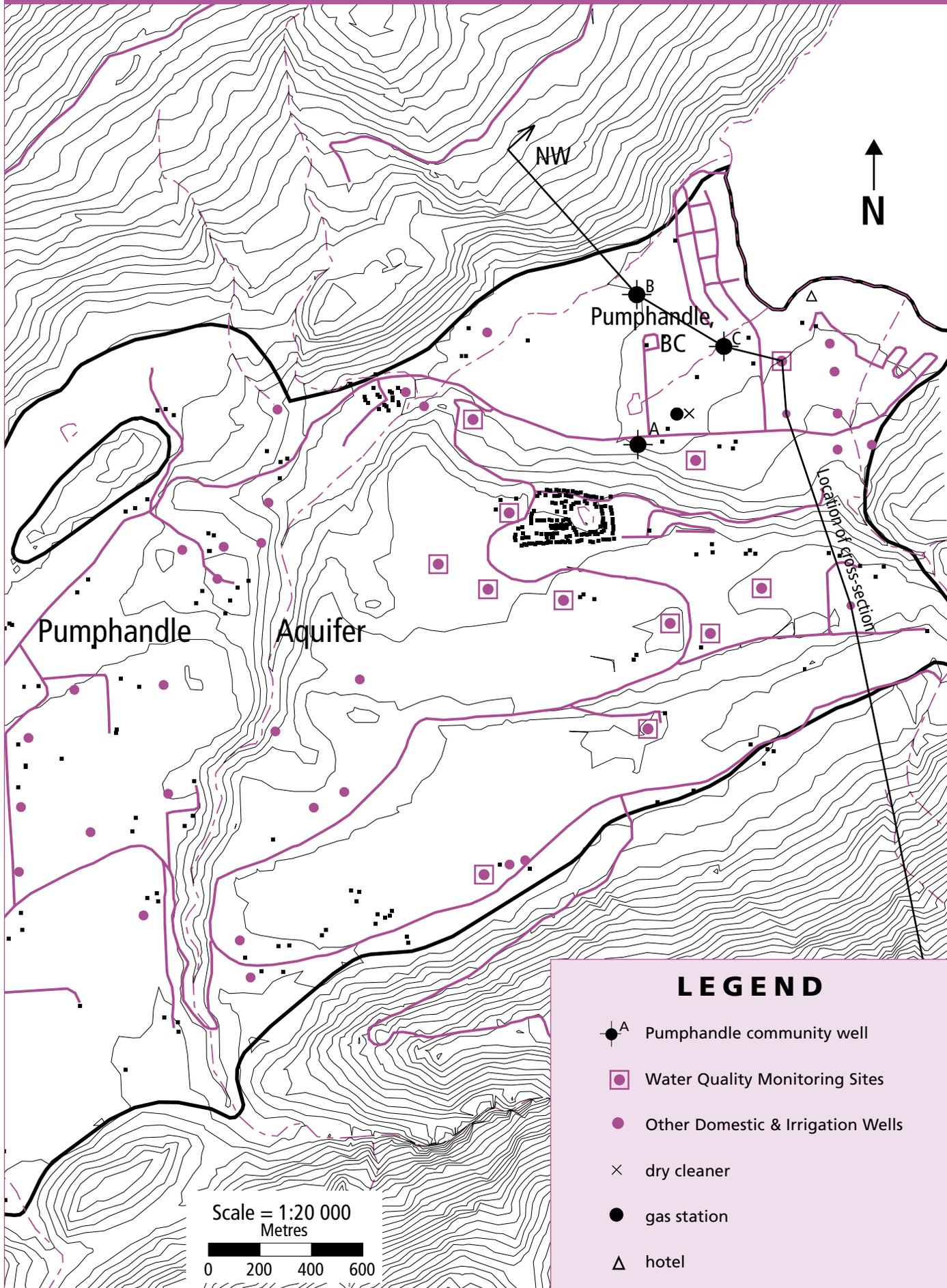
The survey indicated that the two-page newsletter sent out by the Regional District did a good job of communicating the well protection initiative but the details of each protection measure were not as clear. The survey also found that where a protection measure would involve costs of more than \$300 (e.g. grouting off abandoned well or taking the spill response course), landowners were not prepared to bear this cost alone.

Two signs were erected along the main road at both ends of Pumphandle to advise travellers that they are entering a well protection area. The gravel pit owner fenced the pit and put up a sign by the field office. Due to other commitments the Regional District Engineer was not able to evaluate alternatives for chemical road maintenance.

### Monitor Water Quality

The planning team also developed a water quality monitoring program. The three community wells were sampled in the fall of the first year to establish baseline data. Tests were conducted for a comprehensive list of physical, inorganic and organic (volatile organic compounds (VOCs) and selected pesticides), for a cost of about \$950 per sample. Water

**FIGURE CS6.1: WATER QUALITY MONITORING SITES**



quality of twelve private wells in the protection area was also sampled, specifically for Total Dissolved Solids, pH and nitrates at a cost of \$50 per sample. Although pesticides and bacteria could also be present in the protection area, it was felt that these tests would not be necessary at this time in the private wells (see Figure CS6.1).

The planning team used the procedures from Ministry of Environment to collect the well water samples. The Ministry of Environment and environmental health officer/drinking water officer provided technical advice and the field kit to assist with well water sampling. Two duplicate samples and one spiked nitrate sample were also collected to check the field nitrate analysis as part of a minimal quality assurance/quality control (QA/QC) program. A QA/QC program was seen as essential to obtain reliable results.

The water chemistry results detected no VOCs or pesticides in the three community wells. Elevated nitrate levels (above 3 mg/L NO<sub>3</sub>-N) occurred in seven of the 15 wells sampled, including Aiken's Well. Sampling results were sent to well owners. Laboratory results were archived in the Ministry of Environment's EMS<sup>12</sup> database and a paper copy was sent to the planning team by the laboratory. The environmental health officer/drinking water officer reviewed the data and prepared a brief water quality monitoring report to summarize the results (this will be done annually).

### Evaluate and Revise the Well Protection Plan

Overall, the planning team felt that good progress had been made. Part of the success was attributed to good communications within the small community, and high level of community input.

Modifications and plans for the coming year included:

- Continue to encourage the owner at A-6 to adopt BMPs and IPM next year;

<sup>12</sup> Environmental Monitoring System

- Ask neighbouring landowners and the golf course owner to track costs for BMPs and IPM, to assess the long-term cost savings from these measures;
- Approach the community for funds to pay 50% of the costs of grouting the abandoned well and sending the dry cleaner to the spill course. A community garage sale was suggested, as were car washes for raising funds;
- Continue to sample the network of private wells for monitoring ambient groundwater quality, at a cost of about \$700 for laboratory analysis. Agreements will be developed with the landowners. Data collected will be plotted to establish water quality trends.
- Evaluate alternatives for chemical road maintenance.
- Continue the work by the regional district to develop draft by-laws to require environmental impact assessments prior to approving new developments.

### Report on Progress

A year-end report will be produced to summarize the work during the first year. This will be presented at a public meeting, which will also be used to gather community input on activities for the coming year.

A 300-word mid-term progress report was drafted and included in the newsletter sent out by the regional district.

### Celebrate Success

Aiken's Waterworks held the "first annual community well protection picnic" to celebrate the first year-end report.





