CASE STUDY OF THE SPOKANE AQUIFER JOINT BOARD
SPOKANE, WASHINGTON
WELLHEAD PROTECTION PROGRAM
"Don't Pollute Your Drinking Water, It's Beneath You"

INTRODUCTION

The Spokane Valley-Rathdrum Prairie Aquifer is a 321 square mile (831 km^2) aquifer located in eastern Washington State and northern Idaho. One of the first aquifers nationally to receive a sole-source designation from the U. S. Environmental Protection Agency (USEPA) in 1978, the Spokane Valley-Rathdrum Prairie Aquifer is the only source of drinking water for a population of nearly one-half million people. In 1995, 17 public and private water suppliers in the Spokane Valley formed the Spokane Aquifer Joint Board (SAJB) to address groundwater quality issues in the Spokane Aquifer which is that portion of the Spokane Valley-Rathdrum Prairie Aquifer located in Washington. In the intervening years, that number has grown to 22 water purveyors who provide approximately 95% of the supplied water in the Spokane area. Having completed a detailed wellhead protection plan in 2000, the SAJB has embarked on an aggressive four-point campaign to increase public awareness and cooperation in protecting the quality of the Spokane Aquifer. The four components of this program are (1) Education and Awareness, (2) Household hazardous waste disposal assistance, (3) Pro-active business assistance, and (4) Maintenance of a potential contaminant source inventory.

Formation of the SAJB and development of the SAJB wellhead protection program comes after many years of aquifer research and protection efforts by the City of Spokane and Spokane County in Washington, and the Panhandle Health Department in Idaho. As early as 1909, the City of Spokane was testing the groundwater for bacterial contaminants (IDEQ 2000). Aquifer studies conducted as part regional wastewater planning under Section 208 of the 1972 Federal Clean Water Act in the mid-1970s led to the designation of the Spokane Valley-Rathdrum Prairie Aquifer as a sole-source aquifer and to a succession of regulatory programs by Spokane County, the City of Spokane, and the Panhandle Health Department, all aimed at protection of the aquifer.

This case study conducted as part of the AwwaRF funded *Demonstrating Benefits of Wellhead Protection Programs* concentrates on the wellhead protection program being implemented by the SAJB. It is beyond the scope of this project to perform an extensive review or evaluation of the groundwater protection efforts undertaken by the City of Spokane, Spokane County, and the Panhandle Health Department. However, it is not intended to dismiss or understate the importance of the earlier and continuing groundwater protection efforts by these other entities. Rather, it must be recognized that the SAJB wellhead protection program is an logical extension of, and complement, to these other efforts. While not the emphasis of this study, groundwater quality programs developed by City of Spokane, Spokane County, and the Panhandle Health Department have been briefly reviewed to gain a historical understanding of groundwater protection in the Spokane Valley-Rathdrum Prairie Aquifer and to recognize these earlier and ongoing efforts where applicable in the discussion and evaluation of the benefits of the SAJB wellhead protection program.

The SAJB wellhead protection plan was developed at an approximate cost of $485,000 between 1998 and 2000. However, the SAJB wellhead protection plan was an extension of wellhead planning conducted by the City of Spokane in the mid-1990s prior to the city joining the SAJB. The city had already spent nearly $550,000 for that planning. The direct monetary benefit of the wellhead protection program is the avoidance cost of having to construct, maintain, and operate treatment systems for contaminant removal or for construction of replacement wells. None of the water utilities which belong to the SAJB treat groundwater to remove contaminants. In 1995, SAJB member Water District #3 replaced a contaminated well at a cost of $750,000 including well construction, transmission lines, and engineering.

Locally, costs to treat contaminated groundwater at the closed Spokane County Colbert Landfill have run well into the millions of dollars for in construction costs with annual operating costs approaching one-half million.

The SAJB wellhead protection program is administered by volunteer support of the SAJB members and a paid (contract) program coordinator. The annual operating budget for administration of the wellhead program has averaged about $160,000 per year.

The non-monetary benefits derived by SAJB wellhead protection program include (1) improved cooperation between water suppliers and governmental agencies in Spokane County

[where have I discussed this in the report], (2) increased business opportunities for engineers and land scape designers, (3) increased collections of household hazardous waste and waste oil, (4) Improved public awareness of the Spokane Aquifer and issues related to aquifer water quality.

CASE STUDY PROCESS

This case study of the Spokane Aquifer Joint Board wellhead protection program consisted of a site visit to interview officials of the wellhead program, interviews of other persons who might have information about the benefits of the wellhead protection program, compilation of information on the wellhead program, and evaluation of the success and benefits derived from the protection of the Spokane Aquifer.

Site Visit and Interviews

The case study site visit occurred on September 24 - 27, 2002. Meetings, with various individual associated with the Spokane Aquifer Joint Board Wellhead Protection Program, were held at the Spokane Hampton Inn Hotel, offices of the Spokane County Public Works Department, and at the offices of the Vera Water and Power Company. The following individuals were contacted either during the site visit or in subsequent telephone calls.

- Mr. Lars Hendron, [need position title], [needed Department Name], City of Spokane, Spokane, Washington
- Ms. Sara Hubbard-Gray, Environmental Manager, Spokane Industrial Park, Spokane, Washington
- Mr. Dale Jensen, Spill Program Manger, Washington Department of Ecology, Olympia, Washington
- Mr. Mike McCain, Spill Response Coordinator, Washington Department of Ecology, Eastern Regional Office, Spokane, Washington
- Ms. Julia McHugh, Coordinator, Spokane Aquifer Joint Board Wellhead

Protection Program, Spokane, Washington

- Mr. Stan Miller, Water Quality Program Manager, Spokane County Department of Public Works, Spokane, Washington
- Ms. Sharon O'Shaughnessy, Project Manager, CH2M-Hill, Spokane, Washington
- Mr. Ty Wick, General Manager, Spokane Water District #3 and President, Spokane Aquifer Joint Board, Spokane, Washington
- Mr. Bill Wedlake, Solid Waste Closure Section, Spokane County Department of Public Works, Spokane, Washington
- Mr. Scott Windsor, Household Hazardous Water Collection Program, Spokane Regional Solid Waste System, Spokane, Washington

The compilation of this case study would not have been possible without the cooperation of listed individuals and their contribution to this project is gratefully acknowledged.

Information and Records Reviewed

Information obtained from the Spokane Aquifer Joint Board and other sources for this case study included the Spokane Aquifer Joint Board Wellhead Protection Plan, public educational information distributed by the Spokane Aquifer Joint Board, Spokane County and the Idaho Panhandle Health Department, aquifer and geologic maps of the Spokane Valley-Rathdrum Prairie Aquifer, local ordinances dealing with aquifer issues, budget and cost information, comprehensive planning documents, water resource reports, and geological reports. A complete listing of references is included at the end of this case study report. This information provided the history and experiences of the Spokane Aquifer Joint Board wellhead protection program and aquifer protection activities of governmental agencies in Spokane County, Washington and Kootenai County, Idaho.

LOCALITY DESCRIPTION

General Description

The Spokane Valley-Rathdrum Prairie Aquifer is located in Spokane County in eastern Washington and in Kootenai County in northern part of Idaho commonly called the Idaho panhandle. It stretches from the northeast and southeast, respectively, from Lake Pend Oreille and Lake Coeur d'Alene, Idaho to the western edge of the City of Spokane, Washington in a valley surrounded by the Bitterroot Mountains in Idaho and the Selkirk Mountains and the Columbia Plateau in Washington. Figure 1 shows the location of Spokane Valley-Rathdrum Prairie Aquifer.

Source: IDEQ 2000

Figure 1 Location of the Spokane Valley-Rathdrum Prairie Aquifer

Geography, Land Features, and Water Resources

The surface topography in the valley is fairly flat with little relief. The land surface slopes from east to west losing about 700 feet of elevation along the way. Land surface elevations at the eastern extremes of the Rathdrum Prairie near Lake Pend Oreille and Coeur d'Alene in Idaho are about 2,400 feet (731.5 m) and 2,300 feet (701 m) above mean sea level (MSL), respectively, while the surface elevation at the west end of the Spokane Valley is about 1,650 feet (502.9 m) (USGS 1977a and 1997b).

The major water resource of the Spokane Valley-Rathdrum Prairie is the Spokane Valley-Rathdrum Prairie Aquifer which is described in further detail in the following section. The major surface water resource of the area is the Spokane River which begins at Coeur d'Alene Lake at Coeur d'Alene, Idaho and flows generally westward to the City of Spokane. There the river turns north and joins with the Little Spokane River on the northwest side of the Spokane metropolitan area. From there the Spokane River meanders westward flowing into the Columbia River at Miles, Washington approximately 40 miles (64.4 km) northwest of Spokane and about 32 river miles (51.5 km) upstream of the Grand Coulee Dam.

The Spokane River has a complex relationship with the Spokane Aquifer. Depending on location, time of the year, and climatological conditions the river is both a discharge zone and recharge source for the aquifer. The Spokane River is the only surface water in the Spokane Valley-Rathdrum Prairie that exists for any appreciable distance.

The coarse nature of the surface deposits in the Spokane Valley-Rathdrum Prairie prevent the formation of open bodies of water thus there are no lakes or streams within the valley, other than the Spokane River. However, there are important lakes located in depressions or deep troughs at the base of the mountains bordering the valley. The more important of these are Lake Pend Oreille and Lake Coeur d'Alene which are the major sources of water to the aquifer. Smaller lakes located on the edges of the valley include Hayden Lake and Liberty Lake on the east and south sides of the valley and Spirit Lake, Twin Lake, Hauser Lake, and Newman Lake on the north side of the valley. These lakes are held in their basins by finer-grained alluvial deposits also deposited by the glacial floods that swept through the valley. These lakes collect water from the mountainous areas that are part of the Spokane Valley-Rathdrum Prairie

watershed. Each of these lakes contributes water to the Spokane Valley-Rathdrum Prairie Aquifer. Surface streams that discharge from these lakes rapidly percolate into the soil and disappear.

Geology and Hydrogeology

The Spokane Valley-Rathdrum Prairie was formed during the last ice age between 12,000 and 20,000 years ago when repeated massive floods discharged through the valley after ice dams holding back glacial lake Missoula broke releasing as much as 500 cubic miles (1,295 km^2) of water in just a few days; the maximum flood discharge has been estimated to be 750 million cubic feet second (21.2 million m^3/s) and reached speeds of up to 45 miles per hour (72.4 kmph) (IDEQ 2000). The alluvial deposits left by the glacial floods are extremely coarse consisting of gravel and boulders. These deposits range in thickness from about 600 feet (183 m) in the eastern extremes of the Rathdrum Prairie to 150 feet (46 m) in the western end of the Spokane Valley. In 1980 the USGS estimated the total volume of water in the Spokane Valley-Rathdrum Prairie Aquifer is 10 trillion gallons (37.8 trillion L) (IDEQ 2000).

The valley is bordered by the Selkirk Mountains on the north, the Bitterroot Mountains on the east and southeast, and the Columbia Plateau on the southwest and west. The geology of the mountains is complex, but basically consists of Cambrian and pre-Cambrian sedimentary rocks comprised of limestone, sandstone, and mudstone. The Columbia Plateau was formed during the Tertiary Period of the Cenozoic age by basalt lava flows which erupted an estimated 135 miles southwest of present Spokane (IDEQ 2000). Between Spokane and Coeur d'Alene the Columbia Plateau is highly eroded exposing older bedrock and leaving basalt remnants only on the west end of the Spokane Valley.

The Spokane Valley-Rathdrum Prairie aquifer forms at the northern edges of the Rathdrum Prairie from underground discharges from Lake Pend Oreille and Spirit Lake. The groundwater flows south until it joins with groundwater originating from Lake Coeur d'Alene. The aquifer turns to the west and flows through the Spokane Valley. Near the west end of the valley, bedrock intrusions turn the groundwater north for a short distance until it discharges to the Little Spokane River. The estimated groundwater discharge at the Washington-Idaho border

is 390 cubic feet per second (11m^3/s); the groundwater discharge gains an additional 350 cubic feet per second (9.9 m^3/s) as it flows through the Spokane Valley from the Washington state border to its discharge into the Little Spokane River (IDEQ 2000). Because of the coarse nature of the alluvial deposits in the Spokane Valley-Rathdrum Prairie, the flow rate of the aquifer is extremely fast, as much as 60 feet per day (18.3 m/day).

The depth to the water table ranges from about a 50 (15.2 m) feet below the ground surface throughout the Spokane Valley to as much as 600 feet (182.9 m) below the ground surface in the north extremes of the Rathdrum Prairie. Like the land surface, the water table slopes from east to west losing about 500 feet (152.4 m) of elevation along the way. In the northern extremes of the aquifer, the water table elevation is about 2,150 feet (655.3 m) above MSL and drops to about 1,600 feet (487.7m) MSL along the Little Spokane River (IDEQ 2000).

Hydrology and Climate

The climate of the Spokane Valley-Rathdrum Prairie is best described as semi-arid high desert. However, climatic conditions change to a subhumid coastal-type environment in the surrounding mountains. In the Spokane area summers are mild with temperatures rarely exceeding 90E F (32.2E C) while winters are mild without large accumulations of snow or severely cold temperatures. National climate data obtained from the website www.worldclimate.com (2003) shows that the average annual temperature measured at the Spokane Airport is 47.3E F (8.5E C). The warmest temperatures occur in July with a mean monthly temperature of 68.7E F (20.4E C) and the coldest month is January with a mean temperature of 27.1E F (-2.7E C). Spokane receives an average annual rainfall of about 16.3 inches (41.4 cm) with the heaviest precipitation occurring in December and January. Because of the influence of the mountains, rainfall increases across the Spokane Valley-Rathdrum Prairie from west to east. This is illustrated by comparison of the average rainfall at the Spokane Airport to the average annual rainfall of 25.9 inches (65.8 cm) at Coeur d'Alene.

Current and Projected Populations

Estimates of the population living within the Spokane Valley-Rathdrum Prairie are not readily available because the valley occupies portions of several governmental jurisdictions. US Census data (2002a) show a year 2000 population in Spokane County of 417, 939 people of which 195,629 (47%) live in the City of Spokane. Breakdowns of Spokane County population by subarea (Spokane County 2003a) show about 310,000 people living in subareas that are total within the Spokane Valley, but portions of other subareas lie partially within the valley, and the proportion of the population of those subareas that are within the valley is not known. The 22 water purveyors who belong to the SAJB report a total service population of about 400,000 persons.

Rathdrum Prairie occupies about 16% of the land area of Kootenai County, Idaho. US Census Data show that in 2000 Kootenai County had a population of 108,685 people. About 60% of the people of Kootenai County live in the following communities which are within the Rathdrum Prairie: Coeur d'Alene - 34,514; Hayden - 9,159; Post Falls - 17,247; and Rathdrum - 4,186.

Population growth in Spokane County and Kootenai County has been explosive. The population of Spokane County increase 15.7% between 1990 and 2000 while the population growth in Kootenai County was 55.7% during the same period. In Spokane County most of this population growth is being directed toward and occurring over the Spokane Aquifer in the Spokane Valley east of the City of Spokane. In Kootenai County, it appears that the majority of growth is occurring in the southern part of the county in a triangle formed by Coeur d'Alene, Hayden, and Post Falls.

Land Uses and Economy

Although some development around Spokane is occurring the north and south of the city, the major area of land development is occurring in the Spokane Valley east of the city, where the valley is quickly becoming urbanized and land uses are changing from rural to urban use. Land uses within the City of Spokane are the typical mix of uses found in older urban centers. East of

the city, the primary land use over the Spokane Aquifer in Spokane County is urban residential. Comprehensive land use planning by Spokane Count includes commercial corridors along Interstate 90 and several industrial areas, also within the aquifer boundaries.

Land use in the Rathdrum Prairie in Idaho is primarily agricultural except that the cities of Coeur d'Alene, Hayden, and Post Falls in the southern edge of the prairie are growing rapidly along the Interstate 90 corridor from Coeur d'Alene to Post Falls and onward toward Spokane.

Specific summaries of land uses by acres within the Spokane Valley-Rathdrum Prairie are not readily available.

The regional economy of the Spokane Valley-Rathdrum Prairie is diverse and does not appear to be overly dependent on any one economic sector. For illustrative purposes, Table 1 contains information about selected employment sectors in Spokane and Kootenai Counties. The table shows the percent of people employed in any one sector to the total of employees for the sectors shown. These proportions are compared to the proportions for the same employment sectors statewide (Note: The selected employment sectors do not represent total employment in the counties and the total number of employees shown in the table for each county is less than the actual number of employees in the county as determined by the latest census. Although farming is an important industry in the region, it was not included in the illustration because available census information on farming show the farming populations rather than the number of farmworkers.

Table 1

Selected Employment Sectors

Employment Type	Basis Year	Spokane County			Kootenai County		
		Employment	Sector % County	Sector % State	Employment	Sector % County	Sector % State
Accommodation/Food Service	1997	14,490	9.2	9.6	4,086	12.8	10.0
Construction	2000	10,704	6.8	7.7	3,159	9.9	9.3
Education	2000	4,700	3.0	1.9	287	0.9	1.6
Finance and Insurance	2000	9,743	6.2	4.9	1,017	3.2	3.9
Government: Federal State and Local	1998	9,473 25,695	6.0 16.4	6.9 19.1	1,104 6,466	3.4 20.2	5.3 20.6
Health Care	2000	27,213	17.4	13.8	4.546	14.2	12.6
Manufacturing	1997	20,892	13.3	16.1	4,472	14.0	15.7
Mining	2000	260	0.2	0.2	107	0.3	0.6
Trade :Retail Wholesale	1997	22,246 11,268	14.2 7.2	13.9 5.8	5,590 1,171	17.5 3.7	15.1 5.4
Total		156,684	100.0	100.0	32,005	100.0	100.0

Source: US Census 2000, 2002a

WATER SUPPLY INFORMATION

General Information

The Spokane Aquifer Joint Board (SAJB) is comprised of 22 public and private Washington water suppliers that nearly 350,000 persons and provide approximately 95% of the water used in the Spokane Valley. They pump a total average of 144.768 million gallons (502.63 mL) per day and meet a peak hourly demand equivalent to 440.49 million gallons (34.98mL) per day (Note: the peak hourly demand rate does not include the Irvin Water District #6, the Trentwood Irrigation District #3, nor industrial demands because that information was not available.). Table 2 provides basic water supply information about each SAJB member.

Water Quality

The Spokane Aquifer is the sole-source of drinking water for the City of Spokane, Town of Millwood, City of Spokane Valley, and residents living in unincorporated areas in Spokane Valley east and north of the City of Spokane. The aquifer is highly susceptible to contamination because of the coarse nature of the alluvial deposits which form the aquifer and lack of fine grained soils above the aquifer. Nearly every human activity over the aquifer is considered to be a threat to preserving the water quality of the aquifer. Still, the overall water quality in the aquifer is considered to be very good. Information obtained from available recent consumer confidence reports for some of the SAJB members show that there have been no recent violations of federal or state drinking water standards. A major threat to the aquifer is elevated nitrates contributed primarily by septic systems used for disposal of sewage and wastewater. Although measured concentrations of nitrates have never exceeded drinking water standards, increasing nitrate concentrations in the 1970s led to actions by Spokane County and the Panhandle Health District to place restriction on septic tank use to reduce nitrate concentrations detected in the groundwater. Since 1985, concentrations of nitrates in the aquifer have stabilized or decreased as a result of these restrictions.

Table 2

Spokane Aquifer Joint Board

SAJB Member	Service Population	Wells	Wellfields	Pumping Information Capacity mgd (mLpd)	Average mgd (mLpd)	Maximum mgd (mLpd)
Carnhope Irrigation District #7	1,120	2	1	2.60 (9.83)	0.32 (1.21)	1.58 (5.97)
Consolidated Irrigation District #19	14,910	34	11	106.51 (402.61)	12.28 (46.42)	82.77 (312.87)
East Spokane Water District #1	3,722	9	5	7.49 (28.31)	0.90 (3.40)	3.24 (12.25)
Hutchinson Irrigation District #16	2,293	2	1	7.78 (29.41)	0.82 (3.10)	1.75 (6.62)
Irvin Water District #6	2,350	4	4	7.78 (29.41)	1.08 (4.08)	6.07 (22.94)
Liberty Lake Sewer & Water District	4,500	5	5	13.07 (49.40)	5.43 (20.52)	
Town of Millwood	1,720	3	3	9.65 (36.48)	0.61 (2.30)	3.74 (14.14)
Moab Irritation District	1,200	3	1	6.91 (26.12)	1.10 (4.16)	9.48 (35.83)
Model Irrigation District #18	4,883	6	5	10.51 (39.73)	3.67 (13.87)	13.42 (50.73)
Modern Electric Water Company	15,700	8	8	43.78 (165.46)	5.85 (22.11)	20.54 (77.64)
North Spokane Irrigation District #8	1,668	4	1	6.48 (24.49)	1.60 (6.05)	9.95 (37.61)

SAJB Member	Service Population	Wells	Wellfields	Pumping Information Capacity mgd (mLpd)	Average mgd (mLpd)	Maximum mgd (mLpd)
Orchard Avenue Irrigation District #6	3,130	2	2	10.30 (38.93)	1.29 (4.88)	6.25 (23.62)
Pasadena Park Irrigation District #17	4,402	5	5	9.69 (36.63)	3.00 (11.34)	6.00 (22.68)
City of Spokane	204,500	7		272.16 (1028.76)	63.00(238.14)	192.00 (725.76)
Spokane County Water District #3	23,000	22	13	28.68 (108.41)	5.31 (20.07)	32.25 (121.90)
Trentwood Irrigation District #3	4,000	6	4	13.39 (50.61)	4.84 (18.29)	
Vera Water & Power	21,553	9	7	37.44 (141.52)	7.40 (27.97)	21.43 (81.00)
Whitworth Water District #2	17,914	13	9	27.36 (103.42)	21.31 (80.55)	22.16 (83.76)
Honeywell Electronic Materials						
Kaiser Aluminum - Trentwood	1,400*	3	1	1.73 (6.54)	0.35 (1.32)	0.37 (1.40)
Kaiser Aluminum - Mead	900*	4	1	11.38 (43.02)	2.92 (11.04)	7.49 (28.31)
Spokane Industrial Park		4	4	6.48 (24.49)	1.68 (6.35)	

* Non-resident employees *Sources*: CH2M-Hill 2000, SAJB 2001, WDOH 2003

WELLHEAD PROTECTION PROGRAM DESCRIPTION

General Summary of Program

In response to the 1986 Safe Drinking Water Act amendment, the Washington Department of Health developed a statewide wellhead protection program which in turn mandates wellhead protection planning by local water utilities. Water purveyors in the Spokane Valley, recognizing advantages of a regional approach to wellhead protection, joined together in 1995 to form the Spokane Aquifer Joint Board. The board was initially comprised of 17 water utilities, but has grown to a current membership of 22 water utilities that include two public utilities and 20 privately-held water companies or irrigation districts. The goals of the SAJB are (1) to protect the Spokane Valley Aquifer and individual water rights, (2) to mitigate and eliminate conflicts between water utilities, (3) to ensure coordinated efforts in implementing wellhead protection plans, and (4) to create a unified voice for the water utilities of the Spokane area (Wick 1997).

In 1997, the SAJB hired CH2M-Hill to prepare a wellhead protection plan for the member utilities of the SAJB. This plan, completed in 2000, contains the following elements.

- Data resources information was collected to allow proper characterization of the aquifer by groundwater modeling. Work efforts in this area included a review of existing literature describing the aquifer and collection of field data to compile physical information about the aquifer.
- Groundwater modeling was conducted to delineate wellhead protection areas for each well operated by the member water suppliers.
- The SAJB undertook an extensive public education and public involvement campaign to involve the public in the wellhead protection program. Activities undertaken by the joint board included publishing newsletters, issuing press releases, giving media interviews, participating in environmental forums and public meetings, and presenting an information aquifer program to local groups.
- The SAJB developed a scoring system to rank potential contaminant sources and to

assess the risk potential contaminant sources pose to individual water supply wells.

- An extensive survey was performed to gather, inventory, and assess the potential contaminant sources that could pose threats to water supply wells.
- The SAJB wellhead protection plan contains a contingency plan for dealing with contamination emergencies. The contingency plan contains two elements: individual plans for each SAJB member and a master contingency plan that encompasses the individual plans.
- A management and implementation plan which recognizes the regional nature of wellhead and aquifer protection in the Spokane Valley was included in the wellhead protection plan. The basis for the management and implementation plan is a 1998 Memorandum of Understanding between the City of Spokane, Spokane County, the Town of Millwood, and the Spokane Aquifer Joint Board which provides a framework for how these parties will work together in implementing individual wellhead protection efforts.

By the time, the SAJB began developing their wellhead protection plan in 1997, the City of Spokane, under its own initiative, had already been engage in wellhead protection planning for nearly five years. In 1997, the City of Spokane and the SAJB reached an agreement to act cooperatively in the development and implementation of regional wellhead protection activities and the city ultimately joined the SAJB in 1999. Because of this agreement, the wellhead protection planning already under taken by the city became the foundation of the SAJB wellhead protection plan. Of particular importance was the use of groundwater modeling information already developed by CH2M-Hill for the city reducing the efforts and expenses to develop the groundwater modeling needed for delineating the wellhead protection areas for the SAJB members.

Unique or Special Characteristics of Wellhead Protection Program

The SAJB wellhead protection program is truly a regional effort. Presently, it involves 22 public and private water purveyors working in concert to protect the Spokane Aquifer, provide safe drinking water to nearly 350,000 people, cooperate during groundwater emergencies, while at the same time protecting the individual water rights of each of its members. The primary component of the SAJB wellhead protection program is an aggressive education campaign to raise public and business awareness of the need and ways to protect the quality of the aquifer. Although centered in Washington State, these educational efforts are extended into Idaho in an effort to stem potential problems in the source areas of the aquifer. The SAJB program complements and assists groundwater protection programs administered by the Spokane County and the City of Spokane including household hazardous waste collections, waste oil collections, and local zoning controls designed to eliminate or minimize potential threats to the aquifer.

Key Elements of the Wellhead Protection Program

As noted, the key component of the wellhead protection program administered by the SAJB is an aggressive campaign to increase public awareness and cooperation in protection the health of the Spokane Valley Aquifer. This education program consists of four work areas: (1) Education and Awareness, (2) Household hazardous waste disposal assistance, (3) Pro-active business assistance, and (4) Maintenance of a potential contaminant source inventory. The SAJB is organized into committees designed to manage each of these functional components.

The Education and Awareness committee is charged with developing long-term awareness of the Spokane Aquifer. The committee organizes an annual aquifer awareness instructional event in conjunction with an annual interstate water week during September and October, participates in annual Earth Day celebrations, conducts school programs, and issues media spots. The SAJB Aqua Duck and slogan "Don't Pollute Your Water, It's Beneath You" are making aquifer protection a recognizable entity in the Spokane region. The joint board's website, www.spokaneaquifer.org, contains useful information on aquifer protection and the programs offered by the SAJB. The website offers educational tours about aquifers as instructional tools for teachers and students.

The Household Safe Contaminant Disposal Committee provides guidance and assistance to residents with the disposal of household hazardous wastes and waste oil in conjunction with the collection program of the Spokane Regional Solid Waste System. The committee provides lists of potential household contaminants and advice on how to dispose of waste materials. The actions of this committee have been successful. For example, the program manager of the Spokane Regional Solid Waste System attributes a nearly 50% increase in the collection of household hazardous wastes from senior citizens in 2001 to assistance from the SAJB to a collections program operated by the Retired Seniors Volunteer Program (RSVP).

The Business Assistance committee works cooperatively with the Washington Department of Ecology to assist business with managing hazardous wastes generated by a business. They also work with companies that use or make hazardous chemicals to improve usage controls, find alternative products which are more environmental friendly, control discharges of hazardous substances during waste treatment or disposal, and to provide adequate containment of storage areas.

The SAJB maintains and updates an inventory of potential contaminant sources that are located over the aquifer. Under Washington State regulations, water suppliers are required to notify potential contaminant sources located within wellhead protection areas on a biannual basis. The contaminant inventory provides the mechanism for these notifications.

Wellhead Protection Areas

Based on the groundwater model developed for the City of Spokane, wellhead protection areas were delineated for each well or well field operated by SAJB members during the development of the wellhead protection plan. CH2M-Hill undertook an intensive data gathering program to properly characterize the aquifer and hydro-geologic features of the Spokane Valley Aquifer before the wellhead protection areas could be delineated. Data gathering included (1) a groundwater level monitoring system, (2) land surveys to establish horizontal and vertical controls at wells and geophysical monitoring stations, (3) aquifer pump tests, (4) a seismic reflection survey to map bedrock depth and structure in the central Spokane Valley, (5) a microgravity gradiometry survey to evaluate bedrock depth and structure in the west end of the Spokane Valley, (6) a transient electro-magnetic field survey of the area north of the City of Spokane, and (7) an evaluation of the hydrologic conditions of the Little Spokane River Basin.

Subsequent to gathering the data, the groundwater model developed for the City of Spokane was revised and re-calibrated to include evaluation of the SAJB wells and well fields. Although one-, five-, and ten-year capture zones were evaluated for each well or well field as required by the State of Washington, the wellhead protection area for each well or well field was developed based on a one year time of travel under the annual water rights assigned to each well or well field. However, for each well or well field, the base time of travel was adjusted by an importance factor the goal of which was to delineate a wellhead protection area large enough to give the water utility the necessary time to find adequate water replacements in the event of a contamination event. The importance factors varied from 0.5 to 5.0 based on the utilities evaluation of their ability to respond to an contamination event.

Because of the coarse nature of the aquifer bearing alluvial deposits and the speed at which the aquifer flows, the delineated wellhead protection areas in the Spokane Valley tend to be long and narrow (in comparison to length). As an example, the delineated wellhead protection areas for the Spokane Water District #3 are shown in Figure 3. The largest of the wellhead protection areas shown in the figure is nearly 10 miles (16 km) long and has an estimated maximum width of 2,700 feet (823 m).

The land areas within the delineated wellhead protection areas have not been determined. Due to the narrow confines of the aquifer within Spokane Valley, nearly every well or well field of the SAJB members is hydraulically up-gradient or down gradient of at least one other well or well field. As a result, the delineated wellhead protection areas tend to overlap with other wells or well fields. In total, it is estimated by the case study researcher that between 40% and 50% of the land area within the Spokane Valley Aquifer boundaries is also within at least one delineated wellhead protection area.

Figure 3

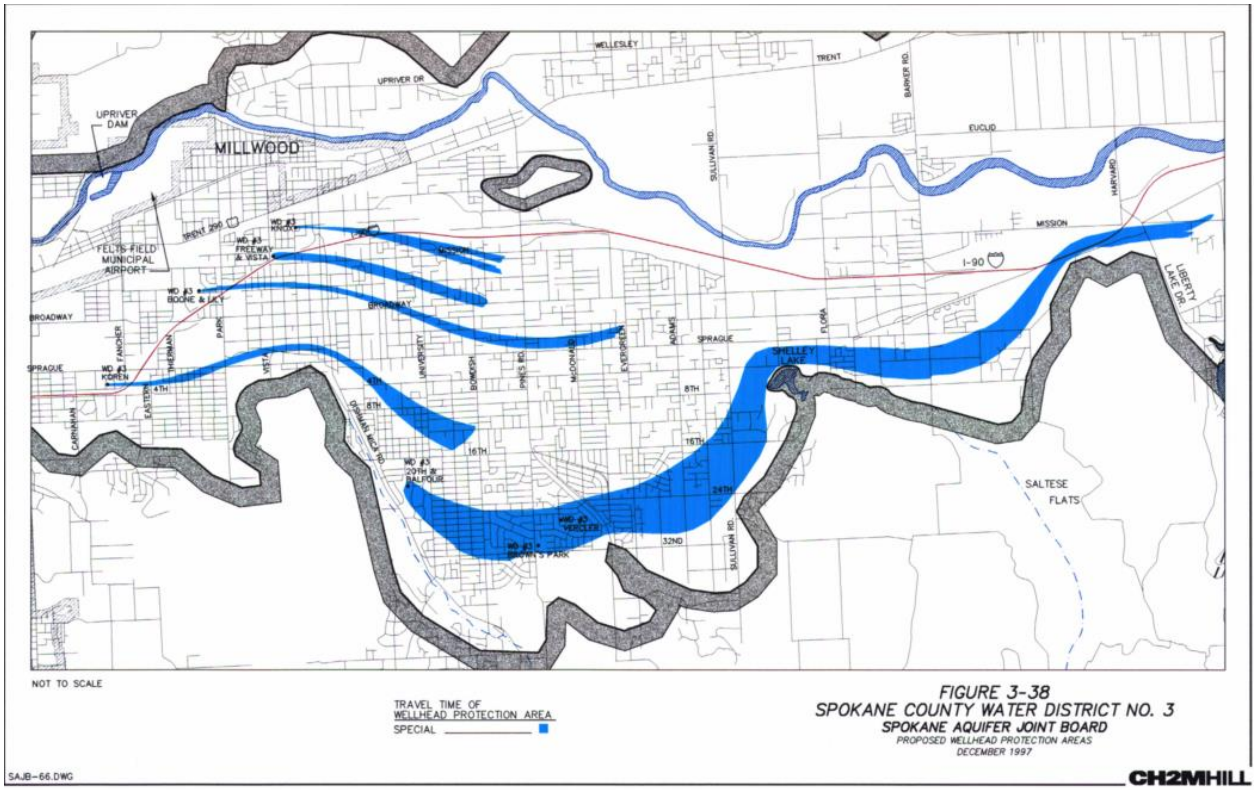

Figure 3-38 from the SAJB Wellhead Protection Plan

Management Strategies

Regulatory

With the exception of the City of Spokane and the Town of Millwood, the SAJB is comprised of privately-held water purveyors that do not have regulatory or rule-making authorities and the SAJB, itself, does not have regulatory authorities. As a result, there is no regulatory component to the SAJB wellhead protection program. It is worthwhile to note, however, the both Spokane County and the City of Spokane have instituted land controls and other programs which are designed to protect the aquifer. Examples of these are restrictions on septic tank use, controls of use and storage of hazardous materials, construction of sanitary sewers, and technical standards for stormwater infiltration basins.

Non-Regulatory

Public input during the development of the SAJB wellhead protection plan decried additional regulations as part of the wellhead protection program convincing the SAJB to emphasis non-regulatory management strategies for its wellhead protection program. As previously discussed the key component of the SAJB wellhead protection program is an education and awareness program consisting of four work areas: (1) Education and Awareness, (2) Household hazardous waste disposal assistance, (3) Pro-active business assistance, and (4) Maintenance of a potential contaminant source inventory.

Contaminant Source Inventory and Susceptibility Assessment

Contaminant Source Inventory

Because of the nature of the alluvial deposits in the Spokane Valley, there is very little protection afforded to the aquifer from spills or releases of contaminants onto or into the soil above the aquifer. Local officials interviewed during this case study stated that any human activity within the Spokane Valley Aquifer watershed poses a potential threat to the aquifer. Contamination could originate from many sources including surface spills, agricultural and landscaping chemical use, leaking underground storage tanks, septic systems, stormwater dry wells, landfills, and business or industries that use hazardous materials or petroleum products. Transportation facilities in the Spokane Valley that lie over the aquifer included the highways, railroads, and pressurized petroleum pipelines.

An extensive search for potential contaminant sources was conducted as part of the development of the SAJB wellhead protection plan. This search included reviews of numerous federal, state, and local environmental and land use databases, historical maps and newspapers, and individual records maintained by the SAJB members. The search identified 1,732 present potential contaminant sources within the delineated wellhead protection areas. Table 3 contains a breakdown of potential contaminant source by type compiled from information contained in the wellhead protection plan.

The potential contaminant source search included a review of historical documents such as Sanborn Fire Insurance Maps, newspaper articles, and sites listed on current environmental databases but which are no longer in operation. The historical review found 170 historical sites located within at least one delineated wellhead protection area. Table 4 provides a breakdown of the historical sites by type compiled from information contained in the wellhead protection plan.

Table 3

Potential Contaminant Sources

Type of Contaminant Source	Number of Sources*
Contaminated Sites:	
Federal (CERCLIS/NPL)	0
State	10
Storage Tank Sites†	
Leaking Underground Storage Tanks	30
Sites	214
Underground Storage Tank Sites	None listed
Above Ground Storage Tanks sites	
Hazardous Waste Handlers (RCRA)	207
Licensed Pesticide Applicators	32
Business/Industrial Sites:	
Auto Repair Shops	14
Printers and Photographers	21
Dry Cleaners	3
Other‡	1,260

Source: CH2M-Hill 2000

* The total number of contaminant sources listed in the table exceed the actual number of sources because some sites have more than one source and are double counted. For Example, an auto body repair shop may also be a RCRA hazardous waste generator and have either underground storage tanks or leaking underground storage tanks.

† Underground storage tank and leaking underground storage tank sites have not been double counted. If a site contains both underground tanks and leaking underground tanks, it was counted only as a leaking underground storage tank site.

‡ Other includes any business or industry which may use or store hazardous materials, but which has not been specifically catalogued by type.

Table 4

Historical Potential Contaminant Sources

Type of Contaminant Source	Number of Sources*
Airport Facilities	5
Auto Body/Auto Repair	27
Auto Sales	8
Dry Cleaners	3
Equipment Sales & Service	6
Equipment Storage	2
Lumber Yards	19
Machine Shops	8
Painters/Paint Storage	8
Petroleum Storage Sites	35
Printers/Photographers	2
Railyards	1
Salvage Yards/Recycling Facilities	3
Undesignated †	52

Source: CH2-M Hill

* The total number of contaminant sources listed in the table exceeds the actual number of sources because some sites have more than one source and are double counted. For Example, a lumber yard may also be a petroleum storage site.

▪ Undesignated listings were those whose functional purpose could not be determined by site name or other information presented in the contaminant survey.

Susceptibility Assessment

The Washington Department of Health (WDOH 1999) has established three levels of susceptibility based on aquifer and well construction characteristics. These susceptibility levels are low, moderate, and high. Based on the characteristics of the Spokane Valley Aquifer and known levels of nitrate contamination in the aquifer, the Spokane Valley Aquifer is considered to by highly susceptible.

Contingency Planning

The SAJB wellhead protection plan contains a contingency plan as required by the WDOH. This plan has two components: individual contingency plans prepared by each of the SAJB members and a master contingency plan that encompasses all the SAJB members' plans. The contingency plan describes the actions which are to implemented in cases of (1) Groundwater monitoring detects a significant reduction in water quality in either a monitoring well or production well or well field, or (2) An emergency event, such as a traffic accident, fire, or rupture in infrastructure where hazardous substances are released, which threatens to shut down one or more production wells.

Each member has examined its water system to evaluate strengths and weakness in the water system and to define alternatives for addressing a contaminant threat or emergency event. The master contingency plan describes how the SAJB as a group should react in concert to use the strengths, and overcome the weaknesses, of any one system in the event of a contaminant or emergency event. Strengths include excess pumping capacity, interconnections with other water systems, reservoir capacity, and the ability to site new wells. Weakness include lack of capacity which would require dependency on another purveyor to meet demands, lack of interconnections or interconnections with insufficient transmission capacity, and limited or no reserved well sites.

The contingency plan contains several decision flowcharts for dealing with (1) contamination detected in a monitoring well, (2) contamination detected in a production well, (3) notification and response to emergency events, and (4) emergency response communications.

The wellhead protection plan recommends that SAJB members re-evaluate their individual contingency plans on an annual basis and updated every five years.

New Well Siting

The SAJB source water protection program does not identify any siting criteria for new wells. Construction of new wells and water rights issues related to well construction are regulated by the Washington Department of Ecology under Chapters 173-160 and 173-152 of the Washington Administrative Code, respectively.

Public Participation

Believing that an informed public would be critical in ensuring aquifer and wellhead protection, the SAJB undertook a public participation program to educate and involve the public with the wellhead protection efforts being initiated by the member water suppliers. The intent of the public participation being to (1) establish the identity of the SAJB, (2) gain and maintain public support, (3) minimize public opposition, (4) establish a working relationship with the media, and (5) with public support improve political support for the wellhead protection efforts of the SAJB. Activities undertaken by the SAJB included public presentations about the Spokane Aquifer and wellhead protection to numerous community groups, a quarterly newsletter, a series of articles about the SAJB and their wellhead protection efforts in local newspapers, and media briefings and news releases. During this period, the SAJB also sponsored exhibits at environmental forums and community events, met with political leaders, and produced a 12-minute video about the SAJB and its wellhead protection efforts.

During this same time period, the City of Spokane was also developing a wellhead protection plan and initiating a public participation activities. Recognizing the that a combined regional effort would be more effective, the SAJB and the City joined forces in 1998 to conduct a joint public participation program to involve and solicit public input into the development and implementation of their individual wellhead protection plans (eventually, these plans were

blended into one plan when the City joined the SAJB in 1999). The joint public participation efforts were framed within an agreement that included the SAJB, City of Spokane, Town of Millwood, and Spokane County. This public participation program included the following components.

- Notifications of Businesses and Agencies. The SAJB sent notices to businesses and facilities which were identified as potential contaminant sources within the (then) proposed wellhead protection areas. The SAJB also notified local and state agencies and local jurisdictions with regulatory responsibilities of the wellhead protection planning being undertaken by the SAJB.
- Public Education and Outreach. The SAJB conducted a series of public meetings to at varying locations in the Spokane Valley during April of 1998. These meetings were designed to inform stakeholders and the general public of the wellhead planning efforts and to solicit the opinion of these parties. Advertisements of these meetings were published in the Spokesman Review newspaper on the Sunday prior to each meeting. The advertisement was also handed out at local schools, libraries, city offices and water district offices. With permission of the Spokane Public School District, nearly 6,900 meeting notices were handed out at Spokane Junior and Senior High Schools.
- Citizens Wellhead Committee. The SAJB and the City of Spokane formed a Citizens Wellhead Committee as another means of soliciting public and stakeholder input into the development of the wellhead protection plan. The committee was composed of representatives from various stakeholder groups who were appointed to the committee by the SAJB, City of Spokane City Council, Town of Millwood, and the Spokane County Commissioners. The Citizens Wellhead Committee met 10 times in the summer and fall of 1998 and spring of 1999.
- Focus Groups. Based on specific concerns raised by the Citizen's Wellhead Committee, focus groups were formed to discuss and investigate three issues

which needed to be recognized and addressed in wellhead protection planning. These issues were the Yellowstone Petroleum Pipeline that runs through the Spokane Valley, handling and disposal of waste chemical from businesses located within the delineated wellhead protection areas, and potential threats from spills occurring within the transportation corridors in the Spokane Valley.

- Community-Wide Telephone Survey. A telephone survey of 400 households was conducted to ascertain the awareness and perceptions of the Spokane Aquifer and measures designed to protect the aquifer.

As previously discussed, ongoing public awareness and outreach to education and involve the public in aquifer protection is a principal component of the SAJB wellhead protection program.

Evaluation Criteria

Neither federal nor state regulations require that wellhead protection plans include evaluation criteria. No evaluation criteria or process have been developed or used as part of the SAJB wellhead protection program. Like most communities, SAJB believes in the preventive nature of the program to minimize the potential for future contamination of its water supply.

EVALUATION OF COSTS AND BENEFITS

Methods and Criteria Used to Measure and Quantify Benefits

The benefits of the SAJB wellhead protection program can be measured both directly and indirectly. Direct benefits can result from a reduction in expenses or by avoiding costs to remediate contaminated sites, treat source water that fails to meet federal and state drinking water standards, construct new water supply wells, or find an alternate water supply. Indirect benefits can be measured in any of the following ways: (1) improved water quality, (2) changes

in the number or water quality complaints, (3) changes in the number of inquiries for wellhead protection information, (4) restricted or prohibited land uses or activities, (5) reduction in the use or storage of petroleum product or hazardous materials within the wellhead protection areas, (6) a reduction of reportable spills of petroleum products or an increase in the reporting of spills, (7) increases in the collection of waste oil, (8) increases in the collection of household hazardous waste, (9) increases in private consultant activities pertaining to spill response or contingency planning, or design of containment features for petroleum products or hazardous materials, (10) changes in land use patterns including creation or preservation of open space, conservancy areas, or recreational facilities, (11) improvements in wildlife or plant habitats, (12) changes in property values including the ease in attracting and retaining businesses, (13) improved working relationships between governmental agencies and water suppliers, and (14) the public's acceptance of wellhead protection.

Monetary Evaluation

The benefits of wellhead protection may be directly demonstrated from financial information obtained during the case study. Direct benefits are the avoided costs of treating contaminated water, or replacing wells that have contaminated water either with new wells or with an alternate source.

None of the SAJB members are currently treating groundwater to removed contaminants. Therefore specific treatment costs are not available. However, it is possible to gauge likely treatment costs based on information obtained from the Spokane County Public Works Department which operates currently operates an air stripping treatment system to removed contaminants from groundwater at their closed Colbert landfill. The system was constructed in1994 for a total cost of $9.2 million dollars broken down into the following components: air stripping treatment system - $1.8 million; extraction wells and conveyance pipeline - $1.5 million; and engineering - $5.9 million. The engineering costs may seem high for this type of project, but included an initial hydrologic study, and remedial investigation and feasibility study, pilot testing, and design of the extraction and treatment systems, construction inspections, and

training. The treatment system has averaged a daily flow through of 1.25 mgd (4.73 mLd) since being placed into operation in 1994, but is currently treating an average flow of about 1.0 mgd (3.78 mLd). The annual operation and maintenance for the system is $400,000. It should be noted that the Colbert Landfill is located north and east of the City of Spokane and is outside of the boundaries of the Spokane Aquifer.

In 1995, the Spokane Water District #3 replaced a contaminated water supply well at a cost of $750,000 inclusive of well construction, new transmission pipes, and engineering fees. There have been no other recent well replacements by members of the SAJB.

Some of the individual contingency plans prepared by SAJB members as part of the wellhead protection plan contain cost estimates for various responses to potential contaminant hazards. A common alternative is to interconnect with another water supplier to meet demands should a well be taken out of service. The estimated cost of these interconnections is in the range of $65,000. The water purveyors also estimate that new wells would cost more than $100,000.

Since the Spokane Aquifer is a sole source aquifer, alternative water sources are not readily available.

The SAJB wellhead protection plan was developed at a cost of $485,000 broken down into the following components: technical background research and data gathering - $200,000; groundwater modeling - $100,000; contaminant source inventory - $40,000; public involvement/participation - $75,000; business notifications - $20,000; and management planning - $50,000. It should be noted, however, that prior to joining the SAJB and sharing information developed during the preparation of their individual wellhead protection plan that the City of Spokane spent approximately $650,000 in wellhead protection planning. An approximate breakdown of this cost is data research - $230,000; groundwater modeling - $70,000; project management, contingency planning, future well siting, and contaminant source inventory - $150,000; survey and city employee costs to establish horizontal and vertical controls - $100,000; and public participation and stakeholder involvement - $100,000. Regionally, the total costs of wellhead protection planning in the Spokane Valley were nearly $1.2 million.

The SAJB operates with an average annual budget of about $160,000. Actual operating expenses for the SAJB were $173, 400 in 2001, $145,700 in 2002, and $155,300 (anticipated) in 2003. Income for the SAJB is derived from membership fees paid by the individual SAJB members. Revenue has exceeded expenses. As best can be determined, none of the SAJB members undertake wellhead protection activities outside of the auspices of the SAJB.

Non-Monetary Criteria

The benefits and costs of wellhead protection may also be indirect and non-monetary in nature. Non-monetary benefits and costs can demonstrate the efficacy of wellhead protection and require discussion.

Improved Water Quality

The wellhead protection program run by the SAJB is a proactive program aimed at minimizing and preventing potential contamination of the Spokane Aquifer through public education and technical assistance. As such there is no demonstrable evidence that the activities of the SAJB have resulted in improvement of groundwater quality in the Spokane Aquifer. Outside of the activities of the SAJB, there has been a measured decline in nitrate levels in the aquifer as Spokane County has limited construction of new septic systems for wastewater disposal, constructed sanitary sewers to eliminate existing septic systems, and implemented stormwater management systems to reduce potential introduction of contaminants carried in stormwater into the aquifer.

Water Quality Complaints

The SAJB does not receive water quality complaints. Individual water suppliers receive and respond to customer complaints usually related to water pressure and aesthetic conditions. Records on complaints were not researched.

Public Requests for Wellhead Protection Information

One of the primary components of the SAJB wellhead protection program is the public education and awareness program. Through this effort, the SAJB works to reduce potential contamination of the groundwater by raising public awareness of aquifer protection. Through the technical assistance programs, the SAJB has helped individuals and business find the proper methods and resources for disposal of waste oil, household hazardous waste, and waste oil. During the development of the wellhead protection plan, the SAJB made presentations on aquifer and wellhead protection to community groups and the media. Records indicate that during this period, they often received requests for wellhead protection information from these groups and the media. However, it appears that those types of requests have diminished as the SAJB has moved from development to implementation of the wellhead protection program.

Restricted or Prohibited Activities

The SAJB has no jurisdiction to restrict or prohibit land uses, or business or industrial activities. And, the SAJB wellhead protection program has no components which would restrict or prohibit activities within the Spokane Aquifer watershed nor within the individual wellhead protection areas delineated in the wellhead protection plan. Outside of the operations of the SAJB, Spokane County, the City of Spokane, the newly formed City of Spokane Valley, and the Town of Millwood have zoning and land use authorities which have been used to restrict certain land uses or activities to protect aquifer quality.

Use of Petroleum Products or Hazardous Materials within Wellhead Protection Areas

There is no compiled information or evidence that the SAJB wellhead protection program has resulted in a decrease in the use or storage of petroleum products or hazardous materials within the Spokane Aquifer watershed or the delineated wellhead protection areas.

Spill Reporting

Spills, by nature, are accidental, but are affected by carelessness. People educated on the effect of spills and the potential threat to groundwater and drinking water supplies are likely to be more careful when handling petroleum products or hazardous chemicals and will be more likely to report and clean up spills when they occur. One indirect benefit of wellhead protection may be a decline in the number of spills occurring within the wellhead protection area after implementation of a wellhead protection program or conversely an increase in the reporting of spills.

A record of spills for the ten year period 1995 through 2002 obtained from the Washington Department of Ecology (WDOE 2003) is summarized in Table 5. Analysis of the spills information shows an almost 14% decline in the number or reported spills from 1998 to 1999 with an additional 14.6% decline from 1999 to 2000. There was a 9.7% increase in the reported spills from 2001 to 2002. Although it is difficult to draw a correlation, the data shows two years of marked decreases in the number of reported spills during the period of active public participation (1998 - 2000) in the development of the SAJB wellhead protection plan.

Table 5

Spill Summary: 1995 - 2002

Year	Reported Spills
1995	88
1996	114
1997	97
1998	95
1999	82
2000	70

Year	Reported Spills
2001	72
2002	79

Source: WDOE 2003

Household Hazardous Waste Collection and Waste Oil Collection

The Spokane Regional Solid Waste System operates a household hazardous waste collection program which is available only to residents of Spokane County. The program has been in operation since 1991. Although we were unable to obtain specific summaries of the annual collection volumes, the program manager stated that there have been increases in the amount of household hazardous wastes collected because of SAJB involvement with the collection program. He cites, for example, that the SAJB has worked collaboratively with the Retired Seniors Volunteer Program (RSVP) to pick up household hazardous wastes from senior citizens who are not otherwise able to bring waste directly to the collection centers operated by the Spokane Regional Solid Waste Center. In 2001, the collection of household hazardous wastes from senior citizens increased from 6,000 pounds (2,721 kg) to 9,000 pounds (4,082 kg) as a direct result of the SAJB working with RSVP.

The regional solid waste system also collects waste oil from residents of Spokane County. The volume of waste collected has steadily increased and in 2001, approximately 90,000 gallons (340,687 L) of waste oil were collected. According to the system manager, some of the increase may be due to the SAJB and RSVP efforts to help seniors dispose of waste oil. The system manager, however, could not quantify the increases in waste oil collections resulting from SAJB activities. He noted, that many commercial facilities also accept waste oil and he does not have information on the volumes of waste oil collected by the commercial facilities. Many residents likely take waste oil to commercial facilities because the commercial facilities are more conveniently located.

Increases in Private Consultant Activities

According to wellhead protection planners at the Spokane CH2M-Hill office, the SAJB wellhead protection program in conjunction with other aquifer protection activities of Spokane County and Kootenai County in Idaho have resulted in increased business opportunities for consultants for doing spill prevention planning, hazardous materials management, design of sanitary sewers, and upgrades of underground storage tanks. CH2M-Hill, for example, has seen an specific increase in the preparation of wellhead protection plans for other communities in eastern Washington that are not part of the SAJB or in the Spokane Valley-Rathdrum Prairie aquifer because of the wellhead planning done for the SAJB.

Changes in Land Use Patterns

Because of the educational nature of the SJB wellhead protection program, immediate changes in land use patterns resulting from the adoption of the SAJB wellhead protection program would not be expected and cannot be demonstrated. Although no new restrictions have yet been implemented, the SAJB is working with the Spokane County, City of Spokane, the Town of Millwood, and the newly formed City of Spokane Valley to enacted land use controls within existing land use regulations that would restrict some land uses and activities within the delineated wellhead protection areas. Should additional land use controls be promulgated, those controls would be expected to change future land us patterns within the delineated wellhead protection areas.

Habitat Improvements

Habitat improvements most likely arise from remediation efforts at contaminated sites, restoration of natural areas, or preservation of open spaces and natural areas. Due to its educational nature and the lack of land use controls which could create or preserve open space, the SAJB wellhead protection program would not be expected to have much influence on the preservation or improvement of habitat of endangered or threatened animal or plant species.

Information obtained from the Washington Natural Heritage Program in the Washington Department of Natural Resources shows that there are endangered, threatened, and sensitive plant communities in Spokane County. However, specific location information about these communities is not readily available and it was not determined whether any of the endangered, threatened, or sensitive plant communities are located within any of the delineated wellhead protection areas of the SAJB members. The Natural Heritage Program website (available at http://www.wa.gov/dnr/htdocs/fr/nhjp/refdesk/lists/4reflist.hrm) does not contain county listings for endangered, threatened, or sensitive animal or invertebrate species.

Information contained on the Spokane County Fish & Wildlife Conservation Areas Map (Spokane County 2001b) shows that there is area of known endangered species in the east side of the county located north of the Spokane River along the Washington-Idaho border (It was not determined whether this areas extends into Idaho). The information does not specify whether this is a plant, animal, or invertebrate species. The overlapping delineated wellhead protection area(s) for wells 6, 7, and 10 of the Consolidated Irrigation District #19 extends into this county designated critical area. Also the overlapping wellhead protection area(s) for wells 8 and 11 of the same water supplier borders on the south edge of the critical area.

Ironically, however, the northern portion of this critical area is also designated mineral land by Spokane County which opens the land to mineral extraction, an activity that could be both counterproductive from both habitat protection and wellhead protection standpoint. USGS (1995) aerial photographs of this area show that gravel mining is already occurring with the designated mineral land.

Property Values

The SAJB wellhead protection plan is not expected to have any immediate negative or detrimental effects on property values in or near the wellhead protection areas. This could change in the future, however, if the SAJB affects any changes to existing government land use controls which could restrict land uses with the wellhead protection areas.

The SAJB wellhead protection plan does not appear to be effecting land development or construction in Spokane County. Table 6 contains a summary of the new construction activities permitted by Spokane County for the years 1990 - 2002. Although the data is for the entire

county, current county-wide planning directs most of the expected growth to occur within the Spokane Valley and the major portion of the construction valuation shown in Table 6 is assumed in the Spokane Valley and within the Spokane Aquifer watershed. During the thirteen year period, construction valuation in the county grew in eight successive years and declined in four years. Declines incurred in 1991, 1997, 1999, and 2001. Given that years of both growth and decline occurred during the period of development and implementation of the SAJB wellhead protection plan, the data suggests that the SAJB wellhead protection program has had no influence on land development and growth in Spokane County or within the Spokane Valley.

Table 6

Summary of New Construction in Spokane County

Year	Number of Construction Permits Issued	Construction Valuation	% Growth from Previous Year
1990	1,662	$ 182,132,947	--
1991	1,935	$ 154,964,524	-14.92%
1992	2,417	$ 221,512,451	42.91%
1993	2,635	$ 229,521,946	3.62%
1994	2,742	$ 242,501,562	5.66%
1995	2,433	$ 246,426,566	1.62%
1996	2,361	$ 260,278,362	5.62%
1997	2,025	$ 186,689,067	-28.27%
1998	2,466	$ 249,642,293	33.72%
1999	2,269	$ 233,402,365	-6.50%
2000	2,065	$ 281,930,129	20.79%
2001	2,094	$ 222,980,640	-20.91%
2002	2,079	$ 223,093,644	0.050%

Source: Spokane County 1999, 2001a, 2002, 2003b

Improvements in Relationships between Governmental Authorities and Water Suppliers

Historically, many of the water purveyors were competitors and relationships between many of the water purveyors were often adversarial and poor at best. However, recognizing that groundwater protection was a common concern for each water supplier and that there were distinct economies of scale and benefits in conducting regional wellhead planning, the water utilities began to work cooperatively in the mid-1990s toward this common goal. Many of the people interviewed during this case study expressed the opinion that attitudes and relationships between the individual water utility member of the SAJB have drastically improved as a result of the combined coordinated effort toward wellhead protection. These individuals also opine that during the same time the relationships of the water suppliers with Spokane County and the City of Spokane have also improved.

As a result, wellhead protection planning in the Spokane, Washington area has become a truly regional effort that requires cooperation of the private and public water supplier, Spokane County, and the City of Spokane. It is anticipated that this cooperation will continue with the emerging government of the newly formed City of Spokane.

Public Acceptance of Wellhead Protection

Individuals interviewed during this case stated that there is good public acceptance and awareness of the SAJB wellhead program. In support of this they point to the intensive public participation component of the wellhead program and the ongoing public education and technical assistance components exercised by the SAJB.

There certainly is evidence that the efforts of the SAJB have raised public awareness of the Spokane Aquifer and groundwater quality issues. It is interesting to note, however, the source of this increased awareness may not be understood by the public. The SAJB has had two public surveys conducted to ascertain general public understanding of water supply and aquifer issues. The first was conducted in 1999 during the development of the SAJB wellhead protection plan, the second was completed in July 2002. Table 7 contains a comparison of selected information gleaned from the 1999 and 2002 studies. Comparison of the data shows

that there is a improved perception and awareness of the Spokane Aquifer. The information also shows, however, that the majority of people in the Spokane do not recognize the organization's name Spokane Aquifer Joint Board nor the acronym SAJB. Most individuals with internet access have not visited the SAJB website.

Table 7

Public Awareness Surveys

Survey Issue	1999 Survey	2002 Survey
Methodology Survey Population Accuracy Respondents	 n = 400 ∀4.9% @ 95 % conf 18 yrs or older	 n = 500 ∀ 4.4% @ 95% conf Head of household
Respondents with knowledge of aquifer	83%	88%
Respondents knowing they live over the aquifer	35%	65%
Respondents who know that drinking water comes from the aquifer	54%	72%
Respondents with knowledge of the Spokane Aquifer Joint Board or SAJB	NA	24%
Respondents with internet access	NA	73%
Respondents with internet access who have visited the SAJB website	NA	2%

Sources: KXLY 1999, Robinson 2002

Summary on Effectiveness of the Wellhead protection Program

The effectiveness of the SAJB wellhead protection program can be demonstrated by both monetary and non-monetary means. Monetary evaluation typically would be the avoided cost of providing treatment of a contaminated water supply, or replacing contaminated wells or well fields, or developing a new water source. Wellhead protection planning for the SAJB, including

costs incurred by the City of Spokane prior to joining the SAJB were about $1.1 million dollars. The annual operating budget of the SAJB is about $150,000. This compares to well replacement costs which were $750,000 in 1995 at the Spokane Water District #3?? and to treatment costs which are could easily exceed $5.0 million in construction costs and $400,000 per year in operation and maintenance costs (based on treatment of groundwater at the closed Colbert Landfill). It should be noted, that the cited treatment costs are for the treatment of 1.0 mgd (3.8 mLd). At least 17 of the 21 water supply members of SAJB meet an average daily demand exceeding 1.0 mgd (3.8 mLd).

The non-monetary benefits derived by SAJB wellhead protection program include (1) increased public requests for wellhead protection information, (2) possible decreases in the number of spills of hazardous substances or petroleum products, (3) increases in the amount of household hazardous waste and waste oil collected by local waste collection program, (4) increased business opportunities for engineering consultants and environmental contractors, (5) improved relations between governmental authorities and water suppliers, and (6) increase public awareness of wellhead and aquifer protection.

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