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Local groundwater protection approaches : Missoula a case study

Mary Louise Fox
The University of Montana

LOCAL GROUNDWATER PROTECTION APPROACHES—
MISSOULA, A CASE STUDY

By

Mary Louise Fox

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Vicki Watson

Chairperson, Board of Examiners

[signature]

Dean, Graduate School

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Introduction

In 1988, in response to increasing concern over contamination of Missoula's groundwater, the Missoula City-County Health Department petitioned for and received Sole Source Aquifer status for the Missoula Valley Aquifer, the first aquifer to receive such status in EPA, Region VIII. An interagency task force was then formed to consider the issue. This was the beginning of a series of actions taken to protect Missoula's supply of drinking water.

Next, the Montana Department of Health and Environmental Sciences (MDHES) and Mountain Water Company (MWC) funded a University of Montana study of aquifer flow and the probable behavior of volatile organics, the primary problem of concern, in the aquifer. In 1989, the first phase of a wellhead protection plan addressed volatile organic contamination in the aquifer under a contract between Missoula County and the Water Quality Bureau.

In February of 1990, the Missoula City-County Health Department submitted three proposals to the Water Quality Bureau for funds under their Wellhead Protection Program. Included with this submission was a work plan for wellhead protection in Missoula County. This work plan contained an outline of work to be completed for groundwater protection. One of the tasks on this outline, under groundwater protection research, was a "survey of communities with local groundwater protection" with a "report and recommendations" to be completed by July 15, 1990.

To accomplish this task, the Health Department decided to hire an intern. This paper is the result of my work as the intern hired for this project. I began in January of 1990 and submitted my report and recommendations to the Health Department on July 9, 1990. This paper includes updated information to February of 1991.

Chapter One of this paper describes various past contamination events in Missoula. Chapter Two describes the hydrogeology of the Missoula Valley. Chapter Three discusses federal and state legislation relevant to protecting groundwater as of 1990. Chapters Four and Five relate information about the survey, methodology, and the bases for selection of the communities most closely studied. Chapter Six discusses the results of study of the selected community programs. Chapter Seven relates developments since 1990 for groundwater protection. The final chapter, Eight, discusses my recommendations for a local groundwater protection program for Missoula.

Present Situation in Missoula

Missoula is a community for which groundwater is of prime importance. Missoula gets all of its drinking water from the Missoula Valley Sole Source Aquifer. Approximately 54 million gallons of water (MCCHD, 1988) are discharged daily from this unconfined sand and gravel aquifer (MCCHD, 1988) to serve 75,000 people, all of whom are within the jurisdiction of the Missoula City-County Health Department (MCCHD).

The Missoula Valley Aquifer is extremely vulnerable to contamination. Because it is unconfined, substances can move freely from the unsaturated zone to the aquifer. The materials near the surface as well as in the aquifer are generally coarse-grained and the depth to groundwater is relatively shallow (0 to 100 feet). Contaminants can move quickly to the aquifer before the soils of the unsaturated zone can neutralize or biodegrade them.

The aquifer is also vulnerable to contamination because it receives much recharge from surface waters. Contamination in the surface water recharging the aquifer can contaminate the groundwater. Consequently, it is important to protect surface waters to protect our drinking water. The Clark Fork River, the major source of surface water recharge to the aquifer, has been significantly contaminated. Milltown Reservoir, created in 1907 has accumulated 6.5 million tons of sediments, containing exceptionally high levels of such metalloids and metals as arsenic, lead, zinc, cadmium, and others from mining activities upstream. These contaminants moved into the shallow groundwater which served the town of Milltown as drinking water, resulting in the need to provide clean water from another source for residents of Milltown until new wells could be drilled tapping clean groundwater (EPA and MDHES, 1988).

The aquifer is also threatened by agricultural sources in the form of herbicides and pesticides. In the fall of 1984, trace levels of picloram and 2,4-D were discovered in the Missoula City-County Weed Control (MCWC) supply well and in nearby wells that supplied a commercial campground and a trailer park. Levels were low enough that the MCCHD concluded there were no immediate health risks. Six potential sources were identified including: 1) a sump receiving MCWC rinsewater from county herbicide application equipment washings, 2) empty 2,4-D containers allegedly buried in an abandoned landfill, 3) aquifer recharge from Grant Creek, which drains an area with some agriculture, 4) irrigation ditch seepage, 5) herbicides disposed of by septic systems, and 6) herbicides that migrated after ordinary use. Investigation of the situation led to the conclusion that the major source was the MCWC sump. Use of the sump was discontinued and sampling four times a year of the contaminated wells and a well near an elementary school is performed in accordance with orders issued by the MT WQB. (Pottinger, 1988)

Another potential threat to the aquifer is leachate from landfills. Possible leachate sources include several historical and one active municipal waste landfill. Missoula's municipal waste landfill is the Browning-Ferris Landfill, which is located between the drainages of Grant and Rattlesnake Creeks. Groundwater contamination was discovered down-gradient of the landfill in the spring of 1986 for most routinely sampled parameters, including total dissolved solids and some metals such as zinc and iron. High levels were still present in the summer, and late in the year, more monitoring wells were installed down-gradient from the landfill monitoring wells already present. Levels were still elevated in monitoring wells in 1987, but leachate from the landfill has not reached any drinking water wells in the aquifer. The situation is still being monitored (MCCHD, 1988).

Another source of contamination to the aquifer is nitrates, primarily from septic systems. In the Linda Vista subdivision near the mouth of Miller Creek, nine wells showed high levels of nitrates, apparently originating from cesspools used for sewage disposal. The systems replacing these dry wells were designed to prevent the problem from recurring (MCCHD, 1988).

Another threat to the aquifer is bacterial contamination. Coliform bacteria were discovered in 25 individual wells in a two square mile area near Frenchtown in September of 1986. The suspected cause was improper well construction coupled with high groundwater leaking from a large irrigation canal. The origin of the problem was a missing headgate and once the headgate was replaced, new wells that have been properly grouted have not been contaminated.

A more recent bacterial contamination event occurred in March of 1990. On March 23, 1990, a boil order was issued for all of Mountain Water's customers south of the Clark Fork River. On March 22, MWC had reported the presence of coliform bacteria in one of the company's largest capacity wells, the Maurice Street well, which pumps 7,000 gpm. Mountain Water began chlorination of the water supply south of the Clark Fork, and the boil order was lifted on March 28, after two consecutive days of negative tests for fecal coliform in the well. The source of contamination could not be proven, but was suspected to be a malfunction with a city sewer lift station (Hydrometrics, Inc., 1990).

Spills and leaks of diesel fuel and gasoline have also contaminated the aquifer. Diesel fuel was discovered in groundwater near Burlington Northern Railroad's refueling location in the north end of the city in the fall of 1986. The free product floated on top of the water, with a layer seven feet thick in one well.

Two gasoline leaks have occurred in the high pressure Yellowstone Pipeline, a 503-mile pipeline from Billings to Spokane, which passes through the Missoula Valley. In July of 1972, Yellowstone Pipeline experienced losses of 1,108 barrels (bbls) of product, while plus or minus 450 bbls was the normal amount of error due to measurement limitations. The amount lost increased during August and September until September 25, when the leak was discovered and repaired. It appeared to have resulted from heavy equipment damage received several years earlier. The spill contaminated two wells in the Grant Creek area. Then, in June of 1982, a second rupture spilled gasoline into La Valle Creek and resulted in contamination of nearby wells.

Underground storage tanks also threaten Missoula's groundwater. The average age of an underground storage tank is 15 years. After this time period, corrosion and leakage of the tank are likely to occur. Many underground storage tanks are reaching or surpassing this age, resulting in many leaks coming to light now.

Another gasoline contamination event occurred as a result of a pressure test when a 1,000 gallon buried tank owned by Champion and located at their sawmill on California Street leaked 600 gallons of gasoline into the ground. This event resulted in contamination of domestic wells in the area with benzene, toluene, and xylene (BTX). The contamination was discovered after area residents reported petroleum taste and smell in their water a month after the event occurred. When the tank was removed, the discovery of corrosion holes, in addition to the larger hole created by the pressure test, suggested that the tank had already been leaking for several years. Gasoline was found in domestic wells in the area in May of 1985. Champion put in 16 new deeper wells to replace those that were already contaminated or were judged to be in danger of contamination by the MT WQB (Peery, 1988).

Cummins Northwest Inc. runs a truck repair and engine building facility at the intersection of North Reserve Street and Interstate

90. In November of 1989, three underground storage tanks were removed from the site, and a leak was discovered. Contamination was also discovered from the decommissioning of an oil/water separator. The contamination is primarily from waste oil and there is localized contamination by solvent constituents such as dichlorobenzenes and xylenes. These contaminants come chiefly from two drainage sumps and the oil/water separator. Approximately 2,300 cubic yards of soil are contaminated, but there has been a minimal effect on the groundwater. Excavation was begun and monitoring wells were installed in January of 1990. Seventeen nearby wells draw water from the upper portion of the aquifer. Sixteen of these wells are down-gradient from the site and all of them are used for consumption. It is possible that there is a plume moving to the south, down the hydraulic gradient. SRH Montana Environmental Management proposed that soil not containing hazardous wastes be landfilled at the Missoula BFI landfill. Contaminated materials containing hazardous wastes, such as sludge from the site, will be treated as hazardous material (SRH Montana Environmental Management, 1990).

Another current contamination problem is that of the former Hart Refinery site owned by the Champion International Corporation, located just south of the Champion Sawmill. Petroleum wastes were discovered in the soil and an investigation was conducted by the EPA in 1985 and 1986 showing possible off-site movement of groundwater. In September and October of 1989, Hydrometrics, Inc. conducted an investigation to determine the extent of the contamination. Contaminated soils were located in the areas of waste sumps and crude oil and finished product holding tanks. Soils located near trenches contained total petroleum hydrocarbon levels of 35,000 to 39,000 ppm. Drilling of wells revealed mixing of hydrocarbons in the upper 10 to 20 feet of aquifer, 30 to 50 feet below the surface of the ground. Groundwater movement is westward, varying from northwest to southwest on the site.

Soils at the site are contaminated with heavy hydrocarbons (diesel, fuel oil, crude oil, and asphalt) and with trace amounts of polynuclear aromatic compounds. Also found in the soil were regulated and unregulated organics, and alkylbenzenes from crude oil and the refining process at levels ranging from trace to 900 ppb. (Hydrometrics, Inc., 1990).

Contaminated wells have been found in many commercial areas in Missoula. Specific examples include the discovery of volatile organics in four private wells, serving local businesses. Gasoline was discovered in a well serving a Dairy Queen on Brooks Street and in a well serving Rocky Mountain Communications on W. Broadway. The smell of gasoline has recurred in the latter well, but resampling did not show elevated levels. Also, two wells, serving American Dental on Reserve Street and the Lewis and Clark Dental Building, on S. W. Higgins, were contaminated with perchloroethylene (PERC). The Dairy Queen well was shut down, and American Dental connected to Mountain Water Company's lines (MCCHD, 1988).

Recently, the EPA notified over 100 auto, boat, and motorcycle shops in Missoula that their dumping of hazardous wastes into dry wells is in violation of the SDWA and that the septic tanks, sumps, dry wells and cesspools must be abandoned. Instead of using the dry wells, businesses must do one of three things: connect to a sewer line, connect to a holding tank, or connect to a private treatment system.

As of February of 1992, approximately 110 of 221 businesses' dry wells have been shut down in accordance with EPA's warning. About half of the businesses with abandoned wells have connected to the sewer system. Most of the others have simply plugged their wells and some have begun recycling the materials. Closure of all these wells should be completed by the summer of 1992 (MCCHD, 1992).

Perchloroethylene (PERC) is the most common volatile organic contaminant found in the Missoula Valley Aquifer. Two MWC wells have been removed from use because their levels of PERC exceeded the compound's MCL. No sources have been confirmed (MCCHD, 1992).

Storm water runoff presents another problem in terms of groundwater contamination. Missoula has over 4,000 storm drains (English, 1992) that deposit many millions of gallons of stormwater into the ground to recharge the aquifer each year. This quantity of runoff introduces several thousand tons of dissolved solids to the groundwater. Many of these dry wells receive runoff from roads and pavement and simply send it into the ground. Many chemicals present in this water remain in the vadose zone, but the more mobile bicarbonate, calcium, magnesium, sodium, chloride, and iron are found in runoff that reaches the groundwater (Wogsland, 1988).

Hydrogeology of the Missoula Valley

Currently, Missoula Valley's only source of drinking water is the Missoula Valley Sole Source Aquifer. Other potential sources of drinking water exist as various bodies of surface water such as Rattlesnake Creek and the Clark Fork River. However, these sources are contaminated with giardia and treatment would require the construction of a costly filtration facility. Mountain Water Company carried out a study to determine the total increase in monthly cost to the consumer that would result from building a Rattlesnake water treatment plant versus putting in a large production well (both yielding 10,000,000 gpd). The results showed increases of $6.20 and $0.73, respectively. Consequently, only groundwater is used for drinking.

The aquifer lies directly below the valley floor and consists of alluvial sediments which were deposited during the Early Miocene and Recent ages. The aquifer is bounded to the north by the Rattlesnake hills, to the east by a line running north-south through the mouth of Hellgate Canyon, to the southeast by Mount Sentinel, to the southwest by the South Hills, and to the west by a line running north-south through the confluence of the Clark Fork and Bitterroot Rivers, (Miller, 1991). This describes an area of about 35 square miles (Hydrometrics, Inc., 1991).

There are three major formations that bear water. The oldest and deepest of these is the Precambrian Belt Supergroup

Metasediments. These sediments provide a shallow bowl that contains close to 2,000 feet of Tertiary Sediments, fine-grained materials interbedded with discontinuous layers of sand and gravel, the second formation of the aquifer. The third and youngest formation lies above the Tertiary Sediments and is made up of a thin layer of Pliocene to Recent coarse sand and gravels. This unit, also called the Missoula Aquifer, varies in thickness from 110 to 150 feet, and has high yields of high quality water from its saturated portions (MCCHD, 1988).

In most areas, depth to groundwater is fairly shallow, generally ranging from between 10 and 50 feet. These physical characteristics of the aquifer make it vulnerable to contamination. The thin coarse sediments immediately above the aquifer allow more rapid movement of contaminants from the ground surface to the aquifer. These soils also have lower sorption, buffering, neutralization, and ion-exchange capacities; processes that can slow or stop the movement of contaminants, or change the contaminants to less hazardous forms before they reach the groundwater. In an unconfined aquifer there is no impermeable barrier to prevent contaminants from moving down into the groundwater, and the shallow depth to groundwater means that the contaminants do not have far to go before reaching the aquifer. Because the Pliocene to Recent coarse sands and gravel are shallower than the Tertiary sediments and yield large quantities of water, wells tap this source of water first and the older, deeper sediments below are generally not explored. The

Missoula Aquifer is extremely productive. It has hydraulic conductivities (K) ranging from 1,550 ft/day to 18,000 ft/day (Miller, 1991), specific capacities of greater than 3,000 GPM per foot, and transmissivities as high as 1,710,000 gpd/ft (Hydrometrics, Inc., 1991). Specific yields vary from .0001 to .47 (Miller, 1991). The Missoula Aquifer has well yields of up to 7,000 GPM.

Groundwater from the aquifer is of very high quality. It is a moderately hard calcium bicarbonate type with pH generally between 6.8 and 8.5 (MCCHD, 1988).

Circulation of the groundwater is fairly rapid. The highly conductive nature of the Missoula Aquifer means that water moves quickly (as much as 18,000 feet per day) as do contaminants in the water, which in turn means that they reach pumping wells more quickly.

The amounts of recharge to and discharge from the Missoula aquifer are summarized in Table 3.1.

Table 3.1: Missoula Sole Source Aquifer — Recharge and Discharge

Recharge	Estimated Amount of Recharge (MGY)
direct precipitation	negligible (Woessner, 1988)
lateral inflow	3,900 (Miller, 1991)
inflow from Clark Fork	63,000 (Miller, 1991)
influent streams (creeks)	4,500 (Miller, 1991)
storm water drains	120 (Wogsland, 1988) most current
MWC pipe loss	4,500 (Hydrometrics, 1991)
irrigation	2,800 (Miller, 1991)

Discharge	Amount of Discharge (MGY)
evapotranspriration	negligible except in riparian areas
baseflow to Bitterroot	23,000 (Miller, 1991)
baseflow to Clark Fork	22,000 (Miller, 1991)
lateral outflow	6,500 (Miller, 1991)
discharge by wells	1,160,000 (Miller, 1991)

Water is discharged from the aquifer by evapotranspiration, baseflow to streams, lateral outflow (flow out of the aquifer to adjacent water-bearing units), and pumping wells. The amounts lost to evapotranspiration and baseflow are not well quantified. Total withdrawal of water for all uses from the aquifer by wells is estimated to be 9.7 billion gallons per year (Miller, 1991).

One source of recharge is direct precipitation on the aquifer. This recharge primarily occurs in the spring. From July to

November, precipitation is evapotranspired and from November to March, the ground is frozen. Recharge from snow melt also occurs in the spring. Another source of recharge to the aquifer is lateral inflow from adjacent, water-bearing sediments that outcrop in topographically higher locations. Approximately 6.8 billion gallons of water from the mountainous terrain north of the valley recharges the aquifer annually. Smaller quantities of recharge also come from the east and southeastern hills and underlying formations.

Another type of recharge to the aquifer comes from influent streams. This type of recharge accounts for approximately 82% of the total recharge to the aquifer and is important in the eastern portion of the aquifer. The Clark Fork River alone has been estimated to contribute approximately 77% of the total recharge to the aquifer (Miller, 1991). Recharge in the Rattlesnake Creek area is 4,850 ac-ft/yr. Other contributing streams include Grant Creek, which enters the valley to the north and contributes 4,900 ac-ft/yr; Pattee Creek, which contributes 2,450 ac-ft/yr; and Butler Creek and La Valle Creek, which together contribute 1,630 ac-ft/yr (Miller, 1991).

Other sources of recharge include storm water runoff, septic systems, irrigation, and water lost from Mountain Water Company's transmission pipes. In the Missoula Valley there are approximately 4,000 storm drains (English, pers. comm.). A 1988 count of 2,669 storm drains was used to calculate a recharge contribution of 119 MGY. Several thousand septic systems contribute several MGY of septic waste (Wogsland, 1988). Irrigation recharges amount to about 2,800 MGY (Miller, 1991) and losses from Mountain Water Company's lines total approximately 50% of total production with an estimated 27,570 acre-feet per year drawn out of the aquifer (Hydrometrics, Inc., 1991). In relative terms, recharge to the Missoula Aquifer is about fifteen times as great as the amount of water withdrawn from the aquifer by pumping wells (Hydrometrics, Inc.,1991).

The fact that recharge is so many times greater than water withdrawn for use combined with the fact that the hydraulic conductivity is so high results in a beneficial/diluting flushing effect in the aquifer. It also means, however, that problems may be worse in absolute terms than is reflected in public concern. A contaminant in the aquifer may be diluted enough so that the level of contamination in a well does not become great enough to pose a threat to public health and the public doesn't learn of the problem until it becomes much worse. Knowledge of where recharge is occurring is important to gauge its effect. Knowledge of recharge is also important so that these sources of water can also be protected because this water becomes the groundwater we drink.

In December of 1990, Ross Miller of MCS, Inc., Mountain Laboratories completed work on groundwater flow path modeling for Mountain Water Company wells to determine their capture zones, the portion of the aquifer surrounding a well that contributes water to that well. He used a two dimensional, transient, advective flow model of the aquifer that he had developed earlier combined with the USGS MODPATH advective particle tracking model. Results of this work show that capture zones for the wells are long and narrow with flow from the direction of the Clark Fork River (MCCHD, 1992).

Federal and State Groundwater Protection for Missoula as of 1990

Currently, groundwater protection in Missoula occurs primarily on federal and state levels. Protection at the federal level consists of portions of federal laws or programs directed at various issues. Six of the federal laws dealing with groundwater protection are the Safe Drinking Water Act (SDWA); the Resource Conservation and Recovery Act (RCRA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Superfund; the Clean Water Act (CWA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); and the Toxic Substances Control Act (TOSCA). These laws are administered by the Environmental Protection Agency. Another federal law dealing with groundwater protection, the Surface Mining Control and Reclamation Act (SMCRA), is administered by the Department of the Interior.

The Safe Drinking Water Act of 1974 (42 USC 300f-300j, 40 CFR Parts 141-147), offers the most direct approach to protection of groundwater. Under this law, the EPA sets either maximum contaminant levels (MCL's) or health advisories for various contaminants. A maximum contaminant level is an enforceable standard and must be met by public water systems serving 10,000 or more, while a health advisory serves as a guideline for state and municipal governments. However, as of June of 1989, the EPA had set standards for only approximately 30 contaminants. There remain many that are unregulated. In Montana, the Department of Health and Environmental Sciences (MDHES) administers the Safe Drinking Water Program and is overseen by the EPA. The MDHES maintains the monitoring records for community supplies.

The SDWA also established the Underground Injection Control Program (UIC). This program is designed to regulate the injection of waste that might threaten groundwater sources of drinking water. In Montana, the EPA is working with the Oil and Gas Conservation Board in the Montana Department of Natural Resources and the MDHES to regulate the injection of wastewaters into aquifers for disposal with a permitting process provided for in this program. This is primarily to protect groundwater from fluid discharges associated with oil and gas production.

Another program administered by the EPA under the SDWA is the Sole Source Aquifer Program. This program is designed to protect aquifers that are the principal source (supplying 50% or more) of a community's drinking water supply. The Missoula Valley Aquifer is such an aquifer, providing Missoula with all of its drinking water and has been designated a sole source aquifer by the EPA. Once an aquifer is designated in this way, federal agencies are prohibited from providing funds for projects or activities such as housing projects, highway projects, and sewage treatment plants that might threaten the aquifer as determined by the EPA.

The 1986 amendments to the SDWA include the Wellhead Protection Program. Under this program, all states were to develop programs to prevent groundwater contamination of public water wells by June of 1989. A wellhead protection program must specify the duties of state and local governments in carrying out the program; it must determine the wellhead protection area, defined as "the area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move and eventually enter a drinking water supply, including the area of influence or contribution around a pumping well and surrounding recharge areas." The program must include financial and technical implementations and contingencies in the case of well contamination, consideration of all potential contamination sources in the area and provisions for public participation.

Wellhead Protection Programs would enable states to get funding to protect groundwater. The EPA can give grants to states for 50% to 90% of program development and implementation costs. However, these grants depend upon Congressional appropriations. No money has yet been appropriated by Congress for the wellhead protection program under the 1986 SDWA amendments. However, the EPA has channelled funding to state wellhead protection programs from the section 106 groundwater grant (under the Clean Water Act), a portion of which is targeted for wellhead protection. Montana has received money from this source for its wellhead protection program for the past three fiscal years (1990, 1991, and 1992) but still does not have a wellhead protection program.

Even after funding, implementation may not be achieved for a long time.

The Montana Water Quality Bureau in MDHES is currently working on development of a state wellhead protection program. A limited amount of work has been done on surveying of major groundwater systems in the state.

Another law administered by the EPA is The Resource Conservation and Recovery Act of 1980 (42 USC 6901-6991(i), 40 CFR Parts 260-271). RCRA's purpose is to regulate "hazardous and other solid wastes." Its goal is the prevention and minimization of groundwater contamination from waste disposal on the land in landfills, dumps, pits, ponds, and lagoons. The EPA adopted regulations to guide states in developing solid waste management plans that are environmentally sound and minimize the threat of contamination to the groundwater. RCRA also prohibits solid waste facilities from contaminating current or potential groundwater sources of drinking water located outside the boundaries of the solid waste disposal site or another boundary set by the court. States are to take over enforcement of RCRA. Although the EPA's planning guidelines are not legally enforceable, they can be used as a basis to withhold EPA funding, and groundwater protection is explicitly the goal of any performance standards and permit approval processes set for operators and facilities. All currently existing and new hazardous waste disposal facilities are to begin groundwater monitoring programs to determine background concentrations of chemicals.

Then, if a concentration above background levels is detected for a contaminant, the second phase of monitoring begins. This phase is "assessment monitoring" and is more extensive.

EPA also has the power to require that special conditions be met by a facility for a permit to operate and to impose "site-specific" requirements for a facility if contamination is detected. The groundwater protection standards in a permit set groundwater concentration limits, which are based on the primary drinking water standards (or maximum contaminant levels) in the Safe Drinking Water Act, or on health advisories for hazardous constituents from the facility for the area groundwater. When a standard is exceeded, the facility owner or operator must initiate a corrective action or program to either remove the contaminant or to treat the contaminated water. According to the EPA drinking water standards are set below the level that actually threatens human health. However, when standards are exceeded, closing a drinking water source causes great economic costs.

In 1984, legislative protection of groundwater from buried tanks containing petroleum products and other hazardous materials was adopted by Congress in the form of the Leaking Underground Storage Tank Program (LUST) contained in amendments to RCRA. These regulations took effect on December 22, 1988. Under this program, states are to establish LUST programs that meet minimum requirements set by EPA. If the state does not establish and enforce such a program, the EPA will enforce a federal program in that state.

Under the federal program, tank locations must be known for all underground tanks, both in and out of operation. Owners of such tanks must report such information as location, size, type of, and substance contained within the tank as well as the date the tank was removed from operation, if applicable.

If a leaking tank is discovered, a two-phase corrective action occurs. The first phase requires that the owner of a tank report a leak or spill from a tank within 24 hours or a reasonable amount of time as determined by the agency. The owner must also immediately act to stop the leak, clean up visible contamination, and determine any damage to the groundwater and soil, and notify the agency as to what has been done within 20 days of the leak's occurrence. The owner must also notify the agency about what damage has occurred to the groundwater and the soil.

Phase two involves action by the agency. If contamination is still present in groundwater or soil after phase one, the agency can develop a corrective action plan to clean it up and subsequently take action to see its implementation by the tank owner through an administrative order for the owner to take action.

LUST regulations carry with them a LUST Trust Fund to pay for corrective actions taken by the agency, including investigation and cleanup. The agency can use the trust fund for such actions when a financially capable owner cannot be found, immediate action is required, or the owner refuses to take action.

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (33 USC 9601-9675, 40 CFR Part 300) or Superfund is directed at cleanup of spills and contaminations that have already occurred at inactive sites. The "superfund" provides money for immediate cleanup, but the law also provides for reimbursement of cleanup costs by the party or parties responsible for the contamination or spill. This can provide funding for cleanup of contaminated groundwater.

The Clean Water Act of 1972 (33 USC 1251-1387, 40 CFR Parts 100-140) indirectly addresses the issue of groundwater protection. The CWA is aimed at controlling the discharge of pollutants to surface waters. This law is relevant due to the interactions between surface and groundwater. Also, states can include groundwater in their definition of "protected waters." The CWA also established the National Pollution Discharge Elimination System (NPDES), which requires permits for the discharge of pollutants to surface waters, including specific standards set to protect water quality.

The Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (7 USC 136-136y, 40 CFR Parts 162-180) regulates pesticides by requiring their manufacturers to register them with the EPA. The EPA can then either restrict their use or prohibit their use if they determine that a pesticide will have unreasonably adverse effects on the environment, including the groundwater.

The Toxic Substances Control Act of 1976 (15 USC 2601-2631, 40 CFR Parts 712-799) enables the EPA to control the manufacture, use, and disposal of toxic chemicals. Manufacturers must give the EPA a "premanufacture notice" before a chemical or mixture of chemicals enters the market so EPA can determine if it poses a significant threat to human health or the environment.

The Surface Mining Control and Reclamation Act of 1977 (30 USC 1201-1328, CFR Parts 700-955) regulates coal-mining to prevent contamination of groundwater. A coal-mining operation must get a permit from the Department of the Interior or an authorized state agency to "comply with design and operating requirements to protect the groundwater from toxic mine drainage."

The state of Montana also has laws and regulations for protecting groundwater quality. In April of 1982, the Montana Environmental Quality Council (EQC), the Water Resources Oversight Committee, and the Montana Water Resources Research Center held the Montana Groundwater Conference in Great Falls. This was an informative conference for many people, including legislators, water user groups, and the general public regarding groundwater and its use, management, and protection. After this conference, groundwater experts from state and federal government agencies and state universities wrote the Montana Groundwater Status Report, which discussed critical groundwater issues in Montana and possible solutions.

In August of 1982, the EQC passed a motion asking the governor to appoint an advisory council on groundwater issues. Consequently, a Governor's Executive order created the

Groundwater Advisory Council with 16 members from the state legislature, state and federal agency personnel, university professors, people representing ranching interests, a water well drilling contractor, a lawyer, and an individual from the governor's office. Their task was to review the current framework for management of groundwater in Montana and develop recommendations on legislation or rule-making for protection of the state's groundwater resources.

The Montana Department of Health and Environmental Sciences (MDHES) is the state agency mainly responsible for groundwater protection. Issues regarding sanitary landfills and hazardous waste disposal facilities are handled within MDHES by the Solid Waste Management Section of the Solid and Hazardous Waste Bureau under the Solid Waste Management Act of 1977 (MCA 75.10.201-233), passed in response to RCRA. Landfills must be licensed under this law and must meet operational criteria. However, landfills put in before 1977 are not required to meet these requirements. When there exists the potential for a problem or an actual problem arises, the bureau can require installation of monitoring wells and the collection of baseline data, closure of the site, or remedial measures to correct the problem. The SWMB also administers the Montana Hazardous Waste Act of 1981 (MCA 75.10.401-441) modelled after RCRA. This state act regulates generators and transporters of hazardous waste by requiring permits for "treatment," "storage," or "disposal" of any "hazardous waste" and monitoring.

During the 1987-1989 legislative interim, the EQC studied issues related to groundwater protection. One result of this was that underground storage tank (UST) legislation was a priority in Montana's 1989 legislative session. Laws that were passed address: 1) MDHES's authority to regulate and enforce regulations concerning underground storage tanks and their contents; 2) prevention of leaking UST's through licensing of UST installers and permitting and inspection of UST installations and closures; and 3) responses to leaks and financial responsibility for them.

In 1986, the state began a program, administered by the Solid and Hazardous Waste Bureau, mandating the registration of UST's. The registration of these tanks began to reveal the magnitude of the problem. This, in turn, revealed the lack of sufficient manpower in the department to deal with the problem. One law passed in the 1989 session, the Montana Hazardous Waste and Underground Storage Tank Act (MCA 75.10.401 through 441), authorizes the MDHES to handle leaks of all regulated substances, that is liquid fuels and chemicals, not just hazardous materials (those in which a contaminant was identified in the petroleum). This bill authorizes the department to take corrective as well as preventive action and provides funding through the collection of annual fees for UST's (up to $50 for tanks larger than 1,100 gallons, and up to $20 for tanks less than 1,100 gallons).

Another legal development in 1989 was the Montana Underground Storage Tank Installer Licensing and Permitting Act (MCA 75.11. 201-203, 209-213, 217-220, and 223-227). This law requires a permit for installation, repair, or closure of a tank, which may also carry fees. These actions can only be performed by a licensed installer, and inspections can only be performed by the MDHES. A UST installer license, which is valid for three years, requires a demonstration of competence and experience in tank installation and closure and a written test. Fees are levied for the written examination and the license. However, farm and residential tanks with capacities of less than 1,100 gallons are exempted from requiring a licensed installer or departmental inspection. This law also provides the MDHES with authority to take action in the case of a violation of the act. License fees and violation penalties are to be used for the administration of the UST program.

The third law passed in the session is the Montana Petroleum Tank Release Cleanup Fund (MCA 75.11.301-321). This law, commonly known as "Petrofund" creates a fee on gasoline wholesalers, which is for fund reimbursement to owners/operators of petroleum UST's for expenses incurred in the cleanup of leaks from such tanks. The "Petroleum Tank Release Compensation Board" will oversee this reimbursement process, decide who can make a claim and how, and will approve corrective action plans. Reimbursement will only be for corrective action costs and for property damage or payments for bodily injury to a third party. Some tanks are not eligible for reimbursement. This law meets the requirements for a federally mandated insurance requirement for gasoline station owners and will protect smaller gasoline station operators. Leaks must be immediately reported, an investigation must be conducted, and a report and corrective action plans must be submitted to the MDHES. After approval of a plan, the department oversees the owner or operator's implementation of the action. Expenses must be documented for reimbursement. The board may guarantee in writing the reimbursement of reimbursable costs that have not yet been incurred or approved. This law was designed to encourage operators, rather than victims to report leaks.

In the MDHES, the Water Quality Bureau (WQB), administers the public water supply laws in Montana, first enacted in 1967 (MCA 75.6.101-113), which regulate the location, construction, and operation of public water supply systems. The WQB also administers the Montana Water Quality Act of 1967 (MCA 75.5.101-641) which requires classification of waters in Montana. Surface waters are classified according to their most beneficial use, and protection is established for them based on this use, including a nondegradation policy to prevent lowering of water quality where it is higher than the standards. Classification of groundwater is a bit different. It is based on "actual quality or actual use, as of October 29, 1982, whichever places the groundwater in a higher class." The specific parameters measured to determine water quality are total dissolved solids (TDS) and specific conductance. The four classes of groundwater are: I) "suitable for public and private water supplies", II) "marginally suitable for public and private water supplies", III) "suitable for some industrial and commercial uses and as drinking water for some wildlife and livestock," and IV) "may be suitable for some industrial, commercial, and other uses, but unsuitable for other higher, beneficial uses". (ARM 16.20.1002) For groundwater, a Montana Ground Water Pollution Control Program (ARM 16.20.1001-1025) has been developed, which results in classification of groundwater when an injection well, landfill, or another facility potentially affecting groundwater quality is proposed. Under this program, there are also permitting requirements for containment or disposal of potentially polluting non-hazardous wastes. There is also provision for emergency powers in the case of a spill or unanticipated discharge to the groundwater.

In Montana, the WQB also reviews subdivision proposals and administers the Sanitation in Subdivisions Act of 1967 (MCA 76.4.101-131), which specifies certain requirements for sanitation facilities in subdivisions. The WQB sets rules and standards for water, sewer, and solid waste disposal facilities. All plans for water supply systems, sewage treatment and solid waste disposal facilities, and storm-water runoff control must be approved by the bureau before a subdivision can be put in. Proposals must assure the following: 1) water will not be polluted with sewage, 2) there will be sufficient water supply, 3) state laws and rules for solid waste disposal will be met, 4) storm drainage will not pollute state waters, and 5) the public's health will not be endangered. Lot sizes are regulated when individual sewage treatment systems are used. Major subdivisions must connect to public sewer systems if they can handle the load and are closer than 500 feet, and water quality reports must be supplied.

Information must also be given to the WQB for review and the quantity of information that must be supplied depends upon the size of the proposal. Major proposals (those of six or more parcels) require significantly more information than minor proposals. Because of their closer contact with the proposed developments, county governments serve as the "eyes and ears" of MDHES and can provide MDHES with much of the data needed, such as that obtained from monitoring. As authorized by the Sanitation in Subdivision Act, MDHES can certify local health departments to carry out the required review for minor subdivisions (those of five parcels or less), but must carry out reviews for larger subdivisions itself.

Under the Sanitation in Subdivisions Act, MDHES sets on-site wastewater treatment regulations (ARM 16.16.101) to regulate construction, location, installation, alteration, and use of on-site wastewater treatment systems. These regulations are also set and enforced by local Boards of Health.

The WQB also administers the Montana In-Situ Mining of Uranium Control System (MIMUCS) for groundwater problems arising from solution mining for uranium.

The Montana Department of Natural Resources and Conservation (DNRC) has responsibility for certain aspects of the protection of groundwater, including allocation of groundwater by the water right permit system. Under the Montana Water Use Act of 1973 (MCA 85-2 parts 1-807), the use of surface water, geothermal water, or groundwater requires a permit. The DNRC must also approve changes to existing water rights regarding place of diversion, place or purpose of use, or place of storage before use. The DNRC also runs programs for financial or technical assistance to groundwater studies and development of ground or geothermal water resources, such as the Water Development Program for water-related projects or activities and the Renewable Resources Development Program for local government development of renewable resources. The Rangeland Improvement Loan Program is for livestock owners wanting to improve range conditions. The Water Use Act can be applicable to this program if a project involves use of groundwater. The Geothermal Commercialization Program provides information and technical assistance for development of geothermal resources.

The Board of Natural Resources and Conservation can designate special controlled groundwater management areas to handle groundwater problems, including mining of groundwater, legal disputes over water rights, or significant declines in groundwater pressures or levels. In these areas, the board can restrict groundwater withdrawal. The Board of Oil and Gas Conservation regulates oil and gas wells to prevent pollution of the groundwater.

The Montana Bureau of Mines and Geology (MBMG) maintains information on aquifer tests, observation water well levels, water quality, and well inventories.

Within the Montana Department of Commerce is the Board of Water Well Contractors (BWWC), which administers and enforces licensing of water well contractors in the state. The board also handles complaints from the public about wells, and it can adopt and enforce rules on materials and construction procedures.

Finally, the Montana Department of State Lands (DSL) is charged with protecting groundwater from contamination by mining. Mining companies can be required to carry on "site-specific" groundwater studies before mining begins and can also be required to monitor the groundwater during and after mining and through the completion of reclamation under the Strip and Underground Mining Reclamation Act of 1973 (MCA 82.4 Part 2) and the Metal Mine Reclamation Act of 1973 (MCA 82.4 Part 4).

Table 4.1 summarizes the federal and state groundwater protection laws for Missoula.

Table 4.1: Summary of Laws

Law	Citation	Year
Federal:	42 USC 300f-300j	1974
Safe Drinking Water Act	42 USC 6901-6991(i)	1976
Resource Conservation and Recovery Act	42 USC 9601-9675	1980
Clean Water Act	33 USC 1251-1387	1972
Federal Insecticide ,Fungicide, and Rodenticide Act	7 USC 136-136y	1972
Toxic Substances Control Act	15 USC 2601-2631	1976
Surface Mining Control and Reclamation Act	30 USC 1201-1328	1977
State:		
Solid Waste Management Act	MCA 75.10 Part 2	1977
Montana Hazardous Waste Act	MCA 75.10.401-441	1981
Public Water Supply Laws	MCA 75.6.101-113	1967
Montana Water Quality Act	MCA 75.5.100-641	1967
Sanitation in Subdivisions	MCA 76.4.101-131	1967
Montana Water Use Act	MCA 85.2.101-807	1973
Strip and Underground Mining Reclamation Act	MCA 82.4 Part 2	1974
Metal Mine Reclamation Act	MCA 82.4 Part 4	1971
Montana Hazardous Waste and Underground Storage Tank Act	MCA 75.10.401-441	1989
Montana Underground Storage Tank Installer, Licensing, and Permitting Act	MCA 75.11 Part 2	1989
Montana Petroleum Tank Release Cleanup Fund	MCA 75.11.301-321	1989

While all of these laws play important roles in protecting groundwater, these laws alone cannot assure groundwater protection. The earlier federal laws deal with protection of the groundwater in a secondary way. Threats to the groundwater are many and varied, depending on location and conditions. Consequently, it is difficult to deal with them in a comprehensive manner. The more that is covered in a single piece of legislation, the broader the ideas must be. Thus, while federal and state legislation must cover groundwater issues in a very general way, a local government can focus on the major threats to the groundwater found in that community. These threats can be determined by past contaminations of the groundwater, land uses, and the physical nature of the groundwater system. Much information is required to develop and enforce effective, efficient laws and regulations. In Missoula, where there is expertise in the area of groundwater, local government can take advantage of this expertise and devote resources to identifying and collecting the necessary local information more quickly than it could be done at the state level. For example, while the EPA is the primary enforcer of the control of 5x28 injection wells, Missoula has taken initiative to accomplish the necessary closures before the state of Montana has established a program.

Federal and state legislation help local efforts by identifying threats to groundwater and alerting local governments to potential problems, enabling local governments to deal more effectively with issues before they become problems in their areas. State and federal legislation also provide minimum requirements which prevent local governments from attracting businesses with inadequate regulation.

A local protection program in Missoula could be both specific and comprehensive more easily than state and federal legislation. Solutions can be designed to solve specific problems within a comprehensive view of all the area's problems. Because the scale on which the program would be implemented is smaller, implementation could take place more quickly and smoothly. Also, the program could be designed to meet community goals and plans. The local government is more in touch with the local people and issues.

National Survey of Local Groundwater Protection Efforts

Communities with local groundwater protection programs were surveyed in order to make comparisons and to determine what strategies would be effective for Missoula. Communities with such a program were identified in various ways. Many were examples of model programs given in seminars or publications about local groundwater protection or related issues. The individuals in charge of groundwater issues in the regional EPA offices were contacted with a request for communities and contacts in their region with programs on a local level. In order to get a geographically diverse representation, the same request was also put to individuals in state agencies who are responsible for groundwater issues.

The survey requested information about the community's use of groundwater, the main contaminants threatening the aquifer and their sources, protection strategies implemented in the community, objectives of the program, and agencies responsible for implementation and enforcement. The survey also requested any additional useful information about the program such as summaries or ordinances.

Approximately 50 surveys were sent out and 32 responses were received, many with additional information included. Table 6.1 summarizes the responses of eight communities that were selected for the closest examination. (Explanations for the selection follow.) Survey information for the 24 communities that returned surveys but were not selected for closer examination is presented in an appendix as is a copy of the survey.

Explanation of Selection of Communities for Closer Analysis

Broward County, Florida:

Broward County, Florida receives 100% of its total domestic water supply from the Biscayne Aquifer. This groundwater is used by 1.2 million people under the jurisdiction of the Broward County Environmental Quality Control Board. Broward County was selected because it has a comprehensive groundwater protection plan and legislation, which employ many protection strategies, including clearly described wellfield protection zones.

Oakley, Kansas:

Oakley, Kansas receives 100% of its total domestic water supply from the Ogallala Aquifer. This groundwater is used by 21,000 people under the jurisdiction of the Western Kansas Groundwater Management District #1. Oakley, was selected because of its thorough inventory of potential contamination sources and because it is a representative community for those communities receiving water from the Ogallala Aquifer.

Cape Cod, Massachusetts:

Cape Cod, Massachusetts receives 100% of its total domestic water supply from the Cape Cod Aquifer. This groundwater is used by 180,000 people under the the jurisdiction of the Cape Cod Planning and Economic Development Division. Cape Cod was selected because it has a comprehensive program with much information available. The program is well established and is used as a model in the Massachusetts area.

Littleton, Massachusetts:

Littleton, Massachusetts receives 100% of its total domestic water supply from the Beaver Brook and Bennett's Brook Aquifers. This groundwater is used by approximately 10,000 people, 7,000 of whom are within the jurisdiction of the Littleton Water Department. Littleton was selected because it employs many methods of protection and the program was incorporated into the state program.

Portland, Oregon:

Portland, Oregon receives from 0 to 90% of its total domestic water supply from the Blue Lake, Columbia River Sands, Troutdale Gravel, Troutdale Sands, and Sandy River Mudstone Aquifers. Groundwater is used as a back-up water supply to be blended with surface water to meet standards (e.g. for turbidity) or as a source of water in times of drought. 700,000 people use the water supply. Portland was selected because of its complete analysis of contamination sources and zoning.

Minnehaha County, South Dakota:

Eastern South Dakota receives 90% of its domestic water supply from the Big Sioux Aquifer. This groundwater is used by all of eastern South Dakota, with 130,000 people in Minnehaha County alone, unincorporated portions of which are within the jurisdiction of the Minnehaha County Planning and Zoning Department. Minnehaha County was selected because the approach is a cooperative effort between the county and the city of Sioux Falls, South Dakota.

Del Rio, Texas:

Del Rio, Texas receives approximately 98% of its total domestic water supply from the San Felipe Springs Aquifer. This groundwater is used by approximately 40,000 people, approximately 30,000 of whom are within the jurisdiction of the city of Del Rio. Del Rio was selected because it has several plans within its comprehensive plan which regulate various activities and developments.

Tacoma, Washington:

Tacoma, Washington receives portions of its total domestic water supply from the Clover/Chambers Creek Basin Aquifer. This groundwater is used by 267,000 people, (167,000 of which are dependant on the groundwater as their sole source of water). All 267,000 are within the jurisdiction of the Tacoma-Pierce County Health Department. Tacoma was selected because its program provides information about the development process for the program.

Table 6.1: Community Survey Information Summary

Community	Aquifer	Type	Discharge (MGD)	Main Contaminants	Sources	Protection Strategies	Object of Program is to Protect	Level of Protection	Enforcement Agency	Enforcement Methods
Broward County, Florida	Biscayne	Unconfined Limestone	230	VOCs, Gasoline Components, Benzene	Degreasers, LUST	ZO PPDR OS SPR GM DS SP PB	WHP Areas Aqu. Sens. Areas Recharge Areas	EPA DW stds	Broward Co. Env. Quality Control Board	Police Powers
Oakley, Kansas	Ogallala	Unconfined Sand and Gravel	5.2	Nitrates, Herbs. and Pests., VOCs	Feedyards, Ag. Uses, UST	Copy of Program Enclosed	WHP Areas	EPA DW stds	KS Dept. of Health and Environment	Fines
Cape Cod, Massachusetts	Cape Cod	Unconfined Sand and Gravel	?	Nitrates, VOCs, Sodium,	Septic Tanks, UST, WWTP, Tox. Haz. Waste Landfills, Roads	ZO HHWC SO PPDR GM SPR SP DS PB	WHP Areas Aqu. Sens. Areas Recharge Areas Surface Water	Nondegradation	Individual Towns	Possibly CCPEDC in Future
Littleton, Massachusetts	Beaver Brook, Bennett's Brook	Unconfined Sand and Gravel	Yield: 2.5 Demand: 1.2	Fe and Mn, Sodium, Petroleum Prod., VOCs	Natural, Road De-icing, Service Stations, Small Industries,	ZO SP SO HHWC OS PPDR DS PPDR PB	WHP Areas Aqu. Sens. Areas Recharge Areas	Nondegradation of GW at Property Line Below stds.	Water Dept. Board of Health	Contamination Liability for Public Water, Fines BOH violations State Ch.21E Liens
Portland, Oregon	Blue Lake, Columbia River, Troutdale-Sand and Gravel, Sandy River Mudstone	Unconfined and Confined	0 - 85	TCE	Historical Industrial Uses	ZO SPR SP DS	WHP Areas	Nondegradation	City Bureau of Buildings, Water Bureau	Building Permit Approval
Minnehaha County, South Dakota	Big Sioux	Sand and Gravel	Unknown	Nitrates, Atrazine, Herbs. and Pests., Bacteria, Controlled Org. HCs	Ag Chems. Storage Tanks and Pipelines, Haz. Materials, Septic Systems	ZO WC GM SPR SP DS OS HHWC PB	WHP Areas Aqu. Sens. Areas Recharge Areas	None Listed	County Planning and Zoning	Fines, Class II Misdemeanors and/or 30 days in Jail
Del Rio, Texas	San Felipe Springs	Limestone Formation	90	Major Threats Averted	N/A	ZO SPR SO DS SP PB OM	WHP Areas Aqu. Sens. Areas Recharge Areas	TX Water Commission and TX Dept. of Health stds.	TX Water Commission and TX Dept. of Health	Permits required for development over protection areas
Tacoma, Washington	Clover/ Chambers Creek Basin	Unconfined Sand and Gravel	Ave: 32 Peak: 109	Bacteria Pb, Nitrates, Organics, Metals	On-site Sewage systems, Landfills, Storm Drain Drywells	WC HHWC SO SP OS WC GM SPR PB	Aqu. Sens. Areas	Slow Further Degradation, Maintain DW stds	Tacoma-Pierce County Health Dept., Pierce County Surface Water Mgt.	Administrative Hearing, Criminal Penalty

Working definitions of protection strategies used by the Missoula City-County Health Department, 1990

ZO — Zoning Ordinances, comprehensive land-use requirements designed to direct the development of an area.

SO — Subdivision Ordinances, are applied to land that is divided into two or more subunits for sale or development.

SPR — Site Plan Review, regulations requiring developers to submit for approval plans for development occurring within a given area.

DS — Design Standards, regulations that apply to the design and construction of buildings or structures.

OS — Operating Standards, regulations that apply to ongoing land-use activities to promote safety or environmental protection.

SP — Source Prohibitions, regulations that prohibit the presence or use of chemicals or hazardous activities within a given area.

PPDR — Purchase of Property or Development Rights, a tool to ensure complete control of land uses in or surrounding a wellhead area.

PE — Public Education, often consists of brochures, pamphlets, or seminars designed to present wellhead area problems and protection efforts to the public in an understandable fashion.

GWM — Ground-Water Monitoring, sinking a series of test wells and developing an ongoing water quality testing program.

HHWC — Household Hazardous Waste Collection. Residential hazardous waste management programs can be designed to reduce the quantity of household hazardous waste being disposed of improperly.

WC — Water Conservation, can be used to encourage individual or commercial/industrial users to limit their water use.

OM — Other Methods. Many communities are using innovative methods that combine elements of the previous management tools. Some create management tools of their own.

Discussion of Local Groundwater Protection Programs

First, a local groundwater protection program should establish goals and objectives, such as nondegradation or EPA drinking water standards. However, it is also important to identify and consider any other community goals that might enhance or conflict with groundwater protection. This is important to prevent conflicts and to provide guidelines which will enable naturally arising conflicts to be resolved in a consistent and appropriate manner. It is helpful if predictable conflicts are dealt with before they become problems.

Another important aspect of anticipating possible problems is a consideration of how comprehensive the law should be. For example, Jeff Leighton, with the local groundwater protection program in Portland, Oregon, revealed problems encountered with their law that they discovered after it was passed. He advised including inspection authority and powers in the law. Portland's program is set up essentially as a land use/zoning review process which addresses water quality issues. A determination is made as to whether the proposed land use is allowed in the zone where it would be located. If the use is allowed, the plan is studied to determine if the proper site development regulations are met. Any other required land use approvals are identified. The ordinance describes the various zones and criteria, but does not include authorization for conducting inspections.

Another problem encountered in Portland is the mechanism by which businesses apply for permits. Mr. Leighton said that businesses must obtain a building permit only. This process does not address contamination that might occur during handling, use, or transport of the material, which are not regulated by a building permit. Also, it is possible that a business may move into a building that was previously used for the same activity and no building permit is required unless they remodel. The groundwater protection program also runs into conflict with other city bureaus with different goals such as economic development.

These problems emphasize the need for anticipation of all potential threats from various businesses and industries. If one is aware of the potential, stipulations or conditions can be applied before the actual problem arises so that problems are avoided instead of corrected. Thus, the program is proactive, rather than reactive.

Portland's problems also stress the need for cooperation with other agencies and the need to identify all goals and objectives of the community. If an aspect of the program could be more easily or appropriately handled by another department or agency, the cooperation and involvement of more people can spread out the work load and the additional involvement can help the idea of groundwater protection be more widely accepted. It is important, however, that responsibilities are clearly assigned and known by those involved to ensure that proper preventative or enforcement actions are taken. Other departments can also sometimes identify problems based on their past experience.

Delineation of the exact area that needs to be protected is important. Once the area to be protected is known, it can be determined what the best strategies are and what entities have the jurisdiction needed to carry them out. It is also possible that the agency with jurisdiction will determine the area to be protected. Mr. Leighton pointed out that the well field for Portland extends beyond the Portland city limits. Consequently, to protect Portland's groundwater, other cities must protect the groundwater also. Thus, support on the state level is important.

Another strategy frequently used by communities for groundwater protection is bylaws or regulations for hazardous materials or hazardous material handling facilities. This strategy focuses directly on a specific contamination threat. It can be applied to common groundwater-threatening chemicals which are used in various businesses or industries. One approach is to regulate facilities that use certain chemicals, facilities like auto repair shops and dry cleaners. For example, a program might contain specifications and requirements for design and performance of such facilities. The main goal of these regulations is prevention of loss of the material to the groundwater.

Controlling the fate of a substance can be achieved through laws that specify: quantities allowed on-site, proper containers, location of storage on a site, the presence of emergency holding and treatment facilities, and access for monitoring in the event of a spill. Regulations might also address building design (to prevent an avenue for a contaminant to reach the groundwater) and requirements for handling and use of the substance. Regulations should also cover transport of the material. Certain routes should be designated for the transport of hazardous materials. These routes should minimize the area of aquifer put at risk and avoid areas that pose a greater risk to the drinking water supply, such as wellhead protection areas. Transportation routes should allow for rapid runoff from the road surface to gutters that direct runoff to a temporary holding place where spills could be treated. This minimizes the potential for infiltration into the aquifer on roads used for transportation of hazardous materials. It is also important to have a spill response program that can respond to a spill quickly. Hazardous materials listed in RCRA and by the EPA provide the basis for the determination of hazardous materials. Any materials that do not have MCL's, but are under study, can be treated as hazardous on the local level.

The city of Sioux Falls, Minnehaha County, and 10 other counties in South Dakota are working together to protect the Big Sioux Aquifer. Using zoning as its chief tool, the program has established prohibited uses as well as conditions for certain uses and activities in "Water Source Protection Districts" (WSPD). The WSPD is superimposed on zoning already in place. Any additional stipulations or regulations established by a WSPD take precedence over already existing zoning regulations only if the former are more protective of groundwater. Because WSPD's efforts are joint actions of the city and the county, the WSPD may extend three miles beyond the city limits. A WSPD can impose a conditional permit on any use involving the storage and/or use of a regulated substance to employ all available practical methods to protect the groundwater.

Program staff also want to develop a system for the collection of hazardous wastes and anticipate recycling as playing a role in the future of Sioux Falls because there is no city landfill, only one at the regional level.

Another important aspect of the Sioux Falls program is public education. One of the main threats to groundwater comes from agriculture; however zoning cannot regulate farming practices. To deal with this problem, a task force was established, which involved the agricultural community. David Queal, who works on groundwater protection for the Department of Planning and Zoning in Minnehaha County, emphasized the importance of the involvement of the agricultural community. He said that the farmers were quite willing to follow guidance that came to them through the ordinary channels through which they received information. Organizations that are involved in groundwater protection efforts include the South Dakota Farm Bureau, the National Farmers Organization, and the Farmers Union.

Involving people in decisions is always preferable to telling them what to do. They can offer input as to what the problems will be, how workable a solution might be and how to make it more workable. Public involvement was important when certain

Missoula businesses were ordered to stop using dry wells and switch to an alternative method. They needed to know that the effort to protect the groundwater is a comprehensive effort and that they were not being unjustly singled out as the cause of the problem.

The agency should provide businesses with information on availability and feasibility of alternatives. Cooperation between agency and businesses and between businesses can make many alternatives more feasible since larger quantities of material can be handled more cost effectively and costs are divided among more businesses.

The city of Del Rio, Texas worked with a consulting firm to complete a study and a comprehensive plan to protect the groundwater. This plan addresses many different threats to the groundwater. One of the main focuses of their plan is to restrict most nonresidential land uses along the highway. The plan includes a recommendation that the 100-year floodplain should not be reclaimed for development. Single family residences and "support land uses" such as schools and parks should be the main land uses in areas more vulnerable to contamination. The plan also states that future plans for land use, water, wastewater, thoroughfare, and storm drainage should reflect primary concern for the environment.

Subdivisions must meet certain requirements. Streets must be developed in accordance with specifications, and the city and developer share the costs of proposed major thoroughfares and frontage roads. Also, thoroughfares must be designed to minimize through-traffic. Collector streets must meet certain requirements to discourage their use as "alternative thoroughfares." Also emphasized is the minimization of water crossings.

The Del Rio plan addresses subdivision wastewater planning because septic tanks are a significant threat to groundwater. To minimize this problem, if a wastewater main comes within 1,000 feet of a subdivision, the main must be extended. Otherwise, septic systems may be used, as long as the following conditions are acceptable: the density and type of the dwellings served, distance to other systems, and system design. Septic systems are subject to unannounced, surprise inspections by the city. The plan advises installation of monitoring wells and testing every six months to detect contamination of groundwater and mapping of all septic tanks in the protection area. The plan also advises requiring city approval of wastewater service or septic system plans and licensing of septic system installers. Finally, the plan specifies location requirements and minimum distances between other septic systems and wells. This system emphasizes careful planning and close watching to keep contamination from septic systems to a minimum.

Another relevant issue addressed by this plan is storm-water runoff. The proposed method of dealing with this threat is retention ponds which would allow controlled release of the water to the ground and passage of the water through the soil before it is released to the groundwater. The holding time provides time to take action if a contaminant should enter the groundwater from this source, and passage through the vadose zone can remove some constituents by adsorption. In some cases tanks may be more appropriate than ponds. In either case, it is retention that is important, not the container as long as the container does not pose a threat to the groundwater.

The survey response from Tacoma, Washington described their program's development process. The program was developed because there was a general deterioration in the groundwater quality in the basin. Their specific problems included chloride, bacteriological contamination, and nitrates as well as toxic chemicals. This discovery prompted a hydrogeologic study of the valley. The Tacoma-Pierce County Health Department took the lead role in development and implementation of the program and a Groundwater Advisory Committee (GWAC) was appointed to help in the process. The process involved an analysis of Tacoma's current protection system as well as recommendations for improvement. One of the motivations for the development of a protection program was the fact that cleanup of a problem was so much more expensive than prevention. The program's goals included working with and building upon regulations and programs already in place, and protecting the groundwater without restricting other goals such as community growth. Even before the program was developed, a source of funding for each activity in the program was specified. Some key elements of their program are: 1) strong regulation and remedial activities at solid waste disposal facilities, 2) specifications for construction of new waste disposal facilities, 3) educational efforts for agricultural practices and small quantity hazardous waste generators, 4) hazardous material spill control and pretreatment system requirements for commercial and industrial users of on-site sewage disposal systems, 5) focus on limiting the impacts of transportation related spills of hazardous materials from storm-water runoff, 6) long-term monitoring in the basin, and the encouragement of water conservation through such means as plumbing codes.

Funding for various parts of the program comes from sources such as underground storage tank fees for an underground storage tank program, initially started with a state grant. Another funding source is a fee ranging from $25 to $110 based on time involved and materials required for review of hazardous materials management plans for commercial and industrial facilities. They also hope to secure a state grant to fund a year of groundwater monitoring.

Considering funding before development of a program helps ensure a more thorough analysis of the practicality of a strategy. Broward County, Florida employs a comprehensive county-wide wellfield protection program, directed at protection of the public potable water supply. Zones of influence for public wells were mapped through computer modelling with a projected population for the year 2020. (Mapping is updated annually). No use, handling, or disposal of regulated substances is allowed in the immediate area surrounding a well (zone 1). Regulated materials are permitted in zone 2 (the area around zone 1), provided that certain conditions are met, including quarterly monitoring of water from the well for those regulated substances.

Zone 3 surrounds zone 2 and requires annual permitting for the use, handling, or production of a regulated material. Zone 3 permits contain specific requirements for such activities (a portion of the requirements imposed in zone 2). All activities regulated by this program are required to install at least one monitoring well with inspection and sampling rights being possessed by the appropriate county agency. The regulated activity must file certified quarterly analyses with the county agency.

Exemptions are allowed in zone 1 for regulated substances not present in sufficient quantity to be a hazard. Quantities less than two gallons or 16 pounds or for retail sale where the material is in a sealed container are exempted. Continuous transport of regulated materials is allowed. Use of pesticides, herbicides, and fungicides in pest or weed control is allowed if the application is done by a licensed applicator and is completed within state and federal regulations. Nitrates in fertilizers are also exempted in quantities less than two gallons or 16 pounds. The exemption of a substance in zone 1 requires that a wellfield protection operating permit be obtained for that substance annually. Such a permit describes specific conditions that must be met regarding the substance. The permit will also contain all the requirements that a substance in zone 2 must meet. Additional exemptions are allowed for underground storage tanks in zones 2 and 3 (there are other regulations that deal directly with underground storage tanks), and automotive accessory uses at gasoline stations in zone 3. Additionally, an individual may petition the Board of County Commissioners for an exemption.

Many of these exempted substances are materials that are common contaminant problems and have been a problem in the Missoula Valley Sole Source Aquifer. Consequently, if exemptions must be included, it is important to realize that other regulations are necessary to minimize the threat to the aquifer from these sources.

In the event of contamination of a well, any activity in zone 2 listed as a source of the contaminant must stop accumulation of the contaminant within three years, unless the specific source is known, in which case only that source must stop. Alternatively, the well's area of influence may be altered by altering the pumping rate or relocating the well hence removing the source from the area of influence.

Once the zones for wells were delineated, the Water Resources Division of Broward County (the administrative body for the program) requested and received county tax money from the general fund of the county to fund the program.

In zone 1, WRD took a preventative approach and either funded relocation of noncomplying businesses out of the zone or relocation of the well where the expense of moving the businesses was prohibitively high. The cost of this stage of the program was 1.5 million dollars (R. Shair, pers. comm.).

The decision to either remove the business or shut down a well is based upon the relative costs of the alternatives. An individual from the Water Resources Management Division of Broward County asks the business how much they would require to move out of the zone and asks the city how much they would require to shut down the well and put in a new one somewhere else. Robert Shair reports that the first amounts named are generally quite high (approximately $1,000,000) but that usually both entities come down in price. When amounts are more reasonable (generally about $250,000), the entity with the lower price receives the amount required.

The Broward County ordinance makes permission for county inspections of the premises a condition of a Wellfield Protection Operating Permit. These inspections may be made without notice during operating hours and refusal to allow an inspection can be sufficient grounds for revoking the permit. Broward County can also use injunctions to stop unpermitted activities requiring a permit. Punishment for violations of the ordinance can be a fine of up to $500 or imprisonment of up to 60 days.

This ordinance is illustrative and typical of wellfield or zoning ordinances used by many communities for groundwater protection. It provides for the necessary inspection authority that Mr. Leighton said the Portland Ordinance lacked. The ordinance also lists regulated toxic and hazardous materials (EPA's priority toxic pollutants likely to be present in the area of Broward County). This enables Broward County to focus on those substances most likely to be a threat to their aquifer.

Oakley, Kansas has also adopted a wellhead protection program to protect the public water supply. The city worked in connection with the Northwest Kansas Groundwater Management District #4, the western Kansas Groundwater Management District #1, and the Kansas Corporation Commission. Oakley identified a wellhead protection area as defined in the Safe Drinking Water Act amendments and completed a computerized inventory of potential pollution sources by inquiring door-to-door about abandoned wells, cesspools, septic tanks, and underground storage tanks and lines. The program established a sampling schedule for the city's public water supply for specific parameters and recommended additional sampling of wells that are up-gradient of the water supply for agricultural contaminants. Their program also contains a summary of alternative water supplies in the case of contamination.

Cape Cod, Massachusetts uses bylaws and health regulations for groundwater protection. These were developed by the Cape Cod Planning and Economic Commission. They address the issues of underground fuel and chemical storage tanks, toxic and hazardous materials, and water resource districts. Storage tanks are required to be registered with information about size, type, age and location of the tank. All tanks must also have an accurate method for gaging volume and reporting amounts delivered during service. All leaks or spills must be reported immediately to the fire department. There are specific laws regarding design, installation, and location.

To control toxic and hazardous materials, registration, inventory, and storage compliance are required. Their system of a water resource district system is similar to others. Certain areas require permits for certain activities. This law also contains violation penalties and authority for inspections.

Cape Cod also has a list of publications on information relevant to groundwater protection that is available to the public. The extensive list includes work done since 1976 on hydrogeology, studies of contamination events, protection efforts, and laws and regulations. This public information makes it easier to respond to questions and provides consistency in responses to questions.

In the late '70's, the Cape Cod area established a regional groundwater quality council, consisting of representatives in health and water departments from towns in the region. The council also held a forum to hear views on the issue of groundwater protection. This forum provided the basis for individual towns to develop their own strategies. The individuals who attended the forum then became instrumental in their own community's programs. The forum gave them the benefit of other ideas for their programs, while still enabling them to develop programs specifically designed for their communities.

The town of Littleton, Massachusetts has a local groundwater program that was incorporated into the state program. Littleton has bylaws for hazardous materials and for an Aquifer and Water Resources District. The purpose of the hazardous materials bylaw is to protect the groundwater supply. The bylaw requires registration with the Board of Health of certain quantities of hazardous materials as determined by the Division of Hazardous Waste under the Massachusetts general (county) laws. The Board of Health can also require that an inventory be kept on a premises and compared with purchase, use, and disposal records on a monthly basis to detect loss of material. The Board of Health can require registration or inventory of substances not specified in the law or smaller quantities than those specified in the law. Before deciding to keep registration or inventory of such a substance, the Board of Health is to consider cost, inconvenience, and degree of hazard. The bylaw also contains requirements for storage, above and below ground.

The Littleton Aquifer and Water Resources District bylaw sets up Aquifer and Water Resource Districts (AWRD's) which overlay existing zoning districts. Current zoning is still in place, but certain uses are either prohibited or require a special permit by the AWRD when its stipulations are more stringent. The Planning Board is in charge of issuing special permits, based on simplicity, reliability, and feasibility of the proposed measures and the degree of threat to the groundwater if contamination were to occur. The bylaw also contains specifications regarding information that must be supplied to the Board, as well as design and operation guidelines such as safeguards, locations, disposal, drainage, and periodic monitoring. There are also specifications for ice control chemicals and violations of the law.

These bylaws look at individual situations and consider various aspects before a decision is made about registration, inventories, or permits. However, there is always the possibility that there is not enough manpower to do all of this in a reasonable amount of time. In such cases, it becomes a question of how much time can be spent and what is most important. The ultimate goal of the groundwater protection program should be kept in mind when determining priorities and not compromised if at all possible.

Savos Danos, the Assistant General Manager of the Littleton Water Department, explained what he believed were the key elements of their program. The program in Littleton is an active program, that is, they have people who constantly work on it: citizens are involved with it daily. He also emphasized that the program not be seen as anti-business. Instead, the business community should be involved. Under Littleton's program, industries are subject to hazardous materials audits and inspections, but education is an important part of their program for businesses. Mr. Danos said it is important that the businesses understand the hydrogeology involved, so maps of well locations are provided for informative purposes. When a program is first implemented, problems can occur with pre-existing uses. In such cases, Mr. Danos said it is best if regulators talk with the businesses about it.

Mr. Danos also believes public education is a strong part of their program, which publishes newsletters and pamphlets to teach people about groundwater protection. Tacoma, Washington also emphasizes public education. Jane Hedges, Senior Environmental Health Specialist in the Tacoma-Pierce County Health Department used a grant for public education to publish and distribute a fact sheet and placed ads in the newspaper. They also produced two public television spots, wrote press releases, and provided speakers from the department. Additionally, they placed display boards in public places.

Another part of the Littleton program that Mr. Danos believes to be important is their Household Hazardous Waste Collection. They have a hazardous waste collection day either annually or every other year in the fall. To set it up, a committee was established, which consisted of people from the community. The city then solicited a hazardous waste collection firm that would become liable for the disposal of collected waste. The city held town meetings and sent handouts to schools to publicize the event. The collection is for residents only and only ten gallons are accepted per household. Mr. Danos also said that forms and containers were provided. The cost was approximately $20,000 for 7,000 people in the first year. Danos emphasized the importance of state support for the program.

City-sponsored household hazardous waste collection should reduce nonpoint pollution, but may be costly and requires coordination of all involved parties, such as a waste disposal company. Alternatively, the state of Connecticut puts out a publication on what household items are hazardous materials, what their potential hazard is, what is the preferred disposal method, where to call with questions about a product and guidelines for safe use and disposal. They also put out a list of safer alternatives to be used in place of hazardous household products such as cleaners, polishes, and disinfectants. These information sources provide people with information about the best means of disposal for their products and require much less effort than the organization of household hazardous waste collection. They can also be enacted more quickly.

Recent Developments in Groundwater Protection in Montana and Missoula

Legislative protection for groundwater continued to increase at the state level during Montana's 52nd legislature in 1990-1991, with bills introduced in both the Senate and the House that expand or more clearly specify the authority of various state agencies.

The authority of the Montana Bureau of Mines and Geology (MBMG) to protect groundwater has increased through the establishment of a Groundwater Assessment Account, which the MBMG will administer. The Board of Water Well Contractors is to create a Groundwater Steering Committee, which will oversee the MBMG statewide groundwater characterization and monitoring program. This program will provide information for a GIS database.

One new law specifies that projects for research and demonstration of low agricultural chemical input farming practices proposed by a public entity is eligible for grants given under the Renewable Resource Development Programs.

The Board of Health and Environmental Sciences will set minimum standards for control and disposal of sewage and local Boards of Health will set local standards within the state's standards.

MDHES's powers were also expanded. It can now issue cleanup orders to other state or local agencies that give approval to activities that are likely to pollute state waters. MDHES will also receive a portion of a newly created Water Quality Rehabilitation Account, consisting of fines and civil penalties paid for violations of the Montana Water Quality Act.

One particularly relevant law, introduced as senate bill 136, provides for the establishment of local water quality districts and authorizes local governments of communities within these water quality districts to pass laws for water protection. It also gives the DHES approval and monitoring powers over local water quality programs and their implementation.

In addition to the passage of new laws, other activities occurred in 1991 at the state level promoting groundwater protection. A coordinator for Montana's Wellhead Protection Program was hired by the Water Quality Bureau and a Wellhead Protection Advisory Committee was appointed by the Director of DHES to make recommendations about a WHP program for the state.

Also, the Department of Agriculture and DHES published rules for implementing the Agricultural Chemical Ground Water Protection Act (MCA 85-15) and a coordinator for the program was hired by the WQB.

As state protection of groundwater increased, local protection of groundwater in Missoula also grew. On November 1, 1990, the Missoula City-County Health Department, aided by local and federal agencies, began a program for the regulation and closure of shallow injection wells in Missoula as mandated by the EPA due to violations of the Safe Drinking Water Act. This program is, in part, funded by an EPA demonstration project grant under its Underground Injection Control Program. The grant is titled A Demonstration of Local/Federal Implementation of the Shallow Injection Well Program in Missoula, Montana, and its purpose is to demonstrate local/federal implementation of a program and an integrated approach to environmental protection in the case of groundwater contamination by shallow injection wells.

This project is a demonstration of federal/local implementation because there is no state regulation of injection wells in Montana. Federal/local implementation enables local government to develop environmental regulations as part of a more comprehensive protection plan more directly and quickly than if state regulation needed to be in place.

The integrated approach is demonstrated by implementing new regulations along with other, already-existing, regulations or programs or by developing them in anticipation of their fitting into a program to be developed and implemented in the future. An integrated approach saves work, time, and money. By doing inspections of injection wells on trips made to the facility for another inspection or purpose, an extra trip is saved, along with the associated extra work and cost involved.

This project has two phases. The first phase took place from November of 1990 to October of 1991. Phase I consisted of gathering information about and regulation of 5x28 wells, which the EPA defines as "automobile service station disposal wells used to inject wastes from repair bay drains at service stations, garages, car dealerships, car washes, etc." (EPA fact sheet, Underground Injection Control)

During the inspection portion of Phase I, all wells defined by the EPA as Class IV and Class V wells were documented (see footnote for definitions of these wells[1]). However, only 5x28 (one kind of Class V well) were inspected and inventoried. MCCHD defines 5x28 wells as dry wells, cesspools, and septic systems that take waste to a drainfield or seepage pit associated with liquid waste fluids from servicing equipment or equipment components used with internal combustion engines (MCCHD, 1991 draft).

Phase II of the project began at the completion of Phase I and will continue until April of 1993. This phase concentrates on regulation of 5W20 wells (another kind of Class V well), which are "industrial process water and waste disposal wells, those used to dispose of a wide variety of wastes and wastewaters from industrial, commercial, or utility processes. Industries include refineries, chemical plants, smelters, pharmaceutical plants,

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[1] Class V are all those wells that are not in Classes I through IV. The EPA definitions of Classes I through IV are as follows: Class I are wells that inject hazardous and non-hazardous waste beneath the lowermost formation containing an underground source of drinking water within one-quarter mile, Class II wells are wells used in conjunction with oil and gas production, Class III wells are wells used in conjunction with solution mining, and Class IV wells are wells that inject hazardous or radioactive waste into or above a formation within one-quarter mile of an underground source of drinking water.

laundromats and dry cleaners, tanneries, laboratories, petroleum storage facilities, electric power generation plants, electroplating industries, etc." (EPA fact sheet, Underground Injection Control)

In addition to locating and documenting 5x28 wells and 5W20 wells, another goal of the program is to provide help to businesses that must comply with the EPA's mandated well abandonment. The program involved inspecting all facilities suspected of having a 5x28 well within the Greater Missoula Urban Area, including Missoula, Milltown, and Lolo. MCCHD helped business owners fill out EPA's information request forms on shallow injection wells, served as a connection between EPA and local businesses, and supplied information to businesses on acceptable disposal alternatives. They are providing EPA with services associated with proper closure of the wells and are storing relevant information in a computer database for use in the GIS system of local groundwater protection. Finally MCCHD characterized and classified waste streams resulting from alternative disposal methods.

The project sought to define more clearly the roles of involved agencies to ensure that all necessary actions were taken, and to develop a program under which enforcement can first be handled by the county, then the state, and finally the EPA, if necessary.

To address the problem of new 5x28 wells, MCCHD put out a public notice in the mail to local firms engaged in or involved with new construction and ran an ad in the local paper, the Missoulian. This notice contained information on the new requirement to stop construction of 5x28 wells. MCCHD also gave the City Building Inspectors a list of relevant businesses for MCCHD plan review.

The development of alternative methods of disposal took place in close connection with the Water Quality and Hazardous Waste Bureaus of MDHES to ensure compliance with state laws and regulations. Information on the closure of wells is retained by both MCCHD and EPA.

MCCHD has received another EPA grant, titled A Regulatory/Management Program and Transfer of Information for Wellhead Protection and Groundwater Protection. This project will attempt to integrate WHP efforts of the WQB and Mountain Water Company to protect the Missoula Valley Sole Source Aquifer, to distribute information locally on WHP and to help the WQB promote WHP in Montana.

Work has begun on the establishment of a water quality district (WQD) as provided for in SB 136. The MCCHD has outlined the steps necessary for the creation of such a district. The bill allows the defining of boundaries for the district around areas "in which water quality problems have been documented." The fact that "problems" are not defined is advantageous for inclusion of all relevant areas.

The first step in establishing a WQD is a public meeting. If there is greater than 20% protest, the issue goes to a referendum, and, a resolution of intent must be passed. This resolution must include: 1) "the proposed name of the district", 2) "the necessity for the proposed district", 3) "a general description of the territory or lands included in the district", 4) "a general description of the proposed water quality program", 5) "the initial estimated cost of the water quality program, and" 6) "the initial proposed fees to be charged." The next steps are provision of an opportunity for those to be assessed fees to protest and a public hearing to hear and decide upon expressed protests.

The WQD proposed for Missoula includes "Mt. Sentinel west to confluence and lake bed sediments, the airport and west to the end of the Missoula Aquifer, East Missoula and east to Bonner-Milltown and the reservoir, and Lolo and north to the Miller Creek area." Additional information about water problems and political and budgetary analysis must also be included. (MCCHD, 1992 draft) Any municipality within the boundaries of a water quality district may be exempted from the district if it wishes to be.

The board for the district may be comprised of either the city-county board of health or may be created from other local boards already in existence. Also, the County Commissioners must approve the area in the district, the statement of necessity, and the board.

The next step is the development of a preliminary budget for the first year of the WQD, explaining how the district will approach accomplishment of its goals and including "staff and personnel costs for program development and implementation;

research funds for the costs of monitoring wells, source investigations, analyses, and modeling; capital, and operations and small capital items." (MCCHD, 1992 draft) Simultaneously, there should be determination of the number of housing units to be assessed fees.

Fees must be based on the volume of water withdrawn and the volume and type of waste produced. Irrigation and livestock withdrawals may not be assessed fees and property fees must be $5-10 per year, with industrial fees being no greater than 50 times the standard rate.

In addition to providing for WQD's, the passage of SB136 gives local governing bodies the ability to pass local ordinances regulating specific pollution sources. This law makes regulation of "storm water runoff from paved surfaces" possible so that putting a hazardous substance down a storm drain can be made illegal. This would allow Missoula to address the issue of contamination from storm water runoff.

Local ordinances may be "compatible with or more stringent" than state water quality regulations. Limitations are placed on ordinances so that a facility affected by the ordinance will not become subject to actions under CERCLA because of the ordinance and the facilitiy's requirements under other state agencies' regulations are not affected.

Boundaries of the water quality district can be changed once the district is established by a specific procedure and DHES will have approval powers over the water quality district. Also, DHES' rules and regulations supersede any conflict with local ordinances. DHES can also have control over sources which require more control than local government can provide. Establishment of a water quality district will enable local governments to more effectively protect the groundwater.

Efforts to protect Missoula's groundwater are also being made in the private sector. Mountain Water Company (MWC), the water purveyor for Missoula, Montana is a privately-owned, stock-held company. Arvid Hiller is vice president and general manager of Mountain Water. He was promoted to current position on April 1, 1990, one week after the contamination of the Maurice Street well. The contamination of this well brought groundwater and its quality into scrutiny by Hiller as well as MWC and all of Missoula.

Hiller had some experience with the interagency task force, which had been established to address the sole source aquifer, protection of water quality, and finally a Wellhead Protection Program as required by EPA. When the Maurice Street Well was contaminated, Mountain Water Company worked with the MCCHD to find the cause.

With the publicity brought about by the Maurice well problem, public interest in the water supply rose. Consequently, MWC began public education efforts. These efforts included radio spots, billboards, and newspaper ads. They also created an informational pamphlet on Missoula's source of drinking water and what individuals can do to protect it.

In addition to public education efforts, in August of 1990, Hiller received authorization from MWC's owner to commit MWC money to research and development of a wellhead protection program. Subsequently, Hiller presented the County Commissioners with Mountain Water's program for wellhead protection and also went before the City Council and the mayor, requesting a resolution supporting Mountain Water's efforts towards wellhead protection. The resolution passed unanimously. Hydrometrics, Inc., an environmental consulting firm that advised MWC on the Maurice Well problem as well as well-siting in Missoula, was hired by MWC to develop a wellhead protection program for Missoula. Hydrometrics subcontracted with various individuals and the Health Department to complete portions of work for the plan, including an inventory of sources of contamination which was then mapped by Hydrometrics.

Working with the various individuals and groups that had been involved with wellhead protection, MWC prioritized what needed to be done for wellhead protection as it related to zones. At that point, MWC began the next phase of the process, implementation.

Hydrometrics' plan for wellhead protection (Hydrometrics, 1992 draft) states that local government would be the leading body of authority. The plan recommends that existing laws and regulations be employed as they already contain a framework for regulation of groundwater users, general sources, specific sources, land use, and inspection, containment, and cleanup requirements.

Hydrometrics also considers use of various management techniques, including their advantages and disadvantages. They examine such techniques as 1) zoning ordinances, 2) subdivision regulations, 3) municipal ordinances concerning storage and handling of regulated or hazardous materials, 4) review of site plans, 5) design standards and building codes, 6) operating standards, 7) source prohibitions, 8) purchase of property or development rights, 9) investigations for verification of environmental soundness at business transactions, 10) groundwater monitoring, and 11) public education. (Hydrometrics, 1992 draft) Specific recommendations are made for managing various sources of contamination using the previously mentioned techniques and for researching potential alternative sources of drinking water in the valley. Hydrometrics also included discussion of a water quality district in their report.

MWC supported SB136 because they believed a WQD to be a key approach for water quality protection in the valley (Hiller, 1991). They saw this as one way to establish a wellhead protection program that could serve the city of Missoula and MWC area of service, and could be readily adaptable to the rest of the valley. (Hiller, 1992) Consequently, MWC has planned for their wellhead protection plan to be acceptable in a water quality district when one is eventually put into place.

The latest activity of the implementation phase is researching all existing local, state, and federal laws that may apply to wellhead protection and how they might fit into a wellhead protection plan for Missoula. The subcontractor's resulting recommendations were accepted and incorporated almost totally by an independent, advisory group of technical individuals and engineers used by MWC to determine technical and political acceptance of the program. MWC then determined that the most immediate step to take was a wellhead protection ordinance. They believed it was necessary to fund the administrative aspects of the ordinance through fees placed on users of potential contaminants and underground storage facilities. MWC believes that Missoulians are ready to support groundwater protection financially, having been made aware of the need through public education efforts (Hiller, 1991).

MWC designed the ordinance to fund wellhead protection. However, other areas of need such as public education, sumps, the sewer system will not be addressed. MWC believes that these issues can only be addressed through a water quality district. Thus the city and county have pledged to integrate the ordinance into the city system so that it can be made part of the water quality district. Nothing in the ordinance prevents this. Currently, the financing portion of the ordinance is being finalized. On Feb. 6, 1992, there was a panel discussion on the wellhead ordinance and a future water quality district to gain the support of the community and businesses for such actions to protect the groundwater. MWC's plan is to spend money now to prevent a problem ten or fifteen years from now that the community will not be able to afford to clean up.

Through the combined efforts of local, state, and federal governments, and of MWC and other private interests, protection of Missoula's groundwater should progress at a fair pace. As new information is obtained a more effective and comprehensive effort can be made. The investment of time, money, and work is well worth the preservation of good water quality.

Recommendations for Protection of Missoula's Groundwater

In choosing alternatives for a program for Missoula, goals and objectives for the program must consider as many issues and potential conflicts as can be anticipated. Missoula's unique government and community requires tailoring of programs or strategies to our situation. However, there are certain strategies that other communities are already using that they find effective.

My recommendations for Missoula based on this survey include:

1) zoning for protection of wellhead areas;
2) continuing public education efforts for all ages;
3) establishment of a water quality district including regulation of material disposal in storm drains;
4) active encouragement and cooperation with underground storage tank owners for compliance with state laws;
5) making use of future statewide monitoring for water quality information; and
6) floodplain protection for the Clark Fork as a recharge source.

The most common means of protection seems to be zoning for the purpose of protecting the groundwater. This method is a very direct way to protect the water supply because it identifies critical areas in terms of contamination and actively regulates uses that threaten the groundwater and protects those portions of the aquifer from which the water supply is drawn. However, the Missoula Sole Source Aquifer is highly transmissive and supports many private wells in addition to MWC production wells. Hence, there are many large, overlapping wellhead areas over the entire aquifer, and the area needing protection is essentially the entire area over the aquifer. Consequently, restrictions on activities and facilities are a more practical approach than are prohibitions.

However, the traditional free spirit of the West often makes zoning unpopular among corporations and individuals. Additionally, zoning may only address future land uses because present land uses are often exempted. Although Broward County, Florida bypassed this problem by removing businesses or relocating wells, most communities, including Missoula, cannot afford these actions.

Acceptance of zoning and other approaches can best be achieved through education. Because groundwater contamination is becoming a more common occurrence in Missoula, the public has more incentive to know where their water comes from and how to keep it clean. This can make public education efforts more effective. It is important to reach as many people as possible and not just those with a special interest in the groundwater. Reaching children in schools gets people thinking about groundwater early and will help the future. Another good way to reach people is through the media, newspaper and television.

These avenues are used by many people and would reach a wide audience. The Maurice Well incident raised public awareness in Missoula about drinking water. Mountain Water Company has provided much public education through the use of billboards, radio spots, and informational pamphlets included in water bills.

Because so much recharge to Missoula's aquifer comes from the Clark Fork, it is important to protect this recharge source. The use of riverside land as parks and trails is a good method to protect the river, as well as regulations about location of activities within the floodplain, especially the storage, handling, and use of hazardous materials within the floodplain.

The threat posed by storm-water runoff is handled in some localities by requiring a system to collect runoff to provide time to remove or treat a contaminant and filtration through the soil to remove some contaminants. Such a system could consist of holding ponds at individual storm drains or with more centralized systems that serve all storm drains within an area, determined by the capacity of each system. However, this would be prohibitively expensive in Missoula. Consequently, an approach must be taken that minimizes contaminants going into the drains.

With the passage of a law authorizing local governments to create water quality districts and pass laws for groundwater protection, the Health Department can now regulate the dumping of hazardous materials down storm drains. However, public education is also a good way to address this issue. Efforts have already been made in this area. The Clark Fork Coalition with volunteer help groups like the boy scouts stenciled short informational messages at some storm drains downtown. These messages contained a picture of a fish and read, "Dump No Waste, Drains to Stream." Mountain Water Company plans to contribute money for stencils and materials to this project to apply it to a larger area.

The state's underground storage tank legislation should reduce this threat; however, local attention to this problem is needed. Local governments can serve as a connection between the state and local levels by informing local businesses of alternatives that will put businesses in compliance with state laws and work best in Missoula. Because much of the problem exists with tanks that are reaching the end of their lifetimes and are leaking, cooperation with businesses is needed to to achieve compliance with new regulations regarding new and existing UST's.

In Missoula, success of groundwater protection efforts will depend upon changes that are made in current practices and habits, such as disposal of wastes in 5x28 wells, installation and closure of underground storage tanks, and response behavior when a leak occurs. Depending upon the approach and attitudes of those involved, it can be a smooth or a difficult transition. Government agencies must keep businesses informed about the problems and the alternative solutions, and must listen to their ideas and concerns throughout the development of protection strategies.

Contamination problems for which no definite source can be identified are more difficult to solve. Determination of the source becomes a major focus, and until the specific source is known, actions taken to stop the contamination must cover all possible sources within the area. Thus, detection of contamination at the earliest possible time will minimize the harm done and the expense of correcting the problem. This can best be achieved with monitoring on a regular basis. Monitoring should concentrate on parameters that are significantly dangerous or more likely to cause a problem. Monitoring should also be used to follow a contamination problem as it progresses. The threat of contamination and the cost of finding a replacement source of water must be weighed against the cost and capability of monitoring.

The Montana Bureau of Mines and Geology will carry out a groundwater characterization and monitoring program with a statewide network of observation wells. The funding for this program will come from four sources until July 1, 1993: 1) drillers licence fees for water well contractors, 2) the ten dollar fee for acquiring the water right for wells of less than 35 gpm, 3) the one dollar per acre-foot volume of water pumped per year for wells greater than 35 gallons per minute, and 4) 25 cents from each $2.25 hookup fee paid by utilities and water companies to the state. This source of funding is expected to bring in about $90,000 for the program. Starting July 1, 1993, the account will receive money from the Indemnity Resource Trust Tax. The groundwater account will receive 14.1% of this tax up to a limit of $666,000 total value for the account. The Bureau will maintain the information collected in a GIS database and over the next 21 years will systematically assess groundwater aquifers in Montana, guided by a Groundwater Assessment Steering Committee.

Because groundwater protection on a local level is a new concept, cost is likely to be fairly significant. For this reason, it is important to prioritize problems so that the time, effort and money put into such a program is well expended and provides effective protection and a firm foundation on which to build later efforts. It is important that the need for local protection be clearly realized throughout the process by all involved.

Groundwater contamination could be a very serious problem for Missoula. Preventing contamination is more feasible and cost effective than cleanup. The sooner prevention efforts begin, the greater the reduction in the risk and magnitude of contamination problems. Good local groundwater protection is essential to our daily quality of life as well as our economy.

Appendix A

Survey of U.S. communities with local groundwater protection programs.

Local Groundwater Protection Program Survey

The Missoula City - County Health Department is conducting a survey of communities with local groundwater protection programs. The following is a questionnaire about your community and groundwater protection program, please include any additional information (i.e. ordinances, projects, summaries) that is pertinent to this request.

Agency Information

1. Agency ______
   Contact ______
   Address ______ Phone ______

Community and Background Information

2. Name of aquifer? ______
   Type? (i.e.unconfined sand and gravel) ______
3. Population within aquifer service area*? ______
   That portion within agency's jurisdiction? ______
4. Percentage of total domestic water use from the aquifer supply? ______
5. Average daily discharge from aquifer (all sources; individual and municipal wells)? ______
6. List the main contaminants that pose the greatest threat to the aquifer. ______
7. List typical sources for the above contaminants. ______

Protection Strategies

8. Methods used to employ groundwater protection strategies as defined on the attached sheet. (Check all those applicable.)

( ) Zoning Ordinances	( ) Household Hazardous Waste Collection
( ) Subdivision Ordinances	( ) Purchase of Property or Development Rights
( ) Operating Standards	( ) Site Plan Review
( ) Groundwater Monitoring	( ) Design Standards
( ) Source Prohibitions	( ) Public Education
( ) Water Conservation	( ) Other Methods

9. The objective of your GW protection program is to protect:
   ( ) Wellhead protection areas.
   ( ) Aquifer sensitive areas.
   ( ) Recharge areas or zones.
   ( ) Other. ______
10. What level of protection is sought by your GW protection program? (i.e. nondegradation, EPA Drinking Water Stds.) ______
11. List programs implemented by state agencies incorporated into local GW protection program. ______
12. If applicable, list agency(s) responsible for enforcement of your GW protection program. ______
13. List enforcement methods used in your GW protection program. ______

* areal extent of the population that is served with drinking water from the aquifer.

Appendix B

Survey Information for Communities Not Selected for Closer Analysis

Appendix B : Survey Information for Communities not Selected for Closer Analysis

Community	Aquifer	Type	Discharge (MGD)	Main Contaminants	Sources	Protection Strategies	Object of Program is to Protect	Level of Protection	Enforcement Agency	Enforcement Methods
Tucson, Arizona	Tucson Basin	Unconfined Alluvial Basin	178	VOC's TCE PERC	Industry-Solvent Use	GM HHWC SP	WHP Areas Aqu. Sens. Areas Recharge Areas	EPA DW stds Nondegradation-state policy	EPA ADEQ ADWR Pima Cty DEQ Tucson Fire Dept	Permitting Inspections Self-monitoring reports
Dade County, Florida	Biscayne	Unconfined	560	Petrochemicals Industrial Solvents Nitrate Fertilizers	UST Improper Solvent Disposal, Heavy Fertilizer Use	ZO SP OS SPR GM HHWC DS PPDR PE	WHP Areas Aqu. Sens. Areas Recharge Areas	Nondegradation-Pristine Clean-up of Contaminated	County Dept. of Env Resources Mgt	Vol. Compliance Civi Viol. Notice Consent Agreement Lawsuits Criminal Charges
Coeur d'Alene, Idaho	Spokane Valley Rathdrum-Prairie	Unconfined, Unconsol. Sand and Gravel	1.8	Sewage Disposal Stormwater Runoff Haz. Materials Solid Waste UST's Ag. Chemicals	Ind. Sept. Tanks Class V Inj. Wells Comm. & Ind. Use Leachate Service Stations Grass Seed Farms	SO SPR OS DS GM PE	Recharge Areas-1 WHP Araeas-2	Nondegradation from Current WQ	Panhandle Health, ID & Dept. of Env. Quality, Spokane 208	Permits for Sewage, Stormwater, & Critical Materials
Crystal Lake, Illinois	Crystal Lake	Sand and Gravel	?	Septic Systems	Domestic Waste	ZO SP SO SPR GM DS PE	Aqu. Sens. Areas Recharge Areas	Nondegradation	City of Crystal Lake	Zoning, Subdivision Site-Specific Analysis
Elkhart, Indiana	St. Joseph Nappannee Natural Lakes Moraine Systems	Unconfined & Confined All Sand & Gravel	90.5	VOC's Nitrates Fuels in UST's	Industry Septics Agriculture	OS SPR GM PE HHWC	Aqu. Sens. Areas	Nondegradation EPA DW stds.	Commissioners & Health Dept.	Fines
Big Bend GW Mgt District #5, Kansas	Pleistocene River Deposits	Semi-Confined	267,000	Oil Fields Nitrates Natural Mineral Intrusion-Chlorides	Oil Industry Ag. Fertilizers Permian Waters	GM DS SP PE WC	Aqu. Sens. Areas Recharge Areas	Nondegradation	KS State Board of Agriculture	State Adopted Program
Bonner Springs, Kansas	Kaw River	River	1-City Wells	Leachate Farm Field Runoff	Farming Landfill Leachate	ZO SO	WHP Areas	Not Yet Developed	KDHE-Topeka	None Listed

Community	Aquifer	Type	Discharge (MGD)	Main Contaminants	Sources	Protection Strategies	Object of Program is to Protect	Level of Protection	Enforcement Agency	Enforcement Methods
Lincoln, Maine	Enfield Horse Back	yes	0.8	Salts Gas Oils	Roads Garages	ZO HHWC SO PPDR GM SPR DS PE	WHP Areas Aqu. Sens. Areas Recharge Areas	EPA DW stds.	Lincoln Water District	Code Enforcement Officer of Lincoln and Lincoln District
Acton, Massachusetts	Nashoba and Fort Pond Brook	Unconfined Sand and Gravel	1.6	VOC's	Manufacturing Auto Service Stations	ZO SPR SO WC OS HHWC GM PPDR DS SP	Recharge Areas	Acton Water District stds-stricter than The EPA	Planning Board Board of Health Fire Dept Bldg Commission	Regulations
Walpole, Massachusetts	Sole Source	None Listed	None Listed	Gasoline Oil TCE	UST's Big Trucks Through Town	ZO WC SO HHWC GM SPR PE PPDR	WHP Areas Aqu. Sens. Areas Recharge Areas	EPA DW stds	Walpole Board of Health	Regulation of UST's, Private Wells, Hazardous Materials, and Septic Systems
Ridgewood, New Jersey	Triassic Brunswick Formation	Bedrock	7	TCE, PERC, 111-trichloroethane, Gasoline Related Organics	Car Repair Shops Gasoline - UST's Dry Cleaners, Old Septic Systems	ZO SPR PE HHWC	WHP Areas	Nondegradation-Unaffected wells No Further Deg. of Affected	None to Date	None to Date
Nassau County, New York	Glacial Magothy Lloyd	Unconfined Unconfined Confined	200	VOC's - TCE, PERC and 111-trichloroethane	Domestic Cesspools Industrial Discharge Dry Cleaners	SO HHWC OS PPDR GM SPR SP DS WC PE	WHP Areas Aqu. Sens. Areas Recharge Areas	VOC's-Non-degradation Inorganics-DW stds	N.C Dept. of Health N. C. Public Works	Permits Monitoring Fines
Schenectady County, New York	Great Flats, aka Shenectady	Unconfined Glacial Drift	25	Petroleum Prod. Radioactive Waste Road Salts Residential Lawn Fertilizers	None Listed	GM PE SP Watershed Rules and Regs.	WHP Areas Aqu. Sens. Areas Recharge Areas Tributary Watershed	N.Y.S. and EPA DW stds	Municipalities Intermunicipal Watershed Rules Board, N.Y.S. Dept. of Health	None Listed
Vestal, New York	Valley Fill	Unconsol. Deposits-Generally Sand and Gravel	3.5	VOC's HC's	Comm. Operators Ind. Spills and Dumping Gas Stations Pet. Pipelines	ZO SPR SO DS OS GM WC PE	WHP Areas Aqu. Sens. Areas Recharge Areas	Nondegradation	Town Board Code Enforcement	Env. and Aqu. Assessment prior to Approval of Site Plan or Certificate of Occupancy

Community	Aquifer	Type	Discharge (MGD)	Main Contaminants	Sources	Protection Strategies	Object of Program is to Protect	Level of Protection	Enforcement Agency	Enforcement Methods
Dayton, Ohio	Great Miami Valley, Buried Valley	Semi-Confined	100	Chloroethenes, Chloroethanes, Petroleum Products	Industrial spills Dry Wells Possible Illegal Dumping of Liq. Waste	ZO PPDR OS SPR GM PE WC	WHP Areas	No Detectable Amts of Cont. in Treated Water, Eliminate Cont. from Raw Water	Office of Env. Protection, Zoning Dept. Law Dept.	Reporting of Chem. Activity, Capping of Existing Businesses' Chem. Activities Fines
Florence, Oregon	North Florence Dunal	Sand	2	Dangerous Chem. Nitrogen Phosphates	Highway Vehicle Accidents, Septic Systems Drainfields-Residential Use	ZO PPDR SO SPR OS SP	WHP Areas Aqu. Sens. Areas Recharge Areas	EPA DW stds	EPA Local	None, Review of Proposed Uses, Densities
North Kingstown, Rhode Island	Hunt-Annaquatucket Pettaquamscutt	Sand and Gravel	13-Safe Yield 5.5-Average	Nitrates VOC's	Commercial, Industrial Uses	ZO PPDR GM SPR SP PE	WHP Areas Aqu. Sens. Areas Recharge Areas	Still in Discussion	Buiding Official, Planning Commission	Zoning
Perryton, Texas	Ogalalla	Unconfined	1.8	Carbon Tetrachloride, Ag. Chemicals	UST's Ag. Use	OS PPDR GM DS	WHP Areas	Nondegradation Of Existing Aqu., Protection and Local Policy stds	City of Perryton	Ordinance to Police Use of Private Wells Within Jurisdiction
Clarke County, Virginia	Not Named	Not Listed	1	Ag. Chem. Nitrates Fecal Coliform	Runoff from Adjacent Properties, Sinkholes	ZO SO Natural Resource Protection Overlay Zoning	Aqu. Sens. Areas Recharge Areas Sole Source Aqu. Designation	Nondegradation	Local Health Dept. Planning Dept. State Water Control Board	Building Permit Approval
Island County, Washington	Island County Sole Source	Glacial and Alluvial Sand/Gravel Dis-continuous	3.2	Sea Water, On-site Sewage, Ag. Fert. and Pest. VOC's HC's	Overappropria-tion, On-site Sewage, Ag. Naval Air Stations Light Ind.,UST's Road Runoff	ZO HHWC OS PPDR GM SPR WC DS PE	Aqu. Sens. Areas Recharge Areas	Stabilization or Reversal of Seawater Int. Reduction of Contamination Reduced Withdrawal	State Dept. of Ecology,Health Dept., County Planning and Health Depts.	To Be Determined
Issaquah, Washington	Issaquah	Unconfined Sand and Gravel	1	Petroleum Distillates	UST's, Petroleum Industry	GM HHWC PE SPR	Aqu. Sens. Areas Recharge Areas Areas of Fast Runoff Going to Recharge	EPA DW stds	None Listed	None Listed

Community	Aquifer	Type	Discharge (MGD)	Main Contaminants	Sources	Protection Strategies	Object of Program is to Protect	Level of Protection	Enforcement Agency	Enforcement Methods
Redmond, Washington	Bear Creek	Unconfined	3.4	Surface Contaminants, Deepest Well- 67 feet	None Listed	GM SPR WC DS PE	WHP Areas Aqu. Sens. Areas	Nondegradation/ Zoning	County and City Enforcement	Review and Insurance or Nonissuance of Building Permits
Renton, Washington	Cedar River	Unconfined	0.008	None Listed	None Listed	ZO HHWC OS PPRD GM SPR SP DS PE	WHP Areas Aqu. Sens. Areas Recharge Areas	Nondegradation	D.O.H. Fire Dept. D. O. E.	None Listed
Spokane, Washington	Rathdrum-ID/ Spokane-WA	Unconfined Sand	90	Heavy Metals VOC's Ag. Chems. Nitrates	Ind.-Septic Sys., Lumber and Ag. Practices, Mining, Storm Runoff, Landfills Hillside Devel.	ZO HHWC SO SPR GM DS SP PE OM	WHP Areas Aqu. Sens. Areas Recharge Areas	Nondegradation	City/County Planning and Building Codes, Fire Dept., Public Works Health	Zone Change Review

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