Wyoming Source Water Assessment & Protection (SWAP)

SOURCE WATER ASSESSMENT
FOR
Sheridan

June 30, 2004

PROJECT: 424-001

ASSESSMENT COMPLETED BY: TRIHYDRO CORPORATION

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Disclaimer and Limitations

The information presented in this Source Water Assessment report is intended to assist planners and water system operators with the decisions concerning groundwater and surface water issues. The results and conclusions were developed in accordance with State and Federal guidelines, applicable regulations and currently accepted hydrogeologic and engineering standards and practices. The DEQ, Trihydro and Lidstone complied the data and information used in this asessment for the SWAP project from State and Federal agency databases and other available sources. The data and information sources are considered to be reliable; however, the scope of this project did not include verficiation of accuracy, quality or authenticity.

The data sources are considered to be both current and historical in nature. The historical data was reported to have been collected through a variety of geopositioning, sampling, analytical and quality assurance regimes. For much of the data, including the location information, the quality, precision, accuracy and original intent was unknown. In cases where data have been translated from one format to another or developed from other sources as part of this project, Trihydro and Lidstone have made reasonable effort to preserve the quality relative to the original intent.

Considerable efforts were made to solicit input and obtain verficiation of the complied information from each public water supply and other sources regarding the reliability, applicability, accuracy and quality of the data and to incorporate the responses and corrected information to the extent practical. Many comments and constructive reponses were obtained from the public water supplies and other interested parties throughout this project; however, in other cases, limited or no ressponces were received relative to project inquiries. In general, the results of this project are only as good as the data obtained and verified from the data and public water supply sources.

The information in this report is intended for information and assessment purposes only and some information may not be suitable for legal, engineering or surveying purposes. Users of this information should review the primary sources of data to acertain the usability, applicability, quality and accuracy. Users of this information also bear the obligation to apply the information in an appropriate and concscientious manner in accordance with applicable professional standards. Should the information used in this assessment prove to be inaccurate or unreliable, TriHydro and Lidstone, upon approval from DEQ, reserve the right to amend or revise the conclusions, opinions and/or results in this report.

Limitations - Because the information in this report is based upon data, the accuracy of which has not been determined as noted above, DEQ, Trihydro and Lidstone cannot guarantee the results and conclusions. Any use, interpretation or reliance upon this report/assessment by anyone other than authorized is at the sole risk of that party.

List of Acronyms

CBM	Coal Bed Methane
CFR	Calculated Fixed Radius
DEQ	Wyoming Department of Environmental Quality
EPA	United States Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Codes
NPDES	National Pollutant Discharge Elimination System
PSOC	Potential Source of Contamination
PWS	Public Water System
SEO	Wyoming State Engineers Office
SWAP	Source Water Assessment and Protection
USGS	United State Geological Survey
WARWS	Wyoming Association of Rural Water Systems
WhAEM	Wellhead Analytical Element Model

Introduction

People who live in or visit the state of Wyoming enjoy pristine natural resources. One of the most important of these resources is drinking water. In 1973, the Wyoming legislature passed the Environmental Quality Act and directed the Wyoming Department of Environmental Quality (DEQ) to both preserve the surface and groundwater resources of the state, and to prevent, reduce, and eliminate water pollution.

In 1996, the United States Congress passed the Safe Drinking Water Act Amendments that required all states having the responsibility for administering the federal rules and regulations of this Act, or "primacy", to develop a Source Water Assessment and Protection (SWAP) Program. Although Wyoming is the only state that does not have primacy, DEQ recognized the value and benefit of SWAP to help protect public water systems (PWSs). During the 1998 legislative session, the Wyoming Legislature authorized DEQ to set aside 10%, or $1.2 million, of the 1997 federal Drinking Water State Revolving Fund monies to develop a SWAP program and to complete Source Water Assessments.

The SWAP Program is a two-part program consisting of source water assessments and source water protection plans. The completion of a source water assessment involves determining a source water area for each PWS, assessing the sources of contamination within this source water area that have the potential to affect the drinking water supply, evaluating the susceptibility of the water supply to contamination by each of these potential sources of contamination, and finally, writing an assessment report that contains a summary of all the information gathered during the assessment. Due to Wyoming's unique primacy status, the completion of source water assessments for all PWSs is voluntary. The DEQ has completed a source water assessment for each PWS that has requested one. Local governments, PWSs, and citizens can then use these assessment reports to develop a source water protection plan that outlines the measures that the community or PWS believes are appropriate to protect their drinking water supply. These measures may include management plans, clean up efforts, public education, or zoning changes.

DEQ Coordination

DEQ contracted and worked closely with the Trihydro Corporation (Trihydro) and Lidstone and Associates, Inc. (Lidstone) to complete the source water assessments. Trihydro and Lidstone were selected because of their geologic experience, Geographic Information System (GIS) expertise, and their knowledge of many PWSs in Wyoming. PWS delineations were completed by the firm most familiar with the geology/hydrology of the area.

The Wyoming Association of Rural Water Systems (WARWS) also provided a great deal of assistance. WARWS published newsletters, helped sign up PWSs for assessments, and helped operators understand and review draft assessments. They also provided valuable input throughout the development and implementation of the SWAP program.

Source Water Area Delineation

The first step in completing the Source Water Assessment was to delineate, or determine, the source water area, or the area that contributes water to the well or intake. In order to protect public water supplies, community leaders, planners, and PWS operators must have information regarding the land area that contributes water to the PWS's wells or intakes. Potential sources of contamination located upstream or upgradient from a water source could reach and possibly impact the water system and its customers. Trihydro and Lidstone delineated three contaminant inventory zones within each source water area for the purpose of inventorying possible sources of contaminants that could affect drinking water quality. The following listing of the three zones provides additional information on their intent:

- **Zone 1** is called the "Accident Prevention" or "Sanitary Protection Zone" and is located within a 100 foot radius of the well or intake. The potential for contaminants released within this zone to affect the quality of PWS water is highest.

- **Zone 2** lies immediately beyond Zone 1 and is called the "Attenuation Zone." Contaminants released within this zone are within close proximity of the well or intake and the chances of their reaching the well or intake is still high. Zone 2 for surface water systems included an area 1000 feet on either side of the perennial streams that extended upstream of the intake for a distance of 15 miles, or the distance from the intake to the headwaters of the drainage contributing water to that intake. Zone 2 for groundwater systems represented a 2-yr time of travel (TOT) that was determined using the best, and most conservative hydrogeologic data available.

- **Zone 3** is the area farthest from the well or intake. Contaminant sources within this zone are less likely to reach the well or intake in quantities that could affect water quality. Zone 3 for surface water sources includes the entire stream drainage basin from Zone 2 to the basin headwaters. Zone 3 for groundwater sources extends from the edge of Zone 2 and represented the estimated 5-yr TOT.

Trihydro and Lidstone used readily available information to determine the locations of each well, spring, infiltration gallery, or surface water intake. No fieldwork or site visits to individual PWSs were conducted to verify the accuracy of the location data. The location of each water source was initially obtained from DEQ or United States Environmental Protection Agency (EPA) databases. Information received from the respective PWS operators on their well information sheets, photographs of individual water sources, the Wyoming State Engineers (SEO) well information database, Wyoming Water Development Commission reports, and Trihydro/Lidstone company experience were also used to locate each water source as accurately as possible.

To determine the source water area(s) for each well or surface water intake, Trihydro and Lidstone reviewed a variety of geologic, hydrologic, and hydrogeologic sources, and incorporated that data into a Geographical Information System (GIS). For PWSs utilizing surface water sources, Hydrologic Unit Codes (HUC) and 7.5-minute U.S. Geological Survey (USGS) topographic maps were used to identify the basin perimeters that contribute water to the surface

water intake. For those systems utilizing groundwater sources, Trihydro and Lidstone reviewed information from the following sources to develop source water areas: the EPA's sanitary surveys, the EPA's early 1980s reports on the occurrence and characteristics of groundwater in each basin of the state, the Wyoming State Engineer's Office (SEO) water rights database, University of Wyoming Master's theses, USGS geologic and hydrogeologic reports, Driscoll's Groundwater and Wells book, Wyoming Water Development Commission reports, Wyoming Water Research Institute reports, and previous delineations completed by other consultants, the Wyoming Geologic Survey and WARWS.

The methods and techniques that were used to delineate the contaminant inventory zones within each source water area were consistent for all surface water systems. However, for groundwater systems, professional geologists for Trihydro and Lidstone considered aquifer type (confined, unconfined, alluvial, etc.), flow system type (porous, or conduit), and PWS type to determine which delineation method was appropriate for each well, as shown on **Figure 1**. For groundwater sources, Trihydro and Lidstone geologists used the most appropriate conservative methodology, which closely followed the EPA-approved Wyoming Wellhead Protection Program Guidance Document.

Contaminant Inventory

An inventory of contaminant sources that lie within the source water areas and have the potential to adversely impact the quality of the water supply was conducted within each contaminant inventory zone. Knowledge of potential contaminants may encourage communities to implement and manage a source water protection area, and enable a PWS to plan for necessary improvements in treatment capabilities, develop emergency response plans, or allow time to remediate the source of contamination. The principal contaminants of concern include those regulated under the Safe Drinking Water Act in addition to microorganisms such as *Cryptosporidium,* and exposure to nitrates.

Contaminant inventories for Potential Sources of Contamination (PSOCs) used information obtained from EPA, DEQ Water Quality Division, DEQ Solid and Hazardous Waste Division, DEQ Land Quality Division, DEQ Abandoned Mine Lands, Wyoming Oil and Gas Conservation Commission, the Wyoming State Geological Survey, the U.S. Department of Transportation, and the Wyoming Department of Agriculture Technical Services databases. Examples of regulated activities or facilities include wastewater treatment plants; confined animal feeding operations; underground injection wells; chemical or hazardous waste use, production, or storage sites; and landfills. These permitted contamination sources produce materials that are regulated by state or federal laws. These databases are also tabulated according to contaminant type in the susceptibility section. Information from citizens and PWS operators played a vital role in verifying land uses and locations of regulated PSOCs.

There are two basic types of contaminant sources, point and non-point, that were evaluated based on their proximity to the water source. Point sources are usually associated with a single location, like an underground storage tank, underground injection well, oil and gas well, coal bed

methane (CBM) well, a solid/hazardous waste facility or a National Pollutant Discharge Elimination System (NPDES) outfall. Point sources are usually regulated and are required to have permits.

In contrast, non-point source pollution results from land use patterns and transportation corridors. Urban land use was considered of greatest concern followed by irrigated agriculture, non-irrigated agriculture, and then forested areas. Forested areas were included to evaluate the potential risks of increased runoff and water quality problems following forest fires. Transportation corridors, including pipelines, railroads, and highways, are a high concern because of the nature of the materials being transported. All remaining land uses were considered low risk.

To evaluate the potential impact of these contaminants, an extensive inventory was conducted in Zones 1, 2, and 3 for both surface and groundwater sources. As part of the inventory, the assistance of local representatives and PWS operators was requested to verify the locations of regulated and non-regulated potential sources, land use boundaries, and to identify any historical sources of contamination.

The Susceptibility Analysis Process

The final step in developing the source water assessment for each PWS was to analyze the susceptibility of each water source with respect to the identified PSOCs. DEQ defines the susceptibility of a PWS as the potential for each well or surface water intake to draw water that has been contaminated by pollutants at concentrations that would pose concern. Susceptibility must be determined for each water supply well or intake used by the PWS. Contaminants may reach the intake or well by infiltration through geologic strata and overlying soil, direct discharge into surface or groundwater, overland flow, or contamination of upgradient groundwater. Contaminants may also enter the water source at the well, intake, or the conveyance. A conveyance is defined as the pipe, canal, or aqueduct between the well or intake and the first form of treatment, or where the water enters the distribution system if there is no treatment.

Water system susceptibility is related to three factors that were evaluated as part of this source water assessment. The first was the physical integrity of the well, intake, and conveyances. The second factor was the sensitivity of the land area through which potential contaminants may reach the well or intake. This included the geologic, hydrologic, and land cover characteristics of the watershed, well location, or aquifer source area. The third factor was the nature of the potential contaminants. Potential contaminants include specific point sources and any land uses that may contribute contaminants to the water supply. For point sources, the type of potential contaminants, the location of the contaminant sources relative to the well or intake, and confirmation of a contaminant release were also considered.

Data that were used to quantitatively evaluate the susceptibility of each water source to potential contaminants were acquired from sources of data readily available for all PWS in the state. The susceptibility of each PWS is based on delineated source water areas, DEQ contaminant

inventories, 1:500,000 scale land use maps compiled by the University of Wyoming, EPA sanitary surveys, EPA's Safe Drinking Water Information System database, and DEQ and Wyoming SEO well or intake permits.

Step 1: Well or Intake Integrity Score

The first step in the susceptibility analysis was to determine the integrity score for each well or intake. The well or intake was assigned a score after being evaluated for a series of factors. The factors and the points associated with them are described below. Each well or intake received a score between 1 and 13. If sanitary surveys, permits, or completion records were not available or did not contain the appropriate information, a maximum score was assigned for that particular factor as a default. Scores for each PWS water source are listed in the Well or Intake Integrity tables located at the back of this document.

If the well or intake was constructed prior to 1983, it was assigned 3 points, between 1983 and 1993, 2 points, and 1 point if constructed after 1993. The points assigned to completion dates reflect DEQ's confidence in the standards applied to the design, construction, and completion of wells and intakes at the time of construction. Conveyance structures were scored based on the length, the risk of damage, and the degree to which the transported water is exposed to contaminants. Short conveyances, less than 1 mile, received a score of 0 points, while conveyances greater than 1 mile received 1 point. Open conveyances and conveyances at risk to structural damage received 1 point.

Well integrity was also evaluated on the basis of four additional factors. The first and most critical of these was the presence of a surface seal that is in good condition. DEQ believes that the surface seal is a good indicator of the overall well condition. Wells that had a surface seal were assigned a score of 0 points and wells that did not have a surface seal were assigned a score of 5 points. The second factor was the presence of a good annular seal. However, this information is less easily obtained, so an assumption about the annular seal was made based on the presence of a surface seal. If a well had an annular seal it was assigned a score of 0 points, wells without an annular seal received 1 point. The third factor was the protection of the vicinity immediately around the wellhead from contaminant sources. This is usually accomplished by enclosing the wellhead in a well or pump house, or a fenced off area. If the wellhead was protected, the well received 0 points, but unprotected wells were assigned 1 point. The fourth factor is the protection of the wellhead from flooding. For instance, the ground around the wellhead should be sloped away from well to encourage water and any water-borne contaminants to move away from rather than towards the well. Wells that were considered protected from flooding were assigned 0 points, wells not protected were assigned 1 point.

The integrity of surface water systems was also evaluated based on three additional criteria. The first of these was the presence of a screen. A screen, or series of screens, will prevent debris from interfering with the water treatment process. The presence of a screen yielded 0 points, while intakes without a screen scored 3 points. Secondly, screens must be inspected and cleared of debris regularly to remain effective. Intakes that were not inspected regularly scored 2 points. Finally, access to the area immediately surrounding the screen location should be restricted. If the area around the intake was not protected, the intake scored an additional 2 points.

Step 2: Water Source Sensitivity

The second step in the susceptibility analysis was to determine the well or intake sensitivity score on the basis of aquifer or watershed conditions and the confirmed detection of chemical contaminants in raw or treated water. Wells were assigned a score between one and ten. Intakes were assigned a score of five or ten. Scores for each PWS water source are listed in the Water Source Sensitivity scoring tables located in the back of this document.

The inherent sensitivity of the aquifer or watershed was combined with indicators of contamination observed within the last five years. If no information was available, the maximum score was assigned as a default for that particular scoring criterion. Documented chemical detections at a well or intake within the last 5 years scored an additional 5 points. A chemical detection indicates that a pathway exists for contaminants to enter the system.

DEQ assumed that all surface water systems were highly sensitive to contamination (default score of 5 points) due to the fact that streams, rivers, and open conveyances directly and rapidly convey released contaminants. A maximum total of 10 points was possible for surface water intakes.

For groundwater systems, Trihydro and Lidstone determined the sensitivity of each groundwater source based on the type of aquifer in which the wells were completed. Porous flow confined aquifers were considered to be the least vulnerable type. Shallow alluvial, fractured, karst, and some unconfined aquifers are more vulnerable to contamination from surface contaminant sources. To evaluate the sensitivity of unconfined aquifers throughout the state, Trihydro and Lidstone used a statewide map of uppermost aquifer sensitivity that was developed using depth to water, recharge and overlying soil characteristics, land slope, vadose zone characteristics, and other hydrogeologic characteristics. Aquifer sensitivity, based on the map, ranged from 1-5 points. Wells that were completed in fractured rock or limestone aquifers received a score of 5 points. Shallow wells completed in alluvium (less than 65 feet deep), could be under the influence of surface water, and received a score of 5 points. Confined aquifers under normal porous flow conditions received a score of 1 point. Groundwater source sensitivity scores ranged from 1 to 10 points.

Step 3: Well or Intake Rating

A well or intake rating was developed from the integrity and sensitivity scores. A water source sensitivity score was determined by adding the well or intake integrity score to the water source sensitivity score. A well or intake rating of low, medium, or high was assigned based on the total number of points scored; low (2-8 points), medium (9-15 points), high (16-23 points). The rating for each well or intake was then combined with the contaminant ratings to determine the final susceptibility for each respective well or intake.

Step 4: Contaminant Ratings

The fourth step in the susceptibility analysis was to rate potential sources of contamination that were located within the contaminant inventory zones delineated for each well or intake. Three categories of contaminants were developed for this rating process: regulated point sources, non-point sources including land uses, and transportation corridor sources.

Point sources were evaluated using the following three critical pieces of information: the contaminant type; the location of the potential source of contamination in relation to the well or intake; and the contaminant release status. For the purposes of the susceptibility analysis, contaminants have been grouped into the following two types on the basis of their DEQ facility or contaminant codes: 'Serious Contaminants' and 'Other Contaminants.' Microorganisms, nitrates/nitrites and carcinogens are considered 'Serious Contaminants,' while 'Other Contaminants' includes the remainder of the contaminants listed in the federal drinking water standards. Point sources identified in the contaminant inventory will have one or both types of potential contaminants. The most serious contaminant type present was assigned a contaminant rating. This process was completed for each point source identified in the contaminant source inventory.

The point source contaminants were also rated on the location of the potential source of contamination in relation to the well or intake (Zone 1, 2, or 3). The last factor in determining a contaminant rating is the contaminant release status. This factor is an indication of whether a potential source of contamination has released contaminants into the environment. Documented releases are typically found with potential sources of contamination like facilities with permitted discharges, groundwater pollution control sites, and leaking storage tanks.

All Serious or Other contaminants that were identified within Zone 1 and Zone 2, regardless of whether a documented release of those contaminants had occurred, were considered a high risk to the well or intake. A known release of a contaminant identified in Zone 3 was considered a medium risk to the well or intake. Contaminants identified in Zone 3 that were classified as a no known release, were considered a low risk to the well or intake.

All point source PSOCs are shown on the source water area delineation map(s). The General Point Source Contaminant Rating Matrix located in the general tables section at the back of this document, shows how the point source PSOCs were rated. The point source PSOCs that are located within the contaminant inventory zones are tabulated in the Point Source Susceptibility Table along with these final contaminant ratings, also located at the back of this document. For further details on any of these sources of contamination, contact the appropriate agency listed in Appendix A.

Non-point sources of contamination were evaluated on the basis of the percentage of land use in the source water area for various activities. The General Land Use Rating Matrix is located in the general tables section of this document. For groundwater systems with modeled, calculated fixed radius (CFR) delineations, and delineations that were hydrogeologically mapped, the percentage of land use in Zones 1, 2, and 3 was evaluated. For all other delineations, including surface water watersheds, groundwater under the influence of surface water, and area-wide aquifer delineations, only Zones 1 and 2 were evaluated. The percent land use, the land use

contaminant rating, and the land use susceptibility ratings for each well/intake are also shown in the Land Use Susceptibility Table, located at the back of this document.

The transportation corridor contaminant ratings were determined by counting the number of each transportation corridor contaminant type within each contaminant inventory zone. The General Transportation Corridor Contaminant Rating Matrix shows how the transportation corridor contaminants were rated and is located in the general tables section. The transportation corridor contaminant rating and the transportation corridor contaminant susceptibility ratings are shown in the Transportation Corridor Susceptibility Table located at the back of this document.

Susceptibility Rating Implications

The susceptibility ratings developed during this assessment project are intended to show the PWS areas where contaminants have the greatest potential to impact their water supply.

High susceptibility ratings should be used to assist the PWS in future planning efforts. A source water protection plan is recommended regardless of a PWS's susceptibility ratings. Please contact WARWS at 307-436-8636 or Kim Parker, DEQ, at 307-777-7781 for additional guidance. There are also consulting firms like Trihydro and Lidstone that are available to help you complete your source water protection plans.

In many cases, high susceptibility ratings were caused by lack of data. As mentioned in the scoring process, whenever well or intake data were unknown, the highest score possible was assigned. One way to reduce the susceptibility would be to replace the unknown conditions with the known conditions associated with the particular well or intake in question. Restricting access to wells and intakes, ensuring well or intake physical integrity, enclosing wells and intakes, and enclosing and protecting conveyances are also ways to reduce your systems well or intake rating and reduce susceptibility to potential sources of contamination. Another way to reduce susceptibility would be to remove or mitigate existing PSOCs and prevent new sources from locating within your source water area.

It is possible that regulated point sources appear within your source water area when they should not or appear in the wrong location. It is very important to have regulated point sources located correctly. Regulated point sources in close proximity to your water source greatly affect your susceptibility ratings. Likewise, please keep in mind that your source water area map may be missing regulated point sources that should appear. Your system is potentially susceptible to these sources and they should be included in any future assessments and protection plans. Please contact Kim Parker, DEQ, at 307-777-7781 for assistance in alerting the appropriate regulatory programs if any errors in point sources are discovered.

Lastly, non-regulated or historical potential sources of contamination should not be overlooked when doing assessment updates and protection plans. For example, septic systems and dry cleaners are not regulated and therefore were not included in this assessment, but can have substantial impacts on water quality. Thorough local contaminant inventories that include such

historical and non-regulated potential contaminant sources should be conducted in conjunction with regulatory database inventories.

Water sources with high percentages of forested land in their watershed can experience significant water quality impacts if a large portion of the landscape is burned. Surface water systems can expect high sediment loads and elevated levels of nitrates, phosphorus, heavy metals, organic carbon, and other chemicals. Forest fires can also cause water to have a smokey flavor.

All surface water systems, groundwater under the influence of surface water, and groundwater systems that rely on alluvial aquifers are vulnerable to drought conditions. PWSs should develop contingency plans that include water storage, water rationing, etc. that are adequate to sustain the PWS through drought cycles.

Technical Assistance

Management of the source water protection area involves knowledge of the resources available for protection efforts. Local planning teams, WARWS, and consultants such as Trihydro and Lidstone can assist with identifying the methods and means available to the community to achieve the desired land use changes necessary to protect the drinking water source. The process of developing management strategies for regional aquifer watershed protection areas may require the collaboration of all municipalities, counties, and land management agencies affected by the protection area.

In addition, DEQ may be able to support protection plan activities by providing financial and technical assistance to PWSs. For instance, low-interest loans may be available through the State Revolving Fund program. These monies may be used for the acquisition of land critical to source water protection, the remediation of contaminant sources, or other protection plan development or implementation activities. For additional information on potential funding opportunities, contact Brian Mark of the DEQ at (307) 777-6371. Local planning teams may also request technical assistance from DEQ while developing protection plans. DEQ will provide assistance to local planning committees to the extent possible given personnel and budgetary constraints. For technical assistance, contact Kim Parker of the DEQ at (307) 777-7781.

DEQ is currently working with EPA to develop a waiver program for volatile and synthetic organic chemicals. The EPA will likely require the PWS to have a completed source water assessment in order to apply for this type of waiver. The EPA may also require the development of a protection plan to be eligible for these waivers. A developed protection plan may also aid the PWS by reducing costs associated with upcoming proposed regulations such as the Groundwater Rule.

Source Water Protection Plans

This Source Water Assessment is the necessary first step toward developing a Source Water Protection Plan. This assessment provides the technical basis for future protection measures. DEQ considers the protection of drinking water resources and the development of source water protection plans to be the long-term goal of the program.

In addition to the information provided in this assessment, DEQ requires three other components in a protection plan. A contingency plan, a section discussing management strategies for all potential sources of contamination inventoried within the source water area, and some method to update the protection plan on a regular basis are required components of a protection plan.

Contingency plans describe how a PWS would handle a contamination event or the loss or interruption of a water supply. Examples of components that local planning teams can include in a contingency plan are: options for replacing a water source; customer notification plans; emergency response plans; water storage plans; and measures to promote water conservation, if necessary.

The process of developing effective management strategies is the most important aspect of preventing drinking water contamination. Management strategies can also be the most difficult and time-consuming step when developing a source water protection plan. Each PWS must balance the responsibility of protecting the water supply with past, current and future land uses to determine what management strategies are appropriate and can be supported by the community.

DEQ also requires the regular review and update of the source water protection plans. Regular reviews will help the local planning team constructively deal with new trends, issues, and activities within the community.

This assessment is not the end product. Please use the information in this assessment as a tool to develop a protection plan for your PWS. Once a drinking water supply becomes contaminated, a community or PWS is faced with the difficult and costly task of upgrading treatment facilities or locating an alternative drinking water source. DEQ believes that preventing contamination is the key to keeping Wyoming's drinking water supplies safe.

SOURCE WATER ASSESSMENT SUMMARY
FOR Sheridan

PWS Source Water Assessment Summary

The City of Sheridan is a community surface water system located in Sheridan County. The system serves 15,500 people through 5,500 service connections year-round. The system is supplied by one surface water intake that obtains water from the Big Goose Creek and its tributaries. Additionally, facilities include pre-sedimentation tank, a water treatment plant, 9.75-million gallons worth of storage capacity, and the interconnecting transmission system. The water source scored high with respect to the combined integrity and aquifer sensitivity. The city scored high with respect to land use susceptibility and low with respect to point source susceptibility.

Delineation Methods

This water system draws water from surface water. Surface water mapping methods were used to determine contaminant inventory zones 2 and 3.

The surface water source area was delineated using surface topographic techniques. Zone 2 for included an area 1,000 feet on either side of Big Goose Creek and its perennial streams that extended upstream of the intake for a distance of 15 miles, or the distance from the intake to the headwaters of the drainage. Zone 3 for the intake includes the entire stream drainage basin from Zone 2 to the basin headwaters.

Surface Water Sources

Sheridan draws water from one surface water intake. The intake obtains water from Big Goose Creek and its tributaries. Additional information on this intake is included on the attached Surface Water Information Sheet. As shown on the enclosed source water area delineation map, contaminant inventory zones 2 and 3 were delineated using surface water mapping methods. Zone 2 consists of a 1000 foot buffer zone area along Big Goose Creek and its tributaries. Zone 2 extends from the surface water intake upstream 15 miles terminating at various lakes. Zone 3 encompasses the entire Big Goose Creek drainage basin upstream from the intake.

Integrity Summary

The intake was constructed before 1983, when less stringent construction standards were required by the State of Wyoming. Records also indicated that while the area around the intake is unrestricted, the intake is screened and inspected regularly to protect against the infiltration of potential contaminants. As shown on the Integrity Summary Table, the intake received an integrity score of 6. This score primarily reflects that the intake was completed before 1983, there is a conveyance structure length greater than one mile, and that there is no protection around the intake.

As shown on the Source Sensitivity Summary Table, the surface water intake received a sensitivity score of 10. The intake received the score for two reasons. The first reason is that surface water intakes are more vulnerable to contamination. The second reason is that there are documented chemical detections in the water supply.

Water System Susceptibility Rating

Susceptibility is defined as the potential for a public water supply to draw water contaminated at concentrations that would pose a threat or concern to human health. In general, Sheridan scores high for land use susceptibility because much of the land surrounding the water sources is forested. Forested areas were included to evaluate the potential risks of increased runoff and water quality problems following forest fires. The overall point source contaminant susceptibility rating is low due to the lack of contamination sources being present within the delineated zones.

A review of your PWS's routine water analysis results revealed that one or more chemicals that are considered contaminants in drinking water were detected at some time within the last five years. Chemical detections have a large impact on your PWS's sensitivity score because it may indicate that there is a pathway for contaminants to reach the water supply. However, it is likely that these chemicals are present only in small amounts and are not a danger to your health. Some of these chemicals may also occur naturally in water.

For more information about which chemicals were detected, please contact the PWS for a copy of the most recent Consumer Confidence Report or water analysis results. Consumer Confidence Reports are prepared by the PWS on a yearly basis. The reports should include information about any chemicals found in the water, even those found at very low levels. Chemical detections at levels that are a concern to human health are reported on the EPA's website: <http://www.epa.gov/enviro/html/sdwis/sdwis_query.html>. To see if your PWS has exceeded the federal primary or secondary drinking water standards, just click on the State of Wyoming and then type in the name of your PWS. You may contact Kim Parker at DEQ, 307-777-7781, or WARWS for assistance. You may also contact EPA to find out what contaminants were detected. You may have to fill out a Freedom of Information Act request to obtain the water test results for your PWS. Please call EPA's Safe Drinking Water Hotline at 1-800-426-4791.

General Tables

The table below illustrates the decision rules used to categorize each system's Integrity and Susceptibility scores described in Step 3.

Well or Intake Rating Scoring

	Low	Medium	High
Combined Integrity and Sensitivity Scores	2 - 8	9 - 15	16 - 23

The decision matrix below illustrates how each land use type receives a contaminant rating based on the percentage of land usage that corresponds to each contaminant inventory zone.

General Land Use Rating Matrix

		Land Use Contaminant Rating		
		Low	Medium	High
% Land Use	Urban	<5%	5-10%	>10%
	Irrigated Cropland	<20%	20-40%	>40%
	Non-Irrigated Cropland	<40%	40-80%	>80%
	Forested Land	<20%	20-40%	>40%

The point source contaminant susceptibility rating is determined for each well or intake using the decision matrix below. The well/intake rating is compared with the point source contaminant rating for each contaminant inventory zone to produce each susceptibility rating.

General Point Source - Contaminant Matrix

	Zone 1		Zone 2		Zone 3	
	Known Release	No Known Release	Known Release	No Known Release	Known Release	No Known Release
Serious Contaminants Microorganisms, nitrates/ nitrites, carcinogens	High	High	High	High	Medium	Low
Other Contaminants Remaining primary and secondary drinking water contaminants	High	High	High	Medium	Medium	Low

The transportation corridor susceptibility rating is determined for each well or intake using the decision matrix below. The ratings for each zone were determined regardless of the length that each pipeline, railroad line, or highway intersected each contaminant inventory zone.

General Transportation Corridor - Contaminant Rating Matrix

Transportation Corridor	Contaminant Inventory Zone		
	Zone 1	**Zone 2**	**Zone 3**
Pipeline	High	High	Low
Railroads	High	High	Low
State Highways	High	High	Low
Interstate Highways	High	High	Low

A final susceptibility rating was determined for each type of contaminant by comparing the contaminant rating with the well or intake rating, using the decision matrix below. A final susceptibility rating was determined for each type of potential contaminant, land use, point source, and transportation corridor.

General Susceptibility Rating Matrix

Well or Intake Integrity Rating	Contaminant Rating Matrix		
	High	**Medium**	**Low**
High	High	High	Medium
Medium	High	Medium	Low
Low	Medium	Low	Low

PWS-Specific Tables

The following tables, specific to each well or intake, summarize your system's susceptibility using the scoring matrices described above. A specific PSOC susceptibility table may be missing because that type of PSOC was not found within your source water delineation area.

Sheridan Water Sources

Water Source Type*	PWS Well ID	Source Name
SW	5600052-101	BIG GOOSE CREEK

* GW - Groundwater
* SW - Surface Water
* GU - Groundwater under the influence of surface water

Well or Intake BIG GOOSE CREEK (5600052-101)

Surface Water / Spring
Integrity & Sensitivity Scores for Sheridan (5600052)

Step 1:

Score Type: Well or Intake Integrity

Water Source: Big Goose Creek

Criterion	Condition	Score
Conveyance open or closed?	CLOSED	0
Risk of conveyance structure damage?	LOW	0
Conveyance structure length?	LONG	1
Area around intake restricted?	Unprotected	2
Intake inspected regularly?	YES	0
Intake screened?	YES	0
Intake completion date	BEFORE 1983	3
	Total Integrity Score	**6**

Step 2:

Score Type: Water Source Sensitivity

Water Source: Big Goose Creek

Criterion	Condition	Score
Confirmed chemical contaminant detection?	Yes	5
Sensitivity	Surface Water Intake	5
	Total Sensitivity Score	**10**

Step 3:

Final Well or Intake Rating: Unknown Wellname (5600052-101)

Well or Intake Rating for Unknown Wellname	**HIGH**	**16 (Integrity + Sensitivity)**

Well Or Intake BIG GOOSE CREEK (5600052-101)

Step 4:

Score Type: Land Use Susceptibility

SWZone 1

Land Use Type	Land Use Percentage	Land Use Contaminant Rating	Land Use Susceptibility Rating
Urban Land	0	Low	Medium
Irrigated Cropland	0	Low	Medium
Non-Irrigated Cropland	0	Low	Medium
Forested Land	0	Low	Medium
Other Land Uses	100	Low	Low

SWZone 2

Land Use Type	Land Use Percentage	Land Use Contaminant Rating	Land Use Susceptibility Rating
Urban Land	0	Low	Medium
Irrigated Cropland	3	Low	Medium
Non-Irrigated Cropland	0	Low	Medium
Forested Land	86	High	High
Other Land Uses	11	Low	Low

POINT SUSCEPTIBILITY SUMMARY TABLE
FOR Sheridan

Point Source Susceptibility Summary

It may appear from the results of this point source susceptibility summary table that your system has too many PSOCs influencing the final ratings. In some cases, a specific PSOC falls within a specific contaminant inventory zone shared by multiple wells or intakes. When this is the case, that PSOC will be scored for each intake. For example, an underground storage tank may appear within a contaminant inventory zone shared by four different wells. This would cause that single storage tank to be entered into the table four times, or once for each well or intake.

Point Source Type	Low	Medium	High
None Identified	N/A	N/A	N/A

* Illustrates the number of PSOCs in a particular rating class for all water sources
* N/A - Not Applicable

Surface Intake Information Sheet

PWS ID 5600052 - Sheridan

Source ID	Source Name	Permit Number	In Use	Abandoned
5600052-101	BIG GOOSE CREEK			

Township	Range	Section	Qtr	Qtr Qtr	Latitude	Longitude	Inspected Regularly
					44.69704314	-107.18853368	YES

Risk of Conveyance Damage	Intake Restricted	Conveyance Length	Intake Screened
LOW	Unprotected	LONG	YES

Date Constructed	Conveyance Open/Closed
BEFORE 1983	CLOSED

Water Bearing Formation	Confined or Unconfined
Big Goose Creek	

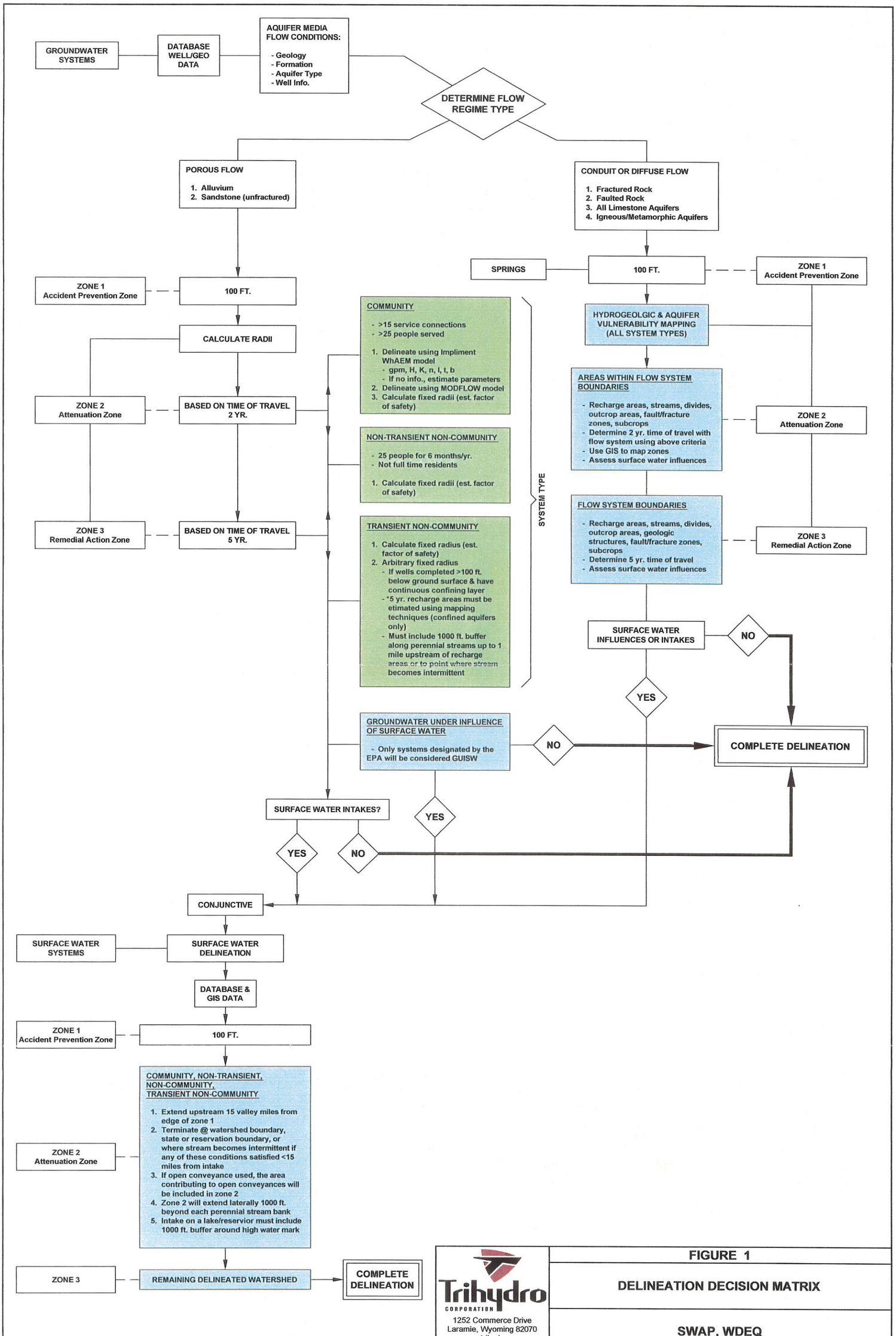

FIGURE 1

DELINEATION DECISION MATRIX

SWAP, WDEQ

Trihydro CORPORATION
1252 Commerce Drive
Laramie, Wyoming 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

Drawn By: MZ	Checked By: BS	Scale: NONE	Date: 2/11/03	File: 424DELFLOW-R1

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Glossary

Alluvium: a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during comparatively recent geologic time by a stream or body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope.

Annular seal: a structure used to plug the annular space, or the space between the well casing and the borehole or outer casing. Annular seals are usually located on either side of each water bearing geologic layer that the well penetrates. Annular seals prevent contaminants from moving into water bearing geologic layers.

Aquifer: a formation, group of formations, or part of a formation that contains enough saturated permeable material to yield sufficient, economical quantities of water to wells and springs.

Bedrock: a general term for the consolidated rock that underlies soils or other unconsolidated surficial materials.

Community public water supply system: water systems that serve a permanent residential population and include municipalities, rural water system, mobile home courts, and housing developments.

Conduit flow: groundwater movement down-gradient along fractures, faults, joints, bedding planes, and solution openings resulting in "flashiness". Flashiness is indicated by rapid aquifer recharge; turbulent flow; and highly variable chemistry, temperature, and flow rates. Darcy's Law does not apply in conduit flow conditions.

Confined aquifer: an aquifer bounded above and below by confining units of distinctly lower permeability than the aquifer media or an aquifer containing confined groundwater. An aquifer in which groundwater is under pressure significantly greater than atmospheric and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the aquifer itself.

Consecutive public water supply system: a water system that is served by another public water supply system.

Contaminant: an undesirable substance not normally present, or an unusually high concentration of a naturally occurring substance in water, soil, or other environmental medium.

Contamination: the degradation of natural water quality as a result of man's activities. There is no implication of any specific limits, since the degree of permissible contamination depends on the intended end use or uses of the water.

Contaminant source inventory: the process of identifying and inventorying potential sources of contamination within delineated source water assessment areas through recording existing data, describing contaminant sources within the source water assessment area, targeting likely contaminant sources for further investigation, and verifying accuracy and reliability of the information gathered.

Diffuse flow: groundwater movement down-gradient along fractures, faults, joints, and bedding planes resulting in less turbulent flow, slower aquifer recharge, and more uniform chemistry, temperature, and flow rates than observed in conduit flow. Groundwater movement is similar to that in porous flow environments and may be described using Darcy's Law. Groundwater movement through a fractured-rock aquifer may be considered to be diffuse flow if: 1) the fractures are closely spaced, 2) the fractures are evenly sized, evenly distributed, and randomly oriented, and 3) the area of consideration is large relative to the spacing of the fractures. Criteria such as pumping test responses, configuration of the water table, water chemistry variation, distribution of hydraulic conductivity, and the ratio of the fracture scale to the problem scale may be used to determine which type of flow regime exists.

DRASTIC model: an analytical model used to assess groundwater pollution potential. The seven parameters that are used in the model also form its name. These factors are: Depth to groundwater, net annual Recharge, Aquifer media, Soil media, Topography or land slope, Impact of the vadose zone, and the saturated hydraulic Conductivity of the aquifer.

Drawdown: The vertical distance groundwater elevation is lowered, or the amount pressure head is reduced, due to the removal of groundwater. Also the decline in potentiometric surface caused by the withdrawal of water from a hydrogeologic unit.

Drinking Water State Revolving Fund (DWSRF): under section 1452 of the Safe Drinking Water Act, the EPA awards capitalization grants to states to develop drinking water revolving loan funds to help finance drinking water system infrastructure improvements, source water protection, to enhance operations and management of drinking water systems, and other activities to encourage public water system compliance and protection of public health.

Groundwater: the water contained in interconnected pores located below the water table in an unconfined aquifer or located in a confined aquifer.

Hydraulic conductivity (k): proportionality constant relating hydraulic gradient to specific discharge, which for an isotropic medium and homogeneous fluid, equals the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angels to the direction of flow.

Hydraulic gradient (*I*): slope of the water table or potentiometric surface.

Igneous rock: a rock that solidified from molten or partly molten material.

Karst: a landscape or region characterized by rock dissolution.

Metamorphic rock: a rock formed when preexisting rocks undergo mineralogical, chemical, and structural changes caused by high temperature, pressure, and other factors.

Nontransient noncommunity public water supply system: nonresidential water systems that serve the same population for at least six months per year and includes factories and schools.

Permeability: ability of a porous medium to transmit fluids under hydraulic gradient.

Porosity: ratio of the total volume of voids available for fluid transmission to the total volume of a porous medium. Also the ratio of the volume of the voids of a soil or rock mass that can be drained by gravity to the total volume of the mass.

Porous flow: groundwater movement down-gradient through the pore space of aquifer host rocks, such as uncemented or poorly-cemented sandstones. Darcy's Law is operative in porous flow environments. Groundwater flow through a fractured-rock aquifer may be considered to resemble porous flow if 1) the fractures are closely spaced, 2) the fractures are evenly sized, distributed, and spatially oriented, and 3) the area of consideration is large relative to the spacing of the fractures.

Potentiometric surface: an imaginary surface representing the level to which water will rise in a well.

Public water supply system (PWS): system for provision to the public of piped water for human consumption, if such system has at least 15 service connections or regularly serves at least 25 individuals daily or at least 60 days out of the year.

Pumping rate: the rate at which water is withdrawn from the well.

Radius of influence: the radial distance from the center of a well bore to the point where there is no lowering of the water table or potentiometric surface.

Recharge area: area in which water reaches the zone of saturation by surface infiltration. An area in which there are downward components of hydraulic head in the aquifer. Infiltration moves downward into the deeper parts of an aquifer in a recharge area.

Semi-confined aquifer: an aquifer that has a "leaky" confining unit and displays characteristics of both confined and unconfined aquifers.

Sensitivity: the potential for a water source to become contaminated based on the intrinsic hydrogeologic characteristics of the watershed or aquifer.

Source water assessment area: the area delineated by the state for a public water supply, whether the water source is groundwater or surface water or both, as part of the state Source Water Assessment and Protection program approved by EPA under section 1452 of the Safe Drinking Water Act.

Source water assessment: three step process which includes delineating the part of the watershed or groundwater area that contributes water to the water supply system; identifying the potential sources of pollution in the delineated area; and conducting a susceptibility analysis of the water supply to potential contaminant sources.

Surface seal: a structure used to plug the annular space, or the space between the well casing and the borehole or outer casing, at the ground surface. Surface seals are usually made with concrete and extend into the well deep enough to be below the frost line. Surface seals prevent contaminants from entering the annular space.

Susceptibility: the potential for a public water supply system to draw water contaminated at concentrations that would pose concern, through geologic strata and overlying soil, direct discharge, overland flow, or cracks/fissures in the physical well or surface-water intake.

Transient, noncommunity public water supply system: water systems that serve a transient or nonresidential population and includes campgrounds, rest stops, and resorts.

Time of travel: the time required for a contaminant to move in the saturated zone from a specific point to a well.

Unconfined aquifer: conditions in which the upper surface of the zone of saturation forms a water table under atmospheric pressure.

Vulnerability: the potential for a water source to become contaminated based on both the watershed or aquifer sensitivity and the likelihood that contaminants will be released where they could reach and contaminate the water source. Vulnerability combines intrinsic hydrogeologic characteristics with anthropomorphic factors.

Watershed area: a topographic area that is within a line drawn connecting the highest points uphill of a drinking water intake, from which overland flow drains to the intake.

Wellhead protection area: a designated area around a public water supply well(s) that is to be protected from contaminants that may adversely affect human health.

Wellhead Protection Program: a program to protect wellhead protection areas within a states jurisdiction from contaminants that may have any adverse effects on the health of persons (Safe Drinking Water Act, subsection 1428(a)).

Appendix A
State and Federal Agency Contacts

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ) AGENCY INFORMATION

Water Quality Division (WQD)
122 W 25th St
Herschler Bldg – 4W
Cheyenne, WY 82002
District Offices
Casper: 307-473-3465
Cheyenne: 307-777-7781
Lander: 307-332-3144
Sheridan: 307-673-9337

* Leaking Underground and Above Ground Storage Tanks
* Surface Water Discharge Permits (NPDES)
* Storm Water Pollution Prevention Plans & Permits
* Sewage Treatment Plants & Wastewater Permits
* Industrial Wastewater Treatment Plants
* Animal Waste Management Facilities (over 1000 animal units)
* Injection Wells (Classes I, III, IV & V)
* Groundwater Monitoring Systems and Water Quality Information
* Private Septic System Rules and Permits for the 8 Undelegated Counties
* Source Water and Wellhead Protection, Source Water Assessments
* Groundwater Pollution Control Sites/Known Contamination Sites
* Groundwater Pollution Investigations
* Groundwater Sensitivity and Aquifer Vulnerability Maps
* Land use maps
* Well characteristic database
* Public Water System (PWS) Construction Permits
* Non-Point Source Pollution Control Program
* Subdivision Permit Reviews

Solid and Hazardous Waste Division (SHWD)
122 W. 25th St
Herschler Bldg – 4W
Cheyenne, WY 82002
District Offices
Cheyenne: 307-777-7752
Lander: 307-332-6924
Casper: 307-473-3450
Sheridan: 307-673-9337

* Hazardous Material Treatment, Storage and Disposal Facilities
* RCRA Permits/Hazardous Waste Facility Cleanup
* Solid Waste Management Storage, Treatment and Disposal Facilities (land farms, landfills, etc.)
* Incinerators, Transfer Stations, Recycling Centers
* Pollution Prevention (Assistance to Industry Regarding Source Reduction, Recycling or Treatment to Reduce Toxicity or Volume)
* Spills, Leaks, Complaint Investigations

Land Quality Division (LQD)
122 W. 25th St
Herschler Bldg – 3W
Cheyenne, WY 82002
District Offices

Cheyenne: 307-777-7756
Lander: 307-332-3047
Sheridan: 307-672-6488
* Mine Permits
* Underground Mines
* Above Ground Mines

Abandoned Mine Lands Division (AML)
122 W 25th St
Herschler Bldg – 3W
Cheyenne, WY 82002
District Offices
Cheyenne: 307-777-6145
Lander: 307-332-5085
Casper: 307-473-3460
Sheridan: 307-673-9337
* Abandoned Mine Areas
* Acid Mine Drainage

Wyoming Oil and Gas Conservation Commission (OGCC)
Casper: 307-234-7147
* Oil & Gas Wells
* Oil and Gas Production, Refining, Transport (Pipelines) & Storage Facilities
* Class II Injection Wells

Wyoming State Geologic Survey (WY GS)
Laramie: 307-766-2286
* General Geologic information
* Geologic and Topographic Maps
* Mineral Production and Reserves

Wyoming State Engineer's Office (SEO)
Groundwater Division
Cheyenne: 307-777-6163
* Well Completion Reports; Permits for water supply wells and monitoring wells
* Groundwater Resource Information

Wyoming Department of Agriculture
Technical Services
Cheyenne: 307-777-6590
* Certification of Pesticide Applicators
* Pesticide and Fertilizer Best Management Practices (BMPs)

Wyoming Department of Transportation (DOT)
Maintenance Dept.
Cheyenne: 307-777-6590
* Identification of DOT Storage Sites of regulated and non-regulated substances (e.g., salt)
* Hazardous Cargo Shipments and Routes
* Chemical Usage Locations
* Aerial Photography Services

University of Wyoming Spatial Data and Visualization Center
Laramie: 307-766-2532
* Groundwater Sensitivity Maps and Aquifer Vulnerability Maps

University of Wyoming Water Resources Data System
Laramie: 307-766-6651
* Water Quality Databases
* Wyoming Water Bibliography
* Public Water System Databases

Wyoming Association of Rural Water Systems (WARWS)
P.O. Box 1750
Glenrock, WY 82637
307-436-8636
* Source Water and Wellhead Protection Planning
* Source Water Assessments

US Environmental Protection Agency (EPA), WY Direct Implementation Team
999 18th ST., Suite 500
8P-W-MS
Denver, CO 80202-2466
1-800-227-8917
* Safe Drinking Water Information System (SDWIS)
* Sanitary Surveys
* Monitoring Data

Trihydro and Lindstone
* Source Water and Wellhead Protection Planning
* Source Water Delineations

Examples of Potential Sources of Contamination

Commercial

Airports
Automobile repair shops
Boat yards, marinas

Construction areas
Car washes
Cemeteries (fertilizers, lawn chemicals)
Dry cleaning establishments
Educational institutions (labs, lawns, and chemical storage areas)
Gas stations
Golf courses (fertilizers, lawn chemicals)
Jewelry and metal plating businesses

Laundromats
Material transport routes, yards, and maintenance facilities (trucks and railroads)
Medical facilities
Paint shops

Photography and printing establishments
Research laboratories
Stormwater drains, retention basins
Road maintenance operations (de-icing, road salt, pesticides)
Road maintenance depots (chemical storage)
Scrap and junkyards
Storage tanks and pipes (aboveground and underground)

Industrial

Asphalt plants
Automobile service station disposal wells
Chemical manufacturing, warehousing, and distribution sites
Construction excavations
Detonation sites
Electrical/electronic products manufacturing
Electroplating and metal fabrication
Foundries

Industrial process water disposal wells
Machine and metalworking shops
Manufacturing and distribution sites for cleaning supplies

Mineral extraction disposal wells
Mining (surface and underground) and mine drainage and waste piles

Oil and gas disposal wells
Petroleum product production, storage, and distribution centers
Pipelines (oil, gas, slurry)
Radioactive disposal sites
Septage lagoons and sludge
Storage tanks and pipes (aboveground and underground)
Toxic and hazardous spills
Wastewater disposal wells
Class I, II, III, IV, and V wells

Wood preserving facilities

Residential

Fuel storage systems
Furniture and wood strippers, paints
Household hazardous chemicals, cleaning supplies
Household lawns (fertilizers, lawn chemicals)
Septic systems, cesspools
Sewer lines
Swimming pools (chlorine)

Waste Management

Fire training facilities
Hazardous waste management sites (landfills, land treatment areas, waste piles, incinerators, and treatment tanks)
Municipal incinerators
Municipal landfills

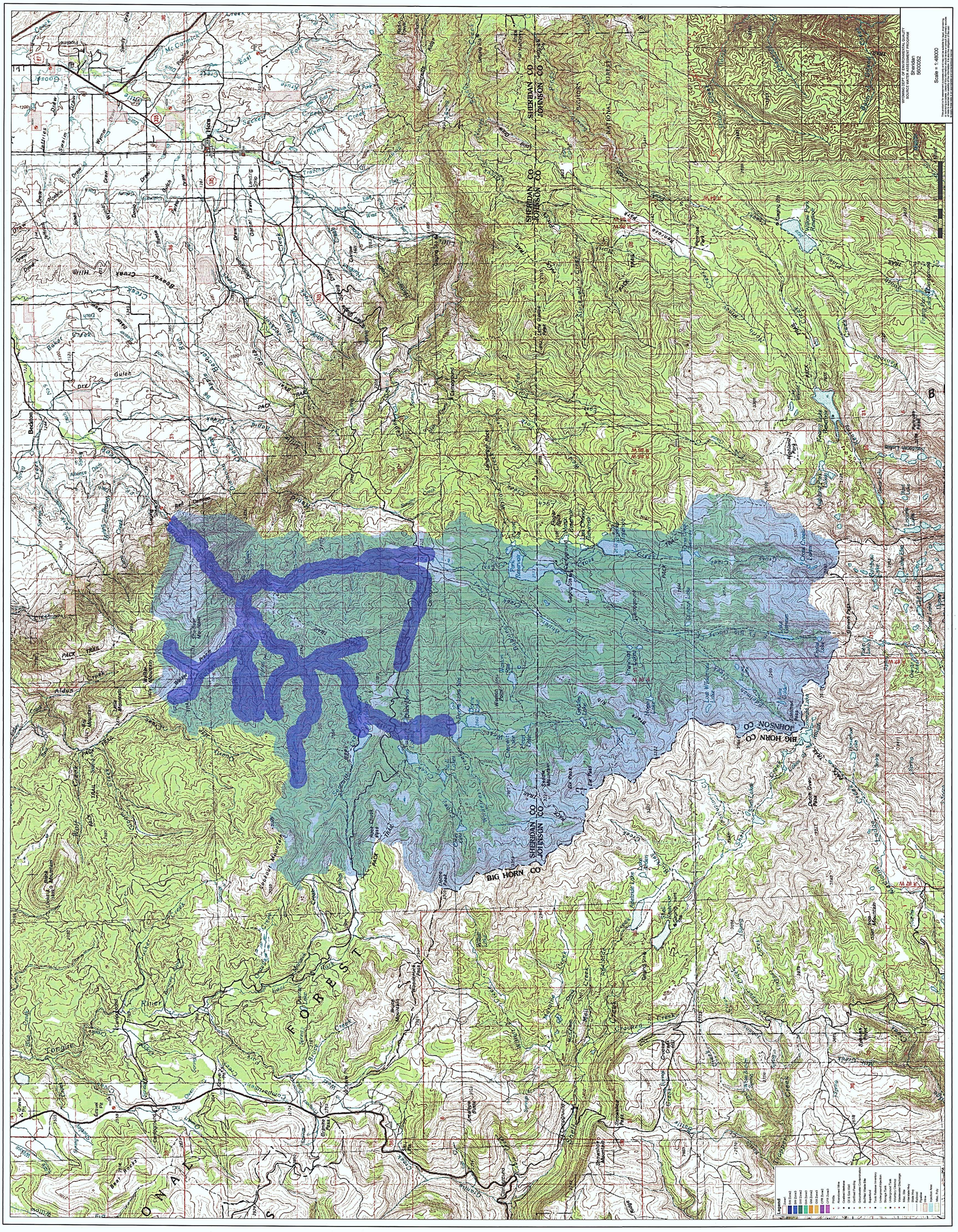
Municipal wastewater treatment facilities
Open burning sites

Recycling and reduction

Agricultural

Animal burial areas

Agricultural drainage
Animal feedlots (operating and abandoned)
Chemical application and storage areas (for pesticides and fertilizers)
Irrigated croplands


SHERIDAN CO
JOHNSON CO
BIG HORN CO