Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Cornerstone Christian School Drinking Water System, Wasilla, Alaska PWSID 220063

November 2006

DRINKING WATER PROTECTION REPORT Report 1591
Alaska Department of Environmental Conservation

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The Drinking Water Protection (DWP) section of the Drinking Water Program is producing Source Water Assessments in compliance with the Safe Drinking Water Act Amendments of 1996. Each assessment includes a delineation of the source water area, an inventory of potential and existing contaminant sources that may impact the water, a risk ranking for each of these contaminants, and an evaluation of the potential vulnerability of these drinking water sources.

These assessments are intended to provide public water systems owners/operators, communities, and local governments with the best available information that may be used to protect the quality of their drinking water. The assessments combine information obtained from various sources, including the U.S. Environmental Protection Agency, Alaska Department of Environmental Conservation (ADEC), public water system owners/operators, and other public information sources. The results of this assessment are subject to change if additional data becomes available. It is anticipated this assessment will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of public drinking water source. If you have any additional information that may affect the results of this assessment, please contact the Program Coordinator of DWP, (907) 269-7521.

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Source Water Assessment for Cornerstone Christian School Source of Public Drinking Water, Wasilla, Alaska

Drinking Water Protection
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

This source water assessment provides an evaluation of the vulnerability of the public water system serving the Cornerstone Christian School to potential contamination. This Class A (community) water system consists of one well near Seldon Road in Wasilla. The well received a natural susceptibility rating of **Low**. This rating is a combination of a susceptibility rating of **Low** for the actual wellhead and a **Medium** rating for the aquifer in which the well is drawing water from. Identified potential and current sources of contamination for the Cornerstone Christian School public water system include: injection wells, septic systems, livestock pastures, and roads. These are considered as sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals (VOCs), heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals (SOCs), and other organic chemicals (OOCs). Combining the natural susceptibility of the well with the contaminant risk, the public water system for Cornerstone Christian School received an overall vulnerability rating of **High** for bacteria and viruses, nitrates and/or nitrites, **Medium** for heavy metals, cyanide, and other inorganic chemicals, and **Low** for SOCs, VOCs, and OOCs,.

CORNERSTONE CHRISTIAN SCHOOL PUBLIC DRINKING WATER SYSTEM

Cornerstone Christian School public water system is a Class A (community) water system consisting of one well near Seldon Road in Wasilla.

Although the quality can vary significantly in a short distance, groundwater supplies are abundant in the area. The Wasilla area has a central water system, and several subdivisions have private water systems. Many homes and businesses in the area, however, rely on individual wells for their water supply. Most of these wells are shallow with depths of less than 100 feet. Static water levels in many of these wells are around 30 feet below the surface. The coarse gravel underlying the Wasilla area provides a large aquifer even in the winter when infiltration is low (*Trainer, 1953*).

A lake covered the Susitna River valley lowland during glacial times. The deposition of glacial silts and clays played an important part in the make up of the soils of the area.

Most of the soils in the area provide good sources of sand, gravel and topsoil. The deposition of silt, clay and organic muck in old lakes and depressions means that some areas have soil conditions that vary over relatively short distances. The U.S. Soil Conservation Service has mapped seven soil associations in and around Wasilla.

The Homestead and Knik soil types dominate the Wasilla area, with smaller areas of Coal Creek, Jacobsen, Salamatof, and Slikok soil types.

The Cornerstone Christian School public water system serves 180 residents through 1 service connection.

CORNERSTONE CHRISTIAN SCHOOL DRINKING WATER PROTECTION AREA

The pathways most likely for surface contamination to reach the groundwater are identified as the first step in determining a drinking water system's risk. These areas are determined by looking at the characteristics of the soil, groundwater, aquifer, and well.

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater capture zone. The groundwater capture zone is located in the area circling the well (the area influenced by pumping) and also the area of the water table upgradient of the well, usually forming a parabola shape.

There are many different methods for calculating the size of capture zones. Drinking Water Protection (DWP) uses a combination of two simple groundwater flow equations, the Thiem and uniform flow equations for all groundwater wells screened in unconsolidated material. The orientation of the capture zone is then drawn using a water table elevation map (if available) or a land surface elevation map of the area. The capture zone calculated by the DWP is an estimate using the available information and resources, and may differ slightly from the actual capture zone.

The parameters used to calculate the shape of this capture zone are general for the whole alluvial plain and were obtained from various United States Geological Survey (USGS) reports, area well logs, and

the Groundwater textbook by Freeze and Cherry (Freeze and Cherry, 1979).

Because of uncertainties and changing site conditions, a factor of safety is added to the groundwater capture zone to form the drinking water protection area for the well.

The protection areas established for wells are usually separated into two zones, limited by the watershed. These zones correspond to times-of-travel (TOT) of the water moving through the aquifer to the well (plus the factor of safety).

The following is a summary of the two zones for wells and the calculated time-of-travel for each:

Table 1. Definition of Zones

Zone	Definition
A	Several months travel time
B	Less than 2 years time-of-travel

The time of travel for contaminants within the water varies with their unique physical and chemical characteristics.

The drinking water protection area outlined for the Cornerstone Christian School on Map 1 of Appendix A will serve as the focus for voluntary protection efforts.

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

Drinking Water Protection (DWP) has completed an inventory of potential and existing sources of contamination within the Cornerstone Christian School protection area. This inventory was completed through a search of agency records and other publicly available information. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of all Class A public water system assessments, six categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates and/or nitrites;
- Volatile organic chemicals;
- Heavy metals, cyanide, and other inorganic chemicals;
- Synthetic organic chemicals; and
- Other organic chemicals.

The sources are displayed on Map 2 of Appendix C and summarized in Table 1 of Appendix B.

RANKING OF CONTAMINANT RISKS

Once the potential and existing sources of contamination have been identified, they are each assigned a ranking according to what type and level of risk they represent. Ranking of contaminant risks for a "potential" or "existing" source of contamination is a combination of toxicity and volume associated with that source. Rankings include:

- Low
- Medium
- High
- Very High

Tables 2 through 7 in Appendix B contain the ranking of inventoried potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide and other inorganic chemicals, synthetic organic chemicals and other organic chemical

VULNERABILITY OF CORNERSTONE CHRISTIAN SCHOOL DRINKING WATER SYSTEM

The vulnerability of public drinking water systems to regulated contaminants is determined by assessing the susceptibility of the wellhead, the susceptibility of the aquifer and the potential contaminant sources identified within the protection area.

The Drinking Water Protection developed a vulnerability assessment tool that assigns a vulnerability risk ranking based upon various factors associated with the well, aquifer and potential and existing contaminants identified within the protection area.

Factors contributing to the susceptibility of the wellhead are: whether the sanitary seal in place, protection from flooding, and if the well casing is properly grouted.

The wellhead for the Cornerstone Christian School received a **Low** susceptibility rating. The most recent sanitary survey (7/14/2004) indicates the well is capped with a sanitary seal, the well is grouted; however, the land surface does not slope away from the well. A sanitary seal prevents potential contaminant from entering the well while sloping of the land surface and grouting help to prevent potential contaminants from traveling down the outside of the well casing. When the land does not slope away from the wellhead, it allows water to build up around the well casing, and help to push potential contaminants from the surface down to the aquifer below.

Factors contributing to the susceptibility of the aquifer are: whether the aquifer is confined or unconfined,

whether the well is completed in unconsolidated or fractured bedrock, whether wells and bore holes are penetrating the aquifer and, if applicable, the confining layer.

The aquifer the Cornerstone Christian School well is completed in received a **Medium** susceptibility rating. The highly transmissive aquifer material and the high water table in the area allow contaminants to travel downward from the surface with the precipitation and surface water runoff. In addition, the presence of boreholes within the protection area may provide contaminants a direct route to the groundwater. Table 2 summarizes the Susceptibility scores and ratings for Cornerstone Christian School.

Table 2: Susceptibility

	Rating
Susceptibility of the Wellhead	Low
Susceptibility of the Aquifer	Medium
Natural Susceptibility	Low

The Contaminant Risk has been derived from an evaluation of the routine sampling results of the water system and the presence of potential sources of contamination. Contaminant risks to a drinking water source depend on the type and distribution of contaminant sources.

Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 3. Contaminant Risks

Category	Rating
Bacteria and Viruses	Very High
Nitrates and/or Nitrites	Very High
Volatile Organic Chemicals	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	Medium
Synthetic Organic Chemicals	Low
Other Organic Chemicals	Low

Finally, an overall vulnerability is determined for each water system by combining each of the contaminant risk scores with the natural susceptibility score:

Natural Susceptibility
+
Contaminant Risks
=
Vulnerability of the
Drinking Water Source to Contamination

Table 4 contains the overall ratings for each of the six categories of drinking water contaminants.

Table 4. Overall Vulnerability

Category	Rating
Bacteria and Viruses	High
Nitrates and Nitrites	High
Volatile Organic Chemicals	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	Medium
Synthetic Organic Chemicals	Low
Other Organic Chemicals	Low

Bacteria and Viruses

Class V injection wells in the protection area represent the greatest risk for bacteria and viruses to the drinking water well. For a complete listing of potential sources for bacteria and virus contamination please see Table 2 in Appendix B.

Only a small amount of bacteria and viruses are required to endanger public health. Coliforms are found naturally in the environment and although they aren't necessarily a health threat, it is an indicator of other potentially harmful bacteria in the water, more specifically, fecal coliforms and E. coli which only come from human and animal fecal waste (EPA, 2006). Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2006). In sampling from 11/28/2005 and 11/30/2005 coliforms were detected.

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability of the well to contamination is high.

Nitrates and Nitrites

Class V injection wells in the protection area also represent the greatest risk to to nitrates and nitrites for this source of public drinking water. For a complete listing of potential sources for nitrate and nitrite contamination please see Table 3 in Appendix B.

Nitrates are very mobile, moving at approximately the same rate as water. Nitrates have not been detected in

recent sampling history for the Cornerstone Christian School well.

After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to contamination is high.

Volatile Organic Chemicals

Class V injection wells represent the greatest identified risk for volatile organic chemical contamination to the well. For a complete listing of potential sources for bacteria and virus contamination please see Table 4 in Appendix B.

Volatile Organic Chemicals have not been detected within source waters. After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is high.

Heavy Metals, Cyanide, and Other Inorganic Chemicals

Roads represent the greatest risk for inorganic chemicals to the well. For a complete listing of potential sources for bacteria and virus contamination please see Table 5 in Appendix B.

Arsenic was detected at 31% of its maximum contaminant level (MCL) in sampling from 2004. The MCL for arsenic is 0.01mg/L. In greater quantities, arsenic is known to cause skin damage, problems with circulatory systems, and may create an increased risk of developing cancer (EPA, 2006).

After combining the contaminant risk for heavy metals, cyanide and other inorganic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

Synthetic Organic Chemicals

Roads represent the greatest risk for synthetic organic chemicals to the well. For a complete listing of potential sources for bacteria and virus contamination please see Table 6 in Appendix B.

Synthetic organic chemicals have not been sampled for in this water system.

After combining the contaminant risk for snythetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

Other Organic Chemicals

Roads represent the greatest risk for other organic chemicals to the well. For a complete listing of potential sources for bacteria and virus contamination please see Table 7 in Appendix B.

Other organic chemicals have not been sampled for in this water system.

After combining the contaminant risk for snythetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

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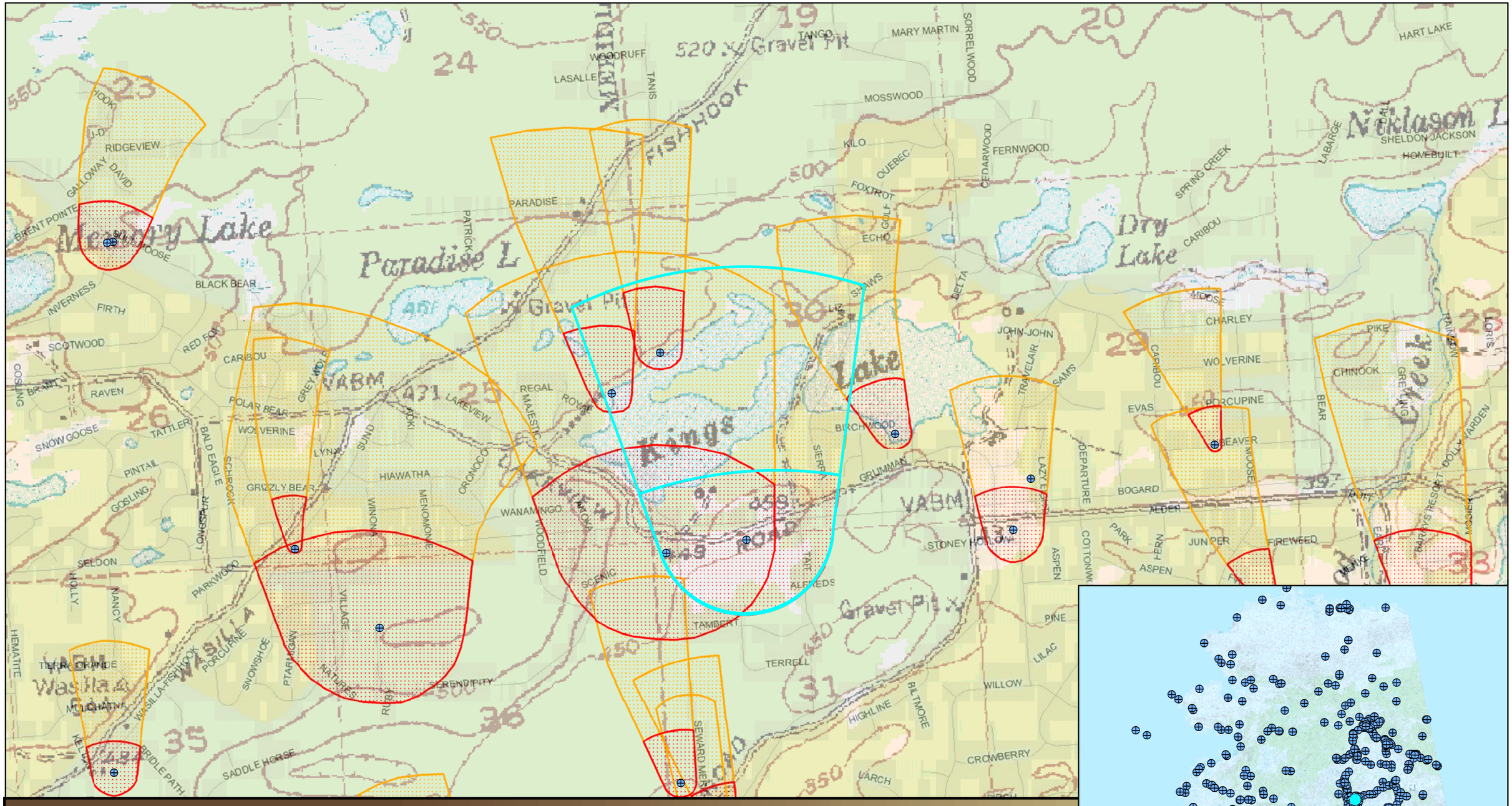
APPENDIX A

Cornerstone Christian School
Drinking Water Protection Area Location Map
(Map 1)



Map 1- Cornerstone Christian School and Surrounding Water Systems

PWSID: 220063.001

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 1:18,320 Feet 4,600

Data Sources:
MSB: Roads and parcels
Potential Sources of Contamination: ADEC

- Public Water Sources
- Zone A Protection Area
- Zone B Protection Area

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Cornerstone Christian School (Tables 1-7)

Table 1

Contaminant Source Inventory for

Cornerstone Christian School

PWSID 220063.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Livestock pastures	A08	A08-1	A		
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A		
Septic systems (serves one single-family home)	R02	R02-1-5	A		
Highways and roads, paved (cement or asphalt)	X20	X20-1-7	A		
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	B		
Septic systems (serves one single-family home)	R02	R02-6-13	B		
Highways and roads, paved (cement or asphalt)	X20	X20-8-10	B		

Table 2

Contaminant Source Inventory and Risk Ranking for Cornerstone Christian School Sources of Bacteria and Viruses

PWSID 220063.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	High		
Septic systems (serves one single-family home)	R02	R02-1-5	A	Low		
Highways and roads, paved (cement or asphalt)	X20	X20-1-7	A	Low		
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	B	High		
Septic systems (serves one single-family home)	R02	R02-6-13	B	Low		
Highways and roads, paved (cement or asphalt)	X20	X20-8-10	B	Low		

Table 3

Contaminant Source Inventory and Risk Ranking for Cornerstone Christian School Sources of Nitrates/Nitrites

PWSID 220063.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	High		
Septic systems (serves one single-family home)	R02	R02-1-5	A	Low		
Highways and roads, paved (cement or asphalt)	X20	X20-1-7	A	Low		
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	B	High		
Septic systems (serves one single-family home)	R02	R02-6-13	B	Low		
Highways and roads, paved (cement or asphalt)	X20	X20-8-10	B	Low		

Table 4

Contaminant Source Inventory and Risk Ranking for Cornerstone Christian School Sources of Volatile Organic Chemicals

PWSID 220063.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low		
Septic systems (serves one single-family home)	R02	R02-1-5	A	Low		
Highways and roads, paved (cement or asphalt)	X20	X20-1-7	A	Low		
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	B	Low		
Septic systems (serves one single-family home)	R02	R02-6-13	B	Low		
Highways and roads, paved (cement or asphalt)	X20	X20-8-10	B	Low		

Table 5

Contaminant Source Inventory and Risk Ranking for Cornerstone Christian School

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 220063.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low		
Septic systems (serves one single-family home)	R02	R02-1-5	A	Low		
Highways and roads, paved (cement or asphalt)	X20	X20-1-7	A	Low		
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	B	Low		
Septic systems (serves one single-family home)	R02	R02-6-13	B	Low		
Highways and roads, paved (cement or asphalt)	X20	X20-8-10	B	Low		

Table 6

Contaminant Source Inventory and Risk Ranking for Cornerstone Christian School Sources of Synthetic Organic Chemicals

PWSID 220063.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low		
Septic systems (serves one single-family home)	R02	R02-1-5	A	Low		
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	B	Low		
Septic systems (serves one single-family home)	R02	R02-6-13	B	Low		

Table 7

Contaminant Source Inventory and Risk Ranking for Cornerstone Christian School Sources of Other Organic Chemicals

PWSID 220063.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low		
Septic systems (serves one single-family home)	R02	R02-1-5	A	Low		
Highways and roads, paved (cement or asphalt)	X20	X20-1-7	A	Low		
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	B	Low		
Septic systems (serves one single-family home)	R02	R02-6-13	B	Low		
Highways and roads, paved (cement or asphalt)	X20	X20-8-10	B	Low		

APPENDIX C

Cornerstone Christian School
Drinking Water Protection Area and
Potential and Existing Contaminant Sources
(Map 2)

2 Large capacity septic systems
1 in Zone A
1 in Zone B

10 Roads
7 in Zone A
3 in Zone B

13 Septic systems
5 in Zone A
8 in Zone B

1 Livestock pasture in Zone A

Zone A Protection Area
Zone B Protection Area
Pasture
Roads
Public Water Sources
Septics
D10

Map 2- Cornerstone Christian School Potential Contaminant Sources

PWSID: 220063.001

0 1:8,390 Feet 2,200

Data Sources:
MSB: Roads and parcels
Potential Sources of Contamination: ADEC