

PROTECTING THE CASPER AQUIFER THROUGH SEPTIC SYSTEM MANAGEMENT

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Cities and communities throughout the United States and the world rely on aquifers for clean drinking water. Aquifer contamination would not only be financially devastating to a community, but a polluted aquifer poses multiple health risks and a degradation of clean drinking water. The Casper Aquifer is a major source of drinking water for Laramie, Albany County, Wyoming. This study examines the Casper Aquifer Protection Overlay Zone (APOZ) as it relates to household septic systems. The number and location of septic systems, growth scenario, and age of septic systems was determined for Albany County's Casper Aquifer Protection Area. The author also examined septic system best management planning strategies to protect and avoid groundwater contamination of the Casper Aquifer.

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TABLE OF CONTENTS

Table of Contents.....	ii
Tables and Figures.....	iv
Chapter One: Introduction	
1.1 Overview.....	5
1.2 Study Area.....	7
1.3 Casper Aquifer Characteristics and Vulnerabilities.....	11
1.4 Objectives.....	14
1.5 Short Description of Each Chapter.....	14
Chapter Two: Casper Aquifer Protection Goals and Objectives	
2.1 Overview.....	16
2.2 Albany County Comprehensive Plan and CAPP.....	16
2.3 City of Laramie’s Regulations for Septic Systems in the APOZ.....	21
2.4 Summary.....	23
Chapter Three: Methodology	
3.1 Overview.....	25
3.2 Septic Systems in the APOZ.....	25
3.3 Linear Growth Models for Septic Systems.....	26
3.4 Subdivision Build-Out Scenario.....	27
3.5 Septic System Age Distribution.....	28
3.6 Casper Aquifer Septic System Database Management.....	29
3.7 Best Management Practices for Regulating Septic Systems.....	29
3.8 Summary.....	29
Chapter Four: Septic System Analysis of the Casper Aquifer	
4.1 Overview.....	31
4.2 Spatial Location and Number of Septic Systems in the APOZ	31
4.3 Casper Aquifer Septic System Growth Model.....	33
4.4 Casper Aquifer Septic System Growth Density Scenario	35
4.4.1 Northern Zone Growth Scenario.....	38
4.4.2 Central Zone Growth Scenario.....	39
4.4.3 Southern Zone Growth Scenario.....	40
4.5 Subdivision Build-Out Analysis.....	41
4.6 Septic System Age Distribution.....	44
4.6.1 Northern Zone Age Distribution.....	48
4.6.2 Central Zone Age Distribution.....	48
4.6.3 Southern Zone Age Distribution.....	49
4.7 Summary.....	50

Chapter Five: Septic System Management Strategies

5.1 Overview..... 52

5.2 Examples of Septic System Management..... 52

5.3 Summary..... 56

Chapter Six: Conclusion and Recommendation

6.1 Summary..... 57

6.2 Recommendations..... 58

6.3 Administrative Feasibility..... 58

6.4 Conclusion..... 59

References..... 61

Appendix A..... 65

Appendix B..... 66

LIST OF TABLE/FIGURES

Figure 1.1 Albany County and Casper Aquifer Study Area.....	9
Figure 1.2 Casper Aquifer Protection Overlay Zone and Land Use.....	10
Figure 1.3 Casper Aquifer Protection Zones.....	13
Figure 4.1 Location and Number of Septic Systems in the APOZ.....	32
Figure 4.2 Detailed Growth Density Zones: Northern, Central and Southern.....	37
Figure 4.3 Current Septic Systems in the Northern Zone.....	38
Figure 4.4 Current Septic Systems in the Central Zone.....	39
Figure 4.5 Current Septic Systems in the Southern Zone.....	40
Figure 4.6 Casper Aquifer Septic System Over 20 Years Old.....	47
Table 3.1 Data Source for Household Septic System Locations.....	26
Table 3.2 Build-Out Scenario: Spur Ridge Subdivision.....	28
Table 4.1 Residential Septic System Density Scenario for the Casper Aquifer.....	36
Table 4.2 Subdivision Build-Out Scenario for the APOZ.....	43
Table 4.3 Age of Septic Systems.....	46
Table 5.1 Septic System Pumping Schedules.....	55
Graph 4.1 Total Number of Septic Systems in the APOZ through 2040.....	34
Graph 4.2 Number and Age of Septic Systems per year in the APOZ.....	45
Graph 4.3 Cumulative Number and Age of Septic Systems 1983-2011.....	45
Graph 4.4 Age of Septic Systems: Northern Zone.....	48
Graph 4.5 Age of Septic Systems: Central Zone.....	49
Graph 4.6 Age of Septic Systems: Southern Zone.....	49

CHAPTER ONE: INTRODUCTION

1.1 Overview

Cities and communities throughout the United States and the world rely on aquifers for clean drinking water¹. Aquifer contamination would not only be financially devastating to a community, but a polluted aquifer poses multiple health risks and a degradation of clean drinking water. If an aquifer becomes polluted, a wastewater treatment plant is required which is expensive and financially burdensome to the community. Groundwater aquifers are becoming more impacted by contamination from wastewater discharge with continued development (Travis and Etnier, 1984; Canter, 1985). In fact, according to the Environmental Protection Agency (EPA), septic systems are the second leading cause of groundwater contamination (Clucas, 2007). Ninety-five percent of rural Americans rely on natural groundwater for a clean water source, making its protection a necessity (Prins and Lustig, 1988).

Twenty-five percent of households in the United States use a septic system. Proper installation and maintenance is essential to avoid failure of the system especially over sensitive aquifer recharge areas (Kaplan, 1991; Ahmed and Katouli, 2004). Even when septic systems are installed properly, 10-20% fail annually increasing the threat for groundwater contamination. Septic systems fail due to the aging components of the system. The threat of groundwater contamination is further increased when septic systems are installed in shallow fragmented terrain close to domestic wells (Onsite wastewater treatment, 2003). Moreover, even proper working septic systems naturally leach nitrates and other pollutants into the ground. A failed

¹ An aquifer is a formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield sufficient, economical quantities of water to wells, springs, and drain tunnels (Casper Aquifer Protection Plan, 2008).

septic system would deposit household waste directly into the ground without the proper leaching mechanisms in place.

According to the EPA, septic systems are the largest source of wastewater to groundwater discharge at 800 billion gallons per year (Yates, 1985). In addition, "...septic systems are a significant source of groundwater contamination leading to waterborne disease outbreak and other adverse health effects" (**Source Water Protection**, 2001 p, 2). The Wyoming Department of Environmental Quality also states, "...septic systems are still the largest reported cause of groundwater contamination resulting in disease outbreaks in the United States" (Wellhead protection fact, 1998, p 1).

Aquifer contamination has been attributed to high nitrate concentrations. Septic systems have been linked to increased nitrates, fecal coliforms, phosphates, and disease outbreaks which include methemoglobinemia², gastrointestinal illnesses, and typhoid fever. Pathogens found in drinking water are often due to the lack of regular maintenance and aging of the system (Craun, 1979; Craun 1984; DeBorde et al, 1998; Arnade, 1999; Steffy and Kilham, 2004; Borchardt, 2011).

This study examines the Casper Aquifer Protection Overlay Zone (APOZ) as it relates to household septic systems. In particular, the author will examine septic system best management planning strategies to protect and avoid groundwater contamination of the Casper Aquifer. The objectives are to examine the current **Albany County Comprehensive Plan (2008)**, **Casper Aquifer Protection Plan 2011 (CAPP)**, and the City of Laramie Municipal Code for goals, objectives, and policies protecting the aquifer as it relates to household septic systems. In addition, this study examines the spatial location and number of residential households using

² Methemoglobinemia is a blood disorder where oxygen cannot be distributed throughout body tissues and is commonly referred to as blue baby syndrome. This is commonly caused by nitrates.

septic systems currently in the APOZ. Finally, best management practices for managing septic systems will be examined from counties who have dealt with groundwater and aquifer issues. The use of Albany County housing and septic system permits files from 1983-2011 and linear regression models will be employed in a Geographic Information System (GIS) as the basis for projecting future septic systems. In addition, a subdivision build-out scenario and an age distribution of installed septic systems will be examined to determine potential contamination to the Casper Aquifer.

1.2 Study Area

The study area for this project is the Casper Aquifer recharge zone located on the eastern edge of Laramie, Wyoming, Albany County (Figure 1.1). Despite geological evidence dating back to the early 1980's illustrating specific aquifer vulnerabilities, to be discussed later, city and county officials lack a consensus on how to protect the aquifer for a continued clean water source. The Albany County Planning Director stated, "One of the big challenges with the aquifer is the lack of information... There's a potential for contamination. It's there, we just don't know to what extent" (Gertsch, 2012).

Albany County, located in southeast Wyoming, is comprised of approximately 4,300 square miles. According to the 2010 Census, Albany County had a population of 36,299 and the City of Laramie accounted for 85% with 30,816 residents ([www.census.gov/American fact finder](http://www.census.gov/American%20fact%20finder), 2012). The City of Laramie receives approximately 60% of its drinking water from the Casper Aquifer and residents located within the aquifer overlay zone rely on the aquifer for nearly 100% of their water source (City of Laramie, 2011). In drought years, the City of Laramie is almost solely dependent on the aquifer for its drinking source. This would classify

and qualify the Casper Aquifer as a Sole Source Aquifer according to the EPA (Lieske & Hammerlinck, 2003).

The Casper formation extends from the Colorado border north to Casper, Wyoming and is part of the Paleozoic Aquifer. The Casper Aquifer recharge zone is located directly east of Laramie, Wyoming (Casper aquifer exploration, 1986) (Figure 1.1). The focus of this study concentrates on the specific area of the **Casper Aquifer Protection Plan 2011** Overlay Zone (APOZ) encompassing 66.8 sq. miles or 42,750 acres (Figure 1.2). The protection zone was defined as a primary area where potential groundwater degradation would likely be prevalent. The APOZ was determined by multiple factors which include exposed surfaces and vulnerable areas of shallow Satanka Shale of less than 75 feet (**Albany County Comprehensive Plan, 2008**).

Figure 1.2 illustrates the land use within the APOZ which includes 62% (26,435ac/42,750ac) agricultural land, 10% (4,326ac/42,750ac) occupied residential land primarily located on the western border of the protection zone, and 5% (2,123ac/43750ac) vacant residential land use (**Albany County Comprehensive Plan, 2008**). As of 2011, there were 460 occupied residential units and 99 vacant units, mostly contained in 17 subdivisions. Figure 1.2 also demonstrates the differences between the Albany County APOZ boundary and the City of Laramie's APOZ boundary. The primary modification is the City of Laramie's western aquifer boundary which extends farther into the eastern portion of the city and follows property boundaries.

Figure 1.1 Albany County and the Casper Aquifer Study Area

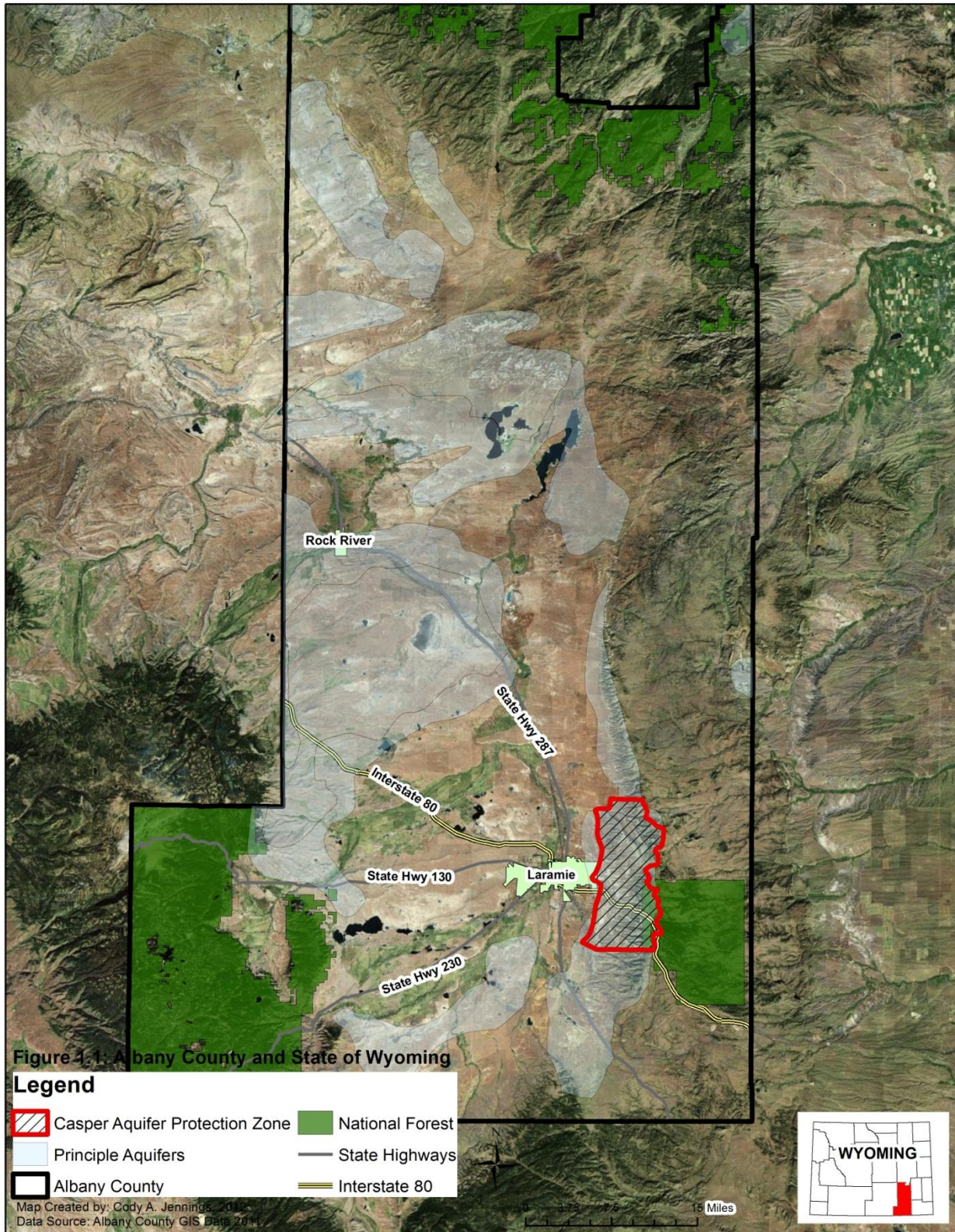
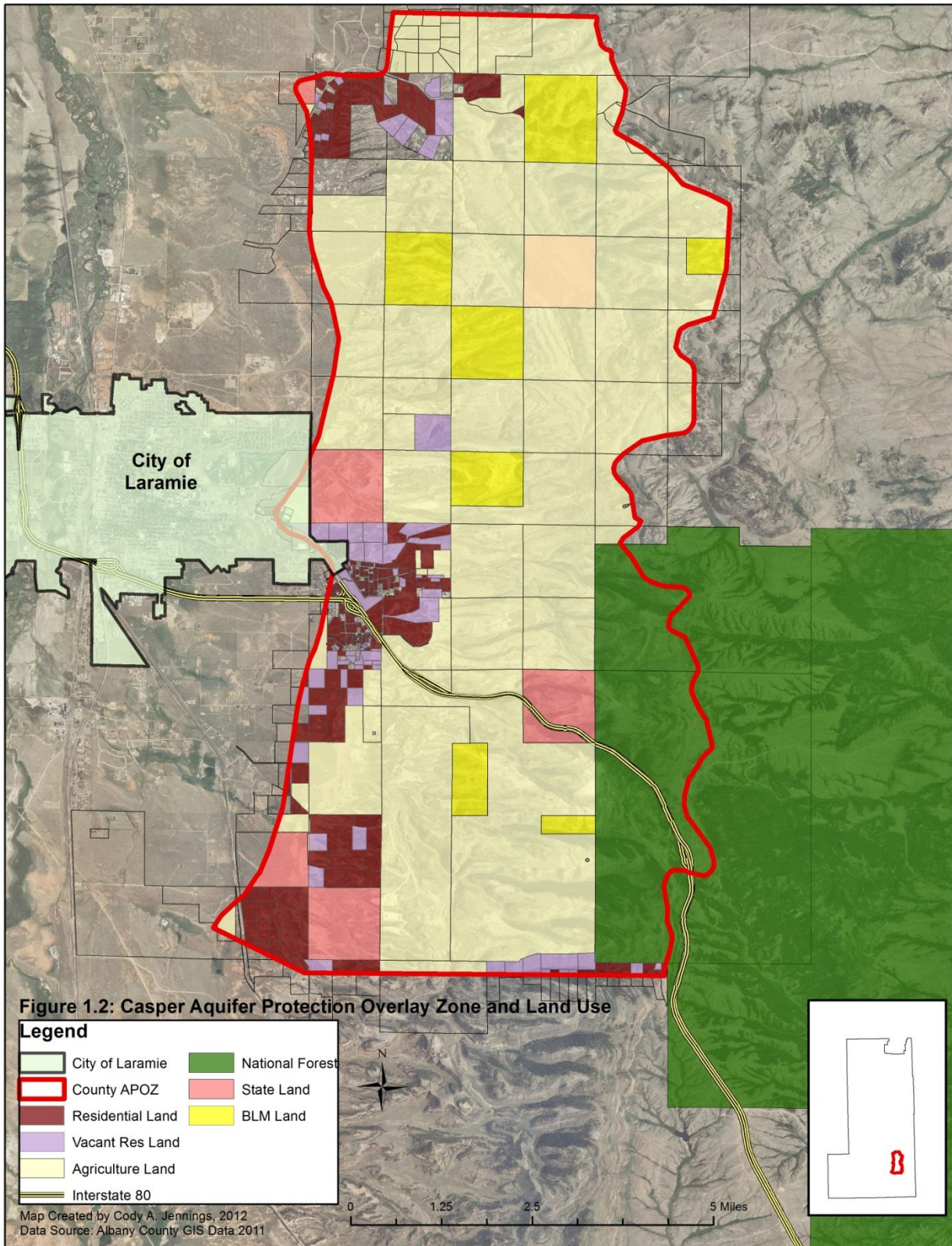


Figure 1.2 Casper Aquifer Protection Overlay Zone and Land Use



1.3 Casper Aquifer Characteristics and Vulnerabilities

The Casper Aquifer recharge zone has been studied and some of its vulnerable features, but not all, have been located and identified. A brief report of the vulnerable features and protection zones will be examined; however, the focus of this study is the management of septic systems in the APOZ. A full list of document resources can be acquired at either the Albany County Planning Department or the City of Laramie Community Development Department.³

Geologic evidence from certified engineers and geologists have determined that, “The Casper Aquifer in the Laramie Area is an anisotropic⁴, fractured sandstone and limestone aquifer that has no apparent hydrogeologic or flow boundaries between wellfields, and has the potential for rapid transport of groundwater over large distances” (**Casper Aquifer Protection Plan**, 2011 p, 2). In a study testing groundwater travel through fractures, a tracer test indicated “...a dissolved salt water plume traveled a distance of 147 feet in 12 minutes before arriving at the pumping well” (**Casper Aquifer Protection Plan**, 2011 p, 31). Wastewater studies have indicated an increase in nitrate levels for the study area particularly in results directly east of the City (Report on summer/fall, 2009). Unsafe nitrate conditions exist when there are 10 mg/L or greater in the water (Report on summer/fall, 2009). From a 2009 study performed by WWC Engineering, average nitrate levels of 3.9 ppm were identified in the study area. At the time of the study there was one well that tested above 10 ppm which is considered to be unsafe and requires additional well-monitoring (WWC, 2010).

There have been numerous reports and studies concentrated on the aquifer that are referenced in the **Casper Aquifer Protection Plan (CAPP) 2011**.⁵ Chapter 3 of the **CAPP** provides a detailed report of the geology, hydrogeology, structural features, depth, and saturated

³ Albany County: (<http://www.co.albany.wy.us/>) City of Laramie: (<http://www.cityoflaramie.org/>)

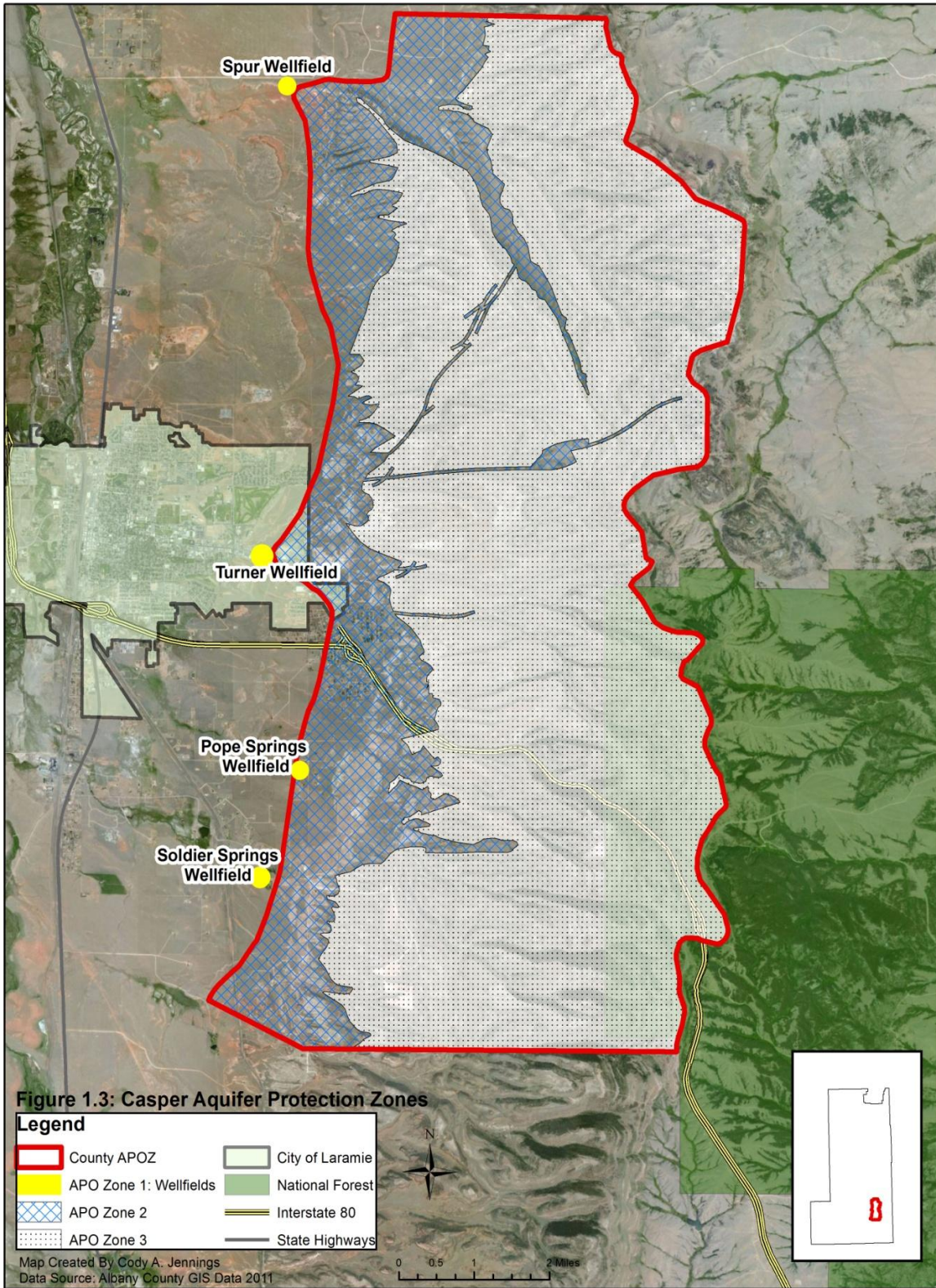
⁴ An anisotropic aquifer refers to equal hydraulic conductivity throughout the area.

⁵ The complete CAPP can be retrieved at (<http://www.co.albany.wy.us/documents-and-reports.aspx>)

thickness of the aquifer. Vulnerable features in the aquifer have been identified as potential factors for natural contamination of the area. The features include faults, folds, exposed bedrock, drainages, and areas of shallow depth-to-groundwater (**Casper Aquifer Protection plan**, 2011).

Three protection zones have been established for the **CAPP** and are illustrated in Figure 1.3. Zone 1 was established to protect any immediate contaminants from entering City of Laramie wells. Zone 2 was delineated as a preventative measure to protect wells from pathogenic material as well as detrimental land uses (**Casper Aquifer Protection Plan**, 2011). Zone 3 was established as a buffer to protect the travel of contaminants entering the first two zones. The majority of residential housing is located in Zone 2. Further information regarding wellhead protection can be found in the **CAPP** which explains the Safe Drinking Water Act of 1974 (Pub. L. 93-523. Stat. 88 Stat. 1660) and guidelines establishing the Wyoming Wellhead Protection Program (**Casper Aquifer Protection**, 2011).

Figure 1.3 Casper Aquifer Protection Zones



1.4 Objectives

The focus of this study is on the management of residential household septic systems.

Specifically the objectives of this paper are:

1. Examine the current **Albany County Comprehensive Plan, Casper Aquifer Protection Plan (CAPP)**, and **City of Laramie Municipal Code** for goals and objectives protecting the aquifer as it relates to household septic systems.
2. Determine the spatial location and number of septic systems/households in the Casper Aquifer Protection overlay zone (APOZ).
3. Create a septic system growth model and subdivision build-out scenario for the study area.
4. Create a Casper Aquifer age distribution of septic systems to illustrate the age of household septic systems.
5. Provide a literature review to identify best management practices for household septic systems from examples of other communities with groundwater or aquifer issues.
6. Provide recommendations to Albany County for current and future septic system management based on best practices and examples from other counties and municipalities.

1.5 Short Description of Each Chapter

This study consists of six chapters including chapter one wherein the introduction to the problem is addressed and the main objectives of the study area are delineated. Chapter two provides an overview of the goals and objectives from the **Albany County Comprehensive Plan** and the **Casper Aquifer Protection Plan** for protecting the aquifer. In addition, The City of Laramie's **Municipal Code** will be examined for aquifer protection measures. Chapter three introduces the methodology for assessing current septic system locations and spatial distribution through the use of ArcMap v.10.0 Geographic Information Systems. Chapter four is a descriptive analysis of the spatial location and number of septic systems in the study area. The chapter also examines the growth potential of septic systems and build-out scenarios of the 17 subdivisions in the aquifer recharge zone.

Chapter five will provide examples of septic system policies implemented in locations with aquifer/groundwater problems through the use of the Environmental Protection Agencies Sole Source Aquifer program and the Groundwater Guardian Foundation. Finally, a summary and conclusion chapter addressing septic system management in Albany County, Wyoming will be presented.

CHAPTER TWO: CASPER AQUIFER PROTECTION GOALS AND OBJECTIVES

2.1 Overview

A Casper Aquifer study in 2001 titled **Land Use Management Strategies for the Protection of the Casper Aquifer** provided an overview of the Casper Aquifer and planning strategies for the protection of the aquifer. In addition, that study identified federal and state policies to protect the aquifer, including the U.S. Clean Water Act (Pub. L. 93-523. Stat. 88 Stat. 1660) and the Wyoming Department of Environmental Quality/Water Quality Division that administers groundwater regulations (Hallgarth, 2001).⁶ In 2001, neither Albany County nor the City of Laramie had Comprehensive Plans or Casper Aquifer Protection Plans (CAPP) in their zoning regulations or municipal code. The focus of this chapter is to identify current County goals and objectives and City of Laramie Municipal Code for protecting the Casper Aquifer.

2.2 Albany County Comprehensive Plan and CAPP

Albany County created their first Comprehensive Plan in 2008. **The Albany County Comprehensive Plan** provides the goals and objectives for protecting natural resources which includes aquifer protection. The **CAPP** recommends specific measures for the county to enact aquifer protection which includes a septic system management plan. The Albany County zoning resolutions provide the specific policies to protect the aquifer⁷. Chapter Six of the plan titled “Natural and Environmental Resources” identified four objectives for protecting resources. The objectives from the plan should guide future management strategies for protecting the aquifer. Chapter Six denotes that the most vulnerable area of the aquifer lies directly east of the City of

⁶ Wyoming Department of Environmental Quality: (<http://deq.state.us/>); US Clean Water Act: (<http://www.epa.gov/lawsregs/laws/cwa.html>)

⁷ Appendix B provides a description in more detail of the comprehensive plan, CAPP and zoning regulations

Laramie (**Albany County Comprehensive Plan**, 2008). The Natural and Environmental

Resource objectives include:

NR1: Conserve and enhance natural and environmental resources.

NR2: Delineate hazardous or sensitive places on plats and/or site plans, which include, but are not limited to, areas of...aquifer recharge, steep terrain... and shallow groundwater. Discourage unsafe development in these areas.

NR3: Protect riparian habitat, wetlands, aquifer recharge lands, and other areas that determine watershed health, as well as scenic vistas.

NR5: Encourage development of natural resources in an environmentally responsible manner.

NR6: Consider the economic impact of proposed land use changes and promote the efficient economic utilization of natural resources, including land, water, wildlife, timber, grasses, and open spaces that enhances or conserves those resources.

The county provides four objectives for the conservation of natural resources which include aquifer protection. The **Albany County Comprehensive Plan 2008** refers to the **CAPP** which was finalized in 2011 for the specific details the county should follow to protect the aquifer (**Albany County Comprehensive Plan**, 2008).

The **CAPP** was established to protect the aquifer and the sensitive recharge area directly east of Laramie. The **CAPP** reports that groundwater contamination would likely occur if the improper disposal of liquid and solid wastes were present (P. 61). As it relates to septic systems, the improper design, construction, and maintenance exacerbates contamination threats to the aquifer. The **CAPP** also provides information for specific zones that residential household septic systems could affect. Zones 2 and 3 are of the greatest concern for household contaminants from septic systems (Figure 1.3). The **CAPP** states

Septic systems in the Casper Aquifer are of particular concern because vulnerable features may provide a direct route for sewage effluent to enter the aquifer. Nitrates, bacteria, and other household wastes are all potential contaminants associated with septic

systems. Additionally, every house over the Casper Aquifer generates household hazardous wastes and if improperly disposed these hazardous wastes may also enter the aquifer (**Casper Aquifer Protection Plan**, 2011, p.67).

Chapter Five of the CAPP “Contaminant Management Plan” states, “If regulations are adopted, they should directly address the management of existing and future contaminant sources.

Regulations should also include enforcement procedures and penalties” (**Casper Aquifer Protection Plan**, 2011, p.77).

The inspection of septic systems as outlined in the CAPP state:

When construction of an individual sewage disposal system has been completed, except for backfilling, an inspection should be performed. The final inspection will verify that the system is installed in accordance with the regulations and the permit. Existing septic systems also may be inspected at regular intervals (**Casper Aquifer Protection Plan**, 2011 p. 82).

As it relates to on-site septic systems in the aquifer, the **CAPP** recommends that the system be inspected by a certified state engineer and have adequate setbacks from vulnerable features.

It is recommended that the City and County require, by regulation, installation, design, repair, and removal of septic systems located within the APO zone be in accordance with plans and specifications prepared by and certified by a professional engineer skilled in the science of wastewater disposal and licensed to practice in the State of Wyoming (**Casper Aquifer Protection Plan**, 2011, p. 96).

Setbacks from vulnerable features include:

Features observed in the CAPA [Casper Aquifer Protection Area] have been identified as have the potential to provide routes of contamination to the Casper Aquifer from the ground surface. These vulnerable features are discussed in detail in Chapter 3 and no septic systems should be installed within 100 feet of these vulnerable features (**Casper Aquifer Protection Plan**, 2011, p. 96).

Recommendations for septic system evaluations suggest that the system be regularly maintained on a scheduled basis in order to prevent buildup of materials such as solids, grease, and oil. In

addition, the **CAPP** suggests, “A database regarding the septic systems and their pumping and inspection schedules should be updated by the County Planning/GIS Departments to maintain records and track schedules” (**Casper Aquifer Protection Plan**, 2011p. 96).

The **CAPP** provides the recommendations to the County and Chapter Five of the Albany County Zoning Resolution Section 10: Aquifer Protection Overlay Zone provides the policies and permitted uses regarding the aquifer. The second prohibited use defined for the aquifer includes “The discharge to groundwater of any waste product” (**Casper Aquifer Protection Plan**, 2012 p, 71). The prohibited use includes any business or facility. Vulnerable features in the Casper Aquifer have been identified in Section D Part 2:

No person shall install, maintain, or use any on-site wastewater treatment system or wastewater storage system or any private connection to a public wastewater system within one hundred (100) feet of a vulnerable feature in the Casper Formation (**Casper Aquifer Protection Plan**, 2012, p. 75).

Part 3:

Within the APO, no permit shall be issued for any wastewater system until the applicant demonstrates to the Planner or designee that there are no vulnerable features in the Casper Formation within one hundred (100) feet of any point of the proposed system. Proof shall be at least the signed and stamped written opinion of a Wyoming licensed professional engineer or Wyoming licensed professional geologist. The Planner or designee may review independently obtained evidence and records in arriving at a decision under this subsection.

Section E: Design Standards for on-site wastewater treatment systems

Part 1:

Installation, design, repair, and removal of septic systems located within the APO zone must be in accordance with plans and specifications certified by a professional engineer registered to practice in the State of Wyoming. This resolution does not grant the right to install a septic system or small wastewater treatment system otherwise forbidden by County resolutions.

Part 2:

Each septic system and leach field within the APO shall be inspected by a person qualified by education or training to inspect small wastewater systems.

- a. During installation and before backfilling
- b. At least once each three years

The Albany County zoning regulations provide the specific measures to protect the aquifer. Section two provides the most specific standards in that no septic system is to be installed within one hundred (100) feet of a vulnerable feature. However, no standard method is established for identifying vulnerable features. During the course of this study, Albany County adopted new Casper Aquifer Protection regulations. On August 7, 2012 Chapter V: Section 10 of the Aquifer Protection Overlay Zone was amended. These amendments make it difficult to effectively manage septic systems in the Casper Aquifer protection zone. For example, the resolution states that...

A Site Specific Investigation shall be performed for all APOZ Development proposed within the APOZ. The purpose of the Site Specific Investigation is to determine the vulnerability of the aquifer to contamination by the proposed APOZ Development (**Casper Aquifer Protection Plan, 2012**)

And "Aquifer Protection Overlay Zone (APOZ) Development" is defined as any modification to the natural land surface that may result in the introduction of contaminants and/or increasing the vulnerability of the aquifer to contamination (**Casper Aquifer Protection Plan, 2012**).

Given the two definitions, any modification to the natural land surface would be required to have a Site Specific Investigation⁸. However, Chapter V Section F.3 provides an exception to the Site Specific Investigation (SSI) to include, "Parcels subdivided or zoned Residential prior to the effective date of this resolution" (**Casper Aquifer Protection Plan, 2012 p.12**). Thus, any

⁸ Albany County Zoning Ordinance Chapter V: Section 10. F. Site Specific Investigations.

residential or subdivided parcel currently in the APOZ as of August 7, 2012 is exempt from a Site Specific Investigation (Figure 4.1).

As it relates to septic systems, new septic installations are still required to follow the Design Standards for on-site wastewater treatment systems outlined in the ordinance⁹. In addition, Section E: Setbacks from Vulnerable Features still requires that septic systems be 100 feet from vulnerable features. However, the setback can be lessened with the approval of the County Wastewater Engineer and documentation that no significant threat to groundwater exists. The problem is identifying the process for documenting a significant threat without a Site Specific Investigation. The two additions of the zoning ordinance allowing for reduced setbacks and eliminating an SSI for residential parcels makes it difficult to manage septic systems in the APOZ.

2.3 City of Laramie's Regulation of Septic Systems in the Casper Aquifer Protection Zone

The City of Laramie has adopted their own version of a **CAPP** that was performed by Wittman Hydro Planning Associates in 2008. The City and County **CAPP** are similar in what is recommended to protect the Casper Aquifer. However, specific policies identified in the **Laramie Municipal Code** (LMC) differ from the Albany County zoning regulations as they relate to septic systems. While the City code only applies to the extent of the municipal boundary, there is a one mile extraterritorial boundary which acts as a joint jurisdiction with the City and County. The City of Laramie has an invested interest in protecting the water source, thus it is important to examine their stance on aquifer protection as it relates to septic system use. The Unified Development Code (2011) is located in Chapter 15.08.040.A of the LMC and

⁹ Albany County Zoning Ordinance Chapter V: Section 10. H. Design standards for on-site wastewater treatment systems.

establishes the Aquifer Protection Overlay (APO) regulations. Section 10 provides the guidelines and design standards for on-site wastewater treatment system/septic systems:

- a.** No new septic systems shall be permitted within the APO zone¹⁰.
- b.** Installation, design, repair, and removal of septic systems located within the APO zone must be in accordance with plans and specifications prepared by and certified by a professional engineer skilled in the science of wastewater disposal and licensed to practice in the State of Wyoming. This ordinance does not grant the right to install a septic system or on-site wastewater treatment system otherwise forbidden by city regulations.
- c.** Each existing septic system shall be pumped to prevent solids, oils, and grease from building up to a level in the tank where these materials will begin washing out to the leach field and clogging the field lines. Pumping shall occur not less than every five years or on a schedule as otherwise recommended by a city licensed wastewater system pumper/hauler. A database regarding the septic systems and their pumping and inspection schedules will be maintained and updated by the city GIS to maintain records and track schedules, which information shall be made available to the county.
- d.** Each existing septic system and leach field within the APO shall be inspected by the city engineer or other city qualified designee skilled in the science of wastewater disposal:
 - (i): During installation of replacement system, before backfilling; and
 - (ii): At least once every three years.
- e.** If upon inspection a septic system is found to be inadequately designed or constructed to serve the use for which it is intended, without undue risk to the Casper Aquifer, it shall not be used for the disposal of wastewater until it is cleaned, repaired or otherwise made to operate properly or replaced.

The City of Laramie applies a more stringent approach to septic system management in the APOZ. Yet, the only residential septic systems that could apply are located within the one mile extraterritorial boundary. Within this boundary, regulations must be approved jointly by the

¹⁰ This regulation applies to the APOZ that is within the City of Laramie municipal boundary. Septic Systems are not allowed inside the municipal boundary.

City and County. However, according to Wyoming State Statutes Title 15; Chapter 3; Article 2; Section 15-3-202¹¹ the mayor has the authority to recommend measures to improve the health, comfort and general prosperity of the city over all places within five miles of the municipal boundary. According to the statute, the City has the authority to expand jurisdictional boundary, up to five miles, for public health and safety. For example, this statute has been applied to remove firework stands. The city would be able to apply LMC 15.08.040.A Section 10 if the jurisdictional boundary was extended. Figure A.1 (Appendix A) displays the five mile jurisdictional boundary that would be applied in the APOZ.

2.4 Summary

Albany County and the City of Laramie have both adopted versions of an aquifer protection plan. The **Albany County Comprehensive Plan** (2008) establishes goals and objectives for protecting natural resources. The CAPP provides specific recommendations regarding septic system use and installation. In addition, Albany County zoning addresses regulations for current and future use of septic systems. Currently, a certified professional engineer is required to examine a septic system before it is backfilled, and it must be installed one hundred (100) feet from vulnerable features. The Albany County zoning regulations also require that the septic system be inspected at least once every three years. Currently, there is no enforcement of this regulation. The City of Laramie has mandated that no new septic systems be implemented in the APOZ. Additionally, the City requires septic pumping to occur every five years.

The **CAPP** provides information for the importance of maintaining and inspecting septic systems. It also specifies that a database regarding septic systems be maintained for pumping and inspection schedules by either the county planning or GIS Departments. The focus of this

¹¹ The Wyoming State Statute can be found at: (<http://legisweb.state.wy.us/statutes/titles/Title15/T15CH3htm>)

project is protecting the Casper Aquifer through septic system management. The subsequent chapter provides the methodology for establishing the spatial location and number of residential septic systems in the APOZ. This study also provides additional measures for septic system management through future septic system growth models, subdivision build-out scenarios, age distributions, and database management.

CHAPTER 3: METHODOLOGY

3.1 Overview

The information provided in the first two chapters established that septic system management is essential for the protection of the Casper Aquifer. The **Casper Aquifer Protection Plan** (CAPP) estimates that 450 housing units are presently in the APOZ. However, this does not accurately reflect the number of septic systems in the area. The **CAPP** also states that Albany County needs to establish a database to maintain regular maintenance schedules for septic systems. This chapter explains the methodology for accurately determining the spatial location and number of septic systems in the APOZ. In addition, a future growth scenario of septic systems using a linear growth model and build-out scenarios for subdivisions was completed. Finally, an age distribution of septic systems was determined for the study area.

3.2 Septic Systems in the APO Zone

It is important to accurately identify the number and locations of housing units that are currently using septic systems in the APOZ. This was accomplished by integrating three ESRI ArcGIS database shapefiles, septic system permit files, and aerial photography from 1983 to 2011 provided by the Albany County Planning Office. ESRI ArcMap version 10.0 was used to compile and integrate the three septic system database shapefiles into one. The database shapefiles titled Assessor Bathroom Points, County Septic Points, and Planning Wastewater contained data from 1983-2011 and were created by the Albany County Geographic Information Services Department.¹² The three databases contained different records for the number and

¹² There were differences in the number of vacant residential lots between data sets from the Albany County GIS data. Parcel data and subdivision data has not been updated. The total number of vacant residential lots was determined by combining the two databases to create an accurate number of vacant residential lots for the year 2011.

location of septic systems within the aquifer protection boundary. The data for septic systems in the APOZ is based on the current available data from Albany County and aerial photography.

Table 3.1 provides a detailed account of the data and how it was obtained.

Table 3.1 Household Septic system locations Data Source

Data Source	Format	Years	Notes
GIS Aerial Photography			
GIS: Ortho_1-1_WY001_2009_1.sid	Aerial photography	2009	Aerial photography from 2009 used by Albany County Planning
GIS Point Files			
Planning Wastewater points	Digital - GIS	1983-2011	Points showing parcels that have applied for a wastewater permit
Assessor Bathroom points	Digital - GIS	1983-2011	Points showing parcels with one or more bathrooms
County Septic Systems	Digital - GIS	1983-2011	Points showing parcels with septic systems in Albany County
Permit Files			
Septic System Permit Files	Paper on File	1983-2011	Paper files located in the Albany County Planning Department

Four different analyses were examined in this study and include

1. A linear growth model for potential septic system increase in the APOZ. This growth model was also applied to three zones: northern, central, and southern based on the spatial distribution of septic systems/housing units.
2. A low, median, and high density septic system growth scenario based on current vacant residential lots, current average size of residential development, and Albany County Zoning Regulations.
3. A subdivision build-out analysis for the 17 named subdivisions in the APOZ
4. Finally an analysis determining the age of septic systems.

3.3 Linear Growth Model for Septic Systems

Determining the spatial location and number of septic systems in the protection area is important to establish a starting point for management. However, creating a future growth model for determining the increase in APOZ septic systems is also a crucial component to aquifer protection. A linear regression model ($Y = a + bx$) was used to determine the potential number

of septic systems into the future, assuming growth continues at the same rate as over the past 30 years. The linear regression equation used for the entire study area is¹³

$$Y = -23,246.5 + 11.72x$$

Where:

y = Total number of septic systems

a= Y-intercept

x = Time, in years

b = Slope

At a 95% confidence level, the data had a significance level of $p = .0000$, an R^2 of .996, and an F value of 4.20. Section 4.4 provides a septic system growth density scenario for the entire study area based on a low, median, and high growth scenario. The septic system permit data ranges from 1983-2011 and comprises 330 installed systems.

3.4 Subdivision Build-Out Scenario

In addition to the linear regression model to determine future growth of septic systems, a subdivision build-out scenario was constructed for the 17 named subdivisions in the study area.¹⁴ This was accomplished by identifying the spatial boundaries of each residential subdivision, the date of creation, and the current number of parcels or housing units that have been occupied versus the number of vacant residential lots. Table 3.2 is an example from the Spur Ridge Subdivision.

¹³ The independent variable is (x) time, and the dependent variable is (y) total number of septic systems.

¹⁴ The septic system growth model for the APOZ should not be confused with the subdivision build-out analysis. The subdivision build-out analysis provides an estimate date when the subdivision will be built-out. It is not intended to be used as a septic system growth model because there are housing units/septics systems in residentially zoned areas that are not part of an identified platted subdivision.

Table 3.2 Build-Out Scenario: Spur Ridge Subdivision

SPUR RIDGE SUBDIVISION		
DATE CREATED	END YEAR	TOTAL TIME
1998	2011	13 YEARS
TOTAL LOTS	DEVELOPED	VACANT
10	7	3

$$\frac{7 \text{ Houses}}{13 \text{ Years}}, \text{ SO } \frac{13 \text{ Years}}{7 \text{ Houses}} \times 3 \text{ Houses} = \frac{39}{7} = 5.57 \text{ Years for complete build-out}$$

The equation produces the projected build-out date at the current rate of development. The Spur Ridge Subdivision was established in 1998 and currently has seven developed parcels and three vacant parcels. At the current rate of .54 parcels developed per year, with three vacant lots left, the equation predicts that it will take approximately six years to complete the build-out. This process for determining the rate and span of time until full build-out was applied to all 17 APOZ subdivisions.

3.5 Septic System Age Distribution

A septic system age map was created based on the expected average lifespan of septic systems. According to several sources (US EPA, 1997; Hanson et al, 2007; Boughner, 2001; “Lake windermere,” 2009; Rosa, 2012), the average lifespan of a septic system ranges between 10-30 years, thus a best-case scenario would be that the septic system would last 30 years before a failure. A table with the number of septic systems installed each year since 1983 was created, in addition each of the three zones were mapped and examined for a septic system age distribution.

3.6 Casper Aquifer Septic System Database Management

The **CAPP** specifies that a database should be kept and maintained for septic systems in the study area. A Microsoft EXCEL database file was created identifying all septic systems by parcel number in the APOZ with dates of installation and additional categories to add information such as inspection and pumping maintenance dates.

3.7 Best Management Practices for Regulating Septic Systems

Best management septic system practices were identified in communities who are either reliant on sole source aquifers defined by the EPA or have dealt with groundwater contamination. There are 77 registered sole source aquifers in the United States and five have been identified in EPA Region 8 (Wyoming, Colorado, Montana, Utah, Idaho, South Dakota, and North Dakota). The counties in which each of the protected aquifers are located were identified and their septic system management policies examined.

Additionally, Hallgarth (2001) identified seven communities in Wyoming and Nebraska who have dealt with groundwater quality issues and are part of the Groundwater Guardian Foundation. These communities were examined not only for groundwater protection efforts, but for septic system management strategies. Examples will also be provided from Colorado, Washington, New Mexico and New York. Finally, Patton and Sawicki's (1986) methods for determining administrative feasibility were implemented to determine Albany County's ability to maintain and monitor existing and new septic systems in the APOZ.

3.8 Summary

This chapter establishes the methodology for determining the location and number of septic systems in the study area. In addition, a future growth projection using a linear regression model and build-out scenario for residential subdivisions was established. Finally, an age

distribution map will illustrate how old and the spatial location of septic systems. The following chapter provides the information that both the CAPP and county have requested to better understand the number and location of septic systems in the APOZ.

CHAPTER FOUR: SEPTIC SYSTEM ANALYSIS OF THE CASPER AQUIFER

4.1 Overview

Septic System management is an essential component to aquifer protection. The Albany County Planning Department has indicated the need to identify the number and location of septic systems in the APOZ. Determining an accurate number of septic systems in the APOZ creates a starting point for management and future use of the area. This chapter focuses on identifying the number and location of septic systems in the APOZ. A linear growth model for septic systems will be used to estimate future septic systems in the APOZ. In addition, a series of subdivision build-out scenarios will estimate future build-out dates and rates of growth in each subdivision. Finally, a septic system age distribution will illustrate the age of the installed septic systems in the APOZ.

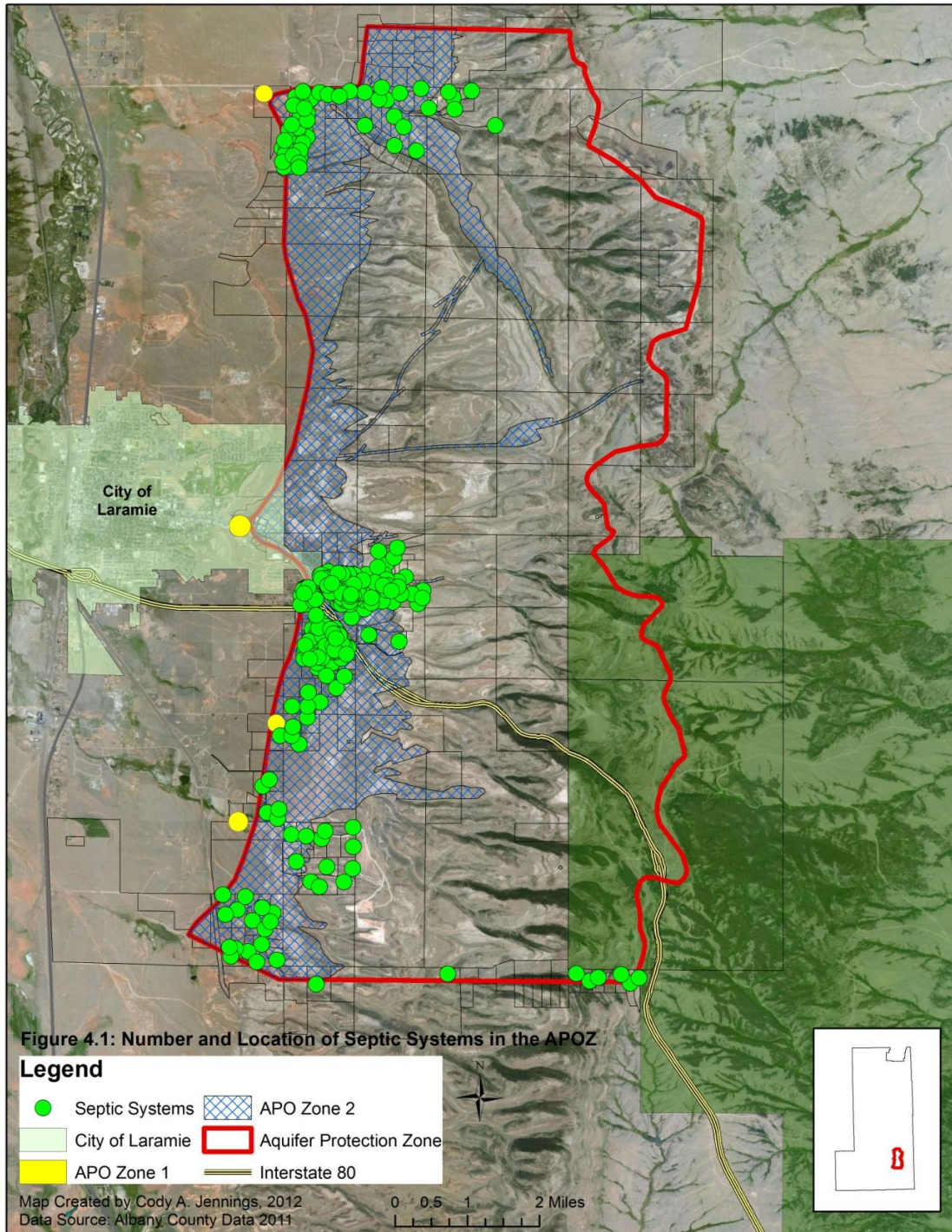
4.2 Location of Septic Systems in the Aquifer Protection Overlay Zone

Determining the spatial location and number of septic systems was accomplished by using ESRI ArcMap version 10.0 and septic system permit data provided by the Albany County Planning Department and Assessors Office. ESRI ArcGIS shapefiles and associated databases provided by Albany County included ownership, address, APOZ boundaries, and imagery files. In addition, three databases containing septic system information from the Planning and Assessor's Offices were compiled and integrated into one database to produce the location and number of septic systems in the APOZ. The number and location of septic systems were verified using existing septic and housing permits, and aerial photography on file at the Albany County Planning Department (Table 3.1).

Figure 4.1 illustrates the location and number of septic systems in the APOZ. As of 2011, there were 330 established septic systems and 460 residential units. There are more

residential units than septic systems because 130 residential units in the protection boundary were annexed into the City of Laramie and are connected to City water and sewer lines. The households are located in the Imperial Heights subdivision on the eastern boundary of Laramie.

Figure 4.1 Location and Number of Septic Systems in the APOZ



Zone 2 is considered a zone of primary aquifer concern based on the permeability of the outcrop area, the shallow depth to groundwater on the western edge of the boundary, and the proximity to municipal groundwater supply. This zone also accounts for 82% (271/330) of the septic systems. Both Zones 2 and 3 require a licensed professional geologist or engineer to inspect the site for vulnerable features before development can occur. The purpose of the inspection is to determine the extent of septic system vulnerability within each zone.

Development as defined in the **CAPP** means, “Any modification to the natural land surface that may result in the introduction of contaminants and/or increasing the vulnerability of the aquifer to contamination” (**Casper Aquifer Protection Plan**, p. 55. 2011). Given this definition, all new septic systems would be required to receive a site specific investigation before installation. However, the August 7th, 2012 adoption of the Casper Aquifer Protection regulations exempts residential zoned lots platted before this date from a site specific investigation (Chapter 2).

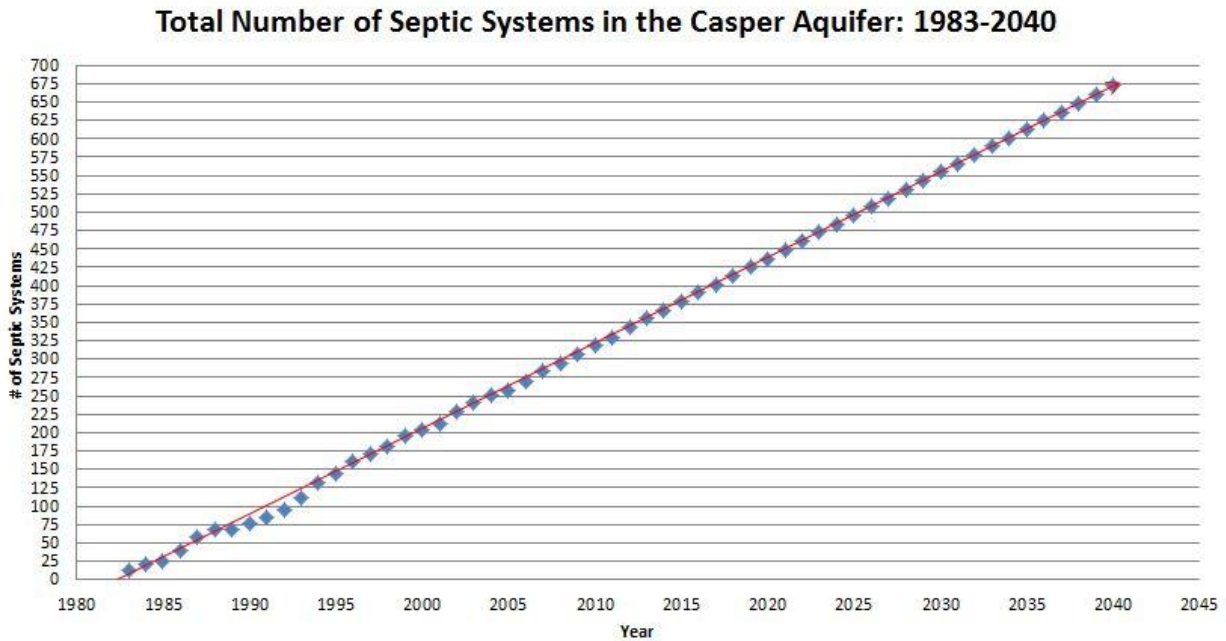
Figure 4.1 establishes the spatial location and distribution of the 330 septic systems located within Albany County’s APOZ. The majority of the housing units and septic systems are located directly east of the city boundary (Figure 4.1). Currently, there are 128 vacant residential lots totaling 2,123 acres in the aquifer boundary that would require septic systems when developed. The following four sections (4.3-4.6) examines four different analyses; linear growth, density scenarios, subdivision build-out rates, and age of septic systems.

4.3 Casper Aquifer Septic System Linear Growth Model

A linear growth model for the APOZ allows Albany County Planners to estimate the potential number of future septic systems in the aquifer protection area. This analysis will provide the number of potential septic system through the year 2040, if growth were to continue at its historic rates since 1983. Graph 4.1 illustrates the linear regression model for septic

systems in the APOZ extended through the year 2040. The red line in the graph represents the equation estimating the number of septic systems based on the independent variable of the year it was registered. At a 95% confidence level, the model had a significance level of $p = .0000$, an R^2 of .996, and an F value of 4.20 ($Y = -23,246.5 + 11.72x$).

Graph 4.1 Total Number of Septic Systems in the APOZ through 2040



There have been 330 septic systems installed in the APOZ over the last 29 years (1983-2011). The linear regression model predicts over a 100% increase in the number of septic systems in the APOZ by the year 2040 for a total of 671 additional systems. Additionally, the average number of people per household in the APOZ is 2.38 ([www.Census.gov/American fact finder](http://www.Census.gov/American%20fact%20finder), 2012). Assuming one septic system per household, there are approximately 785 (330 x 2.38) people living in the APOZ. The linear regression model predicts that there will be 671 septic systems in the APOZ by 2040, which could equate to a population of nearly 1,600 if household size remains the same.

4.4 Casper Aquifer Septic System Growth Density Scenario

The growth of future residential development in APOZ is dependent on current residential vacant land and geographic barriers in the APOZ. In order to incorporate the current land use, three density scenarios were used based on the Albany County Zoning regulations for residential density requirements. Chapter IV, Sections 1 and 4 pertain to both residential and agricultural land use classifications for household density (**Albany County Comprehensive Plan, 2008**). Residential land use allows for one principal structure per five acres. Agricultural land use allows for one principal structure per 35 acres.

The three models are based on low, median, and high density scenarios. The low density scenario assumes one septic system per vacant residential lot. Since there are currently 128 vacant lots, this scenario would increase the number of septic systems by 128 for a total of 457 (Table 4.1). Using the linear regression model (Graph 4.1) for the rate of septic system growth indicates a low density build-out would occur by the year 2019. The median density scenario assumes that future development will mirror the established average residential lot size in the APOZ which is 10 acres. There are 2,123 vacant residential acres in the APOZ, thus this would equate to 212 ($2,123/10$) additional septic systems for an overall total of 542. The linear regression model (Graph 4.1) indicates that 212 additional septic systems could be installed by the year 2029. Finally, the high density scenario is based on one septic system per five residential acres in the APOZ. This would equate to an additional 425 ($2,123/5$) residential septic systems installed in the residential vacant lots. The total number of estimated residential septic systems in the APOZ would equal 755, and this would be obtained by the year 2047 (Graph 4.1).

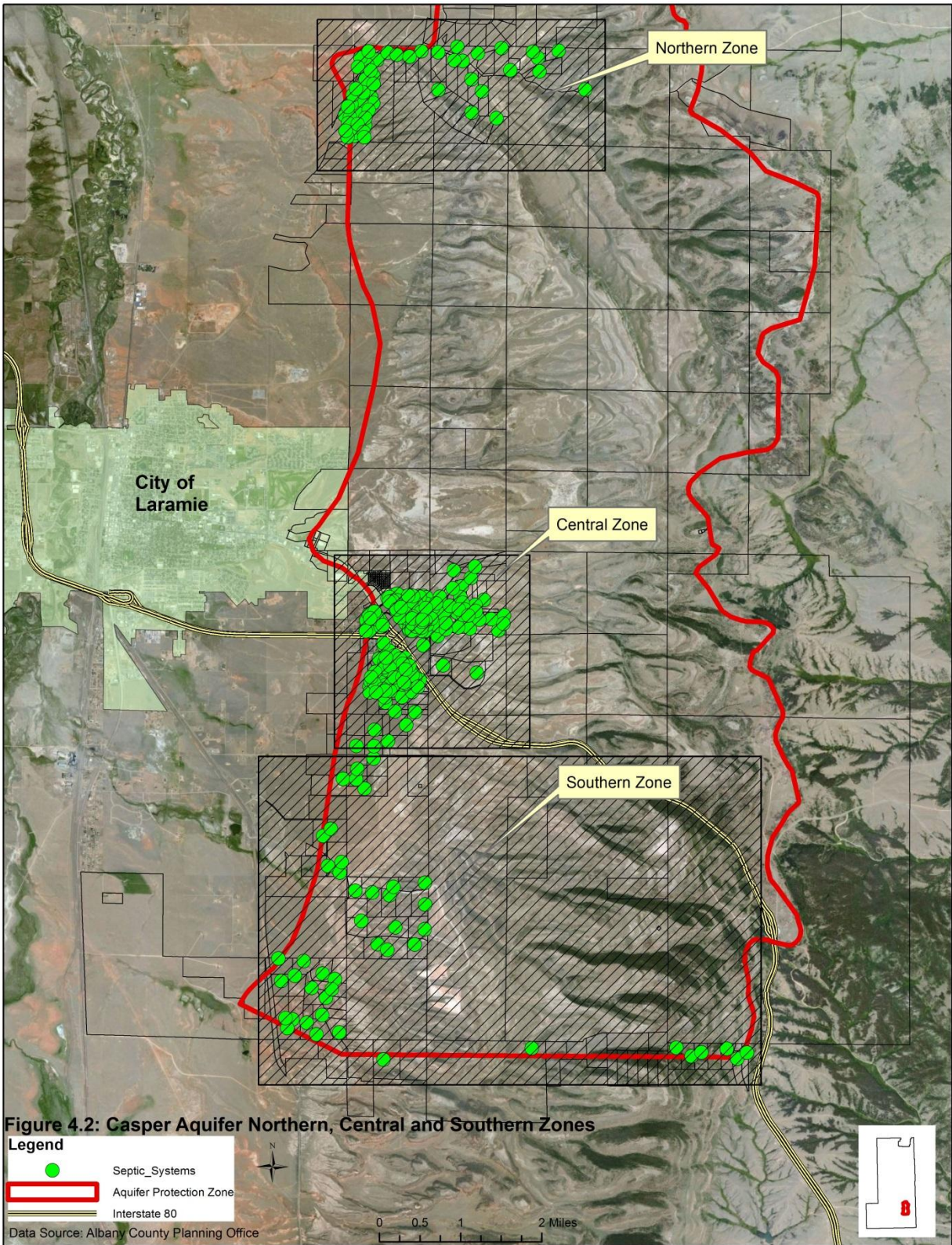
Table 4.1 Residential Septic System Density Scenarios for the Casper Aquifer

Current Density Scenarios	Starting Septic System: 330	Potential Addition of Septic System	Year of Residential Completion
Low	+ 127	457	2019
Median	+ 212	542	2029
High	+ 425	755	2047

Table 4.1 represents three residential septic system growth density scenarios. The unknown factor is the 26,415 acres of agricultural land that can either have one principal structure per 35 acres or go through a land use change to a residential category. If the agricultural land use stays the same and land is developed to its legal potential, there could be an additional 754 (26,415/35) septic systems installed, for an overall total of 1,084. While this scenario is unlikely, it is the maximum potential of septic systems that could be installed in the APOZ agriculture land without subdivision of agricultural land.

In order to provide detailed growth scenarios, three zones were created for the APOZ based on the spatial location of households. Figure 4.2 illustrates the northern, central, and southern zones for future development. The three zones were identified based on the spatial location of housing units and aquifer boundary. The central zone contains the highest density of housing units with 228 followed by the northern zone 55 and southern zone 47. The low density growth scenario will be used for the three zones and are conservative estimates assuming only one septic system per lot.

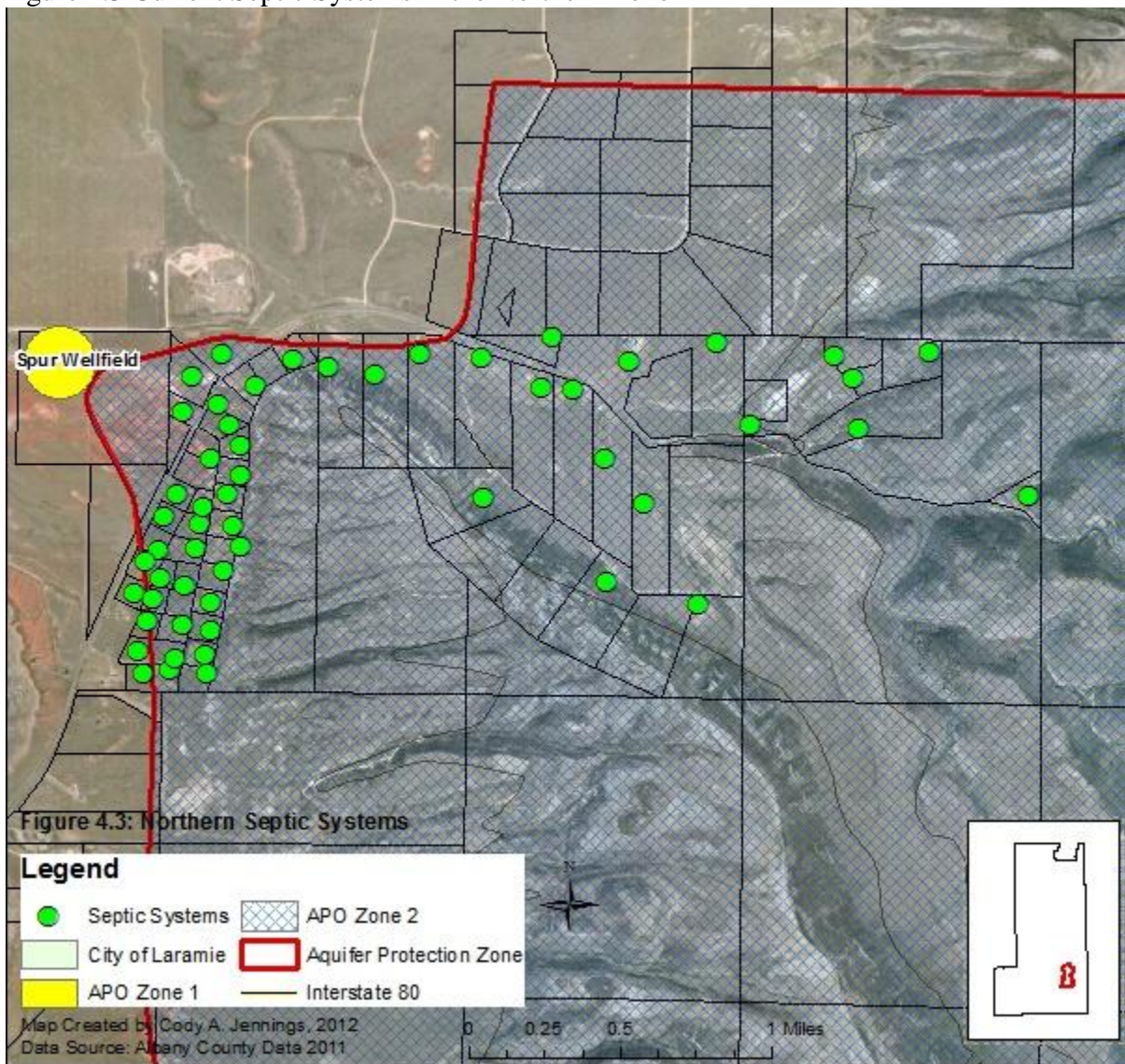
Figure 4.2 Detailed Growth Density Zones: Northern, Central and Southern



4.4.1 Northern Zone Growth Scenario

The northern zone has 55 occupied housing units and 10 vacant residential lots for a total of 65 potential residential units as of 2011. The northern zone linear regression model ($Y = -4949.44 + 2.49x$) indicates that the northern zone could be completely built-out by the year 2015. At a 95% confidence level, the data had a significance level of $p = .0000$, an R^2 of .998, and an F value of 4.35. This will increase the number of household septic systems from 55 to 65.

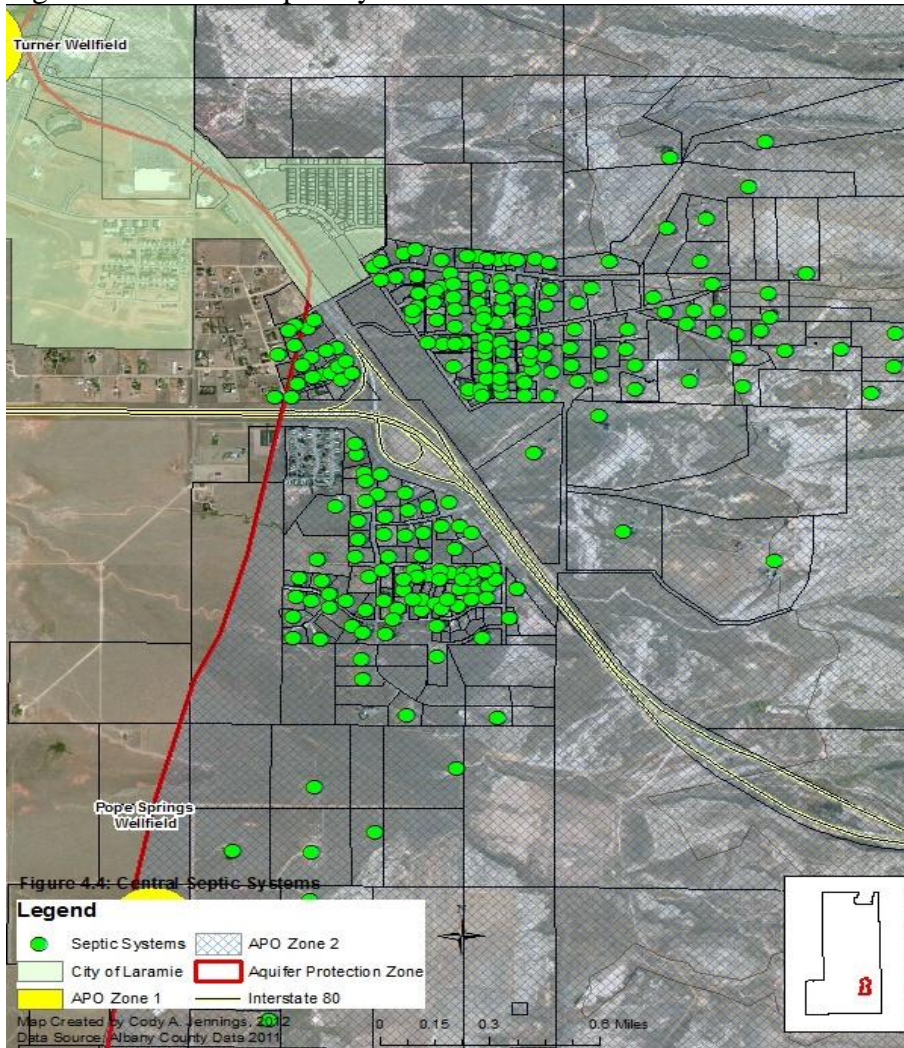
Figure 4.3 Current Septic Systems in the Northern Zone



4.4.2 Central Growth Scenario

The central zone has 228 occupied housing units and 98 vacant residential lots for a total of 326 potential residential units as of 2011. The central zone linear regression model ($Y = -14,238.8 + 7.19x$) indicates that the central zone could be completely built-out by the year 2021. At a 95% confidence level, the data had a significance level of $p = .0000$, an R^2 of .990, and an F value of 4.20. This will increase the number of household septic systems from 228 to 326.

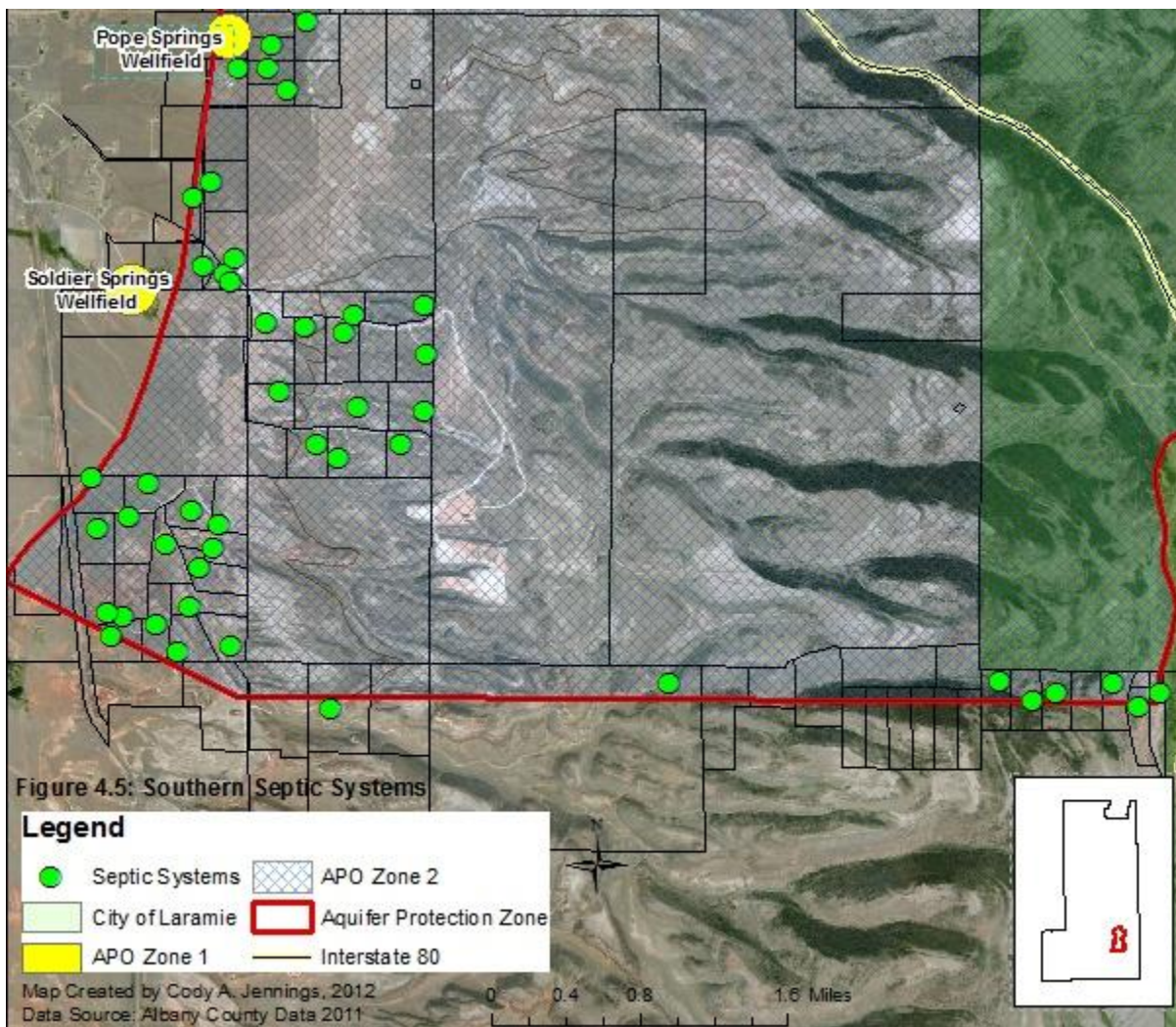
Figure 4.4 Current Septic Systems in the Central Zone



4.4.3 Southern Growth Scenario

The southern zone has 47 occupied housing units and 20 vacant residential lots for a total of 66 potential residential units. The southern zone linear regression model ($Y = -5,404 + 2.17x$) indicates that the southern zone could be completely built-out by the year 2016. At a 95% confidence level, the data had a significance level of $p = .0000$, an R^2 of .955, and an F value of 4.60. This will increase the number of household septic systems from 47 to 67.

Figure 4.5 Current Septic Systems in the Southern Zone



The central zone had the first septic system in 1983 and there have been approximately seven septic systems installed per year in the central zone. The northern and southern zones did not have septic systems until 1987 and 1997, respectively. They both have considerably less subdivisions and have grown at a slower pace. The northern zone increases at 2.5 septic systems installed per year. The southern zone adds an additional three septic systems per year. The central zone has the highest concentration of septic systems and is increasing at seven systems per year approximately twice as fast as either of the other two zones.

4.5 Subdivision Build-Out Analysis

The second part of the analysis will focus on the individual subdivisions located in the APOZ. There are 17 named subdivisions that are examined for a potential build-out date. These build-out scenarios provide both a time and spatial location for when the current subdivisions in the APOZ will be completely built-out.

The 17 named subdivisions and potential build-out dates are listed in Table 4.2. The southern zone has a total of 35 lots and 19 vacant lots with an average size of 28 acres. It has a growth rate at .31 parcels developed per year. The southern zone is estimated to be completely built-out by 2072. Similarly, the northern zone has a total of 58 lots and 10 vacant lots with an average size of 29 acres. The northern zone is estimated to be built-out by 2019. This zone has a growth rate of 1.25 parcels developed per year. The central zone has the most housing units at 176 and 98 vacant lots. The growth rate is 2.07 parcels per year and it has the highest potential for the most housing unit increase. The central zone has the highest potential for septic system increase. The central zone is estimated to be completely built-out by 2058.

Knowing the subdivisions estimated built-out dates (Table 4.2) will help gauge when the current residential lands will be developed. Established subdivisions can be calculated for

potential build-out. However, vacant agricultural land could also support development and septic system use. The number of potential septic systems that could be established depends on the zoning of the land. If the agricultural land goes through a zoning change to a residential use, more households and septic systems could be developed in the APOZ.

Table 4.2 Subdivision Build-Out Scenario for the APOZ

Zone	Subdivision	Beginning Year	Developed Lots	Vacant Lots	Total	Avg. Lot Acres	Build-Out Rate*	Build-Out Date	
North	Rocky Top Ranches	1990	7	3	10	40	0.3	2020	
	Sunset Acres	1991	34	4	38	5.6	1.7	2013	
	Spur Ridge	1998	7	3	10	42	0.5	2016	
		Total	48	10	58	29	1.25		
Central	Sundial Acres	1989	24	2	26	2	1.1	2013	
	Sherman Hills	1989	77	26	103	1	3.5	2018	
	Pilot Peak Estates	1990	6	5	1	6.3	0.3	2015	
	Valley View Acres	1990	34	45	79	0.5	1.6	2039	
	Wyatt Foster	1990	14	2	16	2.1	0.7	2014	
	Mountain Valley Estates	1993	10	1	11	3.2	0.6	2013	
	Snowy View Acres	1994	2	2	4	5.5	0.1	2028	
	Warran Tracts	1997	3	3	6	40	0.2	2025	
	Berner Mill Tract	2000	2	3	5	40	0.2	2027	
	Canyon Acres Ranch	2006	4	9	13	5.5	0.8	2022	
		Total	176	98	264	10.6	2.07		
	Southern	Soldier Springs	1989	3	2	5	29	0.1	2025
		Rockaway Ranches	1995	4	13	17	19.5	0.3	2063
Pope Springs		1999	4	1	5	32	0.3	2014	
Piper Quarry		2002	5	3	8	30	0.6	2016	
		Total	16	19	35	27.6	0.31		

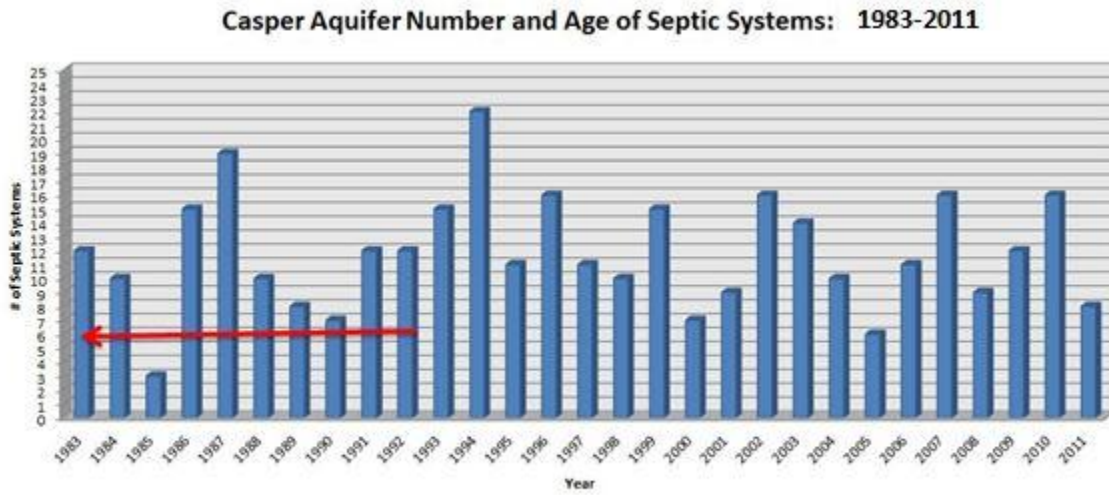
*Build-out rate is based on a weighted average for each subdivision in each zone.

4.6 Septic System Age Distribution

The Environmental Protection Agency suggests that 10-20% of septic systems fail annually and assume an average lifespan of up to 30 years (**Onsite Wastewater Treatment**, 2003). Boughner (2001) also reports that the average life of a septic system is between 10-30 years. The authors' of both studies indicate that the septic system lifespan depends on regular maintenance schedules, types of soils, climate, and the make of the septic system. Depending on the source, the average lifespan of a septic system ranges between 10-30 years (US EPA, 2001; Hanson et al, 2007; Boughner, 2001; Rosa, 2012). However, multiple factors are involved in determining an accurate lifespan.

An average 20 year old septic system could be viewed as having the potential to fail according to the literature. Graph 4.2 illustrates the number of septic systems that were installed each year through 2011. The red line indicates septic systems that are over 20 years old. There were 96 septic systems installed between 1983 and 1992 representing nearly 30% (96/330) of the total APOZ systems. Table 4.3 illustrates the cumulative number of septic systems installed since 1983. There are 228 septic systems that are at least 10 years old representing 69% (228/330) of the total systems and 52% (171/330) of the septic systems are at least 15 years old. Ninety of the 96 septic systems that are over 20 years old are located in the central zone. The remaining six are located in the northern zone as previously indicated in Figure 4.3. The following discussion provides detail about the three zones and ages of the septic systems.

Graph 4.2 Number and Age of Septic Systems per year in the APOZ



Graph 4.3 Cumulative Number and Age of Septic Systems 1983-2011

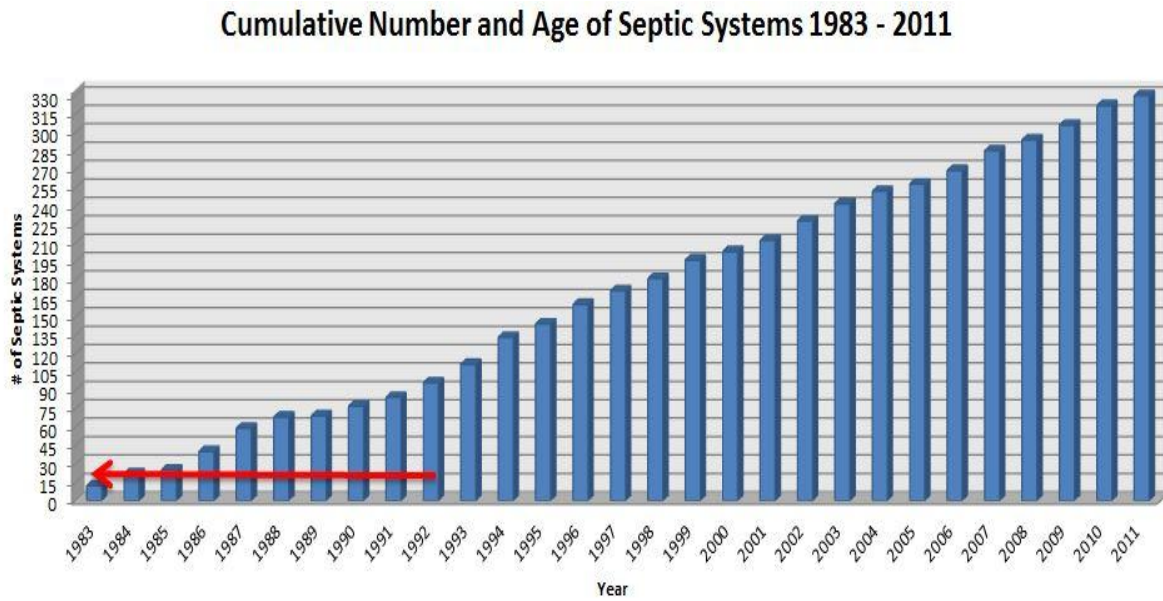
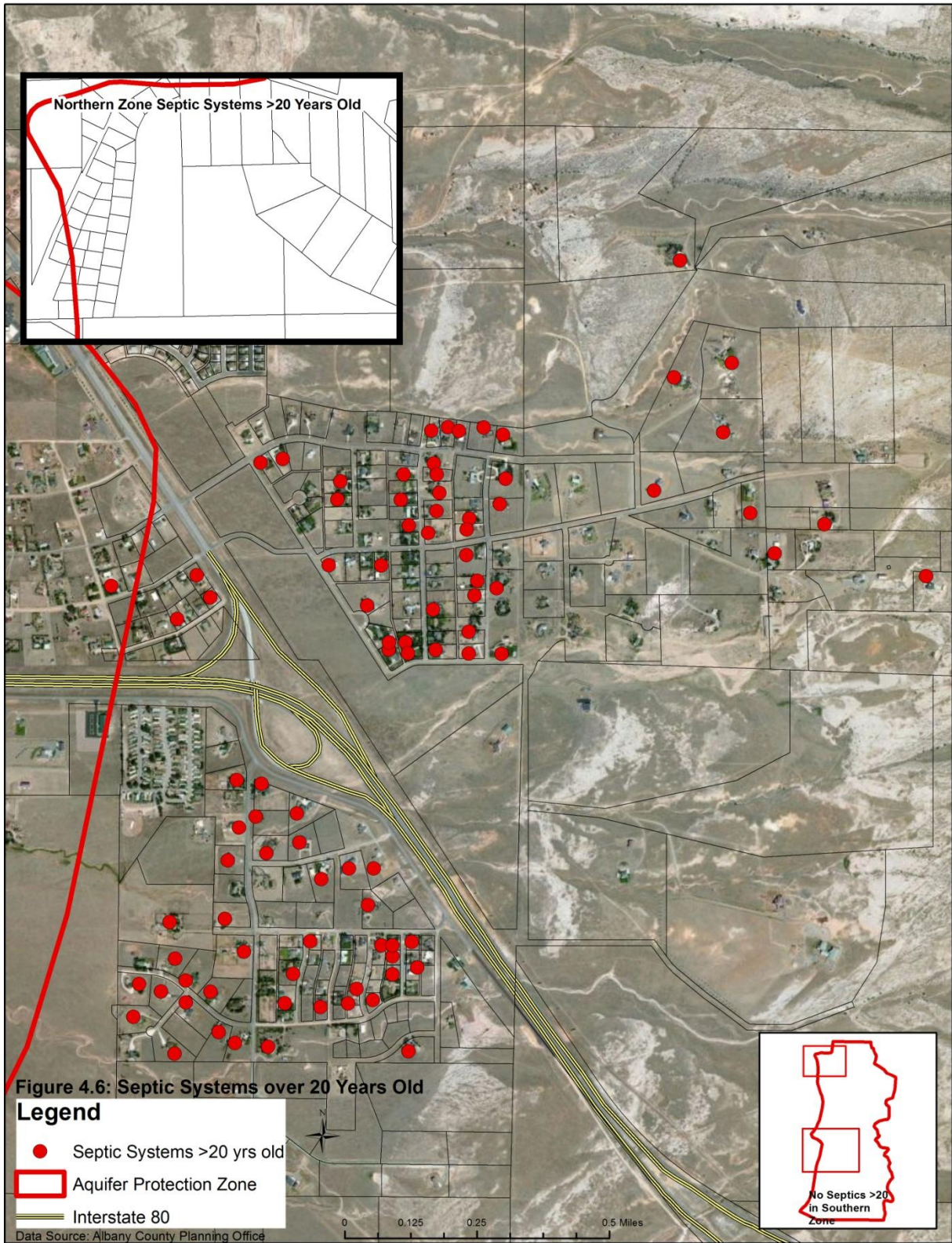


Table 4.3 Age of septic Systems

Year	Number Installed	Combined Total	Combined Total Percentage	Age in Years
1983	12	12	3.6%	29
1984	10	22	6.7%	28
1985	3	25	7.6%	27
1986	15	40	12.1%	26
1987	19	59	17.9%	25
1988	9	68	20.6%	24
1989	1	69	20.9%	23
1990	8	77	23.3%	22
1991	7	84	25.5%	21
1992	12	96	29.1%	20
1993	15	111	33.6%	19
1994	22	133	40.3%	18
1995	11	144	43.6%	17
1996	16	160	48.5%	16
1997	11	171	51.8%	15
1998	10	181	54.8%	14
1999	15	196	59.4%	13
2000	7	203	61.5%	12
2001	9	212	64.2%	11
2002	16	228	69.1%	10
2003	14	242	73.3%	9
2004	10	252	76.4%	8
2005	6	258	78.2%	7
2006	11	269	81.5%	6
2007	16	285	86.4%	5
2008	9	294	89.1%	4
2009	12	306	92.7%	3
2010	16	322	97.6%	2
2011	8	330	100.0	1
2012	N/A	N/A		N/A

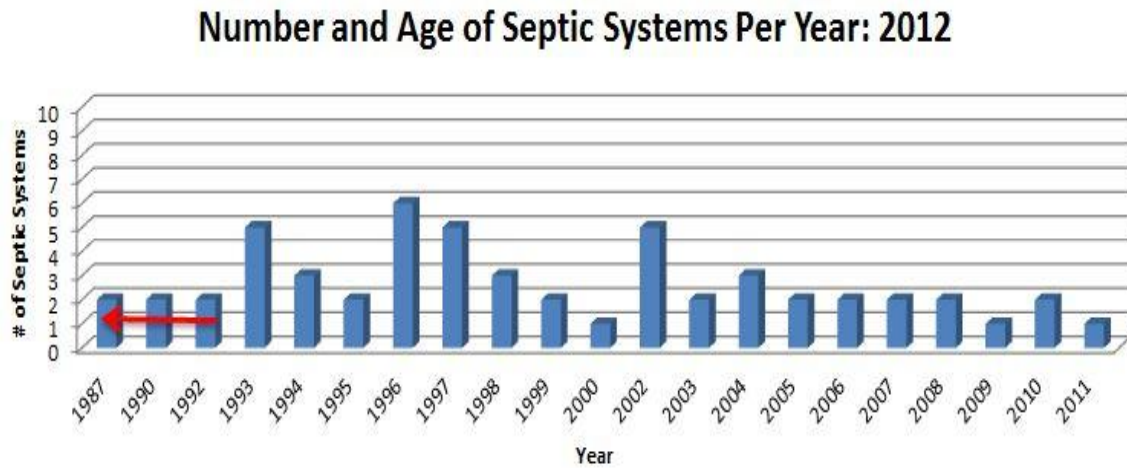
Figure 4.6 Casper Aquifer Septic System Over 20 Years Old



4.6.1 Northern Zone Age Distribution

Graph 4.4 illustrates the age of septic systems in the northern zone of the APOZ per occupied residential household. The first septic systems in the northern zone were installed in 1987 and are 25 years old. Accordingly, there are currently five septic systems that are at least 20 years old.

Graph 4.4 Age of Septic Systems: Northern Zone

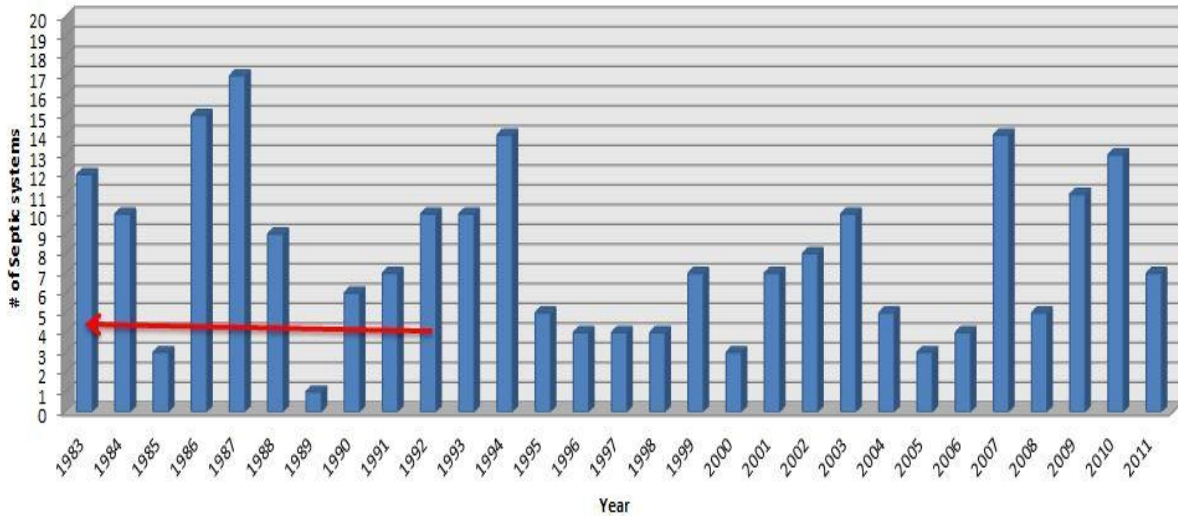


4.6.2 Central Zone Age Distribution

Graph 4.5 illustrates the age of septic systems in the central zone of the APOZ per occupied residential household. The first septic systems in the central zone were installed in 1983 and are 29 years old. And, currently there are at least 93 septic systems that are 20 years old or older.

Graph 4.5 Central Zone Age of Septic Systems

Number and Age of Septic Systems per Year: 2012

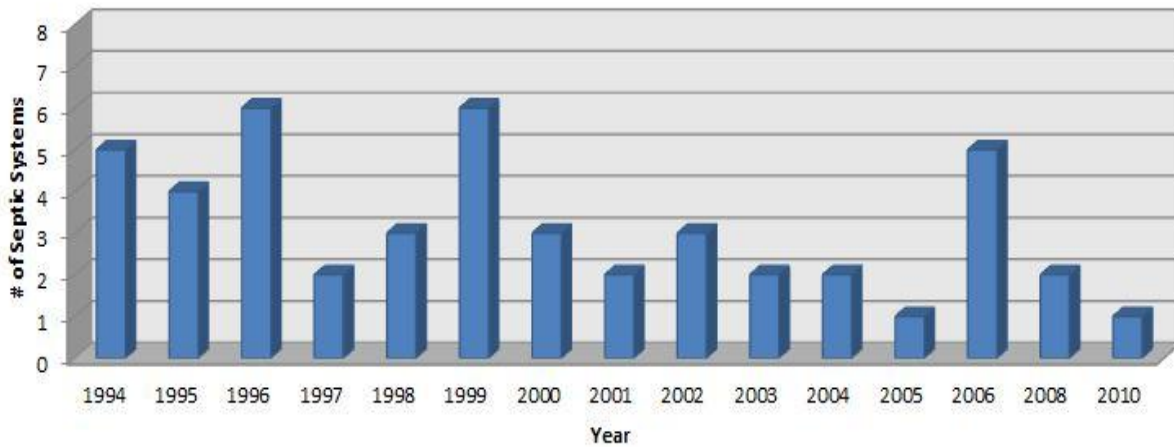


4.6.3 Southern Zone Age Distribution

Graph 4.6 illustrates the age of septic systems in the southern zone of the APOZ per occupied residential household. The first septic systems in the southern zone were installed in 1994 and are 18 years old.

Graph 4.6 Age of Septic Systems: Southern Zone

Number and Age of Septic Systems Per Year: 2012



4.7 Summary

This chapter provided a prediction of the number of septic systems that would be in the APOZ by 2030 if past growth trends continue and completely consume the vacant residential lots. As of 2011, there were 330 septic systems located in the APOZ. The linear regression model (Graph 4.1) predicts more than double the current septic systems by the year 2040. A series of build-out models was applied to vacant parcels, assuming low, medium and high density development. Total predicted septic systems in the APOZ range from 429 to 755, depending on density of development. Using the linear regression model complete consumption dates could occur as early as 2019 with the low density scenario to 2047 with the high density scenario. The potential number of septic systems in the APOZ will vary depending on how the vacant residential lots are developed. Estimated consumption dates for each subdivision are also provided, based on the linear regression model. In addition, land currently zoned agricultural can have one household per 35 acres. If all this land was fully developed, there could be an additional 754 (26,415/35) septic systems in the APOZ.

In order to better understand septic system growth scenarios, the study area was divided into three sections. The central zone has the highest potential for residential growth given the 98 vacant subdivision lots and vacant residential land. The 17 subdivisions in the central area will have 264 housing units on septic systems when completely built-out. The dates for complete build out date for the northern zone is 2020, central zone 2039 and southern zone 2063.

In addition to determining the number of current and future septic systems in the study area, the age distribution of septic systems was established. Data for the average lifespan of septic systems was provided and it ranges from 10-30 years. Nearly 30% of all septic systems in the APOZ are over 20 years old. Albany County has never required regular maintenance or

inspection on septic systems, so data does not exist if regular maintenance or inspections have occurred in the APOZ. Given that 755 septic systems could be installed in the APOZ in the next 35 years and currently 30% are over 20 years old, the County should establish septic system management policies for continued protection of the Casper Aquifer. If the 2040 time frame is used, 56% (425/755) of septic systems would be over 20 years old according to the high density scenario.

CHAPTER FIVE: SEPTIC SYSTEM MANAGEMENT STRATEGIES

5.1 Overview

Regular and routine septic system maintenance is essential to maintain a healthy and properly functioning system. However, all too often, once the system is placed underground it is forgotten until problems arise. The lack of maintenance is a primary cause of premature septic system failure. A modern day septic system should be pumped every three to five years (Soilfacts: Septic System, 1997 Schwartz, Waterman & Lemly, 1998). This chapter examines regional communities and their septic system management strategies. Three types of communities were examined and are either associated with the Groundwater Guardian Foundation (GGF), have been identified as a sole source aquifer by the EPA or have been identified as having groundwater issues. The practices from these jurisdictions will be examined for possible future management strategies in Albany County.

5.2 Examples of Septic System Management

Surrounding communities involved in the Groundwater Guardian Foundation have been identified in previous studies dealing with groundwater management (Hallgarth, 2001). The GGF aims to provide sustainable management strategies for clean groundwater.¹⁵ This study examined the same communities for possible examples of septic system management policies. The communities examined were Seward County, NE; Trenton, NE; Sidney, NE; Imperial County, NE; North Platte, NE; Natrona County, WY; and Goshen County, WY. The Nebraska communities do not have specific management regulations regarding septic systems. They, like most communities, refer to the regulations set forth by the state's Department of Environmental Quality (DEQ). The Nebraska DEQ sets state rules for septic systems in Title 124: Rules and

¹⁵ For more information visit <http://www.groundwater.org>

Regulations for the Design, Operation and Maintenance of Onsite Wastewater Treatment Systems and can be found at <http://www.deq.state.ne.us/> (“Onsite wastewater treatment,” 2011).

The Nebraska DEQ standards are equivalent to the Wyoming DEQ standards found in Title 35 Public Health and Safety

(<http://deq.state.wy.us/wqd/www/Permitting/Pages/SMWW/smallwastewater.asp>).

The WYDEQ regulations are for the initial installation of septic systems but there are no policies for inspection or service required after installation.

There are five sole source aquifers recognized in EPA Region 8. The communities that are reliant on an aquifer were examined for specific septic system regulations that could be applied to Albany County. The communities are the Town of Castle Valley, Utah, Moab, Utah, Summit County, Utah, Carbon County, Wyoming and Missoula, Montana.

Utah has three federally recognized sole source aquifers. The first community is the Town of Castle Valley, Utah which derives their water from the Castle Valley Aquifer. The community has not implemented specific regulations regarding septic systems; however, they have provided septic system educational guidelines. This is an informational guide that recommends users practice regular maintenance and provides tips for identifying septic system failure (**Septic Maintenance**, 2012). The Glen Canyon Aquifer located in Grand County, Utah is the sole source aquifer for county residents and the City of Moab, UT. There are no specific regulations regarding septic systems. Grand County, addressed septic systems in that they must be located in places that will not cause damage to the aquifer (**Grand County Land**, 2008). However, this policy does not delineate for what constitutes damage or acceptable septic system locations. The Western Unita Arch Paleozoic Aquifer is located in Summit County, UT. The zoning regulations state that septic systems must be inspected by a certified engineer, as is the

case in Albany County, WY (**Eastern Summit County**, 2010). However, it does not state anything about a maintenance schedule. In Wyoming, the identified sole-source aquifer is the Elk Mountain Aquifer serving the residents of Carbon County. There are no septic system management regulations identified in the zoning code (**Carbon County Zoning**, 2011).

The last sole source aquifer in Region 8 to be examined is the Missoula Valley Aquifer in Missoula County, MT. The county has a wastewater treatment and disposal system regulations established in the city code. The code prohibits certain uses such as in the **CAPP** and the systems must be permitted and inspected before backfill (Missoula City-County Health, 2007).

Most of the communities with sole source aquifers or who have dealt with water issues have identified some form of regulation for initial septic system installation. However, no regulations exist for ensuring that a system will be monitored after installation. Research data provided in this study has suggested that septic systems have an average lifespan of 10-30 years and should receive regular and routine maintenance, and be pumped every three to five years. An initial inspection for septic systems is not enough to ensure protection of a community's drinking water, especially when it is the only water source.

Additional communities examined for septic system regulations include Boulder County, CO, Bernalillo County, NM, King County, WA, and Worcester County, NY. These counties were selected for their septic system regulations. Boulder County has addressed septic system regulation by proposing that each homeowner be required to have their home's septic system inspected before selling the home (Clucas, 2007). The Bernalillo County Environmental Health department in New Mexico has identified pumping schedules for the number of people using the system and the size of the holding tank. Table 5.1 provides how often a septic system should be pumped. It is also recommended to have the septic system pumped before large gatherings of

people come to the households (**Management Plan**, 2012). The average number of people per household in the APOZ is between two and three. With a known tank size in gallons, the table can be used for recommended pumping schedules.

Table 5.1 Septic System Pumping Schedules

Tank Size Gals.	Number of Persons in Households						
	1	2	3	4	5	6	7
1000	12 yrs.	6 yrs.	4 yrs.	3 yrs.	2 yrs.	1 yrs.	1 yrs.
1250	16 yrs.	7 yrs.	5 yrs.	3 yrs.	3 yrs.	2 yrs.	2 yrs.
1500	19 yrs.	7 yrs.	6 yrs.	4 yrs.	3 yrs.	3 yrs.	2 yrs.
1750	22 yrs.	11 yrs.	7 yrs.	5 yrs.	4 yrs.	3 yrs.	3 yrs.
2000	25 yrs.	12 yrs.	8 yrs.	6 yrs.	4 yrs.	4 yrs.	3 yrs.
2250	27 yrs.	14 yrs.	9 yrs.	7 yrs.	5 yrs.	4 yrs.	3 yrs.
2500	32 yrs.	16 yrs.	10 yrs.	7 yrs.	5 yrs.	5 yrs.	4 yrs.

In 1997, King County, Washington implemented septic system management regulations that require homeowners to complete a full septic system inspection by a licensed septic contractor at least once every three years (King county, 1997). In Westchester County, NY licensed septic system contractors are required to maintain and keep records of every residential and commercial septic system that is pumped for at least six years. In addition, the county planning department must also keep a database of all septic systems and maintenance schedules.

Finally, failed aquifers pose health risks to community's and could be financially devastating for a community to repair. When an aquifer becomes contaminated, the effects can be irreversible. In addition, most aquifers are interconnected and the contamination could be transferred to the next aquifer (Harman, 1996). The only solution to a contaminated aquifer is the installation of a treatment plant which would be financially burdensome to most communities.

5.3 Summary

This chapter provided septic system management examples and strategies from communities in Wyoming, surrounding states, and from counties around the country. Septic system management strategies for installation are common and often regulated by the Department of Environmental Quality. However, after examining the five sole-source aquifer communities identified by Region 8, there are only regulations for proper installation, once installed, there are no management practices to ensure groundwater quality protection by septic system procedures. This can be accomplished by requiring management strategies examined in this chapter.

The Casper Aquifer is unique in that it serves as the primary water source for the City of Laramie and it is under shallow fragmented Satanka Shale. The examples and measures from surrounding communities illustrate potential actions that could protect underground aquifers from septic contamination. However, the **Casper Aquifer Protection Plan** illustrates specific recommendations that should be followed to ensure groundwater protection from septic systems. The final chapter provides the summary and conclusion about the updated zoning regulations, recommendations, and recommendations for Albany County's septic system management.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1 Summary

Septic system management is essential to ensuring groundwater quality, especially over sensitive aquifer recharge areas. This study examined the number and location of residential septic systems that have been installed in the APOZ over a 29 year period.

Chapter four examined the current number and location of septic systems in the APOZ. It also provided three growth scenario models based on current and potential future land use. Currently there are 330 septic systems over the Casper Aquifer. By the year 2040, there is a potential to double the amount of septic systems in the Casper Aquifer to approximately 647 based on a linear growth model scenario (Graph 4.1). According to three residential growth scenario models there is the potential to increase between 429 and 755 septic systems in the APOZ by the year 2040. The build-out scenarios of existing subdivisions provide build-out dates in each of the three zones (Graph 4.2). Using the assumption that septic systems fail after approximately 20 years, an examination of current systems installed since 1983 lists that approximately 30% (96/330) are set to fail at any moment. This chapter provides recommendations to both the City of Laramie and Albany County to increase septic system management and provide further protection to the Casper Aquifer. It also examines the administrative feasibility for Albany County to monitor existing and new septic systems in the APOZ.

6.2 Recommendations

The following recommendations are based on the goals and objectives provided in the **Albany County Comprehensive Plan, CAPP**, and septic system management practices provided in this study.

- 1: All new septic systems located in the Casper Aquifer Protection Zone shall have a Site Specific Investigation that meet the minimum SSI requirements found in Chapter V: Section 10.F. This regulation shall override the provision found in Chapter V: Section 10.F.3.
- 2: All septic systems in the APOZ shall be inspected and pumped by a licensed inspector by the end of year 2013. At this time, the licensed inspector will set maintenance and pumping schedules based on Table 4.x. If the property owner can provide proof of inspection and pumping maintenance by a licensed inspector, this requirement can be waived if the maintenance occurred since January 1, 2010. However, these properties must be inspected within three years of last inspection to receive maintenance and pumping schedules based on Table 4.xxx
- 3: All property owners in the APOZ with a septic system shall complete and turn in an official septic system maintenance form. This form will be provided by the county and must be signed by a licensed inspector indicating the date and type of service completed. The information will be updated in a septic system permit database. Failure to provide the inspection form will result in a letter from the county to contact the planning department within 10 days and also indicating that the system needs to be inspected within 30 days. Failure to do so will result in daily fines.
- 4: Albany County shall maintain a septic system database of current and future septic systems with date of installation, Site Specific Investigation (For new Systems), date of inspection, date of pumping. This database will be updated as new permits and inspection dates are received.
- 5: Albany County will provide best practice management material for maintaining a septic system on the county website and have material for distribution.

6.3 Administrative Feasibility

An administrative feasibility analysis should be established in order to implement the proposed policies. Based on Patton and Sawicki's (1986) **Basic Methods of Policy Analysis and Planning**, the four administrative feasibility criteria are establishing authority, institutional commitment, capability, and organizational support. The constitutional authority is derived from

the Wyoming State Statutes Title 15 Cities and Towns; Chapter 1; Article 5: Planning. Title 15-1-502 establishes the authority for Albany County to implement a planning commission to carry out and adopt a master plan. Title 15-1-503 provides the authority for the County to adopt a master plan and Title 15-1-602 provides for the establishment of zoning regulations.

The institutional commitment is evident through the time and effort spent establishing the master plan, CAPP and Casper Aquifer Protection zoning ordinances. Based on the county planning department's ability to currently maintain permits including building, zoning, billboard, subdivisions and addressing, maintaining a septic system database should not present too much of a burden. The septic system database has already been created through this project and would only need to be maintained and continued.

A process for maintaining septic system permits already exists for paper copies in the planning office; the zoning ordinance adds an additional step to the process. Finally, the support to implement septic system management is evident in the **Comprehensive Plan, CAPP**, and the City of Laramie. Based on Patton and Sawicki's administrative feasibility model, Albany County is capable of implementing the zoning regulations established for Albany County. The question is how much of an effort is the County willing to expend on septic system management to ensure clean drinking water for future generations (Patton and Sawicki's, 1986).

6.4 Conclusion

In conclusion, septic system management in the APOZ is essential for a continued clean water source for both Albany County and City of Laramie residents. The EPA has identified septic systems as the number two cause of groundwater contamination (**Source Water Protection**, 2001). This study provided three septic system projection models for future growth. Currently, there are 99 vacant residential lots that could be developed in the APOZ. The

minimum number of septic systems that could be located in the APOZ is 99. However, based on a linear growth model and subdivision build-out scenarios, septic system projections would range from 429 by the year 2019, 542 septic systems by 2029, and 755 septic systems by 2047. The average lifespan of a septic system is 10-30 years old depending on its maintenance record. In the APOZ boundary, 30% of the septic systems are over 20 years old, 52% of the septic systems are at least 15 years old, and nearly 70% of the septic systems are at least 10 years old.

The time to regulate septic systems for the health and safety of the community is now. The County is in a unique situation to act and plan now for future generations. According to the septic system data and average household size, there are approximately 785 people living in the APOZ on septic systems. The City of Laramie had a population of 30,816 residents who depend on the Casper Aquifer for 60% of their water drinking water. Given the lack of regulation and age of septic systems in the APOZ, a potential threat to safe and clean drinking water exists for the City of Laramie.

The August 7, 2012 Albany County Zoning Regulations suggest the County does not want to infringe on private property rights. However, a Boulder County Health Planner eloquently stated, “While homeowners have a lot of property rights, they don’t have the right to contaminate the groundwater” (Clucas, 2007). The .03% of the population using septic systems in the APOZ may feel their property rights have been compromised; then again, attitudes might change when unmanaged septic systems are developed upstream of their homes polluting their wellheads. The City and County have an obligation to protect the public health and safety of the community by protecting the primary water source for the remaining 99.07% using the Casper Aquifer. The current Albany County zoning regulations fall short of a septic system management strategy for the APOZ.

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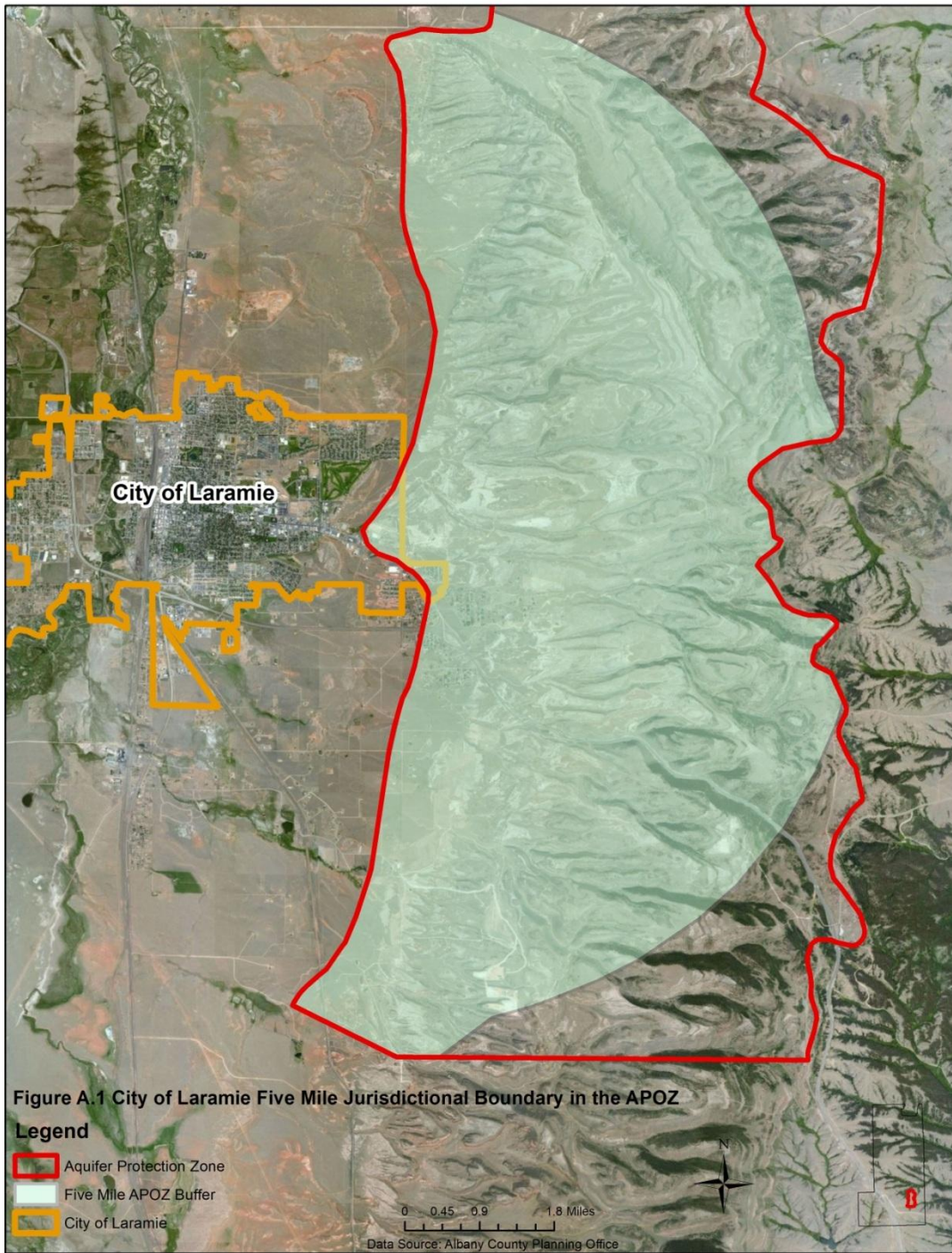
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Appendix A: City of Laramie's Five Mile Jurisdiction



Appendix B: Albany County Plans and Zoning Resolutions

Date	Document	Description	Purpose
2008	Albany County Comprehensive Plan	The Albany County Comprehensive Plan has been adopted pursuant to Wyoming State Statutes 18-5-202(b), which states that “the planning and zoning commission may prepare and amend a comprehensive plan including zoning for promoting the public health, safety, morals and general welfare of the unincorporated areas of the county.”	This Comprehensive Plan serves as a guide for future land use and development in Albany County. It is advisory rather than regulatory in nature, but is the foundation for land management documents such as zoning and subdivision regulations as well as all other decisions made by the County.
2011	Casper Aquifer Protection Plan (CAPP)	The primary purpose of the Casper Aquifer Protection Plan (CAPP) is to reduce the possibility and when possible prevent the contamination of the groundwater within the Casper Aquifer.	The purpose of the CAPP is to protect groundwater resources that supply Public Water Systems (PWS) and Albany County residents within the defined recharge area for the Casper Aquifer.
2012	Albany County Zoning Resolution	Aquifer Protection Overlay Zone	Provides the policy (laws) to implement the Casper Aquifer Protection Overlay Zone

Source: <http://www.co.albany.wy.us/documents-and-reports.aspx>