CHAPTER ONE

INTRODUCTION

Purpose and Objectives

The purpose of this study of the Mint Wash and Williamson Valley system (MWWVS) and aquifer (MWWVA) was to determine a sustainable yield for the ground-water system. The focus was to use field investigations to characterize the geology of the area including previously documented work, as well as the current hydrological and hydrogeological systems. The characterization was the foundation for a numerical finite-difference three-dimensional ground-water flow model.

The objectives of this study were to characterize the geology and hydrogeology of the MWWVS (chapters 2 and 3) and to create a three-dimensional framework model of the study, conduct sensitivity analyses of the ground-water conditions using the ground-water flow model, and create predictive simulations using a transient model to investigate water use scenarios (Chapter 4). Other objectives included estimating the volume of water stored within the aquifer during the time of study, determining the amount of water that could be discharged anthropogenically over the study period without exceeding sustainable yield, determining the location of natural discharge of the Mint Wash / Williamson Valley ground-water system, and

investigating connections to adjacent ground-water basins.

Location

The Mint Wash and Williamson Valley area is located in the Transition Zone physiographic province in central Arizona. The site is approximately 10 miles northwest of the City of Prescott (Figure 1). The region encompasses approximately 480 square kilometers (175 square miles) of semi-arid grassland. The project site is bound to the south by Granite Basin, to the east by a discontinuous linear range comprised of the Sullivan Buttes and Table Mountain, to the west by the foothills of the Santa Maria Mountains, and to the north by the confluence of the Big Chino and Williamson Valley sub-basins (Figure 1). The southern boundary is a surface and ground-water divide (Figure 2). The eastern boundary represented by the Sullivan Buttes and Table Mountain is a surface-water divide and is assumed to be the ground-water divide between the Mint Wash / Williamson Valley aquifer and the Little Chino aquifer in a study conducted by the Arizona Department of Water Resources (Corkhill and Mason 1995). The crest of the Santa Maria mountain range to the west is a surface-water divide and in this study is assumed to be the ground-water divide. The northern boundary is a surface-water and ground-water confluence, where the water from the Mint Wash / Williamson Valley ground-water system joins the water from the larger Big Chino Valley ground-water system.

Significance of Problem

Central Yavapai County has a rapidly growing population, which has more than doubled since the 1980 census (Arizona Department of Economic Security 1999). The population in Yavapai County in 1980 was 68,145, increasing to 142,075 by 1997 (Arizona Department of Economic Security 1999). The cities of Prescott and Prescott Valley and surrounding areas are being developed to accommodate the increase in population, which is occurring mostly in this region of central Yavapai County. Mining of central Yavapai County's ground-water supply has become a major concern due to this increase in population and development. Water resource development in the Mint Wash and Williamson Valley area will rely exclusively on ground water, as there are very limited perennial surface water supplies, and no water is imported to the area from the Colorado River or any other external source.

Most of the ground-water supply in the area of Chino Valley, Prescott and Prescott Valley is protected by the Prescott Active Management Area (AMA). It is an area overseen by a state regulatory agency run by the Arizona Department of Water Resources to regulate the rate of ground water pumping to "safe yield" (Corkhill and Mason 1995). "Safe yield" is the condition where the amount of ground water pumped out of an aquifer each year does not exceed the amount of water that is naturally recharged to the aquifer during that year. The Ground Water Act of 1980 proposed safe yield for all AMA's in Arizona by the year 2025 (Corkhill and Mason 1995).

The Mint Wash / Williamson Valley Aquifer (MWWVA) is outside of the Prescott

AMA. This aquifer is not protected by any state agencies against ground-water mining, so development on the Mint Wash / Williamson Valley area has proceeded without regard for exceeding “safe yield”. Any restrictions on development in the Prescott AMA may be compensated for by increased development in the surrounding areas such as Mint Wash and Williamson Valley. Residents of the MWWVS have expressed concern about how quickly water will be mined due to recent development in the area.

Wildlife and vegetation in the region are dependent on ground water, as well. The MWWVA is unique in central Arizona due to the shallow water table (0.10 meters to 3.0 meters) in the Valley and along the major washes. The ground water has provided water resources for riparian ecosystems dependent on the shallow water table. The riparian habitat found in the area is one of the aspects that makes this ground-water basin unique. Less than 1% of the land in the state of Arizona contains riparian habitat (Briggs 1996). Many reaches of the major washes have perennial springs where the water table intersects land surface. These springs are a water resource for wildlife such as antelope, javelina, migrating Canadian geese, mountain lions, and many others (Maslansky 2000). The process of ground-water mining over time will lower the water table, depleting and possibly removing the ability of the aquifer to support the riparian ecosystem as well as the perennial springs.

Natural resources need to be considered to successfully introduce long term human development into any natural setting. The project study area is a region that depends on it’s water resources to maintain the ecosystem that has evolved. Characterizing the ground-water system through field observations and sensitivity analyses will provide insight on the water

resource that is crucial to the ecosystem in this area. Ground-water flow modeling provided a platform to produce predictive results to interpret how the ground-water system would react to different water use scenarios.

Previous Investigations

The amount of published work on the study area is limited. There is only one published hydrological study within the MWWVS. This Water Resources Investigation produced maps for the ground water conditions in Williamson Valley alluvial basin during 1975 (Wallace and Laney 1976). Other hydrological studies (e.g. The Ground Water Supply of Little Chino Valley (Matlock and Davis 1972), etc.) described basins surrounding the Prescott area. The only published geological studies within the field area are reconnaissance geologic maps of the project and surrounding areas at a 1:62,500 scale (Krieger 1967a and 1967b). These were referred to and field checked as part of the creation of the geologic map (Plate 1).

The map for this study has one improvement in the lithological classification presented in the geologic map developed by Krieger. Current literature describes the Tertiary andesite found in this area to be Tertiary latite (Krieger et al. 1971).

Two ground-water models have been produced for the Prescott AMA, which includes the Little Chino Basin and the Upper Agua Fria Sub-basin. These studies were completed by the Arizona Department of Water Resources (Corkhill and Mason 1995) and Southwestern Ground-water Consultants, Inc. (Wellendorf 1998) and produced ground-water models for the Prescott AMA to quantify “safe yield”. A subsequent study by Woessner (1998) compared the

accuracy of the two models, which had produced different results. The comparison of the two models described the significance of the input parameters, and how they affect the ability of the models to simulate various stresses on the system. The studies provide a basic understanding of ground water systems in the general area.

Other studies in the Prescott vicinity include "Little Chino Valley, Artesian Area and Groundwater Basin" (Schwalen 1967). The Little Chino Basin is to the east of the MWWVS. The basins are separated by a discontinuous north-south trending range composed of Tertiary volcanic rocks (Table Mountain and Sullivan Buttes), uplifted Paleozoic Redwall and Martin Formations (Sullivan Buttes), and Proterozoic schist and gneiss (Plate 1). These basins are very similar due to their proximity, geomorphic similarity and the regional tectonics responsible for their formation.

Little Chino Valley was characterized in other studies such as "The Groundwater Supply of Little Chino Valley" (Matlock and Davis 1972) and "Definition and paleogeographic significance of Cenozoic stratigraphic units, Chino-Lonesome Valley, Yavapai County, Arizona" (Buren 1992).

These publications provide an understanding of the Chino Valley geology and hydrogeology, similar to the geology and hydrogeology of the MWWVS. The literature available for the Little Chino and Upper Agua Fria Sub-basins provides a framework for the general geology and hydrogeology of the Prescott area.

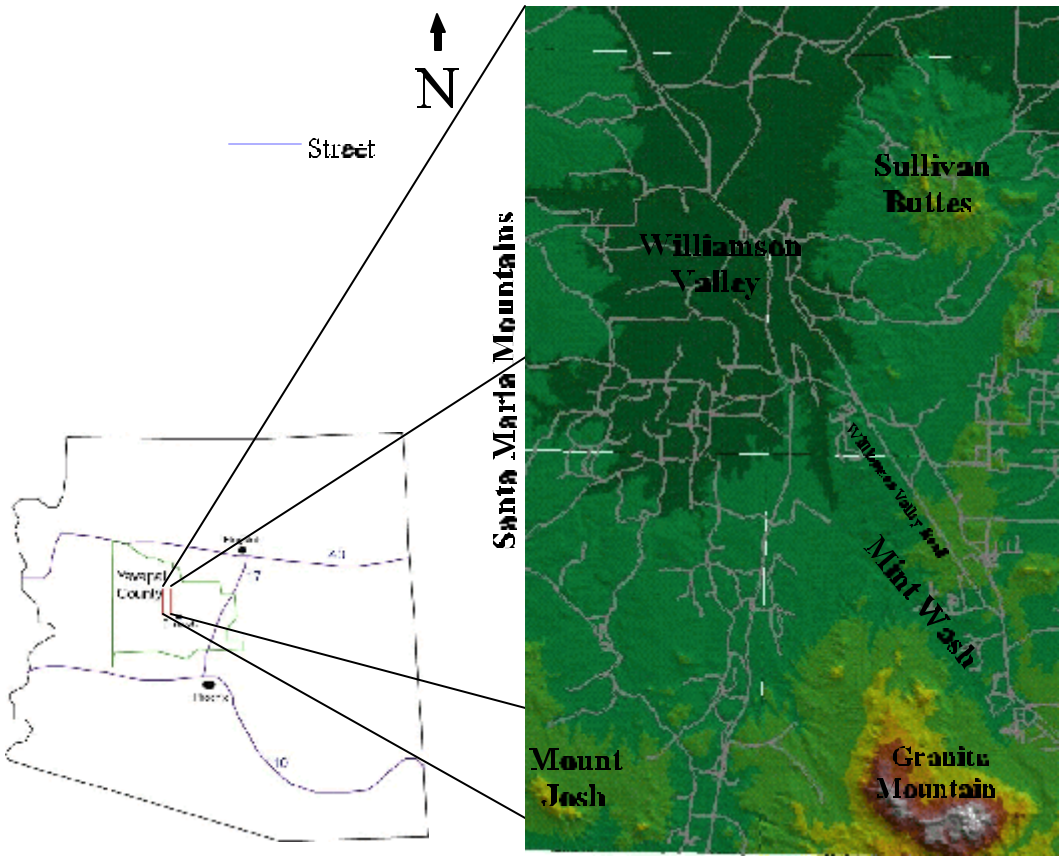

Figure 1. Map showing the location of the Mint Wash / Williamson Valley system, and shaded relief of the topography.