Leon County Aquifer Vulnerability Assessment
A Ground-Water Protection and Management Tool

INTRODUCTION

Located mainly in the Woodville Karst Region, Leon County is underlain by thick and highly permeable limestone layers and other carbonate rocks which make up the Floridan Aquifer System (Pratt et al., 1996). Sinkholes, swallets, river rises, springs and their springsheds, and other karst features are common throughout the area. These include such recognized features as Natural Bridge Spring, Horn Spring, St. Marks River Rise and the Leon Sinks Geological Area. Karst features can enhance the hydrologic interactions between land surface and the underlying Floridan Aquifer System, which can be highly sensitive to activities occurring at land surface.

Leon County's residents all rely heavily on the Floridan Aquifer System, which is the single most important source of fresh water in the region. Identifying areas of Leon County where the Floridan Aquifer System is more vulnerable to contamination is a critical component of a comprehensive ground-water management program. Aquifer vulnerability modeling allows for a pro-active approach to achieve good ground-water protection measures, and can save significant time and greatly increase the value of protection efforts.

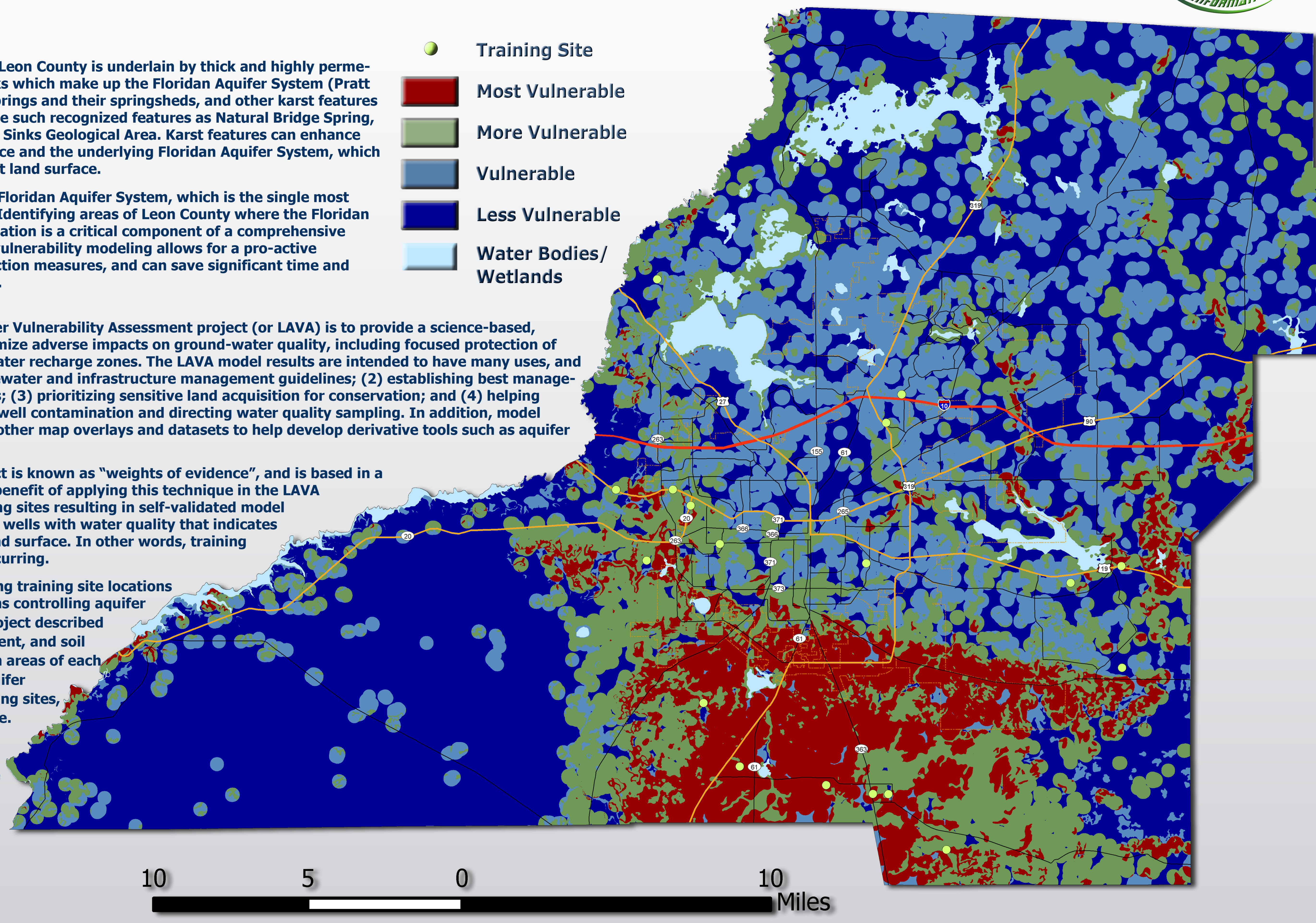
APPROACH

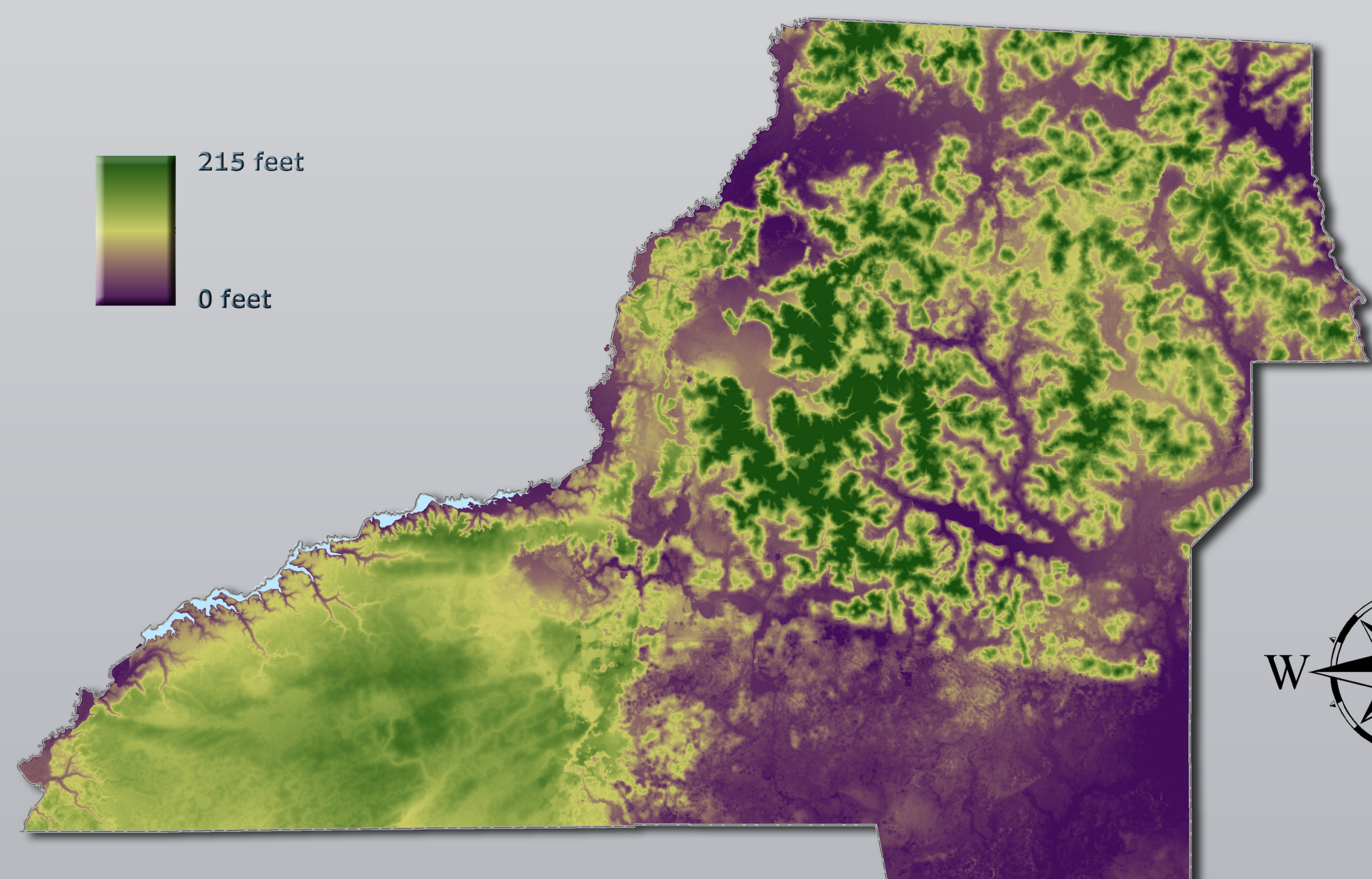
The primary purpose of the Leon County Aquifer Vulnerability Assessment project (or LAVA) is to provide a science-based, water-resource management tool to help minimize adverse impacts on ground-water quality, including focused protection of sensitive areas like springsheds and ground-water recharge zones. The LAVA model results are intended to have many uses, and include: (1) augmenting development of wastewater and infrastructure management guidelines; (2) establishing best management practices for land use and other practices; (3) prioritizing sensitive land acquisition for conservation; and (4) helping identify potential areas of concern for potable well contamination and directing water quality sampling. In addition, model results are also intended to be combined with other map overlays and datasets to help develop derivative tools such as aquifer protection zone maps.

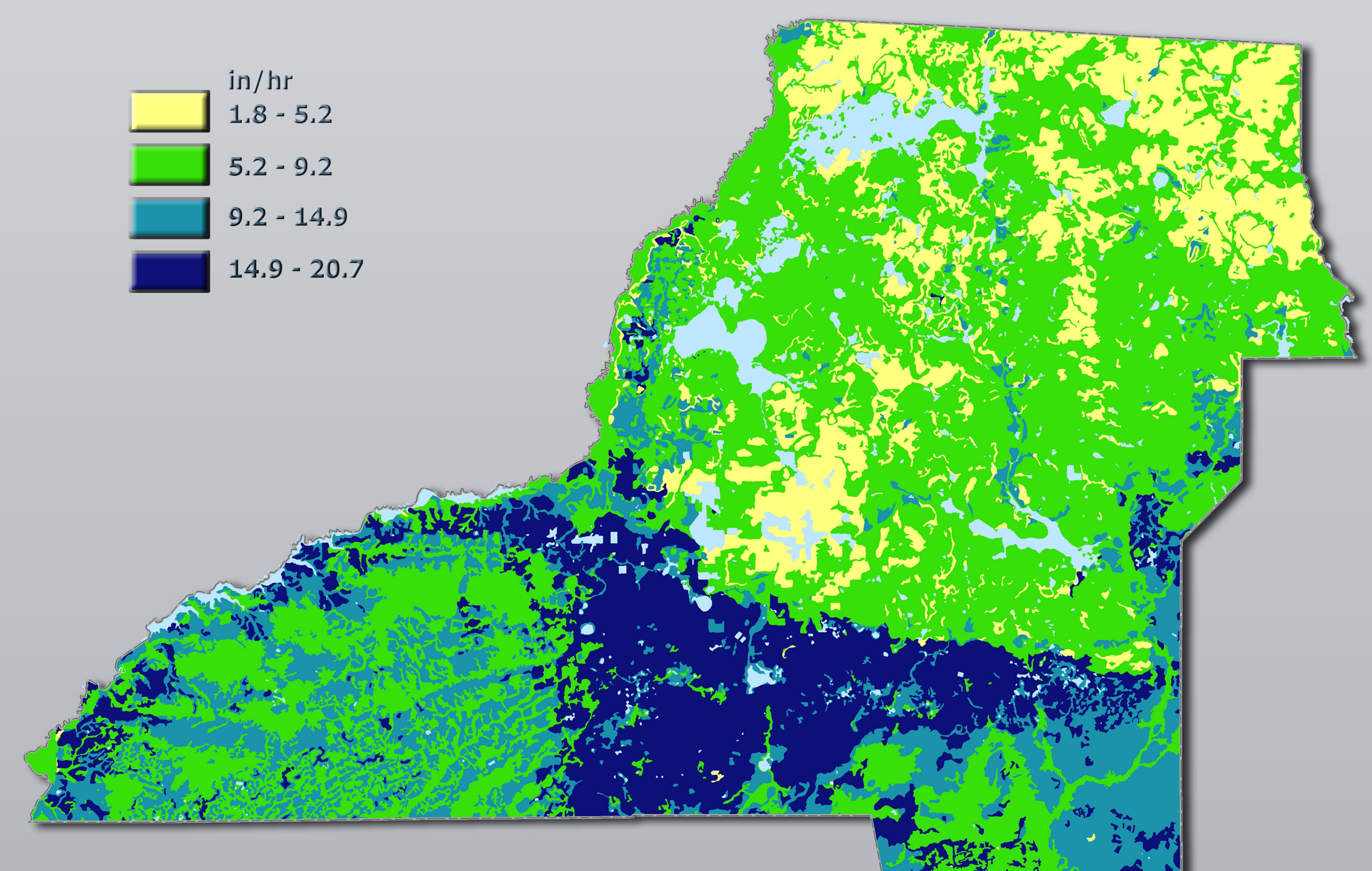
The modeling process used for the LAVA project is known as "weights of evidence", and is based in a geographic information system (GIS). A main benefit of applying this technique in the LAVA project is that model output depends on training sites resulting in self-validated model output. Training sites are simply ground-water wells with water quality that indicates a good connection between the aquifer and land surface. In other words, training sites indicate where aquifer vulnerability is occurring.

Model generation is accomplished by associating training site locations with data layers representing natural conditions controlling aquifer vulnerability. Data layers used for the LAVA project described below include karst features, aquifer confinement, and soil conductivity. The model helps determine which areas of each data layer share a greater association with aquifer vulnerability based on the location of the training sites, and then combine them in a map as shown here. The LAVA model output map indicates that the areas of highest vulnerability are associated with thin to absent aquifer confinement, dense karst-feature distribution, and higher soil hydraulic conductivity.

*U.S. Census Bureau estimate of 2005 population.





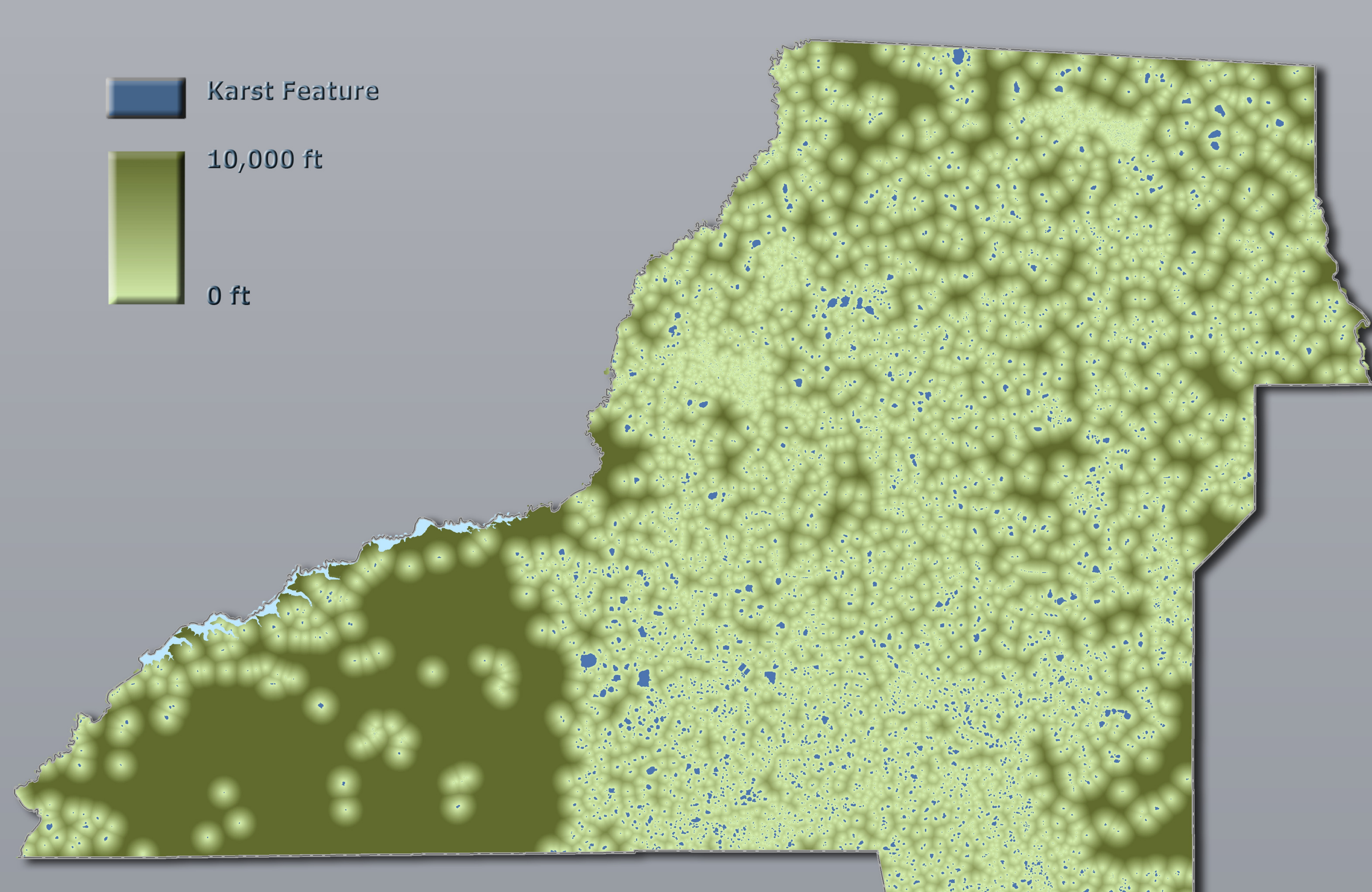


Aquifer Confinement Thickness

Aquifer confinement is an estimate or measure of how well buried or 'covered' an aquifer system is. Where this confinement is thick and continuous and the Floridan Aquifer System is deeply buried, as in the western part of Leon County, aquifer vulnerability is generally lower. On the other hand, in areas of the county where aquifer confinement is thin to absent or breached by sinkholes, the vulnerability of the underlying aquifer is generally higher, primarily because it is present at or near the land surface. This occurs in the southeastern area of the county.

Soil Hydraulic Conductivity

The rate that water moves through soil is a critical component of any aquifer vulnerability analysis, as soil is an aquifer system's first line of defense against potential contamination. Soil hydraulic conductivity is the "amount of water that would move vertically through a unit area of saturated soil in unit time under unit hydraulic gradient" (U.S. Department of Agriculture, 2005). In 2006, Leon County soils data were redesigned for the study area by the Natural Resources Conservation Service. As a result, more detailed information was available for analysis for the LAVA project than during previous projects.



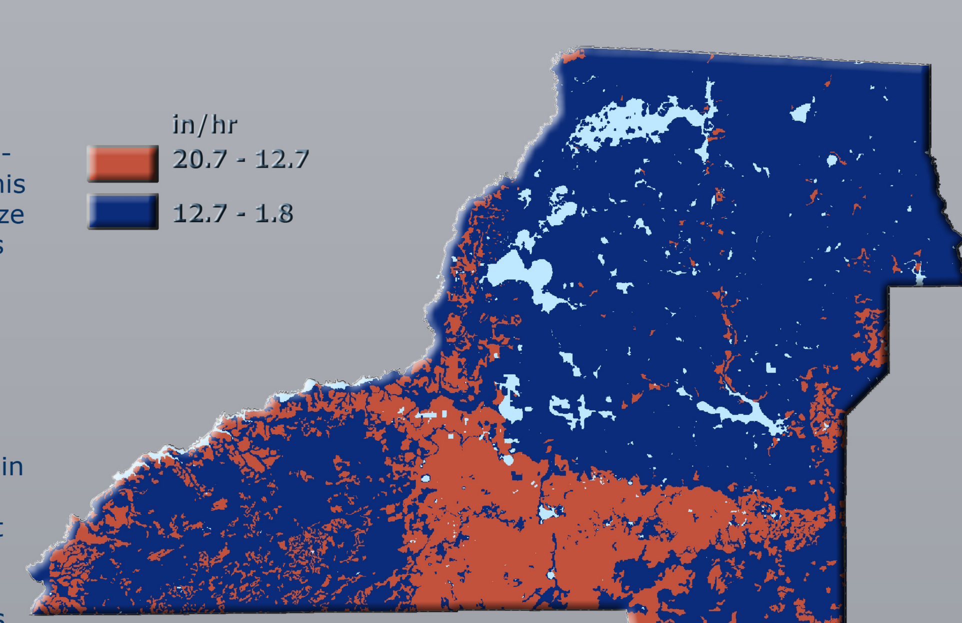
Effective Karst Feature

Karst features, or sinkholes and depressions, can provide preferential pathways for movement of ground water into the underlying Floridan Aquifer System and increase an area's aquifer vulnerability where present. The closer an area is to a karst feature, the more vulnerable it may be considered. Karst features tend to be generally circular in nature (in contrast to non-karstic depressional features which may not be circular) and can be identified and extracted from a digital elevation model based on this characteristic. These resulting effective karst features can be buffered into 20-ft zones to allow for a proximity analysis.

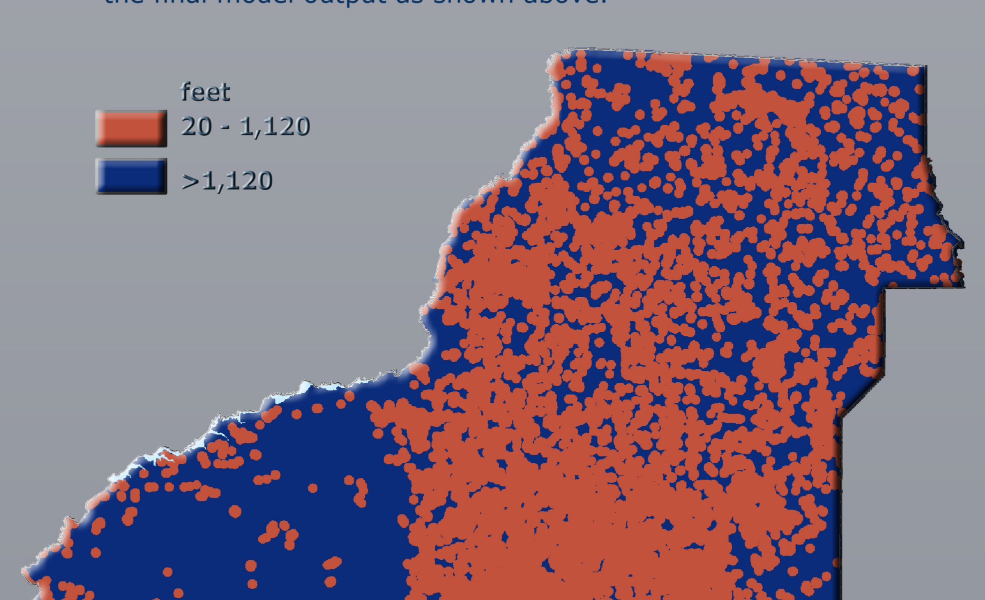
Generalization of Input Data

The modeling process involves generalizing input layers to evaluate which areas of each data layer share a greater association with locations of training sites, or, simply, aquifer vulnerability. Essentially, this process helps to determine the threshold or thresholds that maximize the spatial association between the patterns in the input data layers and the training sites pattern. For the LAVA project, a binary break was typically defined by the modeling analysis for each data layer which creates two spatial categories: one with stronger association with the training points and one with weaker association.

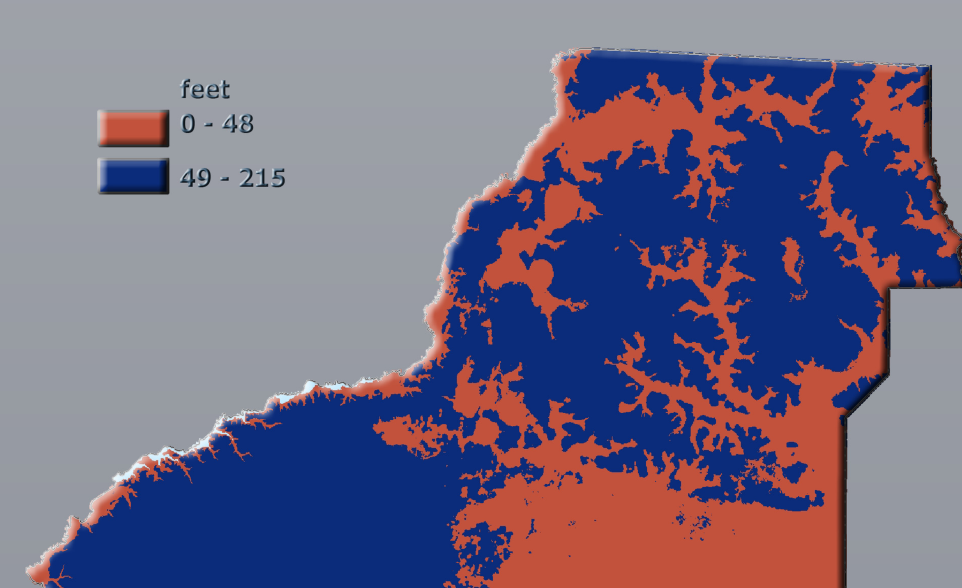
Soil hydraulic conductivity ranges from 1.8 to 20.7 inches per hour (in/hr) across the study area. Modeling indicated that areas underlain by 20.7 to 12.7 in/hr were more associated with higher aquifer vulnerability. The overburden thickness ranges from absent to 215 feet thick across the study area, and the analysis revealed that areas underlain by less than 49 feet of ICU were more associated with higher aquifer vulnerability. Finally, the analysis indicated that areas within 1,120 feet of a karst feature were more associated with higher aquifer vulnerability. These generalized themes are used to generate the final model output as shown above.



Soil Hydraulic Conductivity



Effective Karst Features



Thickness of Overburden

Map developed for Leon County Board of County Commissioners per Leon County Project No. BC-06-20-06-53 by Advanced GeoSpatial Inc.: www.adgeo.net; Version 1.1: July 19, 2007. Map accompanies report of same title by Alan E. Baker, P.G. 2324, Alex R. Wood, and James R. Cichon of Advanced GeoSpatial Inc., and Jay L. Johnson, GISP of Tallahassee-Leon County Interlocal GIS