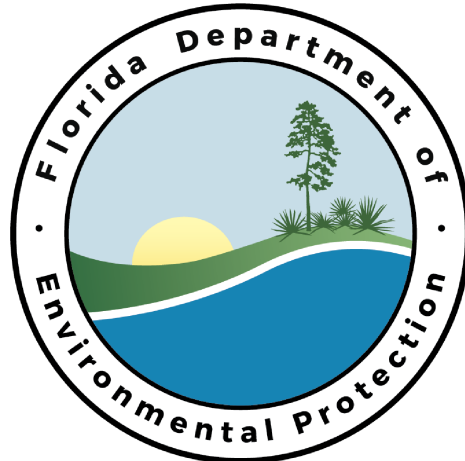
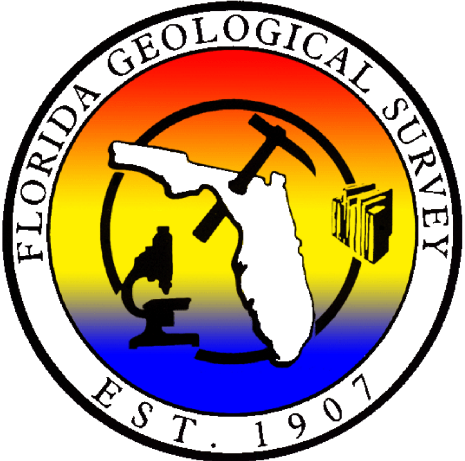




Relative Vulnerability Map of the Surficial Aquifer System

Study Area and Extent

The Surficial Aquifer System (SAS) is the permeable hydrostratigraphic unit in Florida contiguous with land surface that comprises principally unconsolidated siliciclastic deposits, and to a lesser extent, carbonate rocks. The lower limit of the SAS coincides with less permeable sediments of the top of the Intermediate Aquifer System/Intermediate Confining Unit (IAS/ICU; Southeastern Geological Society, 1986). The SAS occurs throughout much of the State and is used extensively in the western panhandle (Sand and Gravel Aquifer) and the southeastern peninsula (Biscayne Aquifer) as a principal source of drinking water.

The preliminary extent of the SAS for the FAVA project was based on the extent of the IAS/ICU. Modifications of this preliminary extent were based on the distribution of Miocene-Pliocene clay-rich sediments as mapped by Scott et al. (2001). In areas where sediments of the IAS/ICU were not mapped on a regional scale, the SAS was not mapped for this project (see *Results – Data Coverages – Intermediate Aquifer System/Intermediate Confining Unit Thickness* for additional information). Further refinement of the SAS extent was accomplished by omitting areas where laterally continuous SAS sediments were calculated at less than ten feet thick and where IAS/ICU sediments were at or near land surface. In some instances, SAS sediments greater than ten feet in thickness were omitted from the extent because they represented isolated, discontinuous, local packages of sediment which do not form part of a major regional aquifer system. In some of these areas, hydraulic heads in the Floridan Aquifer System (FAS) and surficial sediments differ, justifying a local water-table aquifer in the areas; however, these local occurrences are generally discontinuous. Given the statewide scale of the FAVA project, attempting to map and model these isolated areas was beyond the scope of this project. Maps showing the SAS extent in this report reflect only areas where the SAS is present in a laterally continuous and regional extent.

For modeling purposes, the extent of the SAS was further revised to exclude all areas covered by both permanent and seasonal wetlands. These wetlands were identified using the National Wetlands Inventory (NWI) database (US Fish and Wildlife Service, 1988-1993). Wetlands were omitted from the SAS extent because they were poorly represented by training points, i.e., few wells existed in wetland areas. During sensitivity analyses, model outputs for the SAS that included wetlands yielded misleading evidential theme weights and poorly predicted vulnerability of the SAS in wetland areas.

Weights of Evidence Model

Use of the Weights of Evidence (WoE) modeling technique involves the combination of diverse spatial data that are used to describe and analyze interactions and generate predictive models (for a detailed discussion of this statistical modeling technique see Bonham-Carter, 1994; Raines et al., 2000). WoE is a data-driven process that utilizes known occurrences as model training sites to create maps from weighted continuous input data layers. These input data layers, known as evidential themes, are then combined to yield an output data layer (or result of the model), known as a response theme (Raines, 1999). WoE was adapted to mineral potential mapping in a GIS and is based on the application of Bayes' Rule of Probability, with an assumption of conditional independence (Raines et al., 2000). Although Bayesian theory has been applied to ground-water related issues in recent years (e.g., Soulsby et al., 2003; Meyer et al., 2003; and Feyen et al., 2004), the specific application of WoE to ground-water issues is very limited to date (Cheng, 2004).

Training Points Theme and Prior Probability

Training points are locations of known occurrences. In mining applications for example, ore deposits are known occurrences. In an aquifer vulnerability assessment, wells with water quality indicative of high recharge are potential known occurrences. Training points are used in WoE to calculate the following parameters: *prior probability* (or, density of training points), weights for each *evidential theme*, and posterior probability of the *response theme*.

Evidential Themes

An evidential theme is defined as a set of continuous spatial data that is associated with the location and distribution of known occurrences, i.e., training points. In GIS terms, an evidential theme is analogous to a data layer or coverage. Evidential themes in the mining example might include an area's proximity to faults. In the FAVA project, soil permeability and thickness of confinement are examples of evidential themes. Weights calculated in WoE establish spatial associations between training points and evidential themes. The three evidential themes used for the SAS FAVA model are displayed to the right and include closed topographic depressions, soil permeability, and depth-to-water.

Generalization of evidential themes follows calculation of weights in the WoE modeling process. Themes are generalized in an effort to establish which areas of the evidence share a greater association with locations of training points. During calculation of weights for each evidential theme, a contrast value is calculated, which is a combination of the positive and negative weights (positive weight – negative weight) as described in *Introduction – Approach – Models Considered – Weights of Evidence*. Contrast is a measure of a theme's significance in predicting the location of training points and helps to determine the threshold or thresholds that maximize the spatial association between the evidential theme map pattern and the training point theme pattern (Bonham-Carter, 1994).

Response Theme

Following the generalization of evidential themes, WoE output results are generated and are known as response themes. A response theme is an output data layer showing the probability (posterior probability) that a unit area contains a training point based on the evidence (evidential theme) provided. Areas of higher posterior probability indicate that an area is more likely to contain a training point, whereas areas of lower posterior probability indicate that an area is less likely to contain a training point. For the FAVA project, a response theme can be a probability map that is displayed in classes of relative vulnerability based on selected water-quality analytes in training point wells.

Vulnerability Zones

Zones of relative vulnerability of the SAS calculated using Weights of Evidence are displayed in the large map to the far right. As noted in the report, all aquifers are vulnerable to contamination. As a result, this generalized SAS FAVA map reflects three levels of vulnerability. Each zone represents a range of probability values that an area is vulnerable to contamination from land surface. Evidential themes (data coverages) used for input into this model include: soil permeability, an area's proximity to closed topographic depressions, and depth-to-water.

More Vulnerable

Areas of the vulnerability map designated in red represent the *more vulnerable* zone based on output probabilities calculated using WoE. The *more vulnerable* zone encompasses approximately 42,620 km², which is approximately 66% of the total study area.

Vulnerable

Areas of the vulnerability map designated in green represent the *vulnerable* zone based on output probabilities calculated using WoE. The *vulnerable* zone encompasses approximately 19,353 km², which is approximately 30% of the total study area.

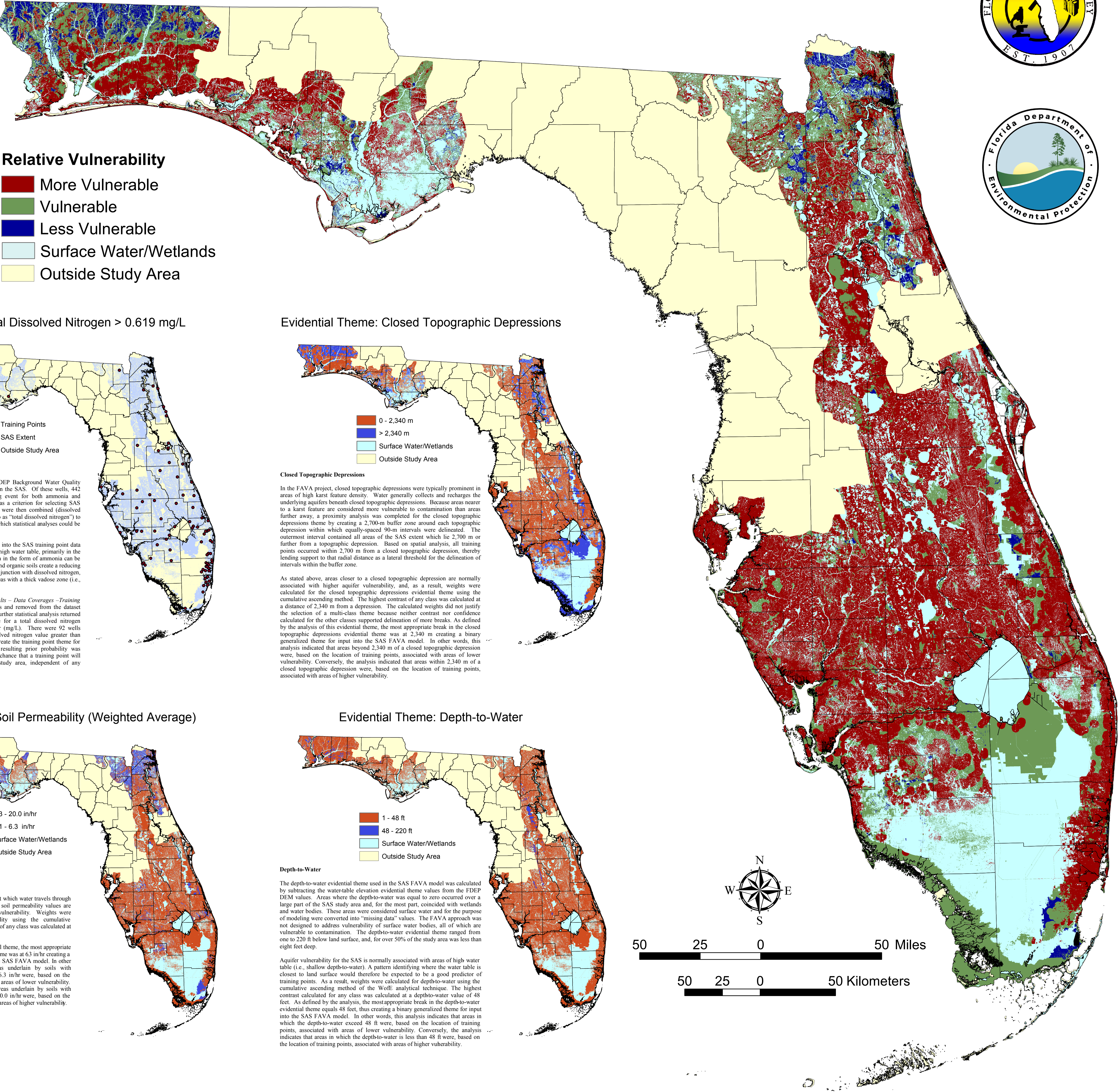
Less Vulnerable

Areas of the vulnerability map designated in blue represent the *less vulnerable* zone based on output probabilities calculated using WoE. The *less vulnerable* zone encompasses approximately 2,737 km², which is approximately 4% of the total study area.

Disclaimer

The FAVA maps were developed by the FDEP/FGS to carry out agency responsibilities related to management, protection, and responsible development of Florida's natural resources. Although efforts have been made to make the information in these maps accurate and useful, the FDEP/FGS assumes no responsibility for errors in the information and does not warrant the accuracy of the information. Similarly, FDEP/FGS assumes no responsibility for any consequences resulting from inappropriate uses or interpretations of the data on these maps. As such, these maps are distributed on an "as is" basis and the user assumes all risk as to their quality, the results obtained from their use, and the performance of the data. FDEP/FGS further makes no warrant, is, either expressed or implied as to any other matter whatsoever, including, without limitation, the condition of the product, or its suitability for any particular purpose. The burden for determining suitability for use lies entirely with the user. In no event shall the FDEP/FGS or its employees have any liability whatsoever for payment of any consequential, incidental, indirect, special, or tort damages of any kind, including, but not limited to, any loss of profits arising out of use of or reliance on the maps or support by FDEP/FGS. FDEP/FGS bears no responsibility to inform users of any changes made to this data. Anyone using this data is advised that resolution implied by the data may far exceed actual accuracy and precision.

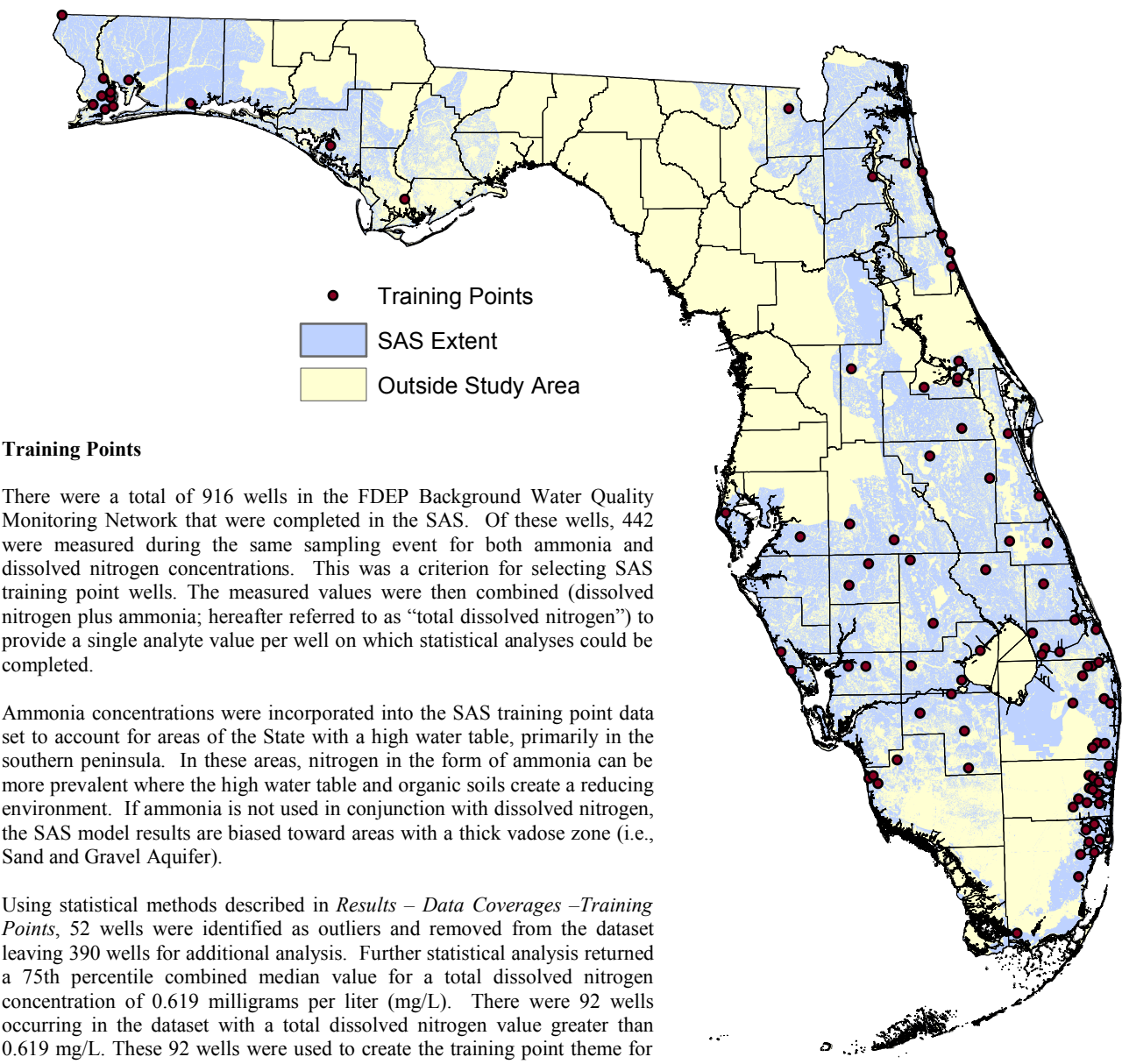
Comments on this data are invited and FDEP/FGS would appreciate that documented errors be brought to the attention of our staff. Because part of this data was developed and collected with U.S. Government and/or State of Florida funding, no proprietary rights may be attached to it in whole or in part, nor may it be sold to the U.S. Government or the Florida State Government as part of any procurement of products or services.



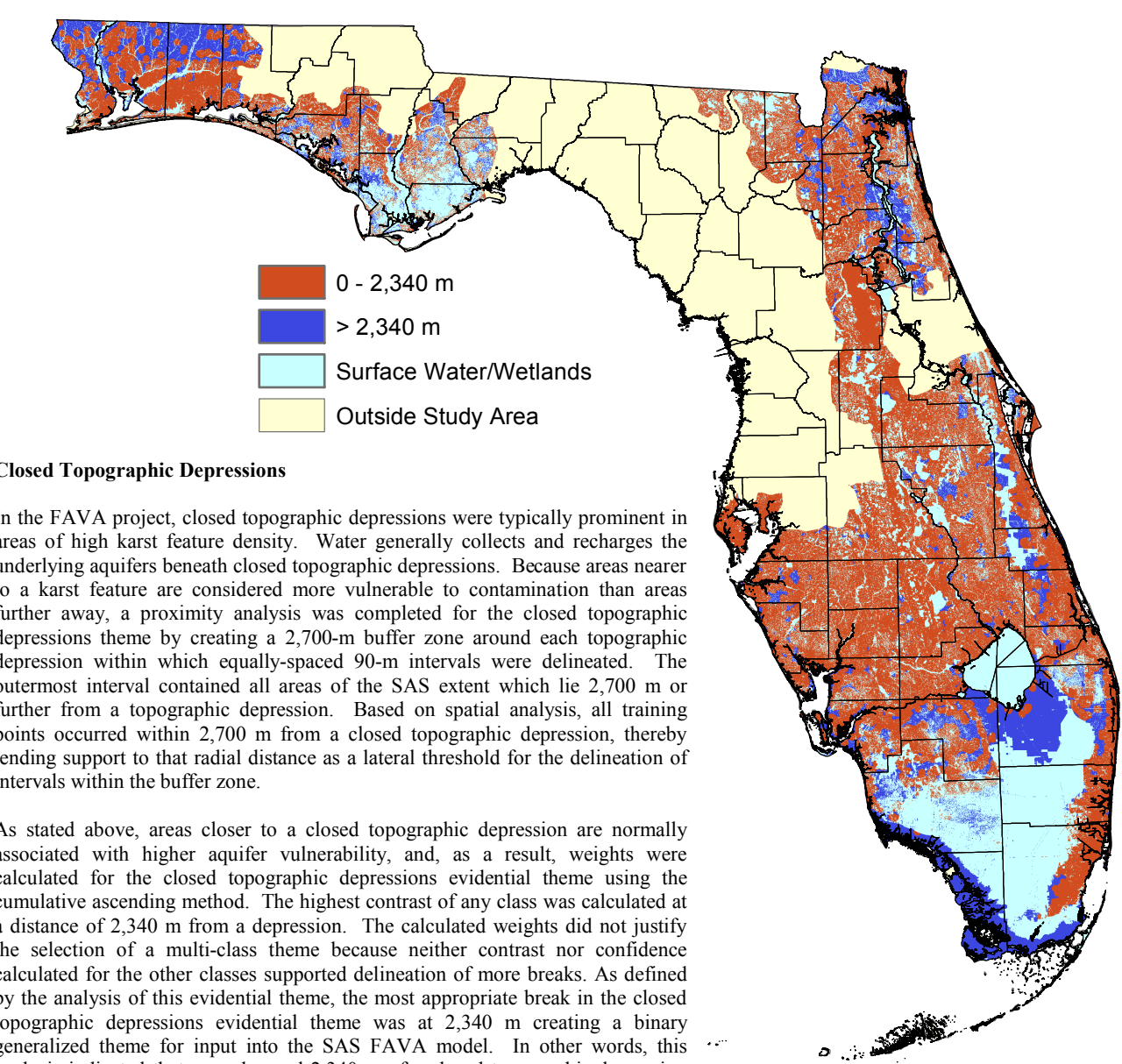
Relative Vulnerability

- More Vulnerable
- Vulnerable
- Less Vulnerable
- Surface Water/Wetlands
- Outside Study Area

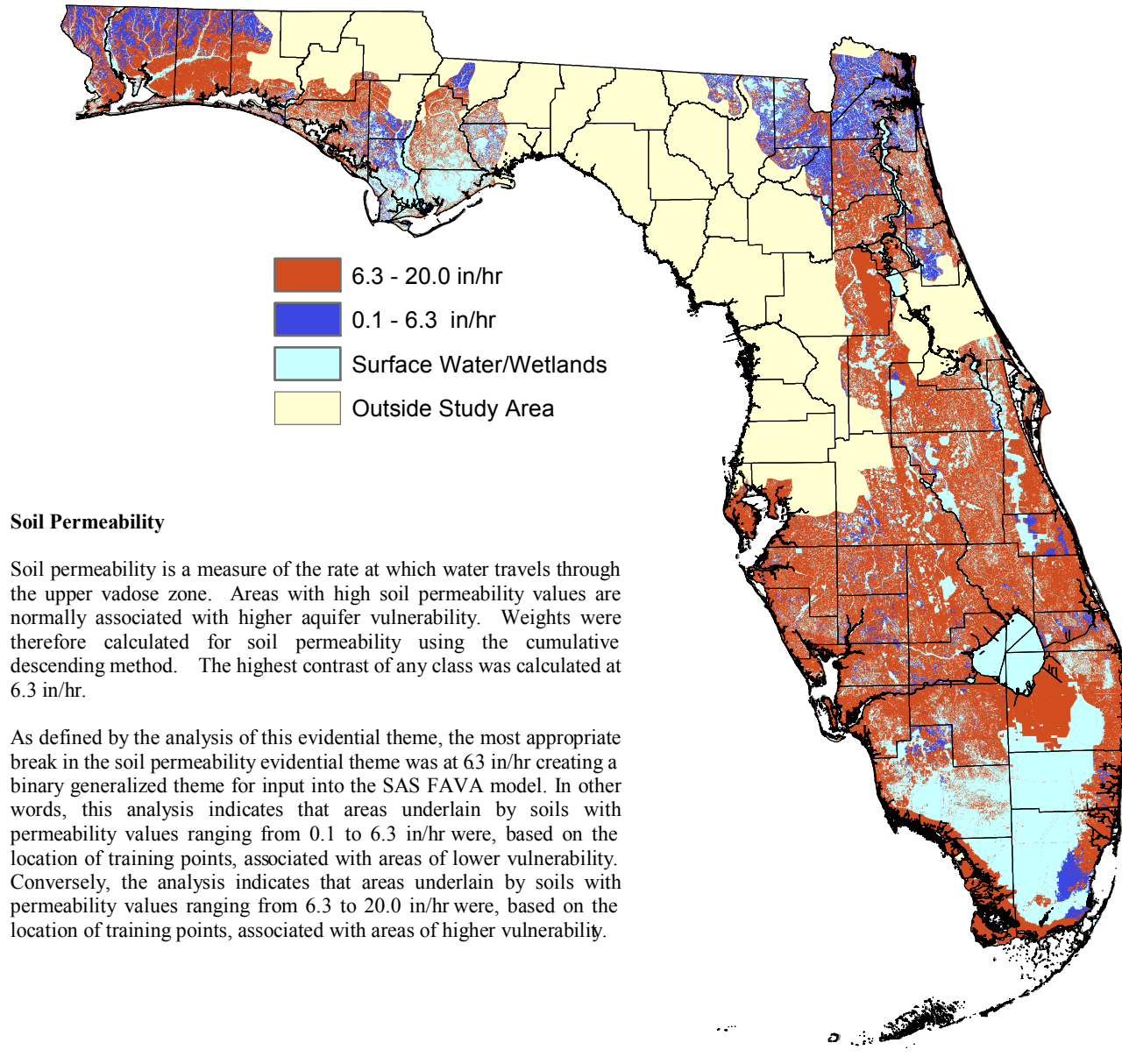
Training Points: Total Dissolved Nitrogen > 0.619 mg/L



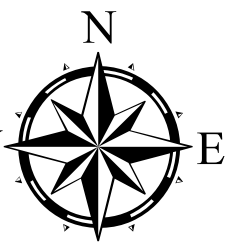
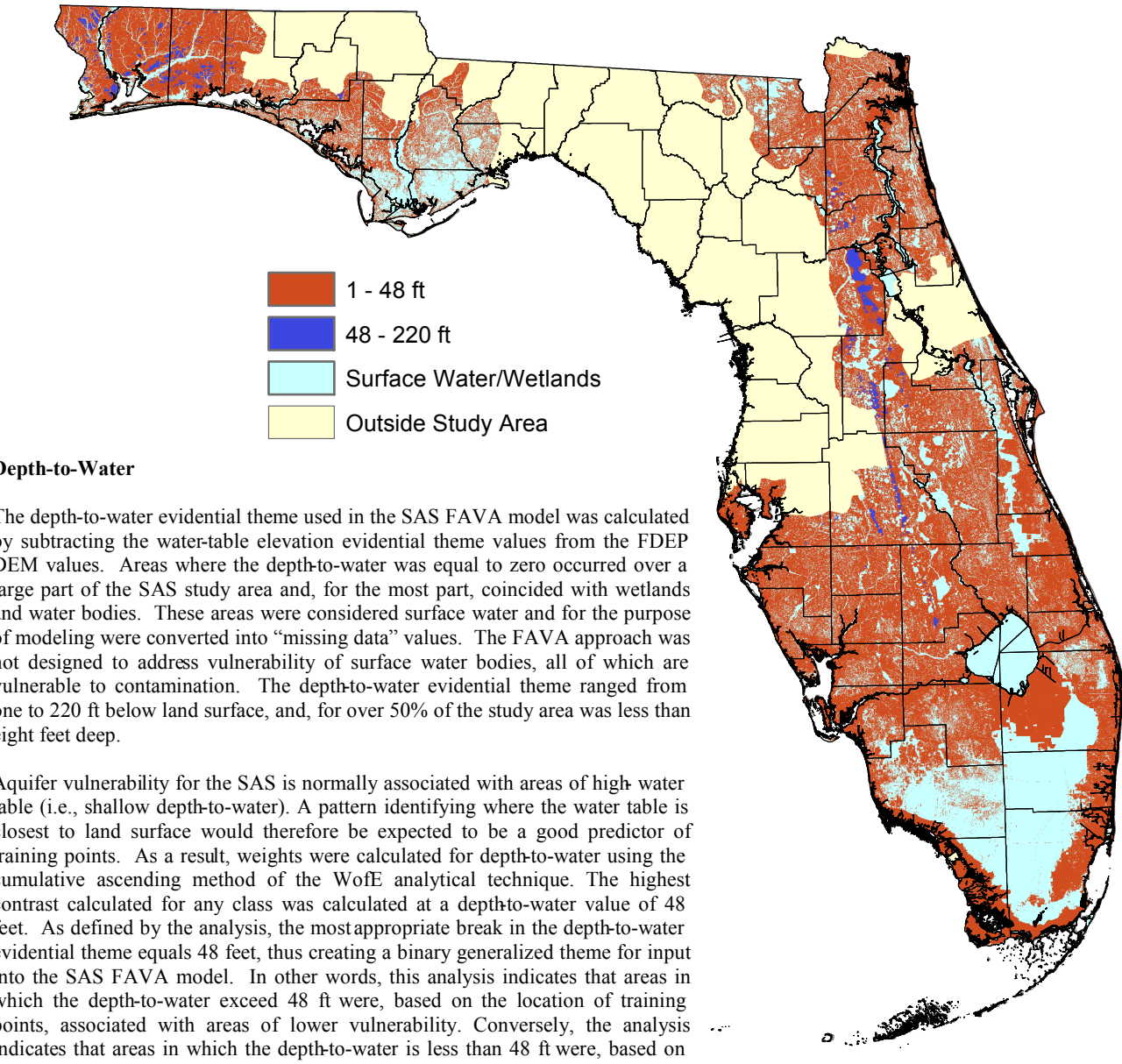
Evidential Theme: Closed Topographic Depressions



Evidential Theme: Soil Permeability (Weighted Average)



Evidential Theme: Depth-to-Water



50 25 0 50 Miles

50 25 0 50 Kilometers