DIGITAL MAPPING TECHNIQUES 2016

The following was presented at DMT'16
(May 22-25, 2016 - Florida Geological Survey,
Tallahassee, FL)

The contents of this document are provisional

See Presentations and Proceedings
from the DMT Meetings (1997-2016)

http://ngmdb.usgs.gov/info/dmt/

Managing a Potentiometric Surface Mapping Program

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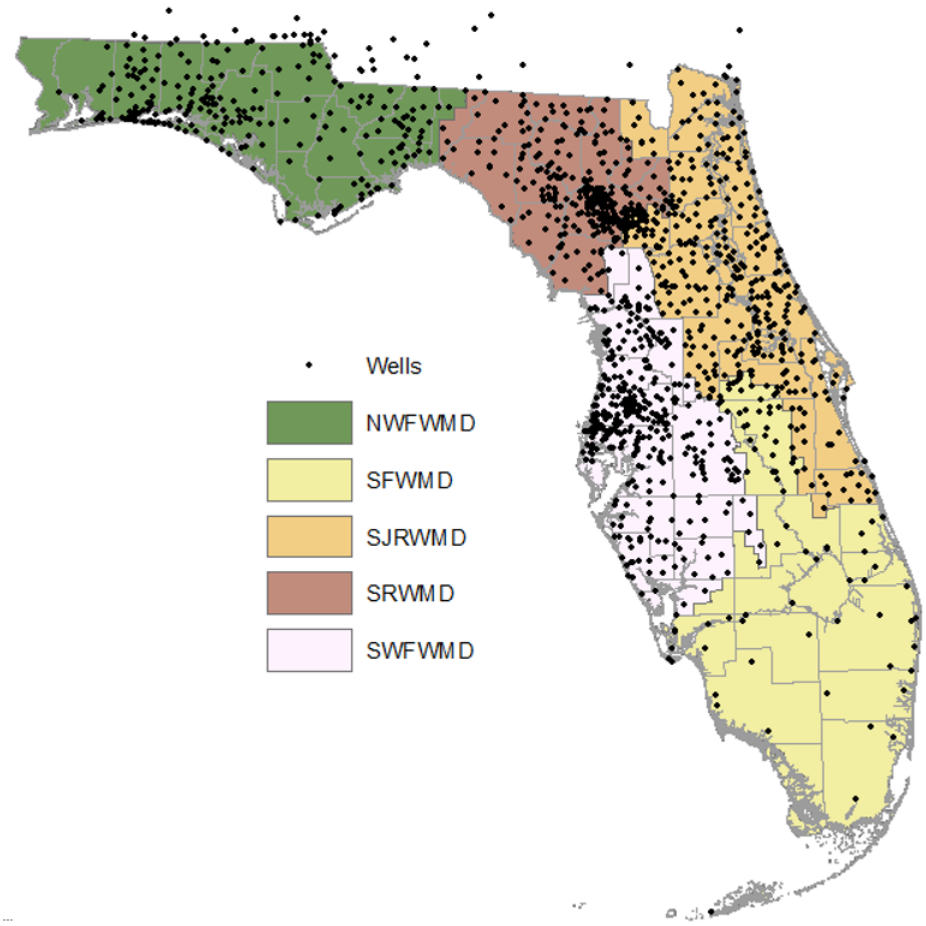
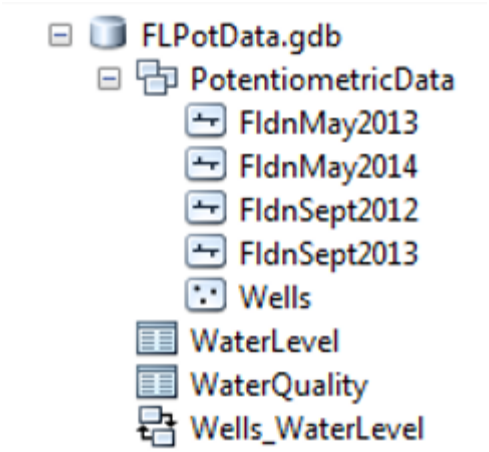
The Florida statewide potentiometric surface mapping program was reestablished in 2013 in cooperation with Florida's five water management districts (WMD) to map the upper Floridan aquifer (UFA) semiannually in May and September. Water-level data is submitted by numerous agencies with the majority coming from the WMD. Collaboration with WMD staff is critical due to the expertise they provide in data assurance and technical review of potentiometric surface contour lines. The well network currently comprises over 1,400 wells with approximately 1,100 used in each surface creation.

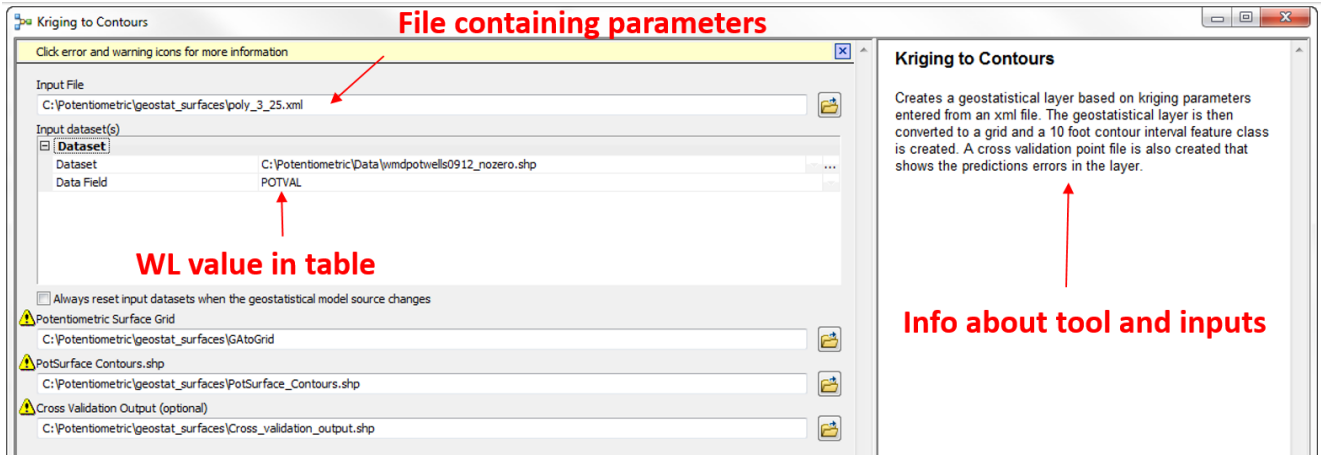


Large amounts of data require that data be organized as efficiently as possible. This begins with setting up a data structure that minimizes input error while concisely managing a "tidy" database. Data from eight sources is converted into the same format and then imported into the database. Summary statistics are run to check for any errors in the data and are corrected prior to any analysis.

Data is stored in an ArcGIS file geodatabase consisting of feature classes for the well network and contour lines of the potentiometric surfaces developed for the UFA. Water-level and water-quality tables are included in the geodatabase providing information about each well during a specified date. Finally, a relationship class is established to link the many water-level measurements to the appropriate well.



Creating the potentiometric surface contour lines is a two-step process. First, an automated process using kriging is used to make a raster surface of the water-level data. This process is saved and documented in an ArcGIS Toolbox.



An error report is included to help identify overall error and trouble spots in the raster surface. This report can aid in identifying locations where additional wells can improve the interpolated surface.

Next the raster surface is refined using post editing rules to create the final contour lines:

- Rivers intersecting the UFA follow the rule of V's.
- Potentiometric surface contour line values do not exceed the topographic digital elevation model (DEM) in unconfined areas.
- Potentiometric surface contour lines do not violate valid measured water-level data.

Data is shared as an interactive ArcGIS Online map or by downloading the entire geodatabase.

FDEP ArcGIS Online projects

http://fdep.maps.arcgis.com/home/

FDEP Geospatial Open Data Portal

http://geodata.dep.state.fl.us/

Florida Department of Environmental Protection
Florida Geological Survey

Managing a Potentiometric Surface Mapping Program

James Cichon - Hydrogeologist

May 24, 2016





Project Overview

Statewide potentiometric surface mapping of the upper Floridan aquifer (UFA)

- Reestablished in 2013 in cooperation with Florida's five water management districts (WMDs)

- WMDs provide:
  - Water level data* – last two weeks of May and September
  - Product review

- FGS/FDEP provide:
  - Generation of statewide potentiometric surface (contours, raster)
  - Final products shared as a geodatabase, pdf and ArcGIS online map

- *Additional water level providers are Geological Survey of Alabama, Alachua County and the USGS

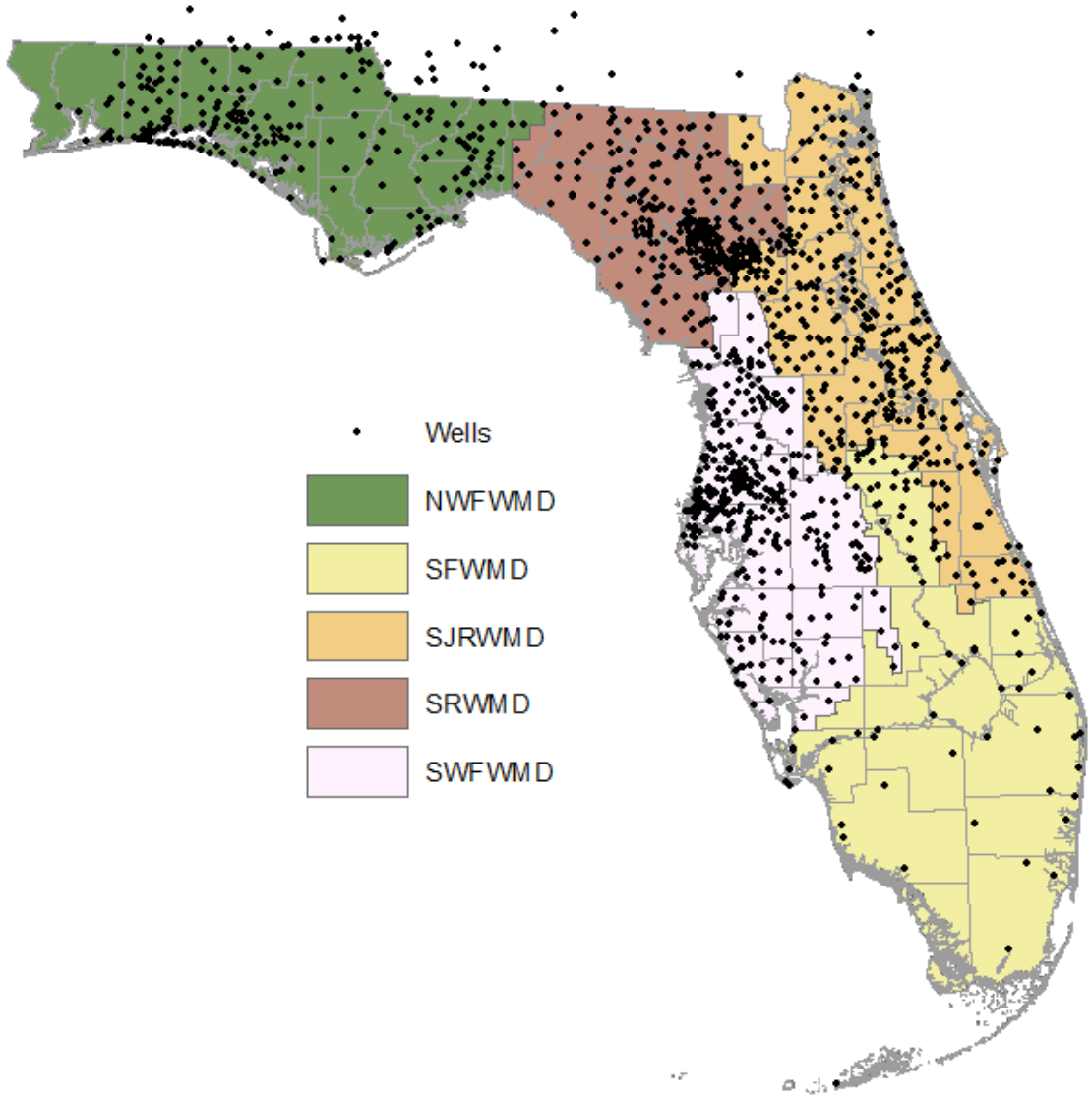
Water Level Data

Florida's five water management districts:

Currently 1,411 wells in network

1,192 WMDs
175 Alachua County
17 Geological Survey of Alabama
27 USGS

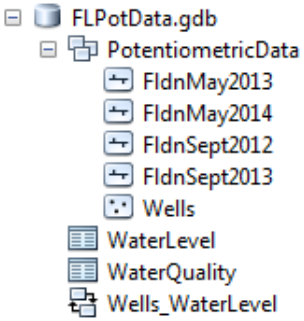
Approximately 80% of wells have daily water level readings



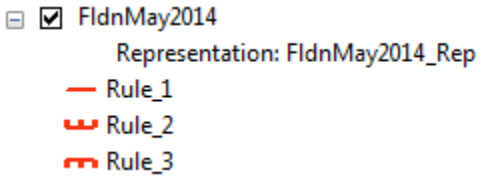
Project Goals

- Develop Statewide potentiometric surface maps for the months of May and September
- Manage and **share** a geodatabase of wells, water level data and contour lines for agency/public use
- Develop raster surfaces from wells and contour lines
- Collect, compile and digitize (GIS format) historic potentiometric surface maps

Geodatabase Schema



- Wells and water level linked through relationship class. There are currently 1,411 wells and 9,119 averaged WL readings
- Domains to restrict data entry
- Contour lines symbolized using cartographic representation.



- Metadata included

Upper Floridan Aquifer Potentiometric Surface May 2015

File Geodatabase Feature Class

Thumbnail Not Available

Tags

potentiometric surface, water level, water level elevation, pot map, Floridan aquifer

Summary

To provide contour lines of the potentiometric surface of the upper Floridan aquifer (UFA) for May 2015.

Description

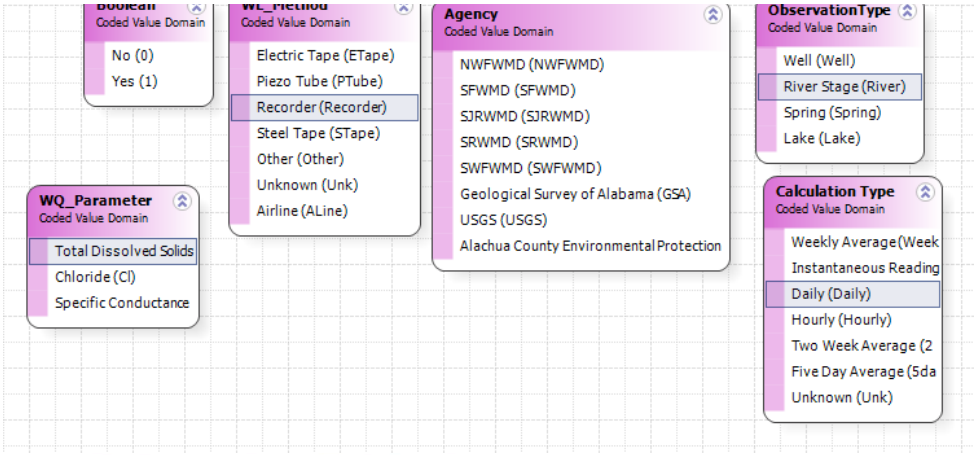
Contour lines are created for the potentiometric surface of the upper Floridan aquifer from water level data submitted by the water management districts. Water level measurements were obtained from 1,157 wells collected during May 1 - June 5, 2015. The majority of measurements occurred during the last two weeks of May. In the NWFWMD 12 wells were measured between May 1 and May14, and 4 wells were measured between June 2 and June 5, In SRWMD, 20 wells were measured between May 1 and May 14. In SFWMD one well was measured on June 2. The points associated with the water level data are added to Geostatistical Analyst and ordinary kriging is used to interpolate water level elevation between the points. The Geostatistical Analyst layer is then converted to a grid (using GA Layer to grid tool) and then contour lines (using the Contour tool). Post editing is done to smooth the lines and fix areas that are hydrologically incorrect. The rules established for post editing are: 1) rivers intersecting the UFA follow the rule of V's; 2) potentiometric surface contour line values don't exceed the topographic digital elevation model (DEM) in unconfined areas; and 3) potentiometric surface contour lines don't violate valid measured water level data. Errors are usually located where potentiometric highs are adjacent to potentiometric lows (areas where the gradient is high). Expert knowledge or additional information is used to correct the contour lines in these areas. Some additional data may be river stage values in rivers that intersect the Floridan aquifer or land elevation in unconfined areas. The potentiometric surface is a snap shot in time and is only meant to describe water level elevation based on existing data for the time period measured. The contour interval for the statewide map is 10 feet and is not meant to supersede regional (water management district) or local (city) scale potentiometric surface maps.

Credits

FGS - James Cichon, Frank Rupert, Tom Greenhalgh. SFWMD - Anne Dodd, Emily Richardson, Linda Lindstrom. SRWMD - Tom Mirti. SWFWMD - Dave DeWitt, Granville Kinsman, Margit Crowell, Roberta Starks, Steve DeSmith. SJRWMD - Don Boniol. NWFWMD - James Sullivan, Tony Countryman. FDEP - Rick Copeland. Alachua County - Robin Halbourg, James Hatchitt . Geological Survey of Alabama - Amye Hinson.

Use limitations

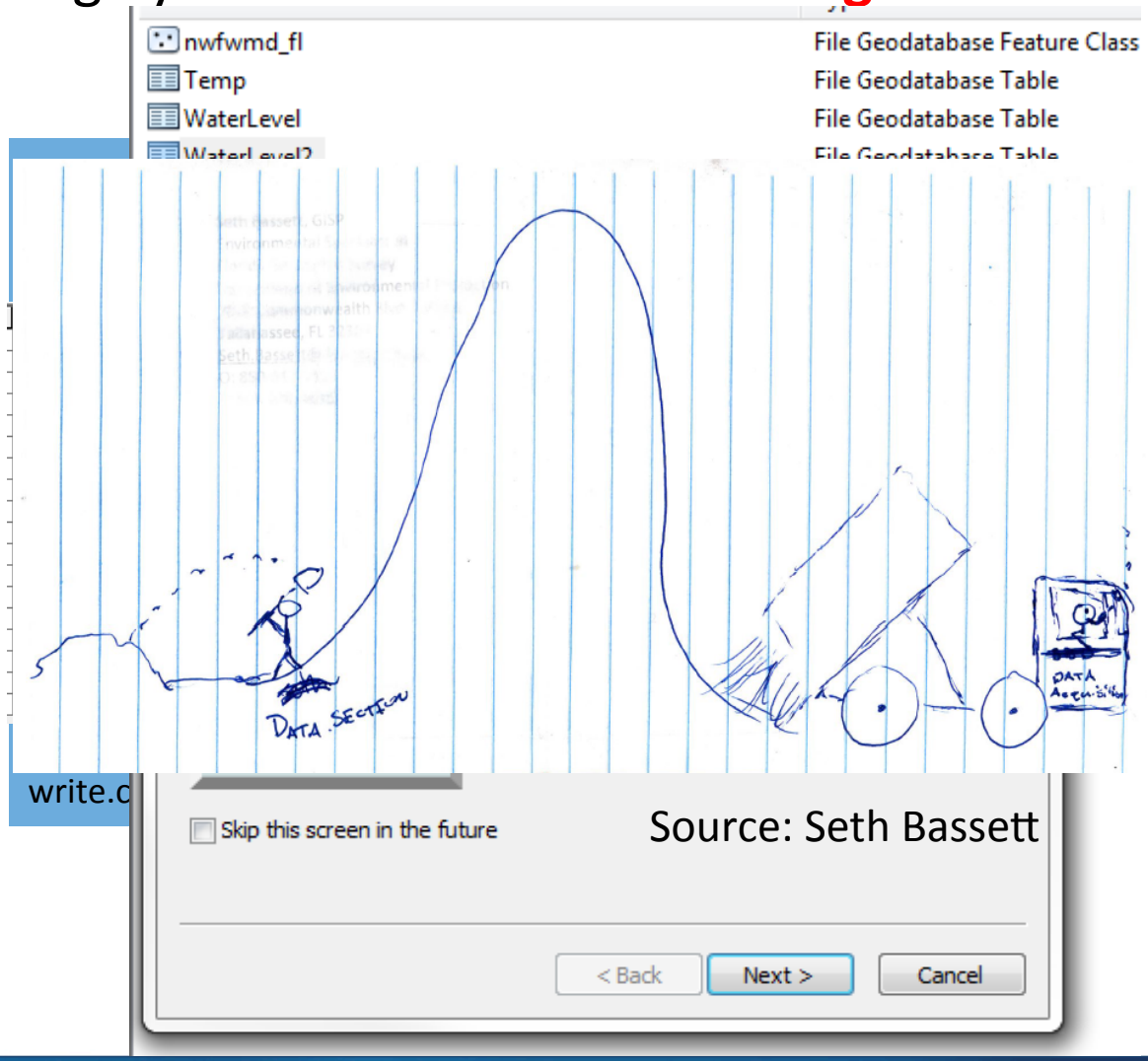
This geologic data was developed by the Florida Department of Environmental Protection (FDEP) - Florida Geological Survey (FGS) to carry out agency responsibilities related to management, protection, and development of Florida's natural resources. Although efforts have been made to make the information accurate and useful, the FDEP/FGS assumes no responsibility for errors in the information and does not guarantee that the data are free from errors or inaccuracies. Similarly FDEP/FGS assumes no responsibility for the consequences of inappropriate uses or interpretations of the data. As such, these digital data are distributed on "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 bears no responsibility to inform users of any subsequent changes made to this data. Anyone using this data is advised that precision implied by the data may far exceed actual precision. Comments on this data are invited and FDEP/FGS would appreciate that documented errors be brought to staff attention. The development of these data sets represents a major investment of staff time and effort. As a professional responsibility, we expect that the FDEP/FGS will receive proper credit when you utilize these data sets. Further, since part of this data was developed and collected with U.S. Government 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.



Data Hygiene

Put a process in place to manage your data – **Don't create digital litter**

- USGS data – R script to download and export WL data to csv file
- dataRetrieval - http://usgs-r.github.io/dataRetrieval/#1
- Load WL data into GDB using the simple data loader and update attribute fields
- Summarize WL data by min, max, avg, SD and variance
- Check for new wells



Source: Seth Bassett

Kriging

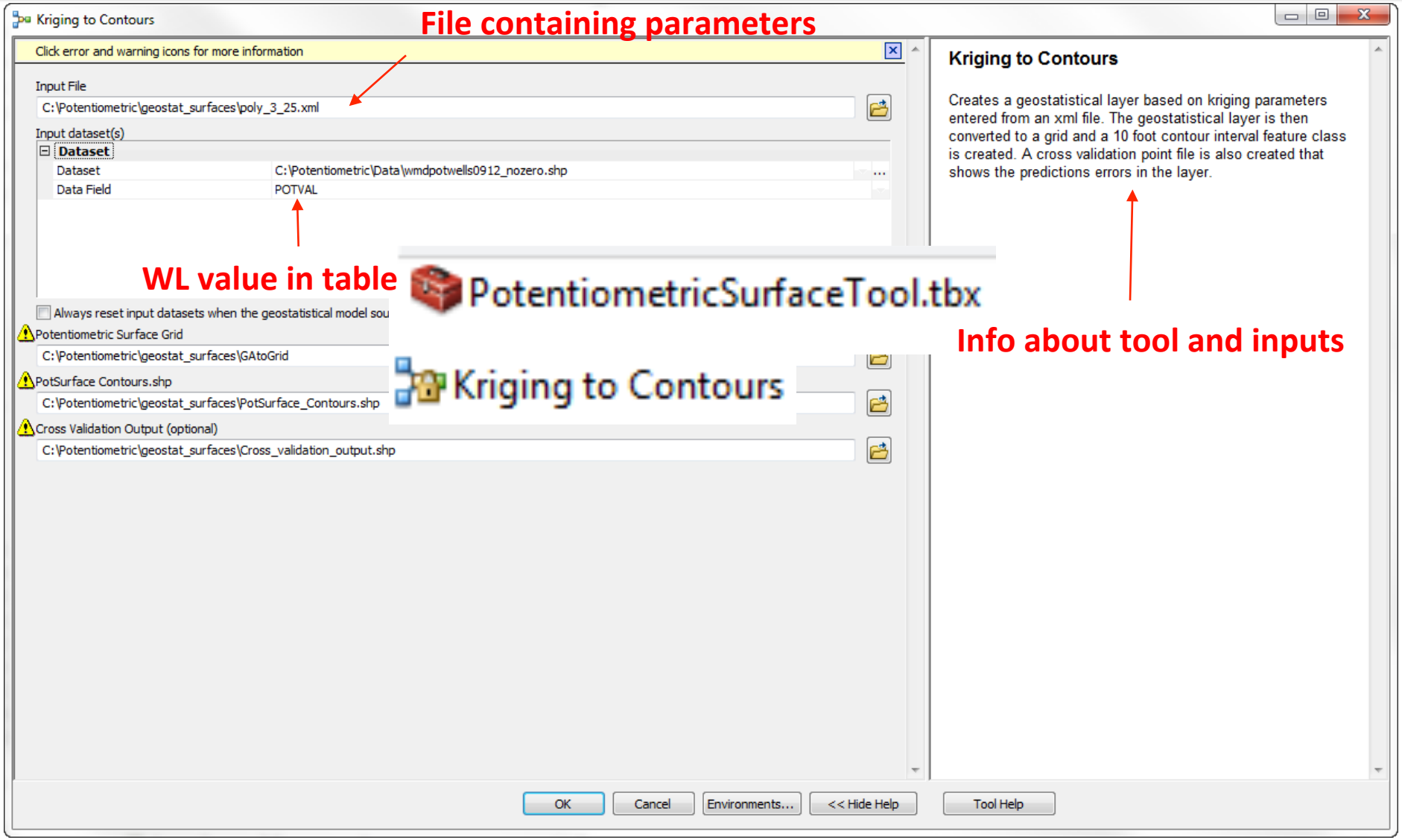
What is kriging?

Kriging – interpolation technique that uses distance and spatial arrangement of points to predict a value where one does not exist.

Kriging will also predict a value at the well point. This is how we get the error value from the interpolation process.

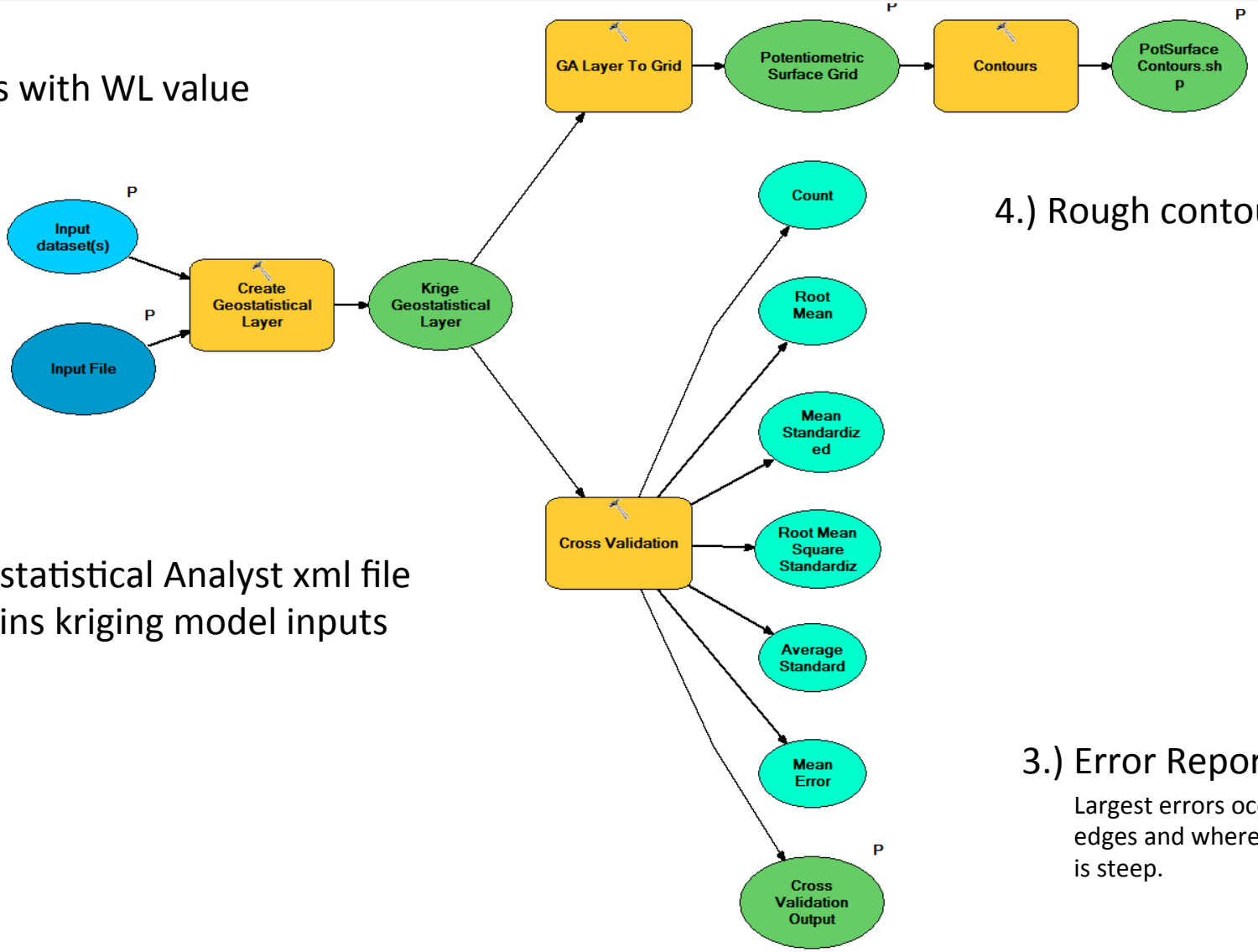
The benefit of kriging is generation of an error report and it's a good interpolator where data is sparse.

Potentiometric Surface Tool



Kriging to Contours

1.) Wells with WL value



2.) Geostatistical Analyst xml file
- Contains kriging model inputs

4.) Rough contours

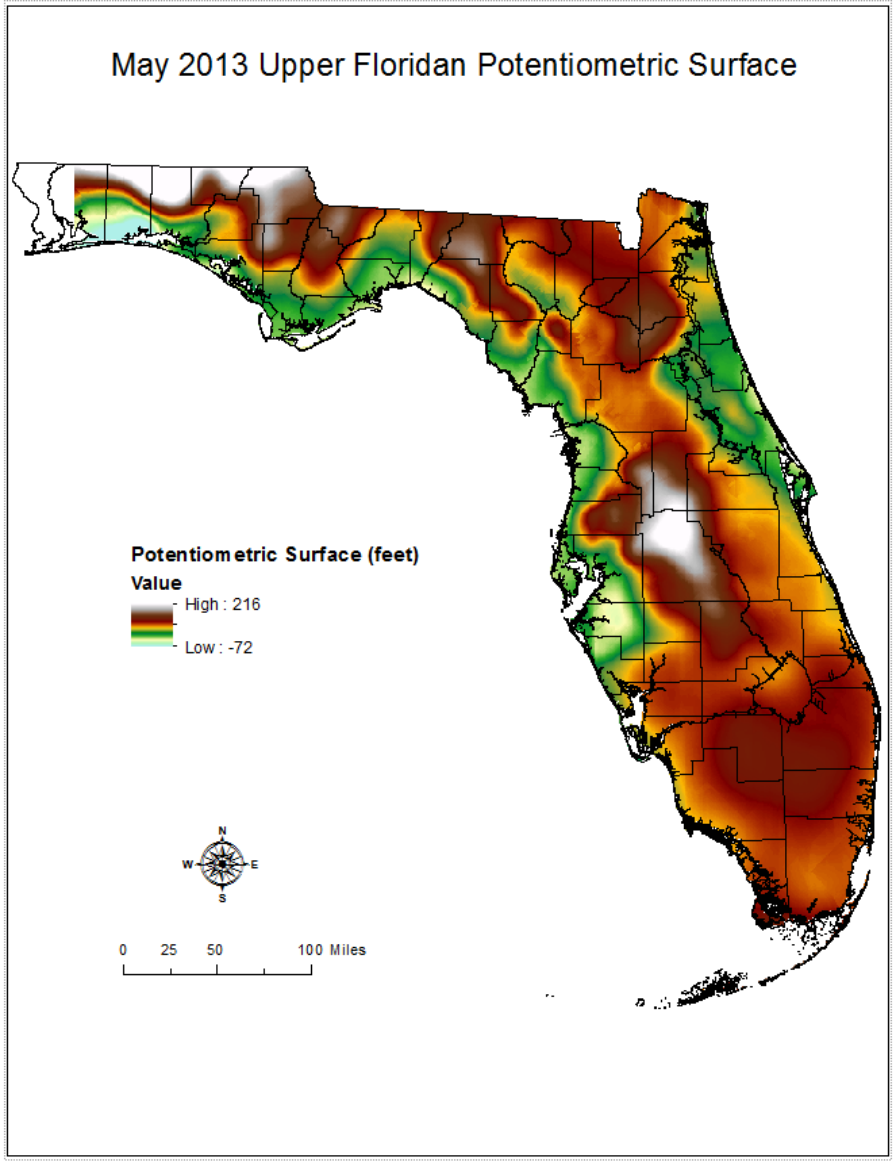
3.) Error Report

Largest errors occur along edges and where gradient is steep.

GA Layer to Grid

Geostatistical Analyst layer created from points used in the kriging process is converted to permanent grid.

- Automation provides a nice starting point for potentiometric surface
- Surface needs manual refinement



Error Report

Error report – shows difference between measured and predicted water level values.

Will be used to analyze surface creation results to improve model or **locations for new wells.**

<u>September 2012</u>

- 73% of predicted water level values are within 5 feet of measured value.

- 89% of predicted water level values are within 10 feet of measured values.

- Greatest errors occur where gradient changes rapidly and along edges of State.

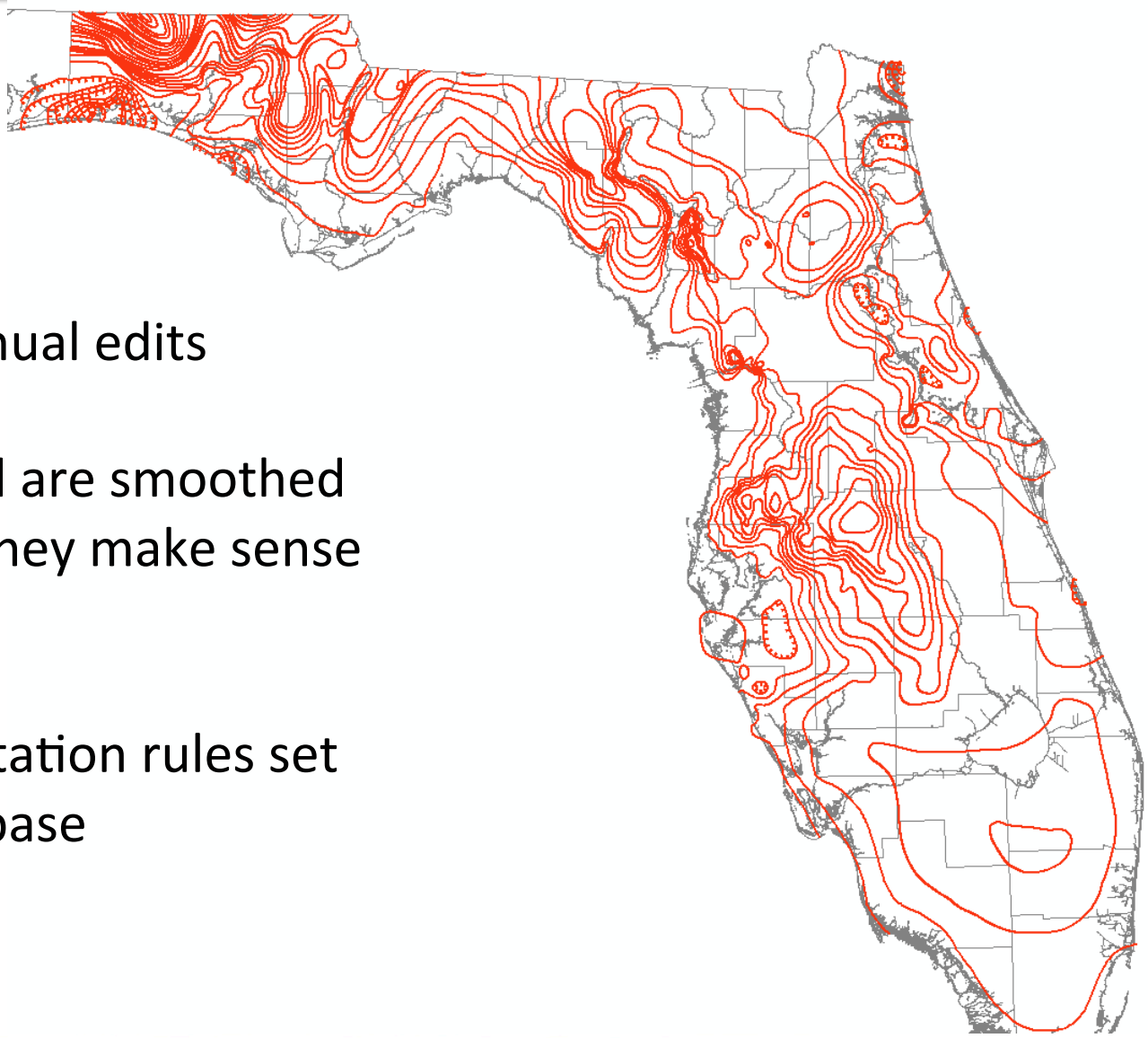
may2013_measured_cross_val

FID	Shape *	Measured	Predicted	Error	StdError	Stdd_Error	NormValue	Source_ID	Included
0	Point	57.61	49.611791	-7.998209	3.042209	-2.629079	-1.377013	0	Yes
1	Point	124.67	127.184776	2.514776	2.894722	0.868745	0.612033	1	Yes
2	Point	21.59	20.868365	-0.721635	2.910701	-0.247925	-0.182191	2	Yes
3	Point	34.73	31.133514	-3.596486	2.807011	-1.281251	-0.808212	3	Yes
4	Point	67.33	62.508185	-4.821815	2.557192	-1.88559	-1.05397	4	Yes
5	Point	44.61	43.922512	-0.687488	3.373475	-0.203792	-0.156434	5	Yes
6	Point	46.83	46.977552	0.147552	4.150104	0.035554	0.021929	6	Yes
7	Point	29.58	28.091948	-1.488052	3.334543	-0.446253	-0.352214	7	Yes
8	Point	1.66	2.187268	0.527268	2.711099	0.194485	0.135438	8	Yes
9	Point	3.53	2.842159	-0.687841	2.670726	-0.257548	-0.19629	9	Yes
10	Point	107.39	109.622489	2.232489	2.705639	0.825124	0.603704	10	Yes
11	Point	110.77	102.888715	-7.881285	2.62258	-3.005164	-1.452334	11	Yes
12	Point	14.48	11.898255	-2.581745	3.145075	-0.820885	-0.598174	12	Yes
13	Point	60.3	62.130116	1.830116	2.594797	0.705302	0.527846	13	Yes
14	Point	77.89	79.29722	1.40722	2.455359	0.573122	0.444698	14	Yes
15	Point	98.23	91.788955	-6.441045	3.019869	-2.132889	-1.188068	15	Yes
16	Point	100.51	92.388498	-8.121502	2.730296	-2.974586	-1.445739	16	Yes
17	Point	22.34	17.799115	-4.540885	2.544246	-1.784766	-1.018435	17	Yes
18	Point	69.92	59.518875	-10.401125	2.4258	-4.28771	-1.70886	18	Yes
19	Point	125.43	121.021807	-4.408193	3.164881	-1.392847	-0.853854	19	Yes
20	Point	123.21	108.00789	-15.20211	3.02848	-5.019716	-1.794433	20	Yes
21	Point	18.05	19.262181	1.212181	2.802926	0.43247	0.322892	21	Yes
22	Point	87.9	78.931931	-8.968069	2.630806	-3.408868	-1.522066	22	Yes
23	Point	-8.79	11.096379	19.886379	2.861331	6.950046	2.165012	23	Yes
24	Point	2.94	1.841048	-1.098952	2.57448	-0.426864	-0.335074	24	Yes
25	Point	59.75	61.355084	1.605084	3.448294	0.465472	0.349759	25	Yes
26	Point	34	36.10016	2.10016	2.99909	0.700266	0.519904	26	Yes
27	Point	56.32	57.338736	1.018736	3.034123	0.33576	0.257878	27	Yes
28	Point	34.24	33.432856	-0.807144	3.043266	-0.265223	-0.205711	28	Yes
29	Point	87.54	95.866669	8.326669	3.199371	2.602596	1.325266	29	Yes
30	Point	17.47	13.107442	-4.362558	3.108806	-1.40329	-0.857182	30	Yes
31	Point	14.17	14.154542	-0.015458	3.066502	-0.005041	-0.010387	31	Yes
32	Point	111.55	102.315582	-9.234418	2.956947	-3.122956	-1.465716	32	Yes
33	Point	46.43	46.457369	0.027369	3.338004	0.008199	-0.003462	33	Yes
34	Point	13.28	7.706392	-5.573608	2.687277	-2.074072	-1.142556	34	Yes
35	Point	88.33	84.206265	-4.123735	2.428743	-1.697889	-0.972965	35	Yes
36	Point	16.25	22.540879	6.290879	3.058955	2.056545	1.107782	36	Yes
37	Point	31.58	27.63911	-3.94089	2.551773	-1.544373	-0.908299	37	Yes
38	Point	38.8	36.778741	-2.021259	2.452699	-0.824096	-0.603704	38	Yes
39	Point	78.37	80.495547	2.125547	2.656537	0.80012	0.587169	39	Yes
40	Point	80.41	82.98795	2.57795	2.492929	1.034105	0.665822	40	Yes
41	Point	84.41	83.186186	-1.223814	2.742966	-0.446164	-0.349759	41	Yes
42	Point	77.61	79.11253	1.50253	2.656508	0.565603	0.419359	42	Yes
43	Point	44.69	44.837299	0.147299	3.881184	0.037952	0.024238	43	Yes
44	Point	40.36	41.302394	0.942394	2.506032	0.37605	0.277016	44	Yes
45	Point	22.07	23.138997	1.068997	2.369702	0.45111	0.335074	45	Yes
46	Point	21.91	23.51123	1.60123	2.372835	0.674817	0.504115	46	Yes
47	Point	21.3	19.333735	-1.966265	2.549192	-0.771329	-0.562662	47	Yes
48	Point	64.03	69.982956	5.952956	2.554111	2.330735	1.202211	48	Yes
49	Point	48.58	53.643957	5.063957	2.536349	1.996554	1.082556	49	Yes

Post Kriging Edit Rules

- Rivers intersecting the UFA follow the rule of V's
- Potentiometric surface contour line values do not exceed the topographic digital elevation model (DEM) in unconfined areas
- Potentiometric surface contour lines do not violate valid measured water level data

May 2013 Contours



Contour lines post manual edits

Lines created from grid are smoothed and checked to see if they make sense with WL data

Cartographic representation rules set and stored in geodatabase

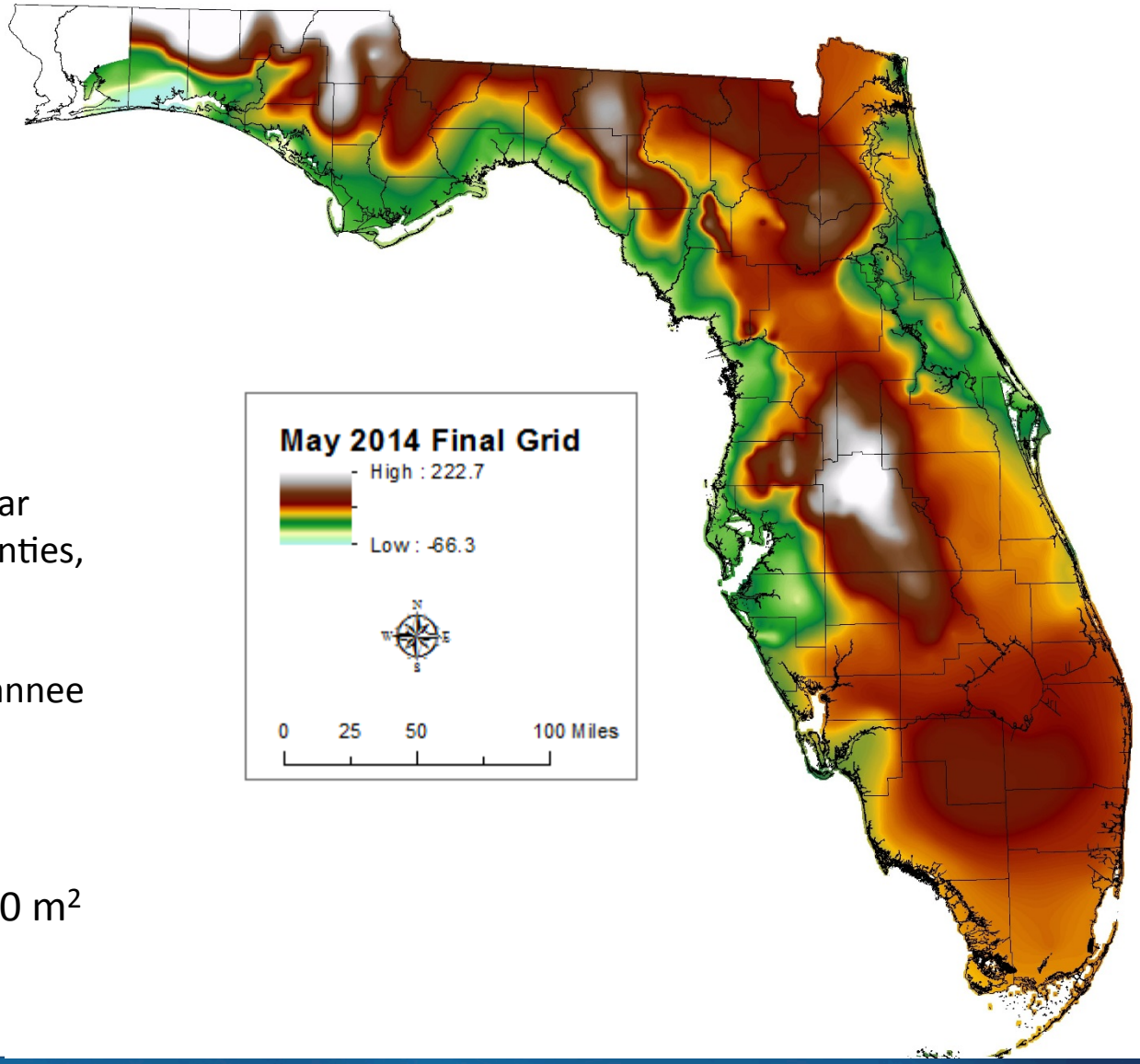
Final Raster Surface

May 2014 pot map raster

Data sources:

- May 2014 edited contour lines.
- May 2014 well water level values.
- Estimated zero contour placed near shoreline (Wakulla to Pinellas counties, Volusia County).
- Estimated river values along Suwannee River.

Topo to Raster tool to create 500 m^2 Raster.



Data Sharing

FDEP ArcGIS Online projects

http://fdep.maps.arcgis.com/home/

FDEP Geospatial Open Data Portal

http://geodata.dep.state.fl.us/

FDEP GeoData Directory

http://www.dep.state.fl.us/gis/datadir.htm

Shiny App coming soon…

Contact

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