



Development of a Virtual Geotechnical Database System to Store and Retrieve Subsurface Information

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Agenda

- ◆ Overview
- ◆ Process
 - Acquiring Geodata
 - Formatting Geodata
- ◆ Applications: Manipulations of database information
- ◆ Conclusions



Why have a VGDB?

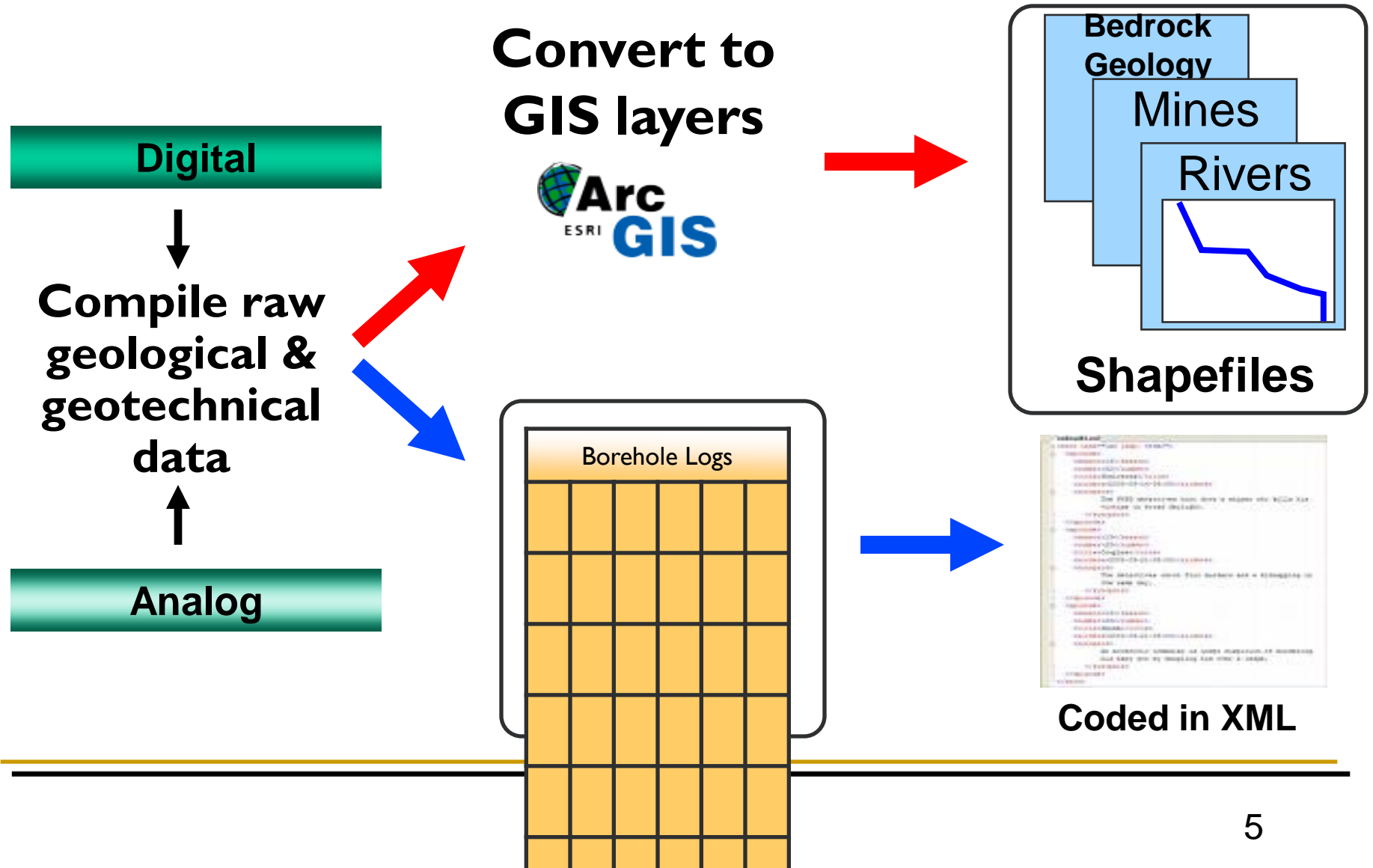
- ◆ Need for **easy access** of existing geologic and geotechnical data useful for **assessing vulnerability** of underground facilities, groundwater, and environmental conditions
- ◆ Need for **up-to-date information**, such as expected subsurface conditions, physical properties, depth-to-groundwater, which can easily be updated and shared with end users



Broader Motivation

Department of Defense agencies need accurate geodata for:

- navigation
- target evaluation
- environmental sustainability
- resource assessment
- prediction of site conditions



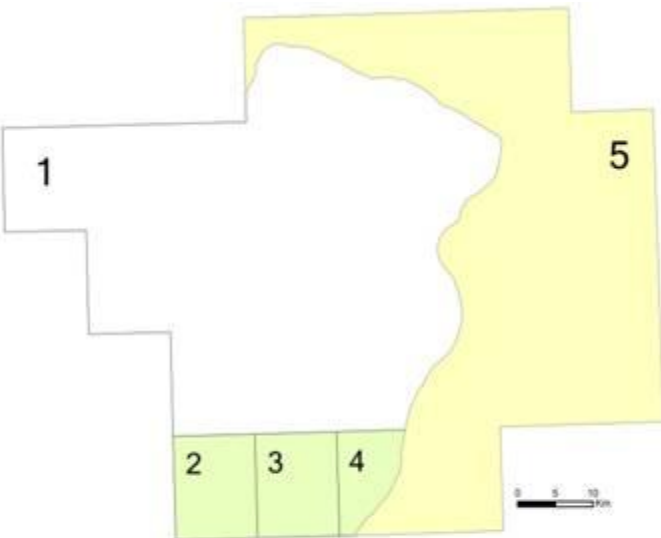


ACQUIRING GEODATA

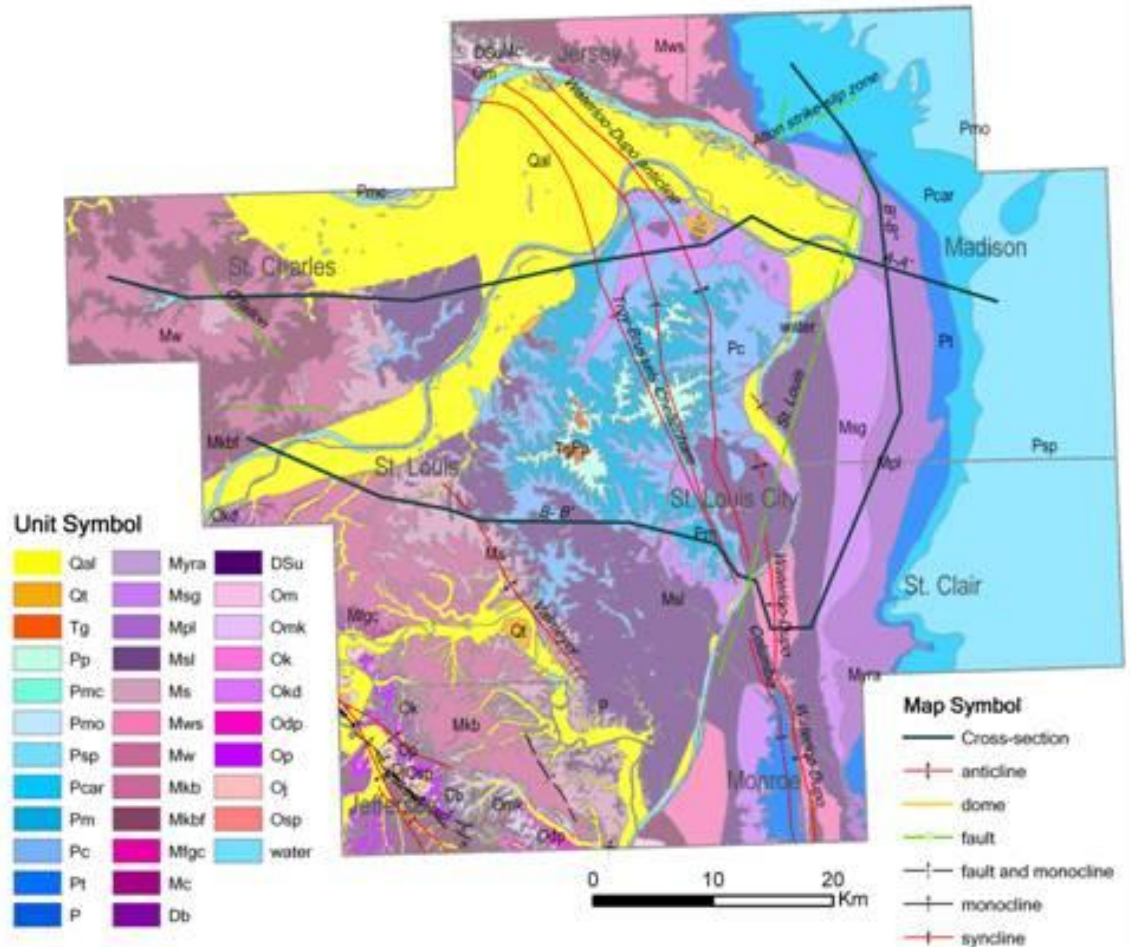


BEDROCK GEOLOGY & SURFICIAL MATERIALS

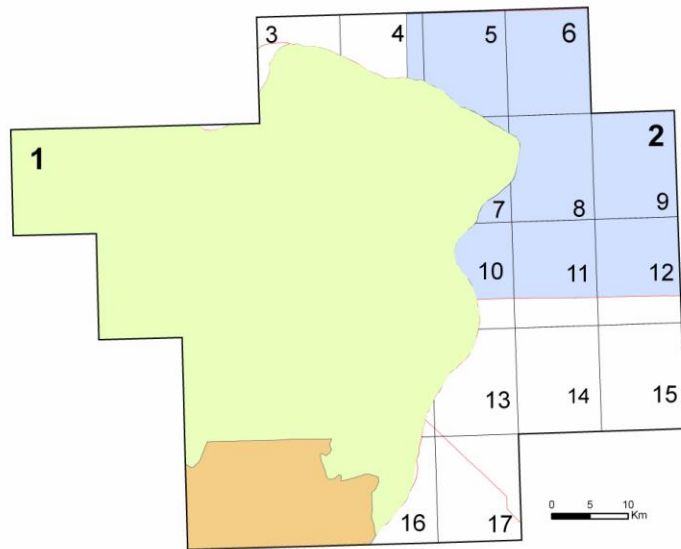
Bedrock Geology



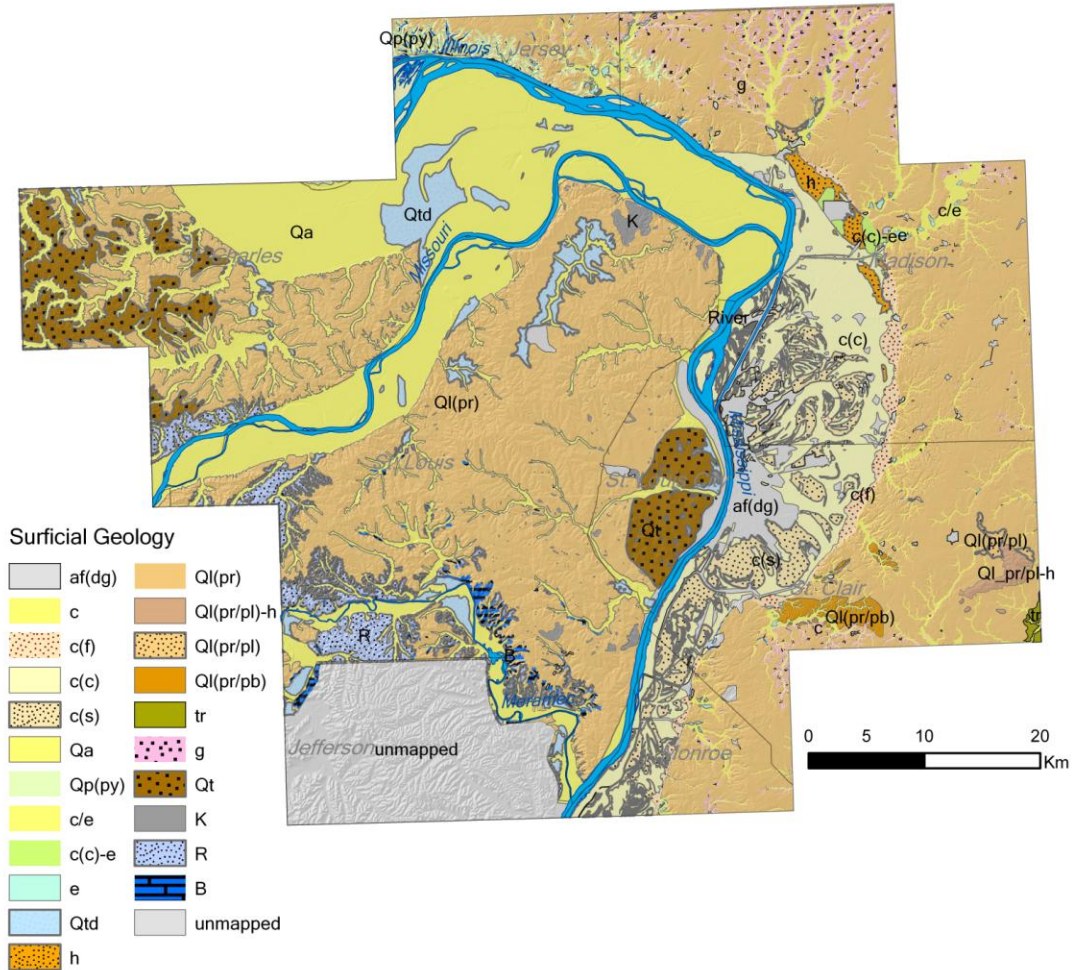
1. Harrison (1997), scale 1:100,000
2. Whitfield (2002), scale 1:24,000
3. Stincomb and Fellows (2002), scale 1:24,000
4. Middendorf and Brill (2002), scale 1:24,000
5. Kolata (2005), scale 1:500,000



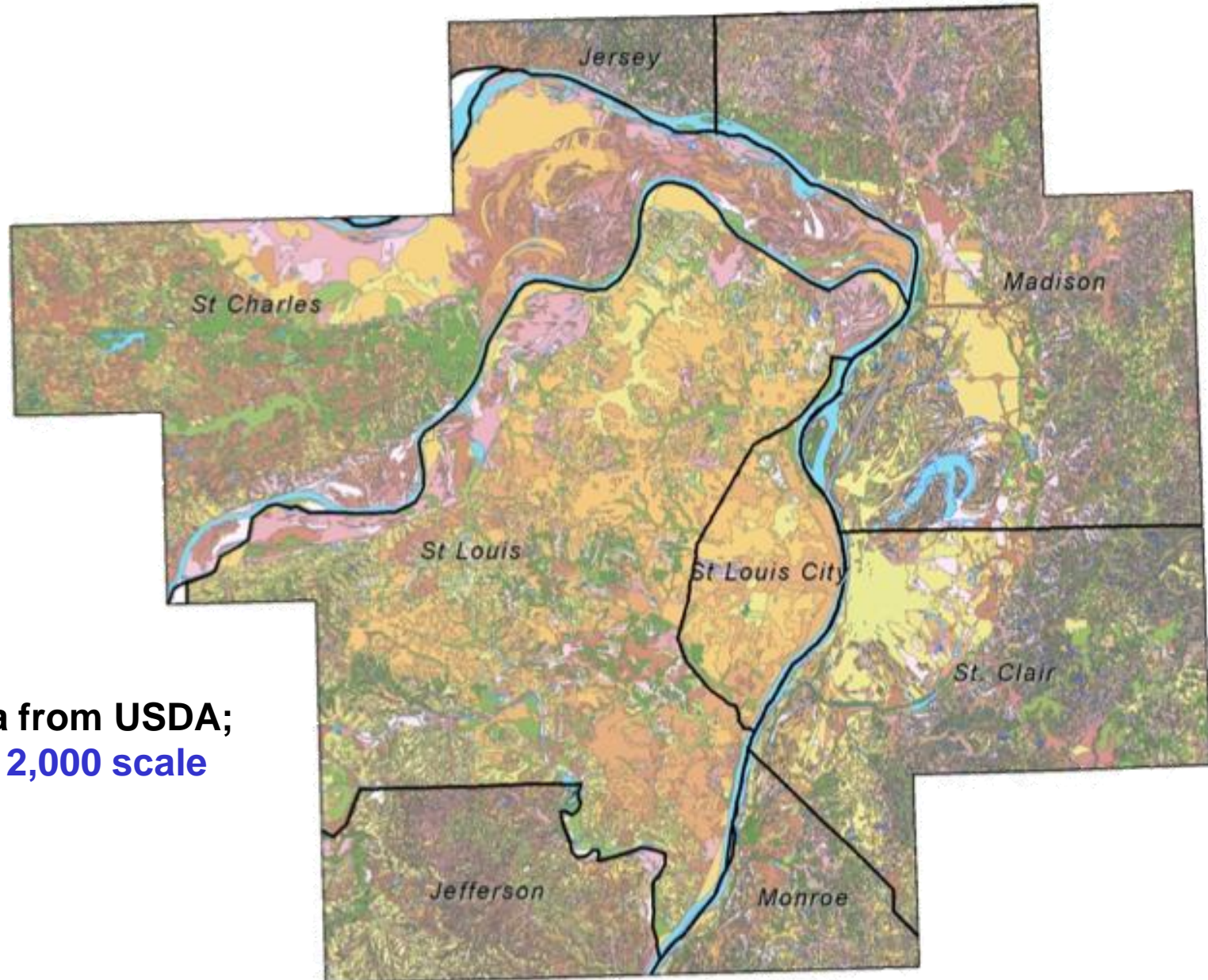
Surficial Materials



1. Schultz (1993), scale 1:100,000
2. Grimley and Phillips (2006), scale 1:100,000
3. Grimley and McKay (1999), scale 1:24,000
4. Grimley (2002), scale 1:24,000
5. Grimley (1999), scale 1: 24,000
6. Grimley (2005), scale 1:24,000
7. Unknown, scale 1:24,000
8. Grimley and Lepley (2005), scale 1:24,000
9. Phillips (2003), scale 1:24,000
10. Phillips et al (in review), scale 1:24,000
11. Grimley et al (in review), scale 1:24,000
12. Phillips (2004), scale 1:24,000
13. Unknown, scale 1:24,000
14. Grimley (2004), scale 1:24,000
15. Grimley (unpublished), scale 1:24,000
16. Devera (unpublished), scale 1:24,000
17. Grimley (unpublished), scale 1:24,000



Composite Soils Map



Data from USDA;
1:12,000 scale

Hyperlink Soils Info

Engineering Properties

St Clair County, Illinois

[Absence of an entry indicates that the data were not estimated]

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percent passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 Inches	3-10 Inches	4	10	40	200		
	<i>in</i>				<i>Pct</i>	<i>Pct</i>					<i>Pct</i>	
79B:												
Menfro	0-10	Silt loam	CL	A-6	0	0	100	100	95-100	90-100	29-43	12-18
	10-62	Silty clay loam, silt loam	CL	A-6, A-7	0	0	100	100	95-100	95-100	34-47	16-25
	62-80	Silty clay loam, silt loam	CL, CL-ML	A-4, A-6	0	0	100	100	95-100	90-100	25-40	9-21
79C2:												
Menfro	0-7	Silt loam	CL	A-6	0	0	100	100	95-100	90-100	28-41	12-19
	7-56	Silty clay loam, silt loam	CL	A-6, A-7	0	0	100	100	95-100	95-100	34-47	16-25
	56-80	Silty clay loam, silt loam	CL, CL-ML	A-4, A-6	0	0	100	100	95-100	90-100	25-40	9-21
79C3:												
Menfro	0-5	Silty clay loam	CL	A-6	0	0	100	100	95-100	90-100	35-45	15-25
	5-50	Silty clay loam, silt loam	CL	A-6, A-7	0	0	100	100	95-100	95-100	35-45	15-25
	50-80	Silty clay loam, silt loam	CL, CL-ML	A-4, A-6	0	0	100	100	95-100	90-100	25-40	5-20
79D2:												
Menfro	0-7	Silt loam	CL	A-6	0	0	100	100	95-100	90-100	30-35	10-15
	7-56	Silty clay loam, silt loam	CL	A-6, A-7	0	0	100	100	95-100	95-100	35-45	15-25
	56-80	Silty clay loam, silt loam	CL, CL-ML	A-4, A-6	0	0	100	100	95-100	90-100	25-40	10-20

PDF of
Engineering
Properties

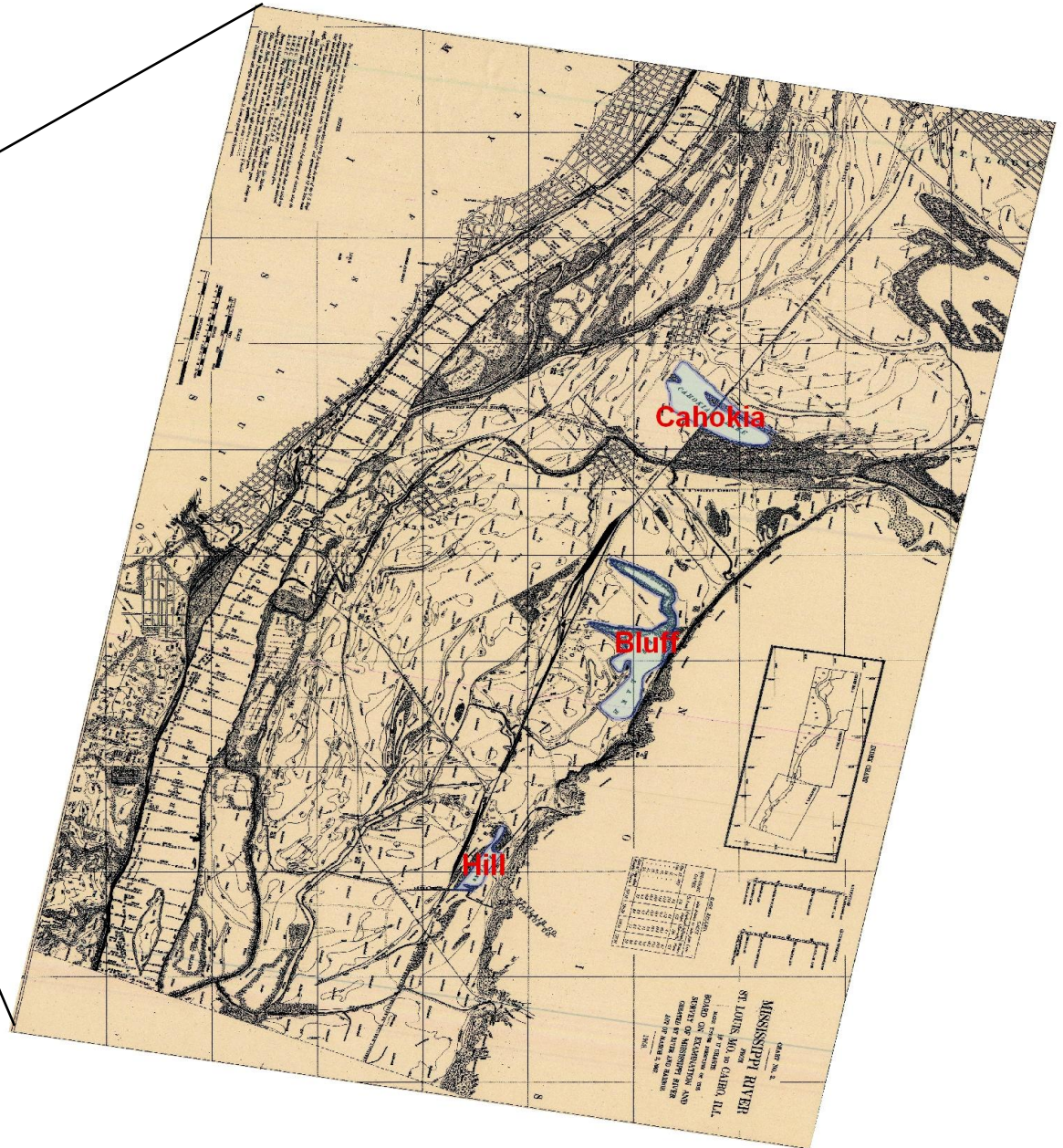
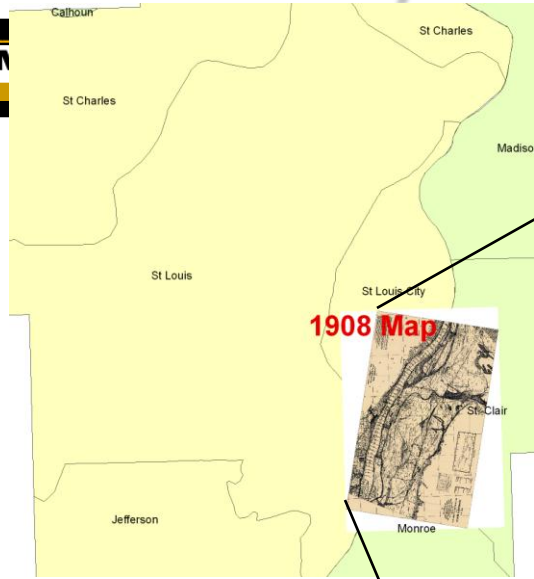


HISTORIC MAPS



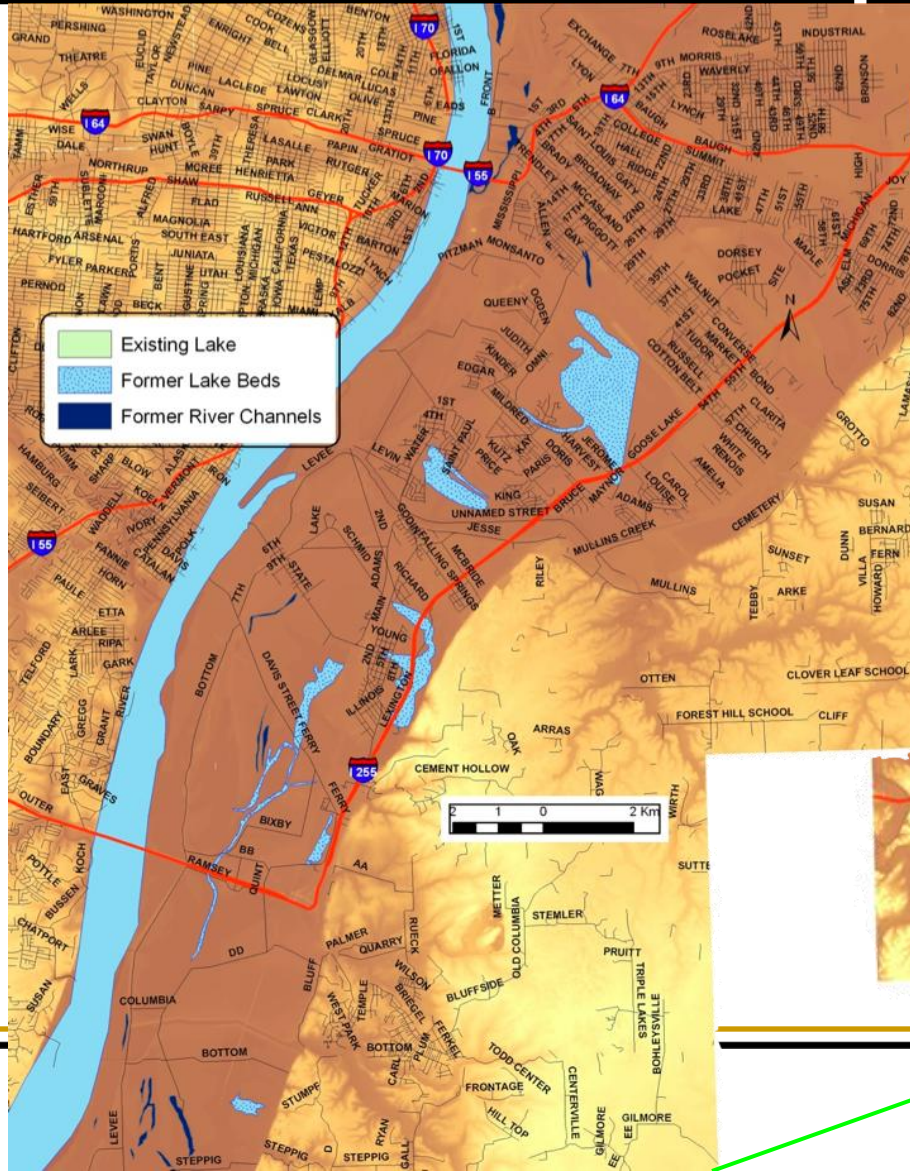
1796 map of St Louis area; note large oxbow lakes in flood plain

Overlay of 1908 Mississippi River Map

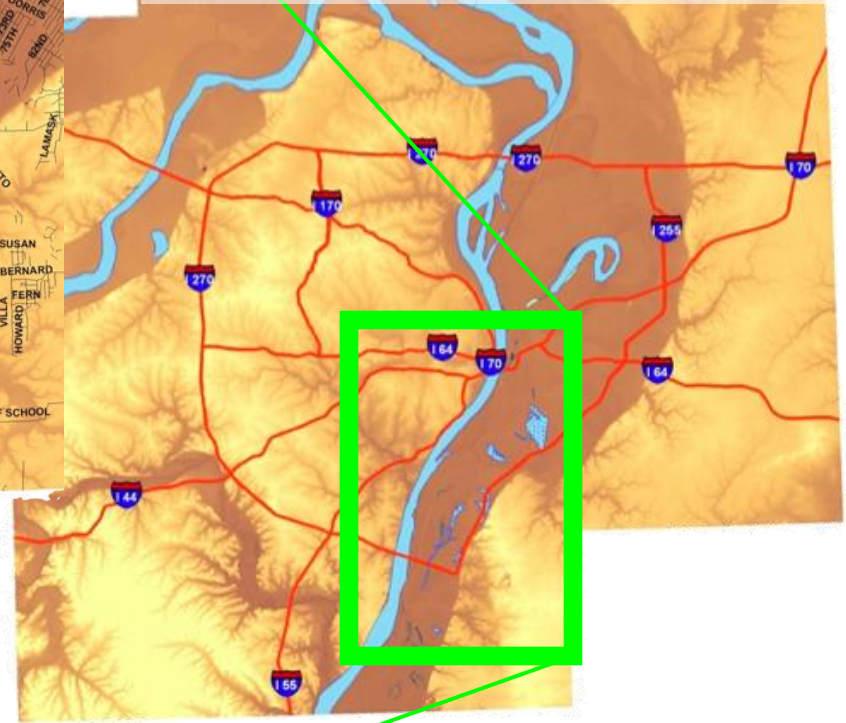


**Overlay
information on
historic maps –
in this case, old
oxbow lakes and
cutoffs that have
since been
infilled**

Overlay of 1908 Map on Current Data

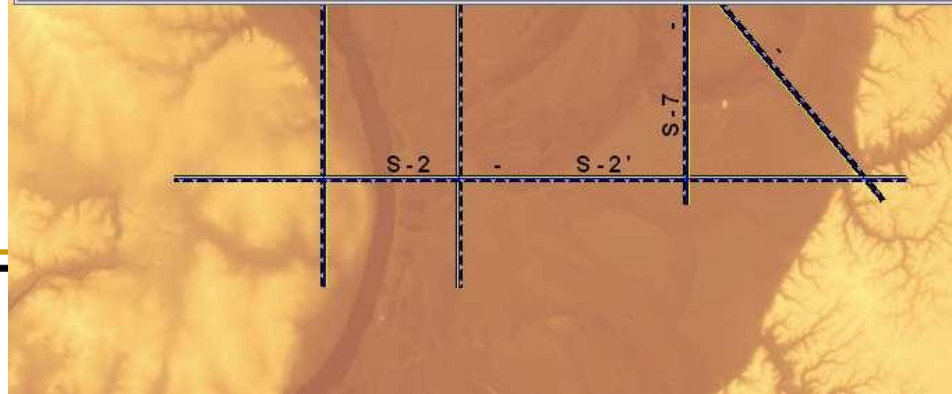
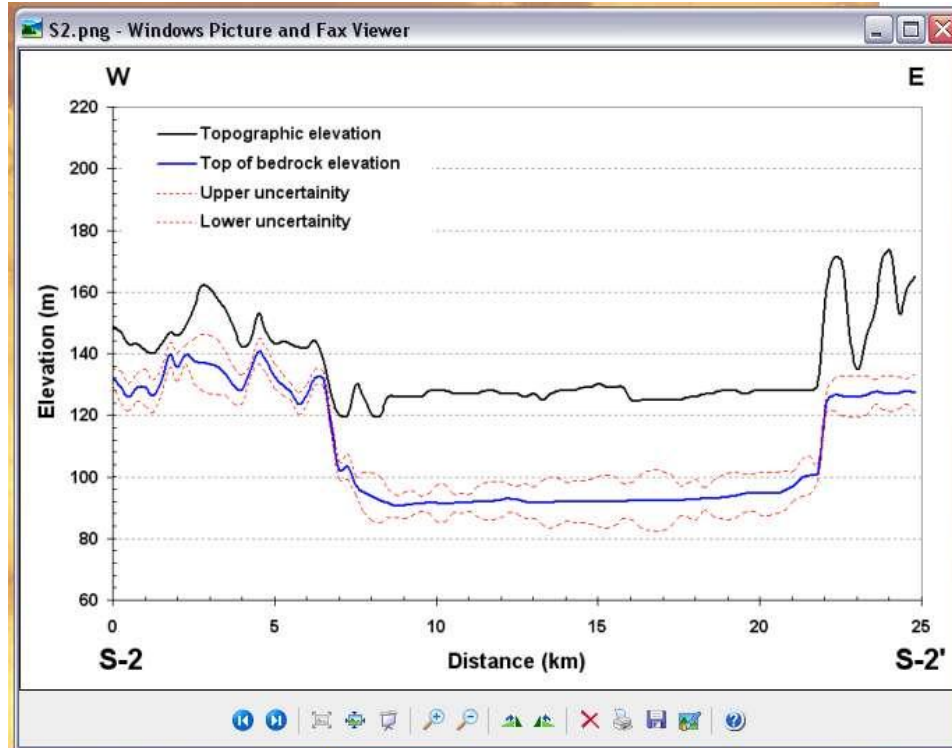


Lakes identified on 1908 map have been filled in and covered by development.





CROSS SECTIONS



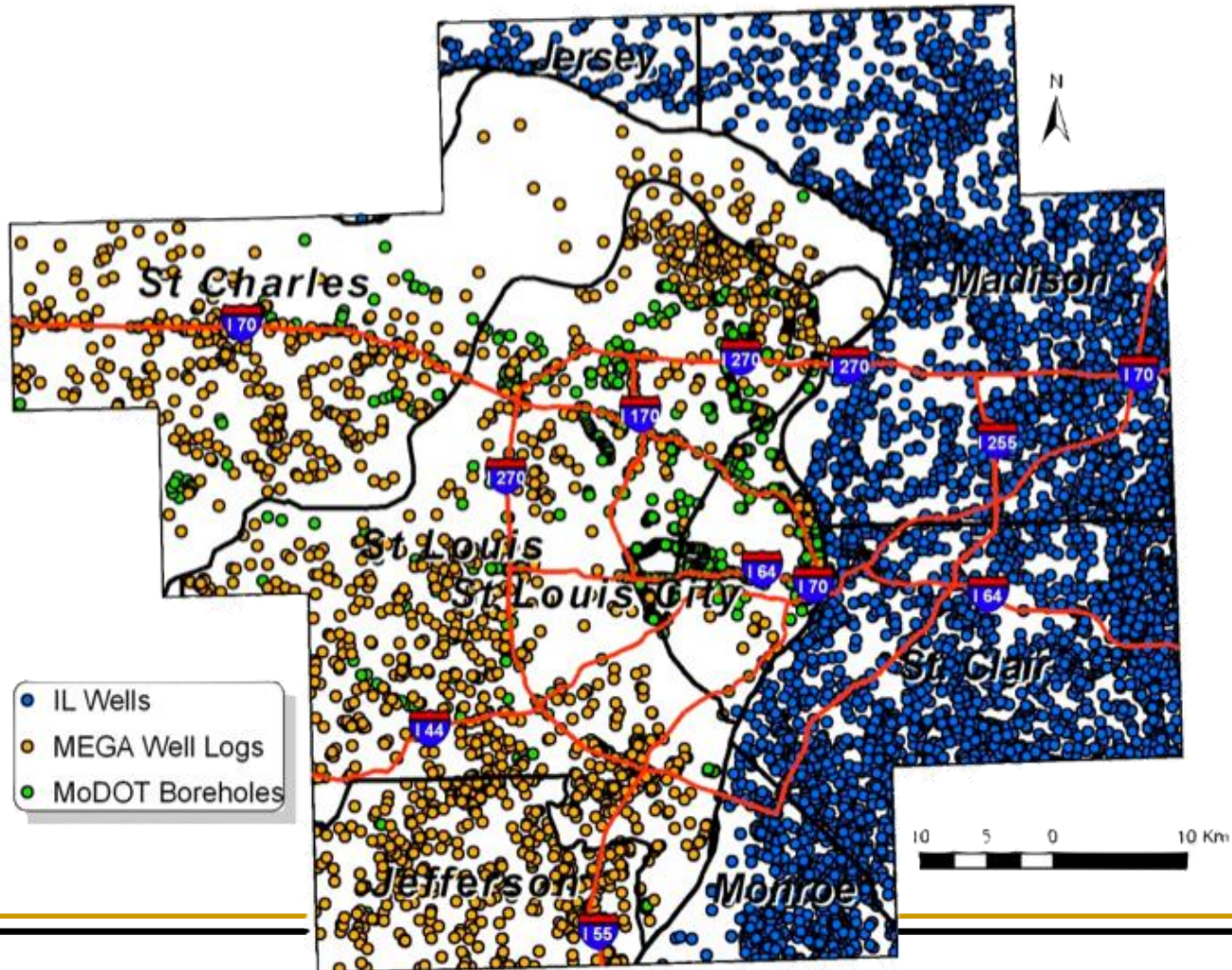


GEO TECHNICAL BORINGS



Borehole data in Excel spreadsheet

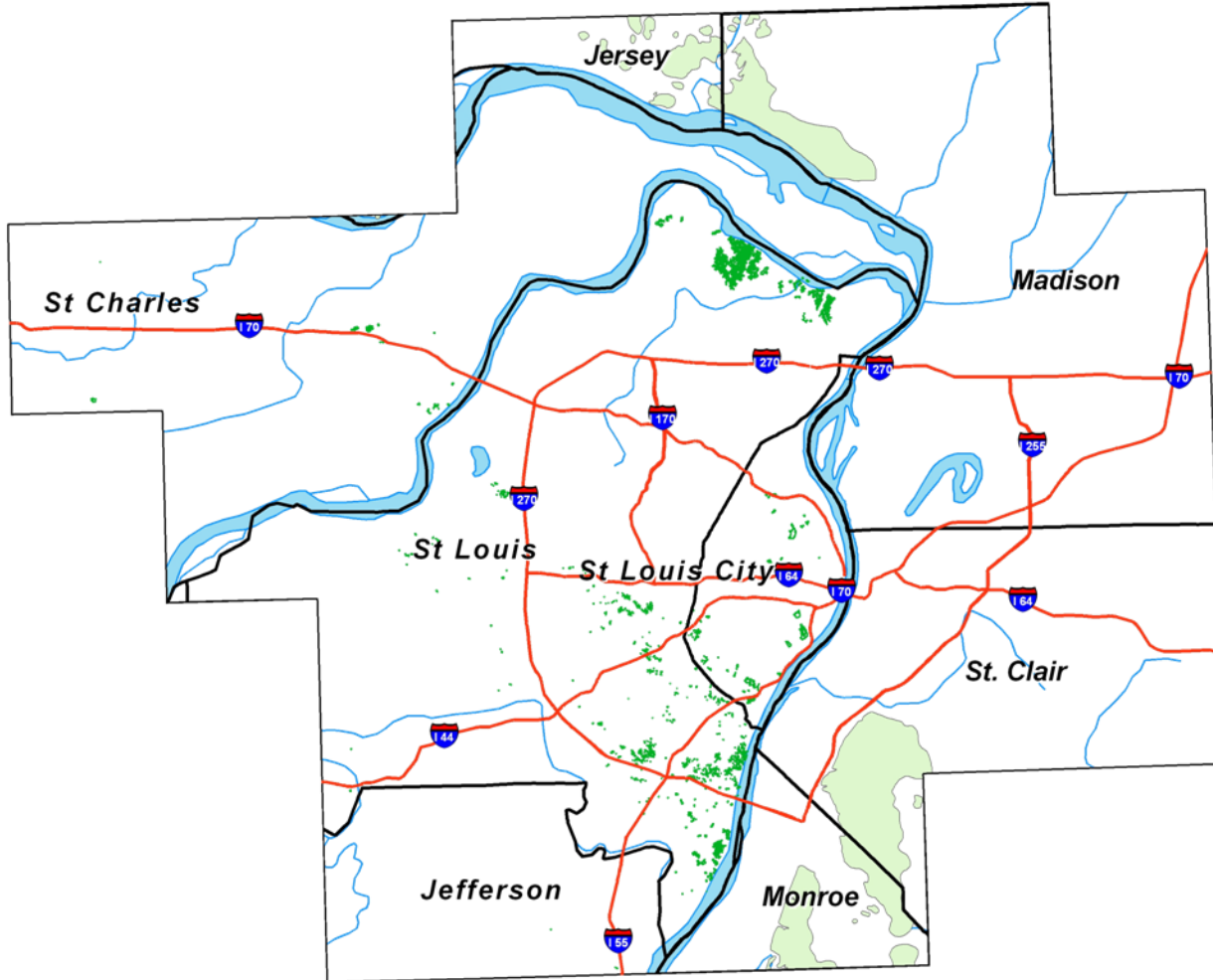
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	api	latitude	longitude	UTM 15_N83_X	UTM15_N83_Y	lamx	lamy	td	sect	twp	tdir	rng	rdir	nsf	nsdir
2	121192772200	38.990684	90.05987	754640	4319861	2841726	2173419	28	12	6 N		9 W		2000	N
3	121192700200	38.887035	90.168782	745563	4308057	2810661	2136084	63	13	5 N		10 W		0	
4	121192772300	38.990684	90.05987	754640	4319861	2841726	2173419	19	12	6 N		9 W		2000	N
5	121192700100	38.887035	90.168782	745563	4308057	2810661	2136084	69	13	5 N		10 W		0	
6	121192772100	38.990684	90.05987	754640	4319861	2841726	2173419	27	12	6 N		9 W		2000	N
7	121192772400	38.990684	90.05987	754640	4319861	2841726	2173419	35	12	6 N		9 W		2000	N
8	121192653700	38.79997	90.034284	757546	4298764	2848553	2104296	56	18	4 N		8 W		1400	S
9	121192653400	38.79997	90.034284	757546	4298764	2848553	2104296	56	18	4 N		8 W		1400	S
10	121192653500	38.79997	90.034284	757546	4298764	2848553	2104296	56	18	4 N		8 W		1400	S
11	121192822600	38.779319	90.003328	760310	4296559	2857286	2096766	40	20	4 N		8 W		1800	S
12	121332238500	38.385297	90.256454	739623	4252136	2784328	1954548	28	6	2 S		10 W		0	
13	121332238600	38.385297	90.256454	739623	4252136	2784328	1954548	26	6	2 S		10 W		0	
14	121192808700	38.831107	89.996329	239894	4302307	2859373	2115513	80	4	4 N		8 W		0	
15	121192808600	38.831107	89.996329	239894	4302307	2859373	2115513	35	4	4 N		8 W		0	
16	121192808800	38.831107	89.996329	239894	4302307	2859373	2115513	40	4	4 N		8 W		0	
17	121632861600	38.623844	90.171873	746198	4278836	2809081	2040761	130	14	2 N		10 W		0	
18	121190221300	38.721131	90.155587	747281	4289678	2813963	2075965	66	12	3 N		10 W		1100	S
19	121192647300	38.721131	90.155587	747281	4289678	2813963	2075965	61	12	3 N		10 W		1100	S
20	121192647200	38.721131	90.155587	747281	4289678	2813963	2075965	66	12	3 N		10 W		1100	S
21	121192647500	38.721131	90.155587	747281	4289678	2813963	2075965	66	12	3 N		10 W		1100	S
22	121632871500	38.612713	90.167898	746582	4277611	2810181	2036721	120	23	2 N		10 W		0	
23	121632871300	38.612713	90.167898	746582	4277611	2810181	2036721	131	23	2 N		10 W		0	
24	121632869900	38.609094	90.172519	746192	4277197	2808858	2035420	71	23	2 N		10 W		0	
25	121632872400	38.605429	90.167946	746603	4276803	2810148	2034083	120	23	2 N		10 W		0	
26	121192668400	38.762041	90.150287	747601	4294233	2815573	2090772	51	25	4 N		10 W		0	N
27	121630290100	38.618868	90.069488	755131	4278564	2838163	2038760	72	14	2 N		9 W		0	
28	121632871600	38.612713	90.167898	746582	4277611	2810181	2036721	118	23	2 N		10 W		0	
29	121632903700	38.575023	90.111199	751652	4273582	2826203	2022956	100	32	2 N		9 W		0	
30	121632884900	38.5778	90.11232	751545	4273887	2825891	2023964	100	32	2 N		9 W		0	
31	121632871800	38.612713	90.167898	746582	4277611	2810181	2036721	136	23	2 N		10 W		0	
32	121632885000	38.5778	90.11232	751545	4273887	2825891	2023964	100	32	2 N		9 W		0	
33	121632833800	38.509428	90.204787	743719	4266049	2799407	1999390	72	28	1 N		10 W		0	
34	121632833900	38.509428	90.204787	743719	4266049	2799407	1999390	72	28	1 N		10 W		0	





KARST FEATURES

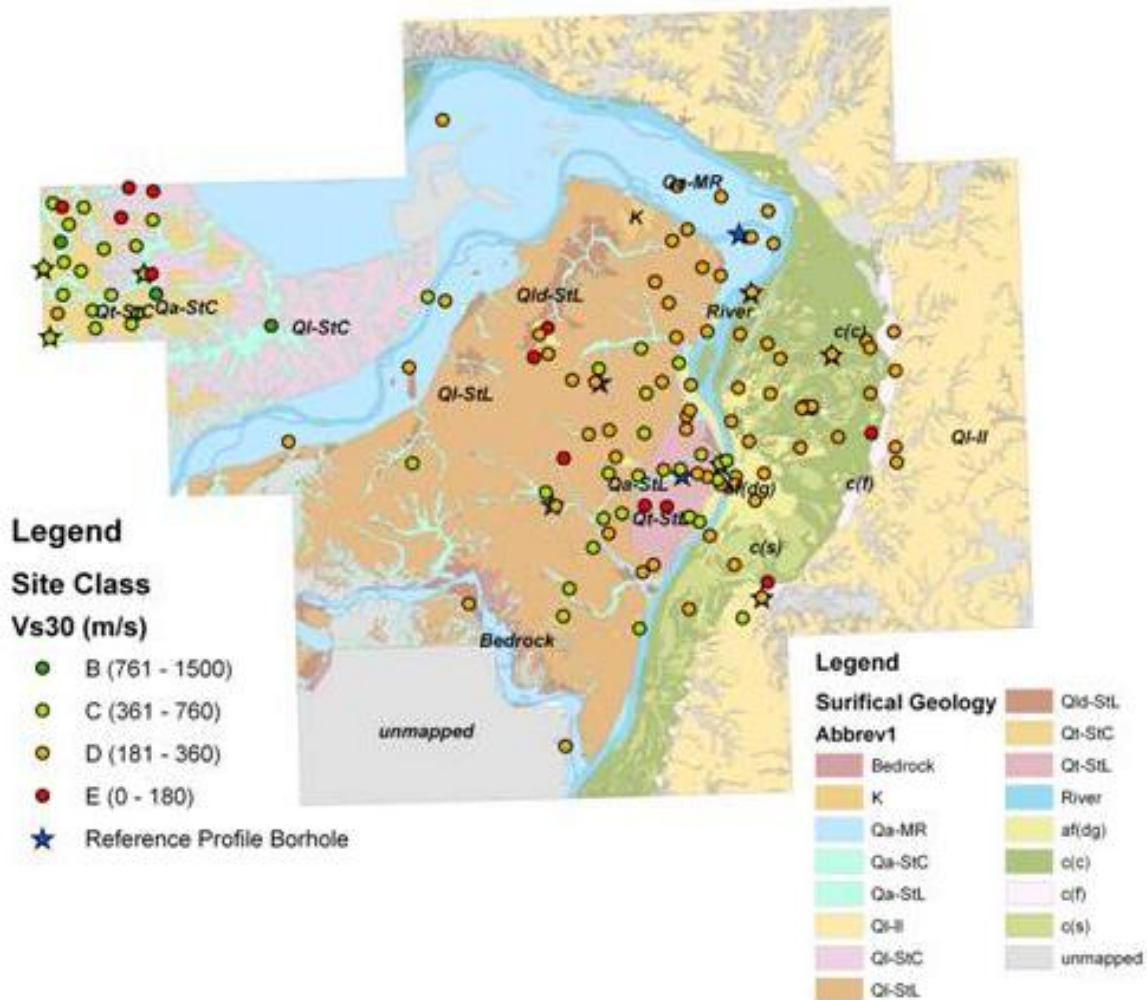
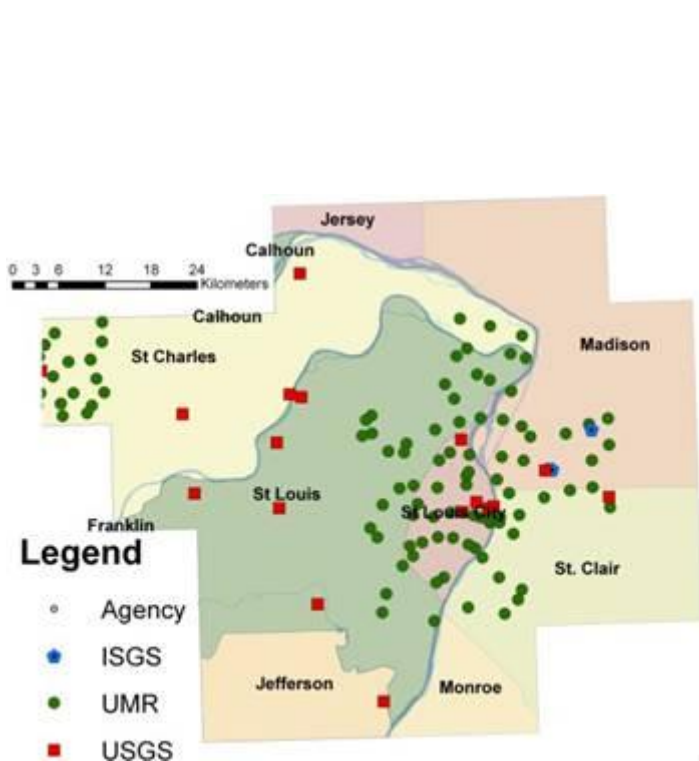
Sinkholes



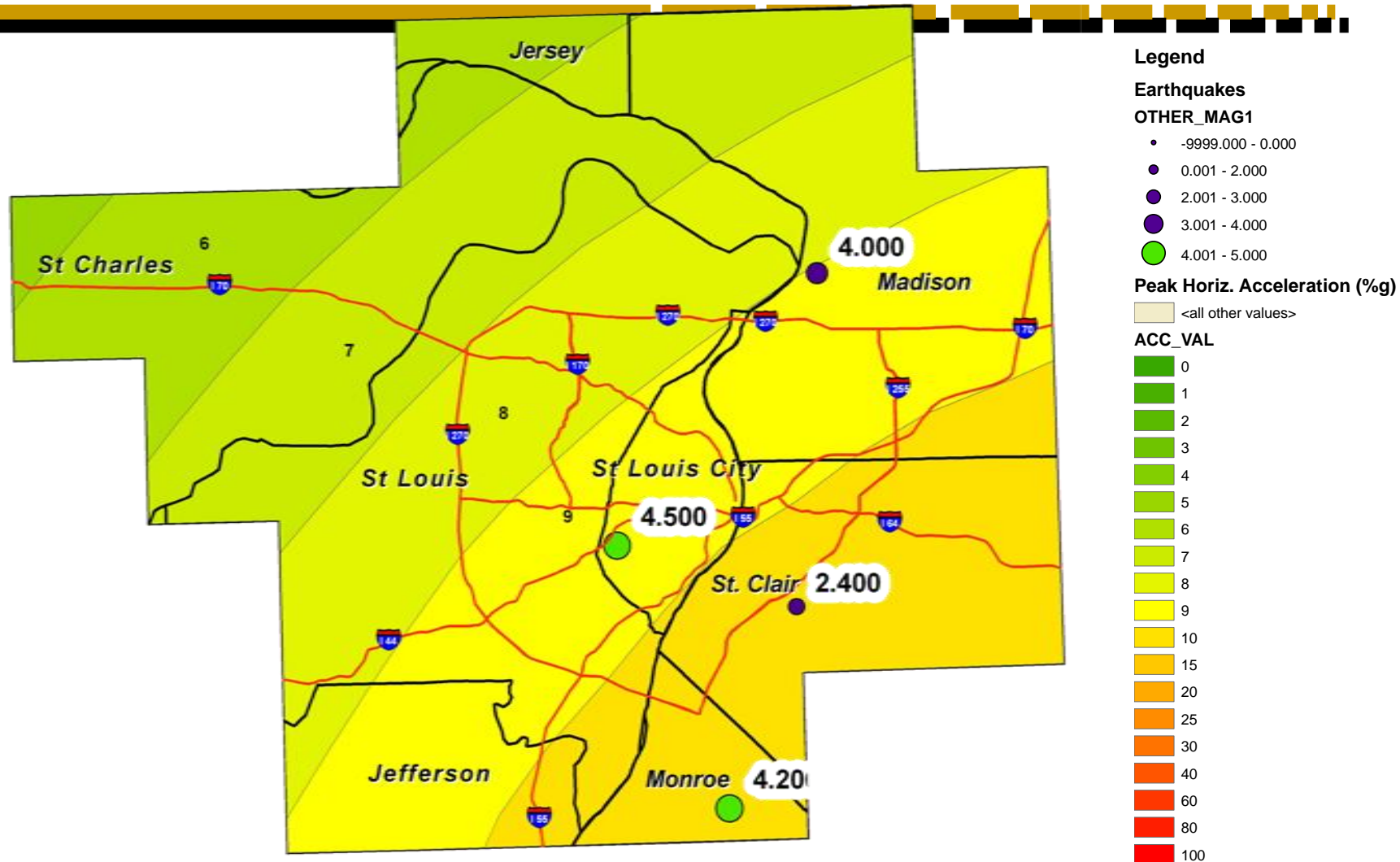


GEOPHYSICAL INFORMATION

Shear Wave Velocity (V_s) and Surficial Geology



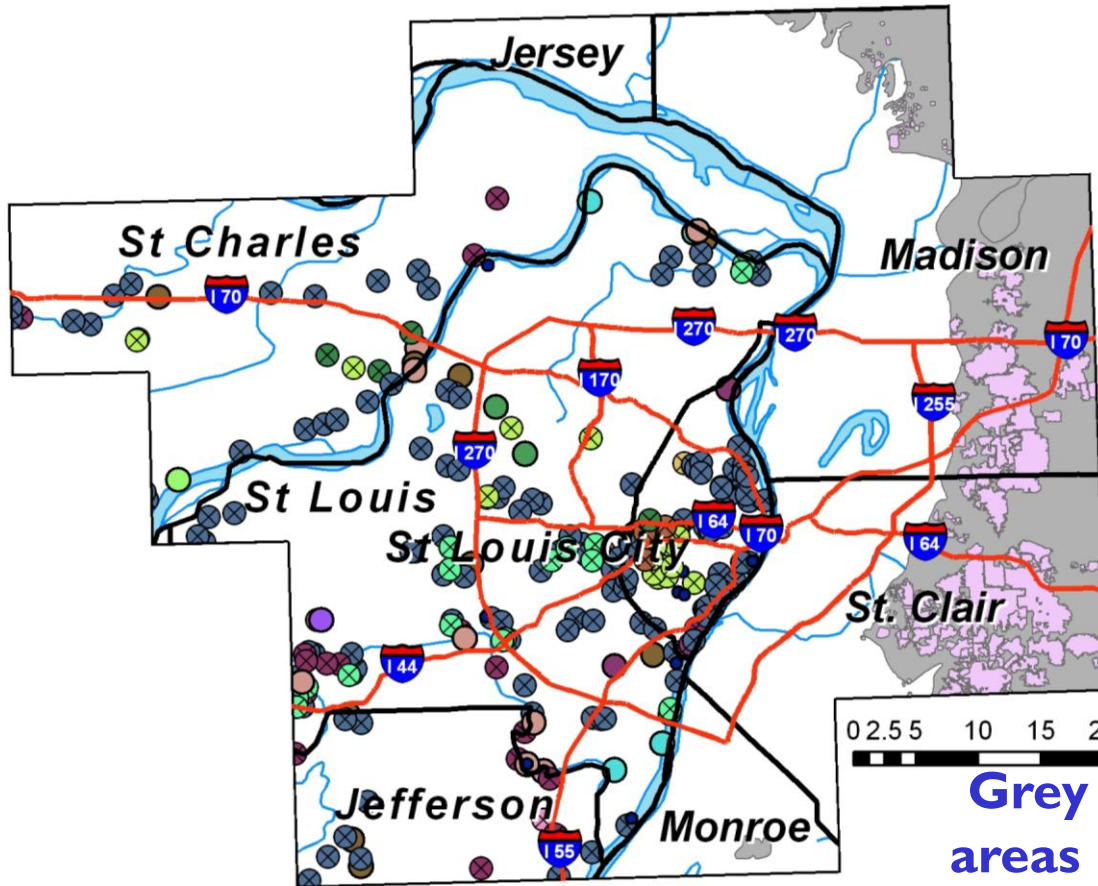
Peak Horizontal Accelerations from New Madrid Seismic Zone





HUMAN ACTIVITY

Mines



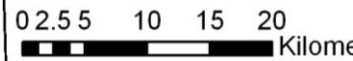
Legend

MO Mines

● <all other values>

COMMODITY, STATUS

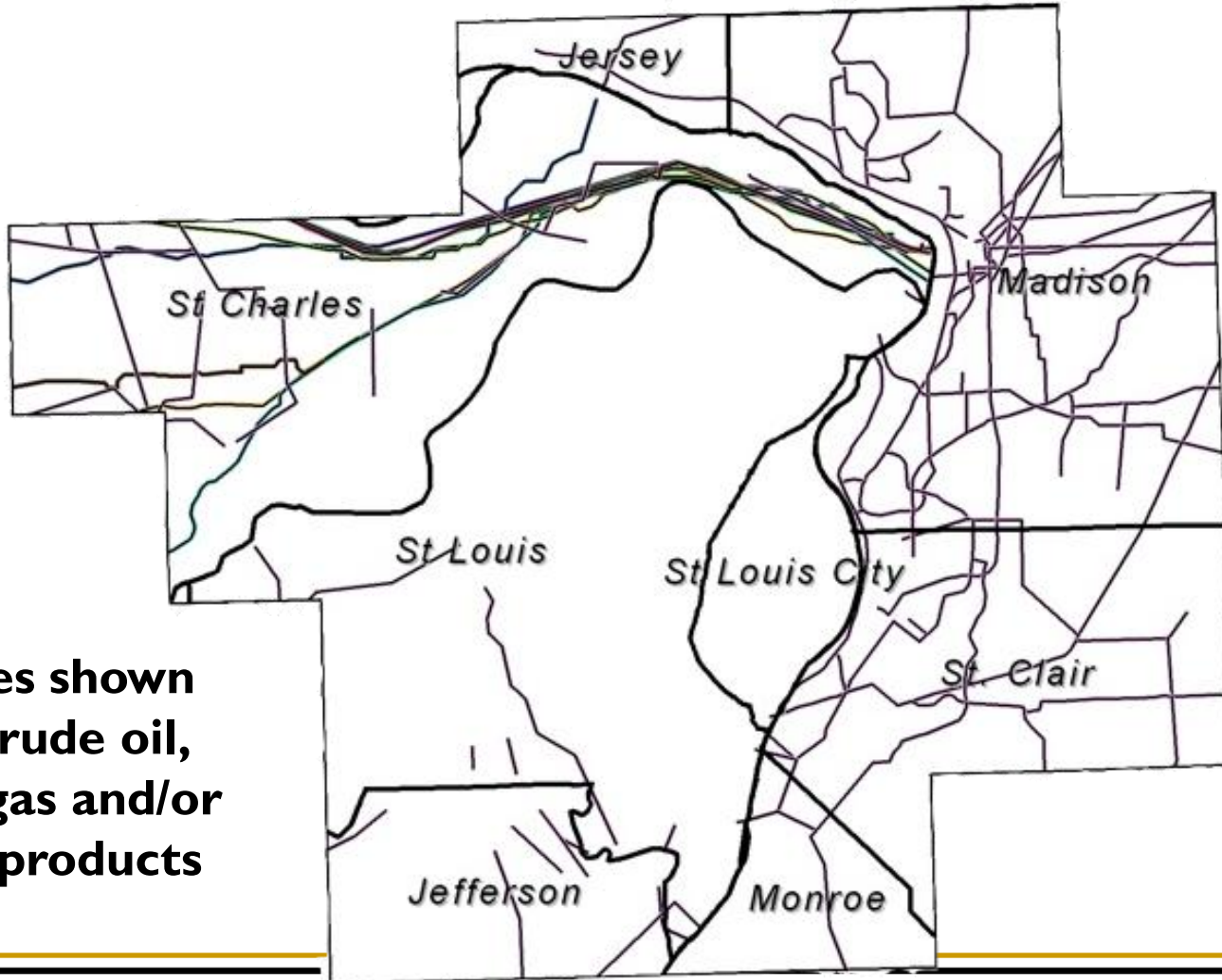
- Barium, Past Producer
- Clay, Past Producer
- Clay, Producer
- Clay-fire, Past Producer
- Clay-refractory, Past Producer
- Clay-refractory, Producer
- Coal, Past Producer
- Coal, Producer
- Lead, Past Producer
- Lead, Producer
- Limestone cb, Other
- Limestone cb, Past Producer
- Limestone cb, Producer
- Limestone cb; Clay, Past Producer
- Limestone cb; Clay, Producer
- Limestone, Past Producer
- Limestone, Producer
- Mica Schist dm,
- Perlite, Producer
- Sand & Gravel, Past Producer
- Sand & Gravel, Producer
- Sandstone cb, Past Producer
- Sandstone cb, Producer
- Silica, Past Producer
- Silica, Producer
- Mined Areas
- IL Coal



Grey areas underlain by coal; pink areas underlain by mines on IL side

Circles with X's indicate abandoned mines on MO side

Pipelines



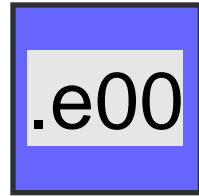
**Pipelines shown
carry crude oil,
natural gas and/or
refined products**



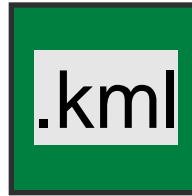
FORMATTING GEODATA

Formatting: ArcGIS

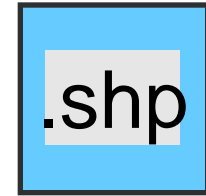
- ◆ File type



ArcInfo



Google Earth



Shapefile

- ◆ Projection - NAD 1983 Datum
- ◆ Attribute tables

Formatting: XML

- ◆ Data Interchange for Geotechnical and Geoenvironmental Specialists (DIGGS) Standard
- ◆ Used by:



12 state DOTs

Metadata

- ◆ Data about data
 - Source
 - Map scale
 - Method of acquiring data
- ◆ Must follow Federal Geographic Data Committee standards

Data Dictionary

MoDOT
Struc_Id
BH_Id
FHoleElev
FDepth
FSampEl
Blows_2
Blows_3
Nm
Em
Ne_N60
PP
Torvane
Qu_psf
c_psf
phi_angle
Cc
Cv_e
P1_e
Pc_e
P2_e
e0
ec
e2
LL
PI
ASTM_class
Wn_percent
EDryWt
DryWtMeth
Comment
Xutm_point
Yutm_point

MEGA
ID
WELL_TYPE
OWNER
DRLDATE
DRILLDEPTH
DEPTHTOBED
SWLA
ELEVATION
TOP
BASE
NAME
UNIT_1
TOP
BASE
NAME
UNIT_2
TOP
BASE
NAME

ISGS
api
UTM 15_N83_X
UTM15_N83_Y
elev
elevref
cdate
st
fname
fnum
cname
permitnum
permitdate
project
bridge
route
station
offset
surface_water_elev
gwater_compl
gwater_final
gwater_time
metric

Heading	Description	Example
base	Measured depth or distance to the base of Layer. If the depth is unknown because it occurs below the depth of investigation, set to the base of the hole. If Layer is a point depthBase should be set equal to depthTop, or depthBase may be left blank.	1.6
baseBoundary	A description of the Boundary at the bottom of this layer	
reference	Stratum Reference	A
classifications	Classification of this Layer	
components	Components of this Layer	
descriptions	A description of the Layer within the context of the descriptive system	

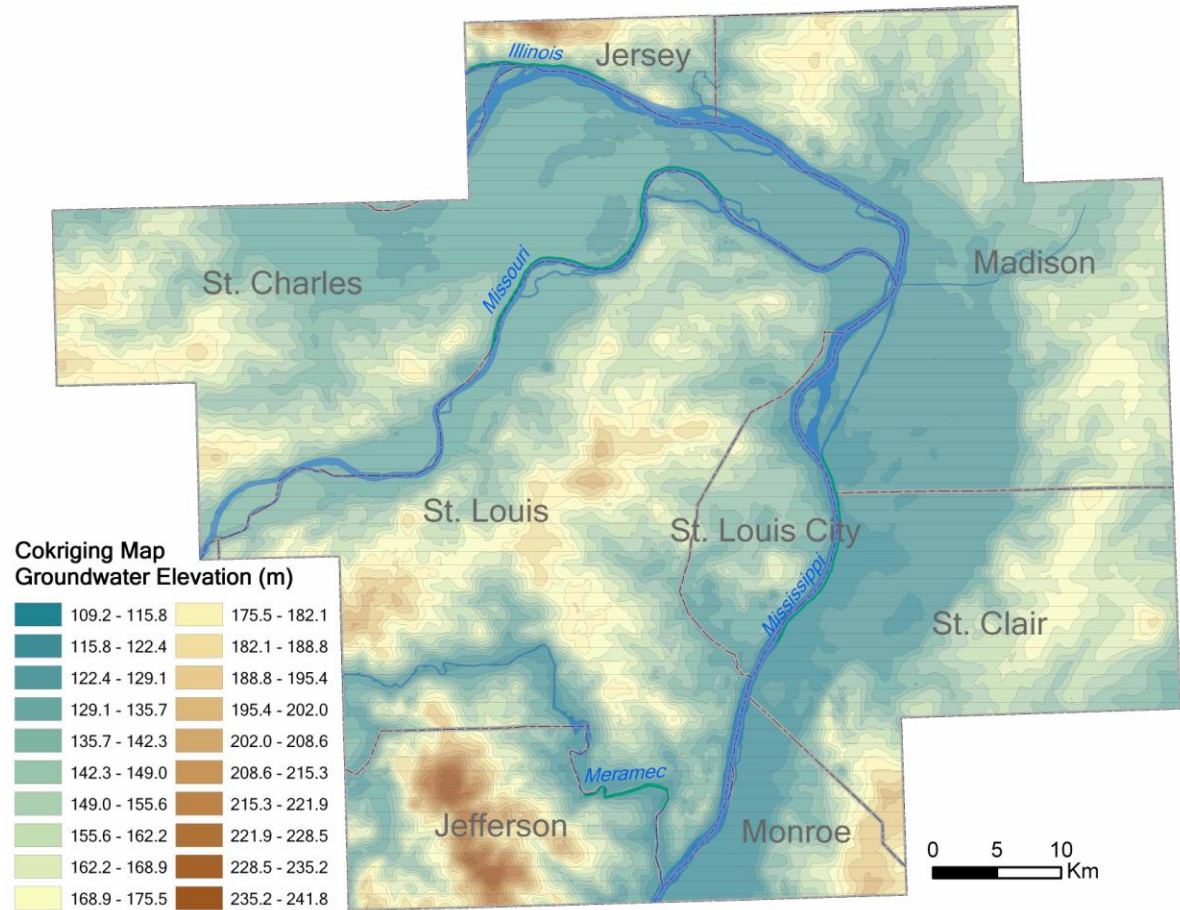


Manipulation of Database Information to Enhance Quality Control of Predictive and/or Hybrid Map Products

Cokriging Map of Groundwater Elevations

Data Sources:

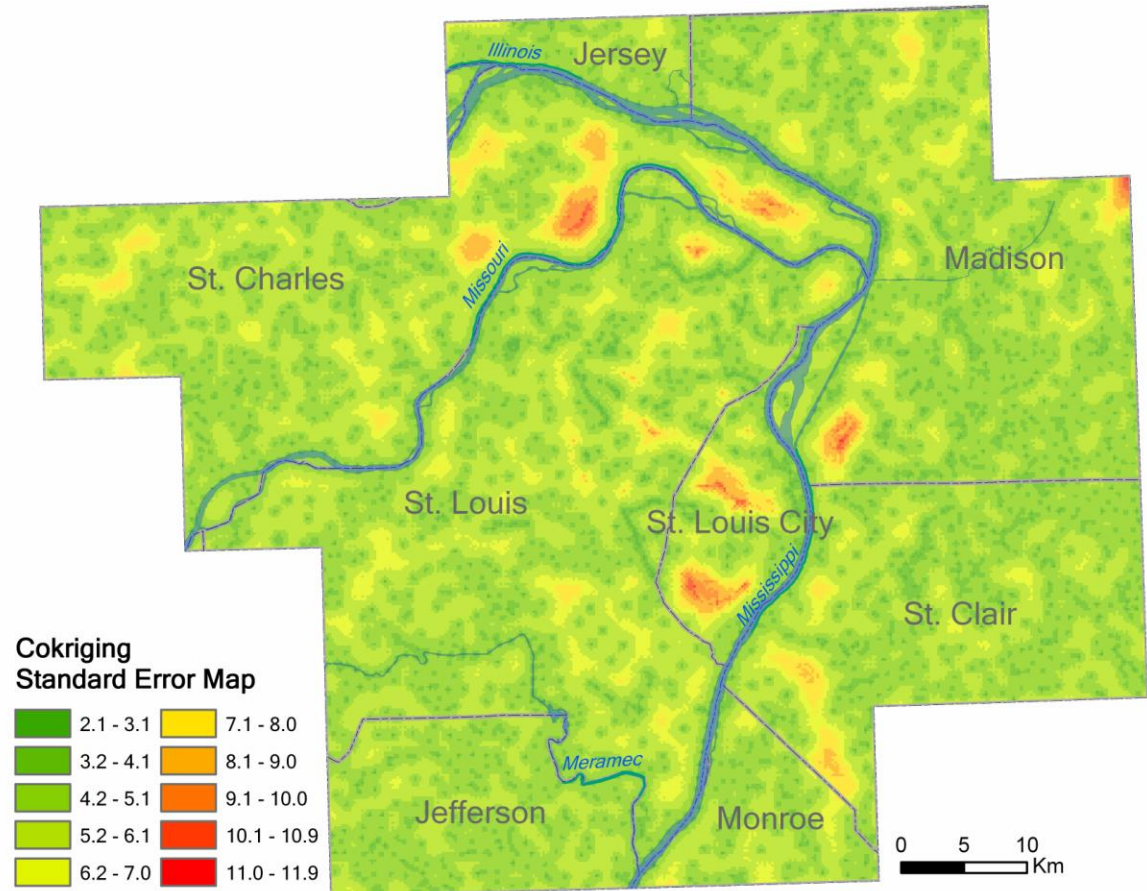
1.) 1069 well logs from **MoDNR** and **ISGS**
2.) 469 inferred points from **topo maps** (1:24,000)
3.) 2100 points along rivers & streams from **USGS**



Predicted **Standard Error** of Groundwater Elevation using **Cokriging**

The larger value, the more error (the less accurate)

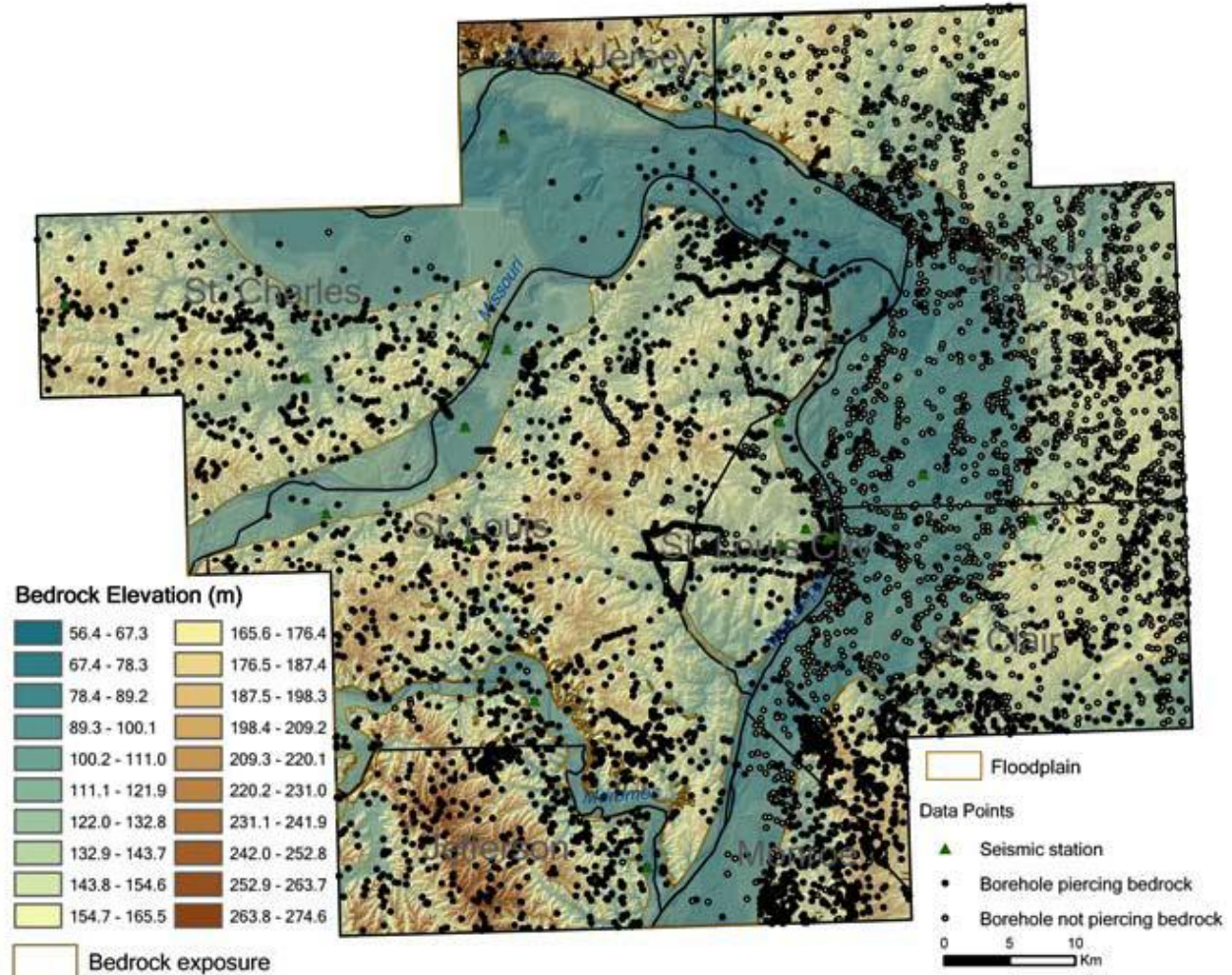
Thus, more dataset of well logs are necessary for these areas for better estimation.



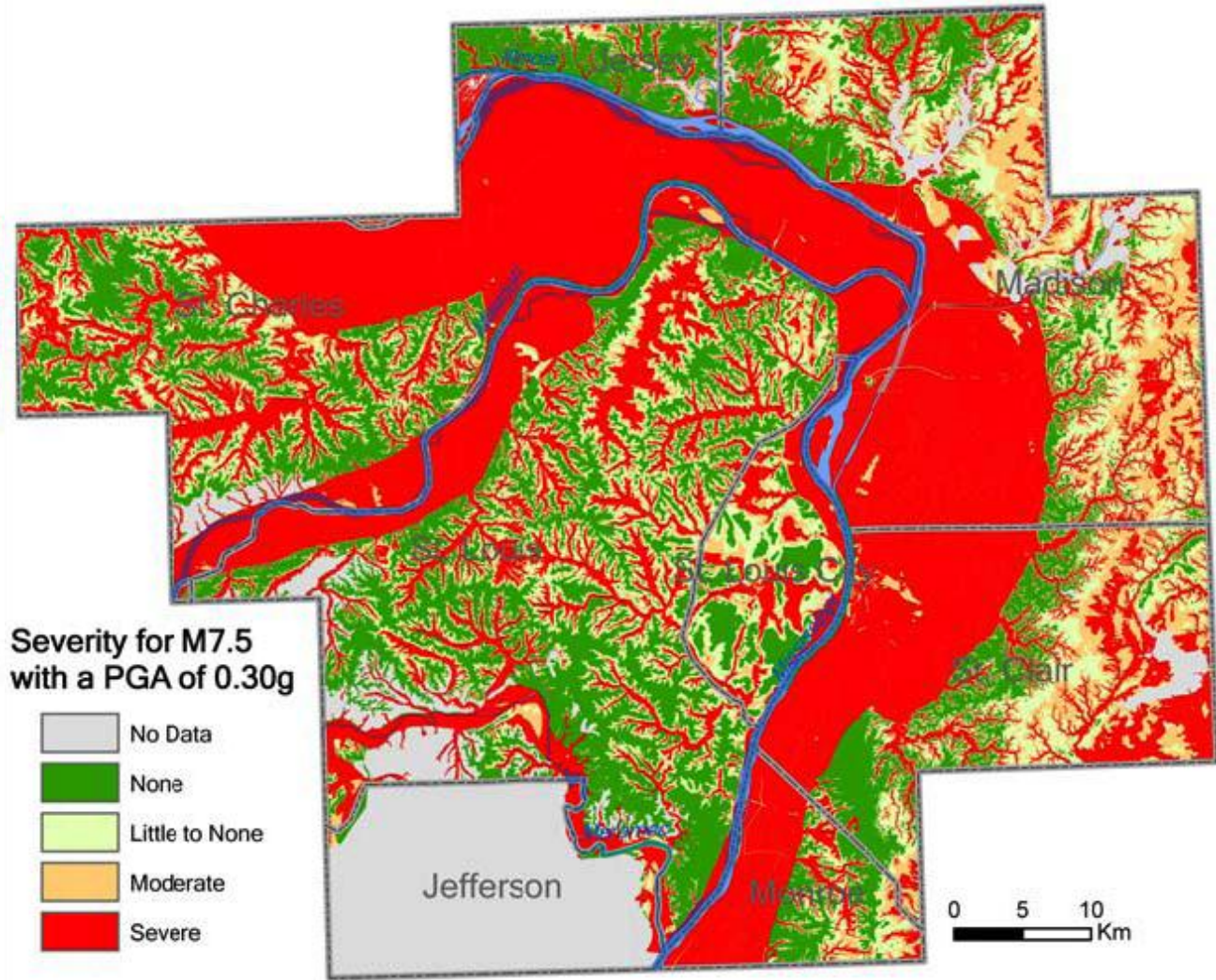
Cokriging Map of Bedrock Elevation and showing data points (geotechnical borings)

Data Sources:

1.) 2637 boring logs from **MoDNR**
2.) 3997 boring logs from **ISGS**



Map of Liquefaction Potential Index



Conclusions

- ◆ Data from disparate sources:



Missouri
Environmental
Geology Atlas



Missouri
Department
of Natural
Resources





Conclusions

- ◆ **Result:** comprehensive & unique source for geospatial analysis of the St. Louis area
- ◆ Many applications of data use
- ◆ Other areas can use this as a template



Questions?