

Class II Injection Wells in Kentucky—An Update of the Map Service of Wastewater, Brine-Disposal, and Enhanced-Recovery Wells in Kentucky*

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*Adapted from oral presentation given at 2016 AAPG Eastern Section Meeting, Lexington, Kentucky, September 25-27, 2016

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Abstract

Following creation of a map service providing information on Kentucky's Class II injection wells, new data have been made available and integrated into the online map through permits issued by the Kentucky Division of Oil and Gas for proposed injection well locations and by the release of new information from the U.S. Environmental Protection Agency (USEPA) through Freedom of Information Act (FOIA) requests. Administrative data identified an additional eighteen injection wells now cataloged into the Class II database, seventeen permitted or recompleted as brine disposal wells and one permitted for enhanced recovery.

Monthly operations data (casing pressures and injection volumes) for selected active Class II wastewater wells covering a five-year period (2008-2012) were compiled from yearly records and examined during the course of a multistate research investigation of brine disposal in the Northern Appalachian Basin. Subsequent to that study, injection volumes reported on a yearly basis were later released for 25- and 30-year periods for brine disposal and enhanced recovery wells, respectively. Analysis of this longer term injection history has identified increases in both disposal and recovery operations over the past fifteen years.

Active injection zones include shallow Pennsylvanian sandstones to deeper Ordovician Knox Group porous dolomites and sandstones. Recently permitted injection wells are also targeting Cambrian Copper Ridge Dolomite (Lower Knox Group) and Conasauga Group intervals.

Kentucky has requested and received tentative approval for oversight (primacy) over Class II injection wells. Approval should result in more timely access to data for map service updates and in monitoring ongoing injection activity.

Reference Cited

Sparks, T.N., D.C. Harris, and J.R. Bowersox, 2013, Class I Waste-disposal wells and Class II brine-injection wells in Kentucky: KGS Map and Chart 204, series XII, 1p. Website accessed March 7, 2017, http://kgs.uky.edu/kgsweb/olops/pub/kgs/MC204_12.pdf.

Websites

Injection Partners LP. Website accessed March 7, 2017, <http://www.injectionpartners.com>.

KGS. Website accessed March 7, 2017, <http://goo.gl/xQZ2QD>;
<http://kygs.maps.arcgis.com/home/webmap/viewer.html?webmap=9380ec4940cd46c9b2c65a1160753f6f>.

USGS, Induced Earthquakes. Website accessed March 7, 2017, <http://earthquake.usgs.gov/research/induced/>

***Class II Injection Wells in Kentucky—An
Update of the Map Service of
Wastewater, Brine-Disposal, and
Enhanced-Recovery Wells in Kentucky***

**Thomas N. Sparks, Energy and Minerals Section
Kentucky Geological Survey
September 26, 2016
2016 Eastern Section AAPG**

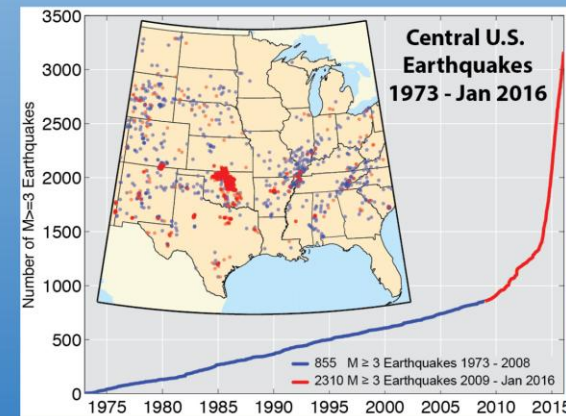
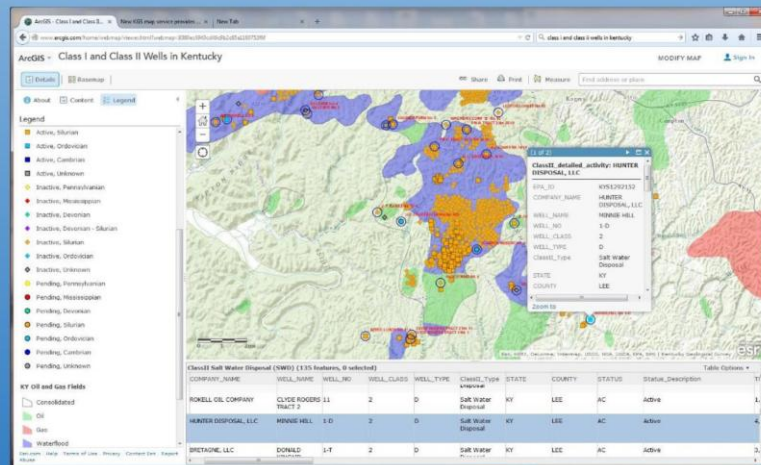


Outline of presentation

- **Class II brine disposal and injection wells** (overview, definition, types, purposes)
- **EPA Region 4** (UIC Program, FOIA requests, data availability, primacy, map products)
- **Map service** of disposal and injection wells in Kentucky (online database 2014, tools, tables, statewide numbers, spatial locations, geology, updates)
- **Newly released injection volumes** (March 2016), reconnaissance maps, charts, data currently under evaluation

Purpose for study

- Establish a baseline database to **identify, catalog, and track** brine disposal in Kentucky by location and geologic setting
- Distinguish between Class II **saltwater disposal (SWD)** and **enhanced recovery injection (ERI)** wells
- Provide a mapping tool for disposal and injection (recovery) wells to assist KGS Hazards Section in **analyzing potential risks for induced seismicity**



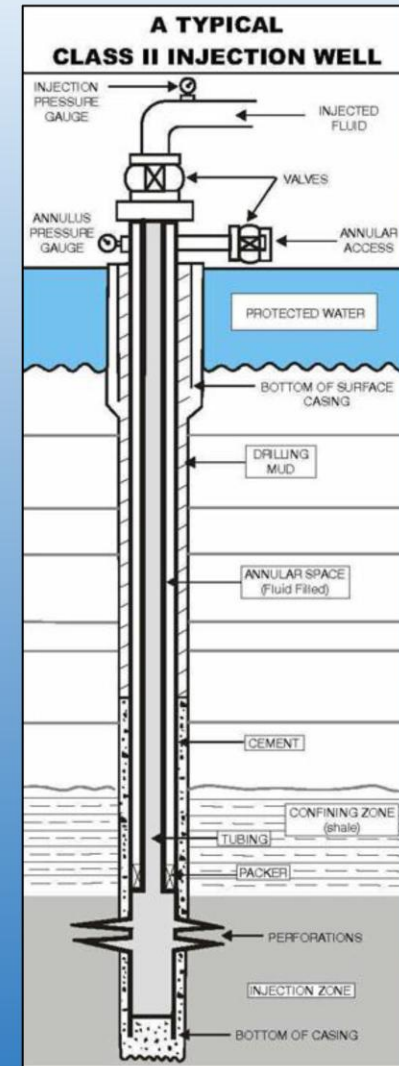
Source: <http://earthquake.usgs.gov/research/induced/>

Presenter's notes: Develop database of brine disposal in Kentucky from EPA-provided FOIA requests.

What are Class II injection wells?

- **Inject fluids** associated with oil and gas production into underground porous formations – wastewater, brines (salt water), steam, CO₂, flowback fluids (frack fluids)
- **Protect** underground sources of drinking water (USDW)
- **Two types of Class II wells:**
 - ❖ Type **D** for permanent **disposal** for brines (SWD)
 - ❖ Type **R** for injection into existing reservoir for increased **recovery** of hydrocarbons (80%, 95% KY)
- **2 billion gallons** brine injected every day in US
- **180,000 Class II wells** in US, majority in Texas, California, Kansas, Oklahoma (Kentucky >3,000)
- **Service wells** (SWD, ERI, EOR, SRI, TRI, GI, waterflood)

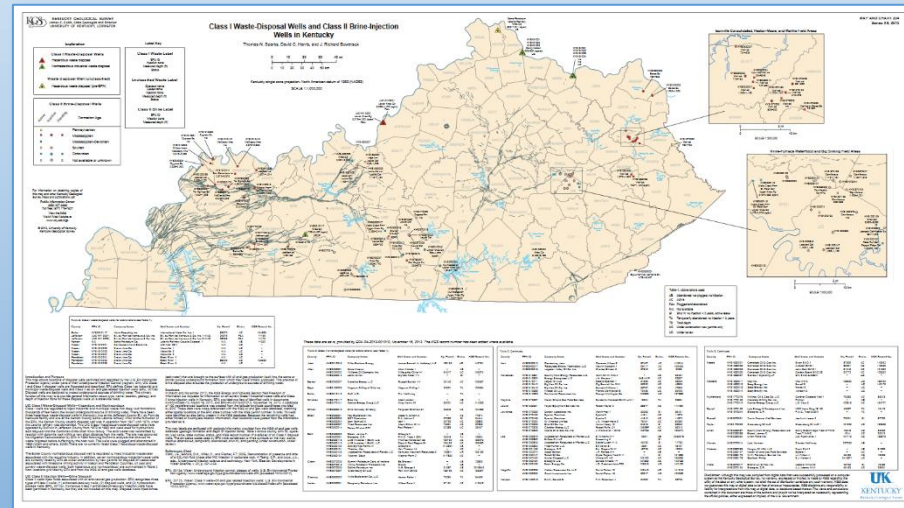
Source: Injection Partners LP
<http://www.injectionpartners.com>



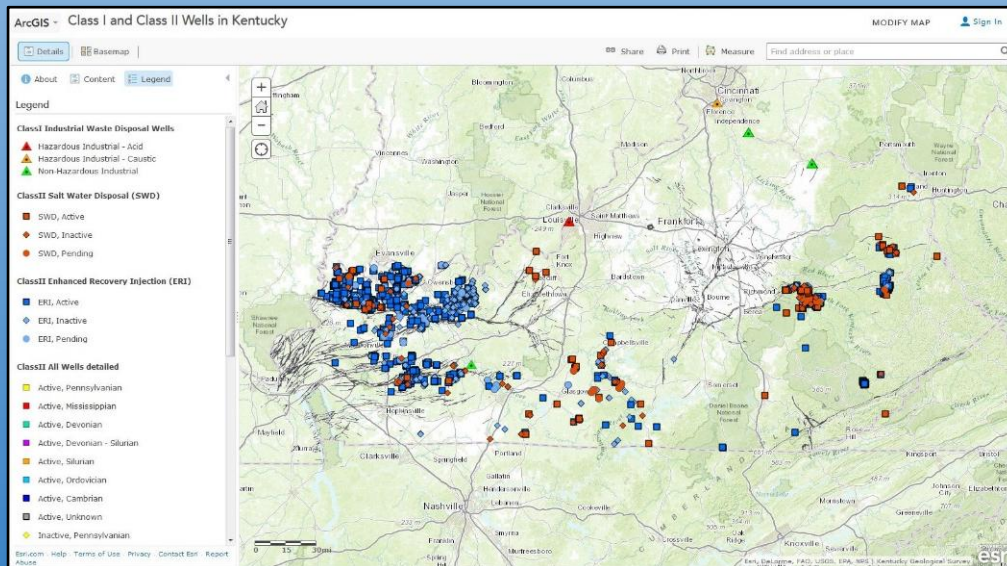
Presenter's notes: 2 billion gallons brine injected every day in US = 48 million barrels (MMBBL) (EPA, 2016), Service wells (SWD, ERI, EOR, SRI, TRI, GI). Drill as new well or utilize existing well borehole.

KGS map products from FOIA documents

- March 2013: published 'Class I waste-disposal wells and Class II brine-injection wells in Kentucky,' KGS Map and Chart 204, ser. 12
- December 2014: online map service, updated inclusion of 2,900 ERI wells: <http://goo.gl/xQZ2QD>
- Available on KGS Online Maps Home



Sparks, Harris, and Bowersox, 2013; KGS Map and Chart 204, ser. 12
http://kgs.uky.edu/kgsweb/olops/pub/kgs/MC204_12.pdf

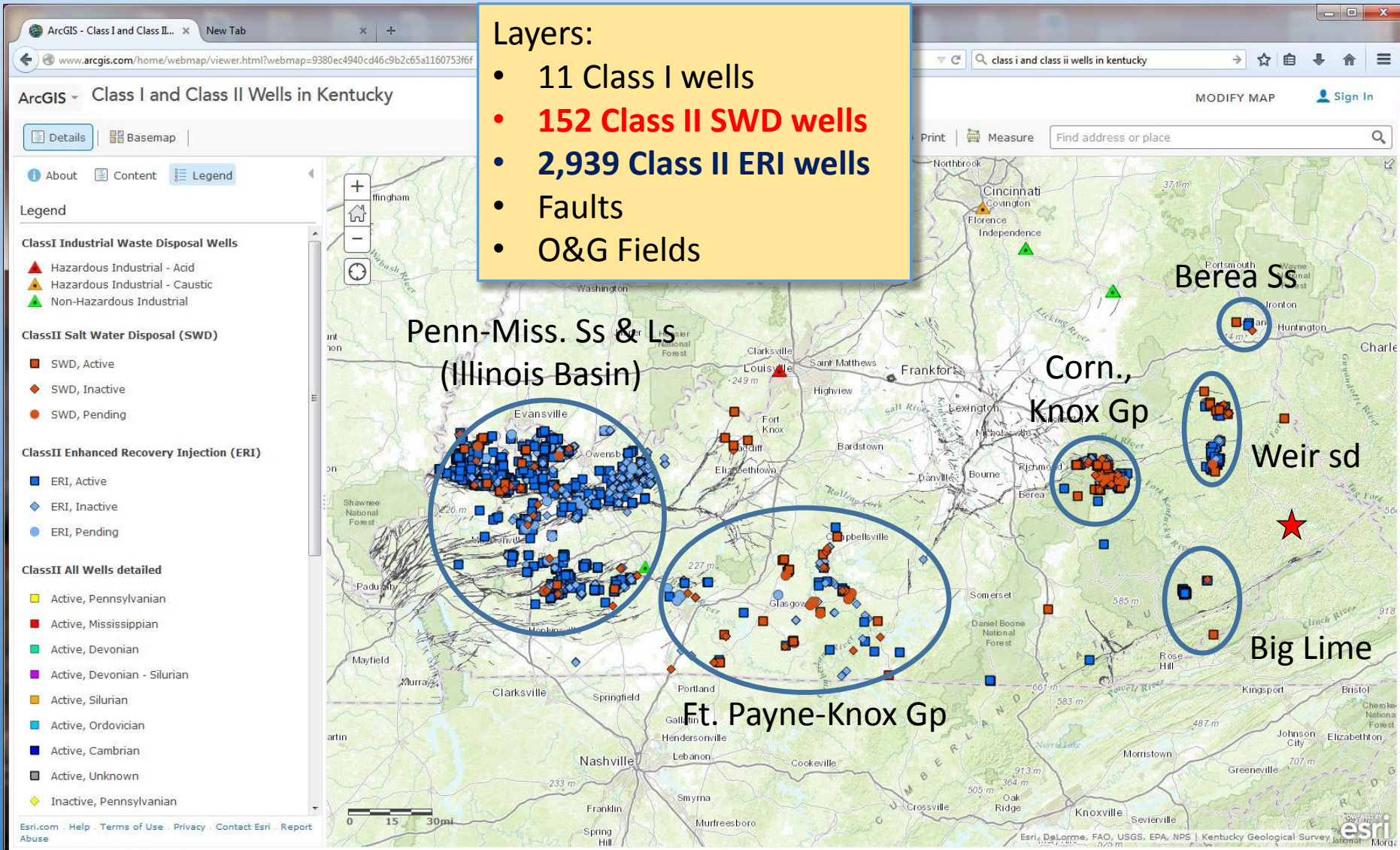


GIS Map service of EPA permitted Class I industrial waste-disposal wells, Class II brine-disposal (SWD) and enhanced-recovery injection (ERI) wells

Map service of disposal and injection wells

Layers:

- 11 Class I wells
- **152 Class II SWD wells**
- **2,939 Class II ERI wells**
- Faults
- O&G Fields



Map service of disposal and injection wells

About Content Legend

Legend

ClassII Salt Water Disposal (SWD)

- SWD, Active
- SWD, Inactive
- SWD, Pending
- SWD, Other

ClassII Enhanced Recovery Injection (ERI)

- ERI, Active
- ERI, Inactive
- ERI, Pending
- ERI, Other

KY Oil and Gas Fields

- Consolidated
- Oil
- Gas
- Waterflood
- Big Sandy Gas

Faults

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Big Sinking waterflood, c. 1949, Lockport, Big Six (Corniferous)

Service includes:

- Legends
- Tables
- Popups
- Metadata
- Links to KGS DB

20ec4940cd46c9b2c65a1160753f6f

Search

ClassII_SWD_detailed: BRETAGNE, LLC

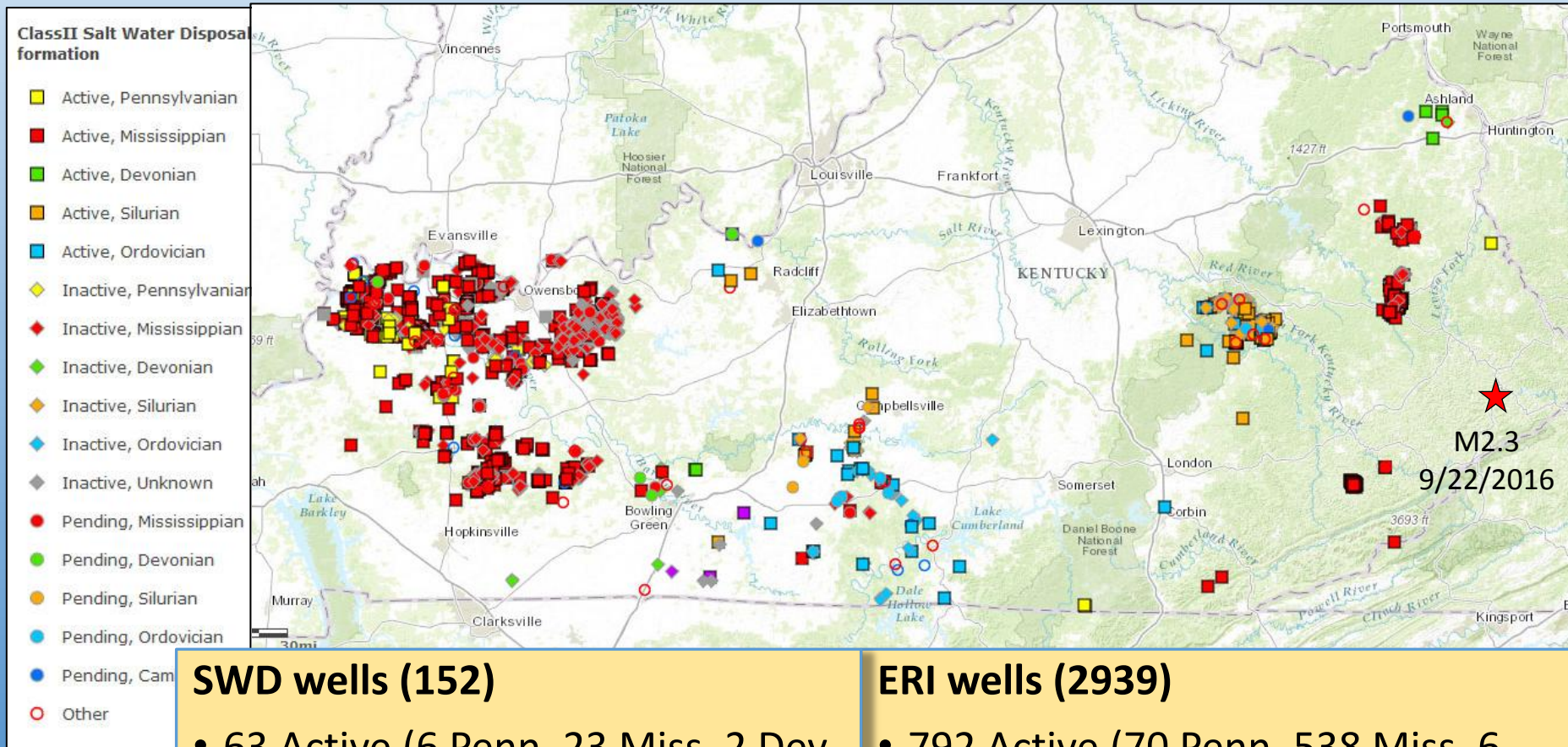
EPA_ID	KYS1292154
COMPANY_NAME	BRETAGNE, LLC
WELL_NAME	DONALD KINCAID
WELL_NO	1-T
WELL_CLASS	2
WELL_TYPE	D
ClassII_Type	Salt Water Disposal
STATE	KY
COUNTY	LEE
STATUS	AC

Zoom to

disposal (SWD) (152 features, 1 selected)

WELL_NAME	WELL_NO	WELL_CLASS	WELL_TYPE	ClassII_Type	STATE	COUNTY	STATUS	Status_Description	GROUND_ELEV	INJECT_ZONE
NE, LLC DONALD KINCAID	1-T	2	D	Salt Water Disposal	KY	LEE	AC	Active	3975	1055
BASIN ENERGY COMPANY J.D. CRABTREE HEIRS	P23	2	D	Salt Water Disposal	KY	LEE	AC	Active	3297	920
KYS1490215 SMITH, DONALD FEM	4	2	D	Salt Water	KY	MCCLELLAN	TA	Temporarily		

Current inventory 2016 (updated legend 2)



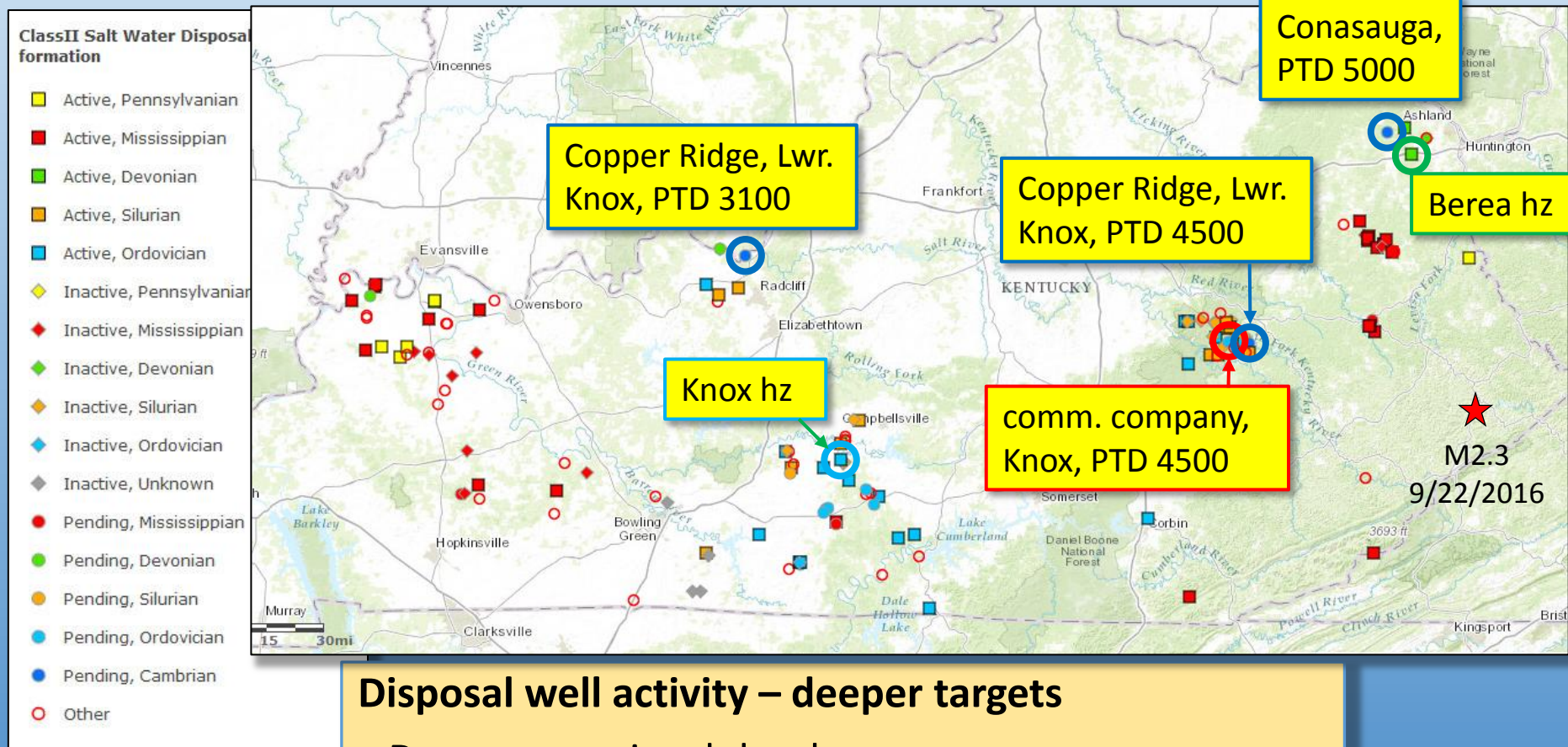
SWD wells (152)

- 63 Active (6 Penn, 23 Miss, 2 Dev, 13 Sil, 19 Ord)
- 33 Inactive (SI, TA, Abn, Unk)
- 17 Pending (Loc), 39 Other (P&A)

ERI wells (2939)

- 792 Active (70 Penn, 538 Miss, 6 Dev-Sil, 143 Sil, 12 Ord, 1 Cam, 22?)
- 2,028 Inactive (SI, TA, Abn, Unk)
- 68 Pending (Loc), 51 Other (P&A)

Recent activity – Class II SWD only



Disposal well activity – deeper targets

- Deeper permitted depths
- Commercial disposal company identified (2014)
- Horizontal (hz) SWD wells (converted oil, D&A)

New FOIA release (March 2016) - Injection Volumes EPA-R4-2016-002431

What was the data, what was revealed?

- Database of 512 yearly injection volumes for **65 SWD** wells in 27 counties, over a **25-year period** (1989-2014)
- Database of 14,008 yearly injection volumes for **1,535 ERI** wells in 40 counties, over a **30-year period** (1985-2014)
- Preliminary, reconnaissance **charts** and **maps** based on liquid barrels reported injected on yearly basis (*no MCF included*)

Note:

- Some injection volumes appear to be missing or not reported to EPA (*2015 data was still being added in March 2016, duplicate values noted, overlapping report periods*)

BBL

Saltwater (Brine) Disposal

SWD

Annual Volume (BBL) & SWD count

3,000,000

35

2,500,000

2,000,000

1,500,000

1,000,000

500,000

0

■ ANNUAL VOL

— SWD Count

data missing ?
not reported
not recorded

1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

30

25

20

15

10

5

0

2

2

1

3

3

14

23

27

28

25

22

24

26

29

23

21

22

22

28

30

25

?

BBL

Saltwater (Brine) Disposal Annual Volume (BBL)

Henderson – N. Smith Mills 2 (10 MMB)
Harlan – Millers Cove 4 (2 MMB)
Hart – Clarence Wilson 3 (2 MMB)
Lee – Minnie Hill 1-D (1.7 MMB)

3,000,000

2,500,000

2,000,000

1,500,000

1,000,000

500,000

0

LEE HENDERSON HART HARLAN

OTHERS

data missing ?
not reported
not recorded

?

1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014



Class II Type D (SWD) wells County Totals

21.8 million barrels (1989-2014)

27 counties (2 no data)

65 wells reported (2 no data)

Top WKY

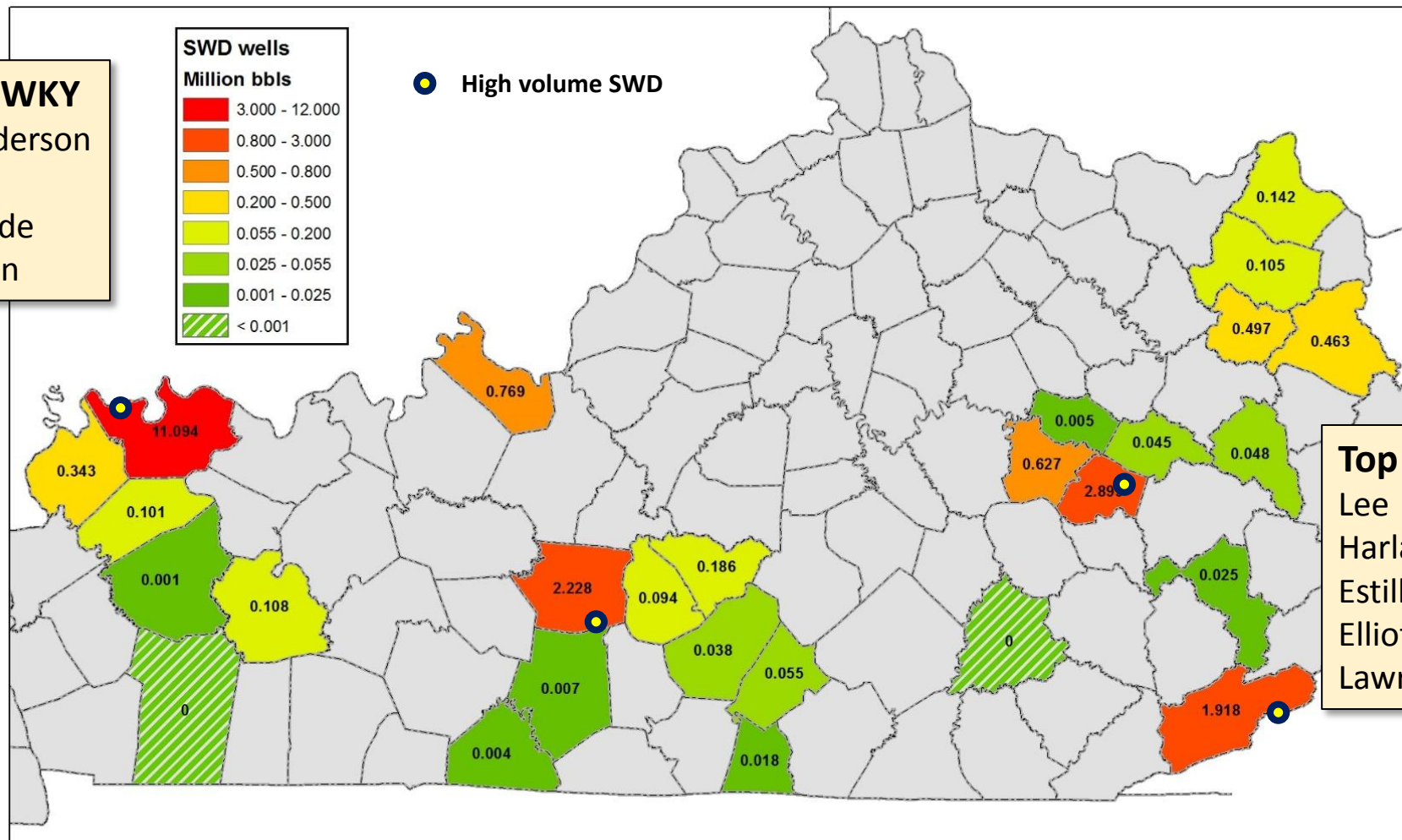
Henderson
Hart
Meade
Union

SWD wells

Million bbls



High volume SWD



Top EKY

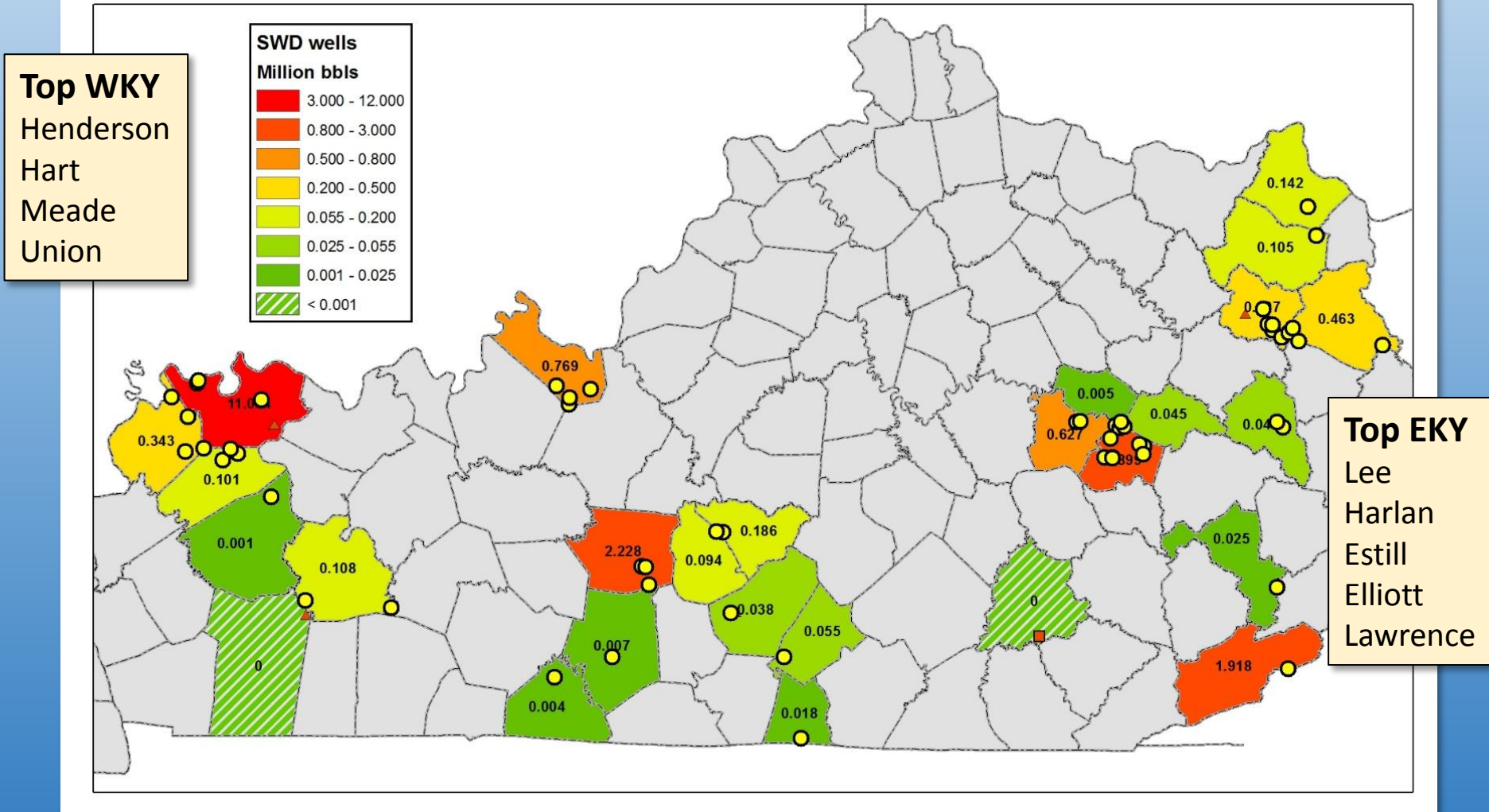
Lee
Harlan
Estill
Elliott
Lawrence

Class II Type D (SWD) wells
County Totals

21.8 million barrels (1989-2014)

27 counties (2 no data)

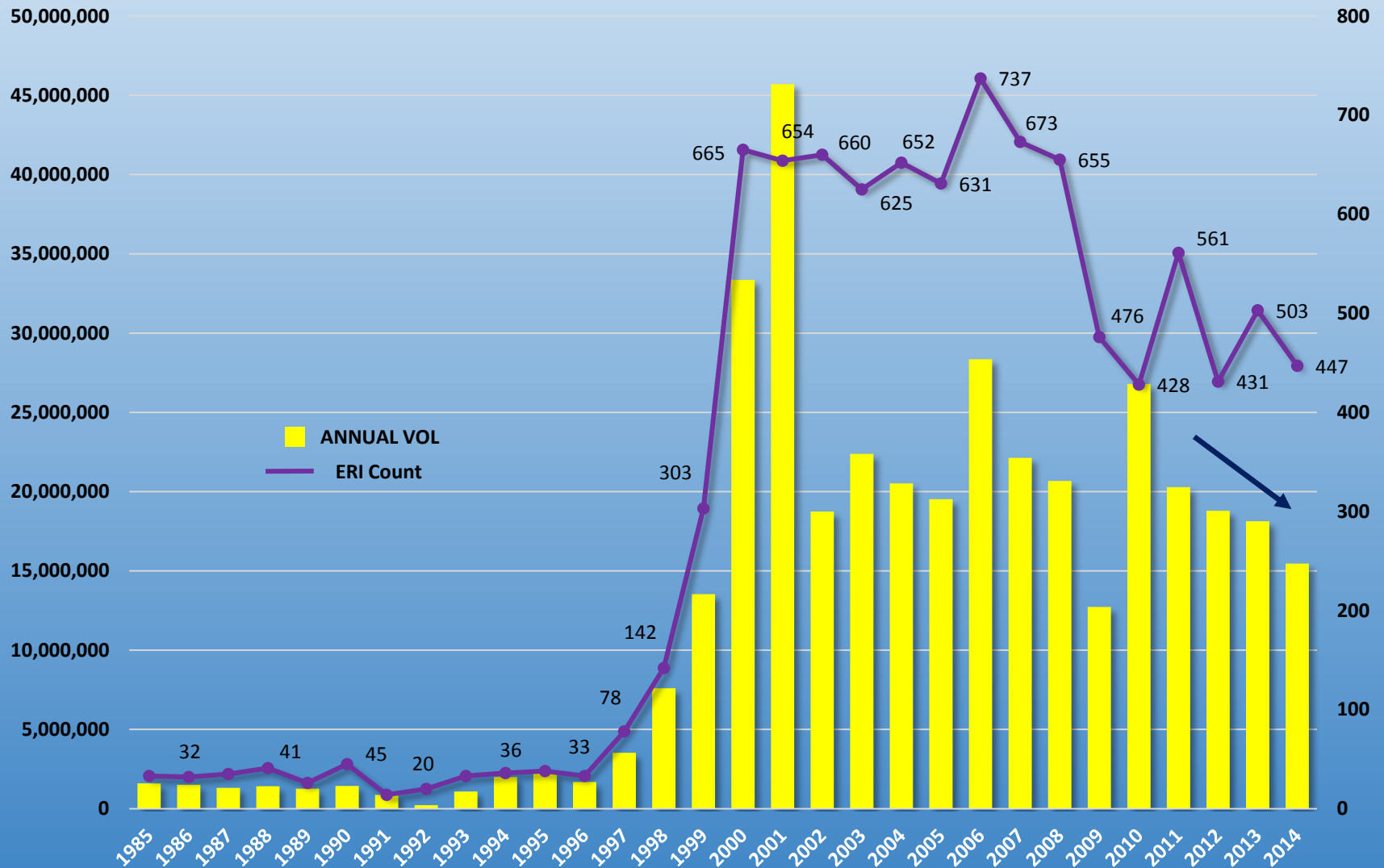
65 wells reported (2 no data)



BBL

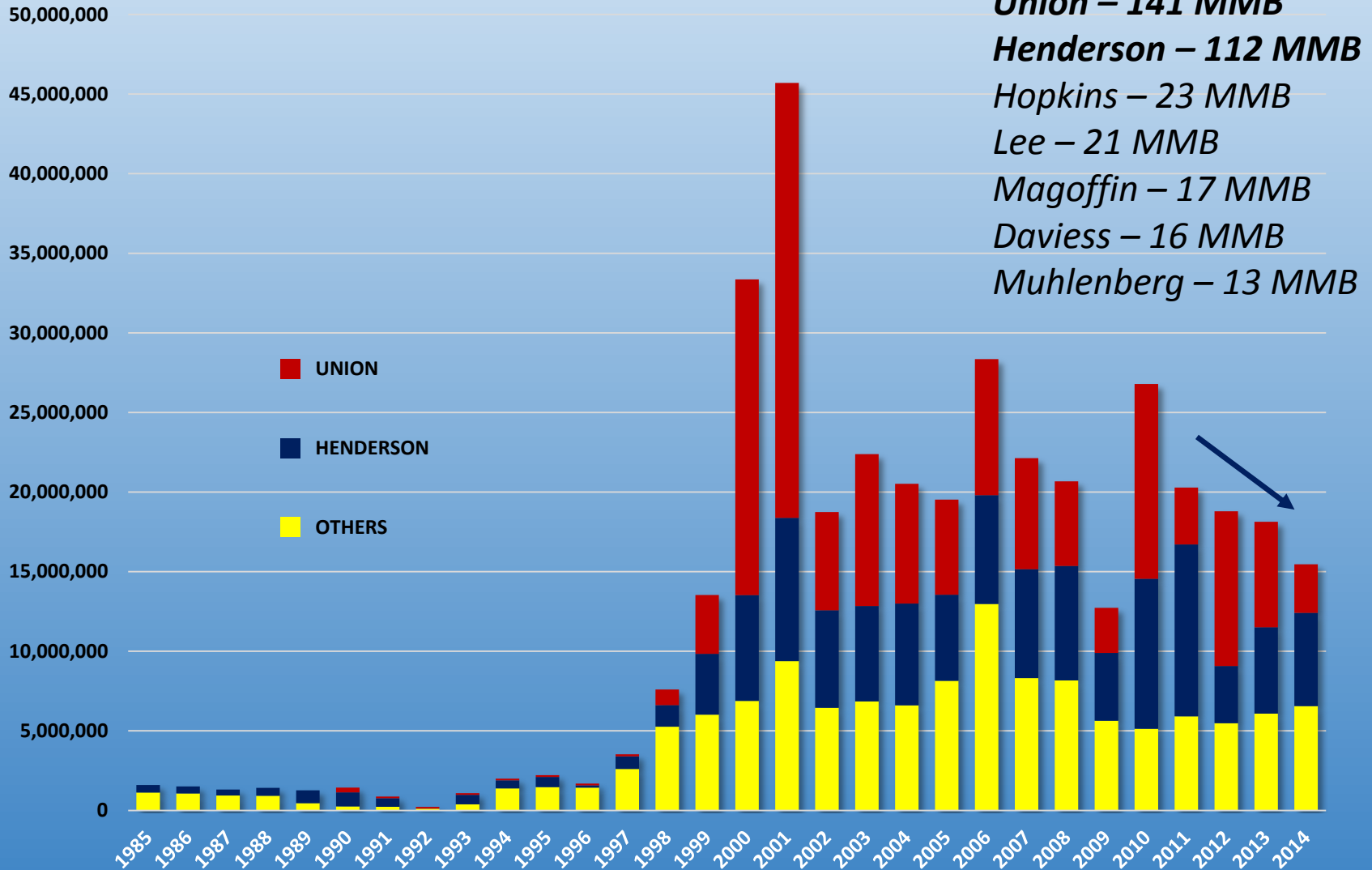
Enhanced Recovery Injection Annual Volume (BBL) & ERI Count

ERI



BBL

Enhanced Recovery Injection Annual Volume (BBL)



Class II Type R (ERI) wells County Totals

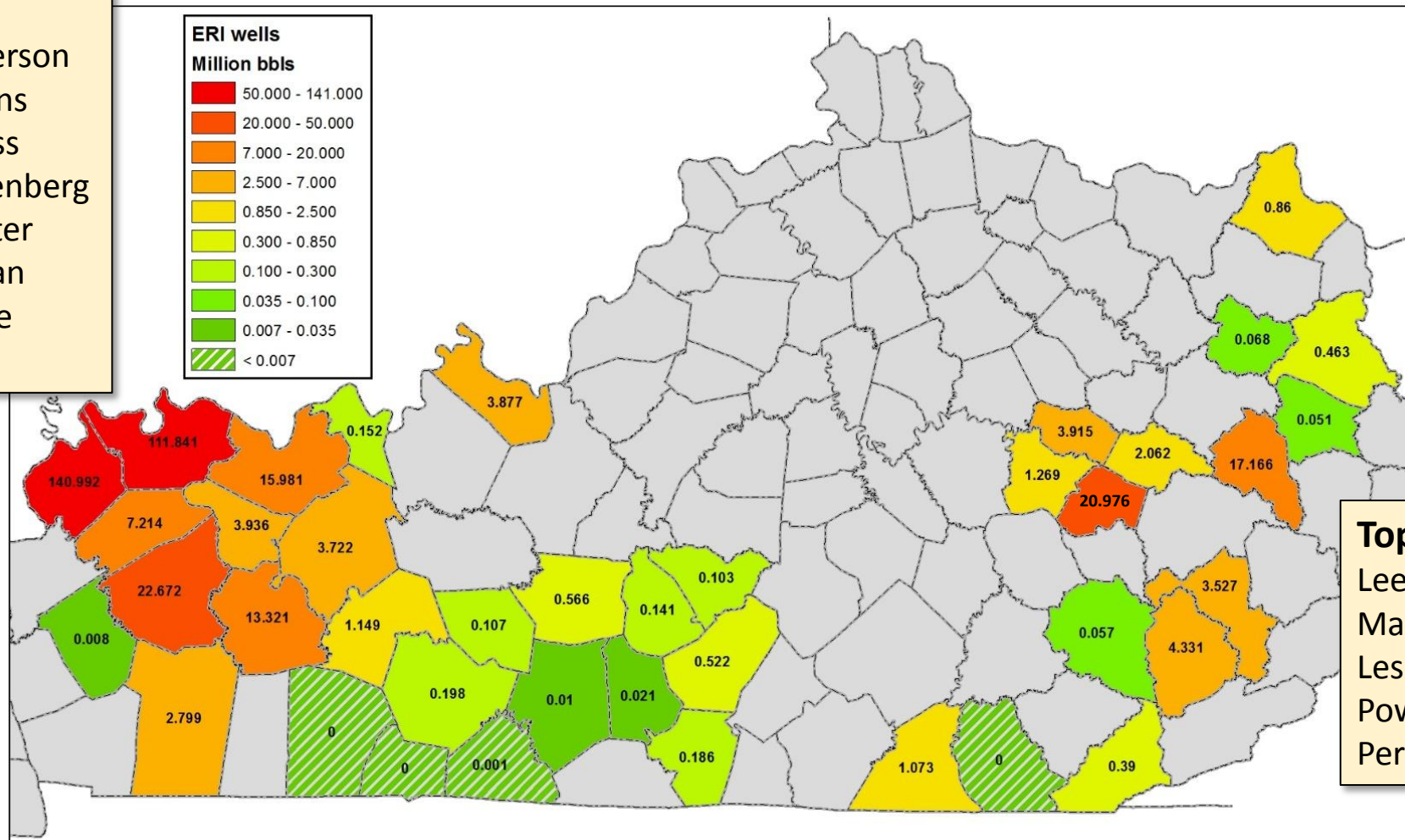
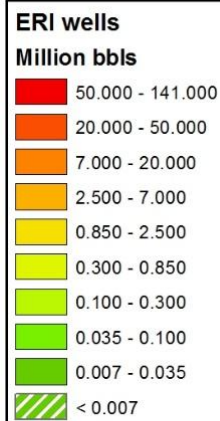
385.7 million barrels (1985-2014)

40 counties reported

1535 wells reported

Top WKY

Union
Henderson
Hopkins
Daviess
Muhlenberg
Webster
McLean
Meade
Ohio



Top EKY

Lee
Magoffin
Leslie
Powell
Perry

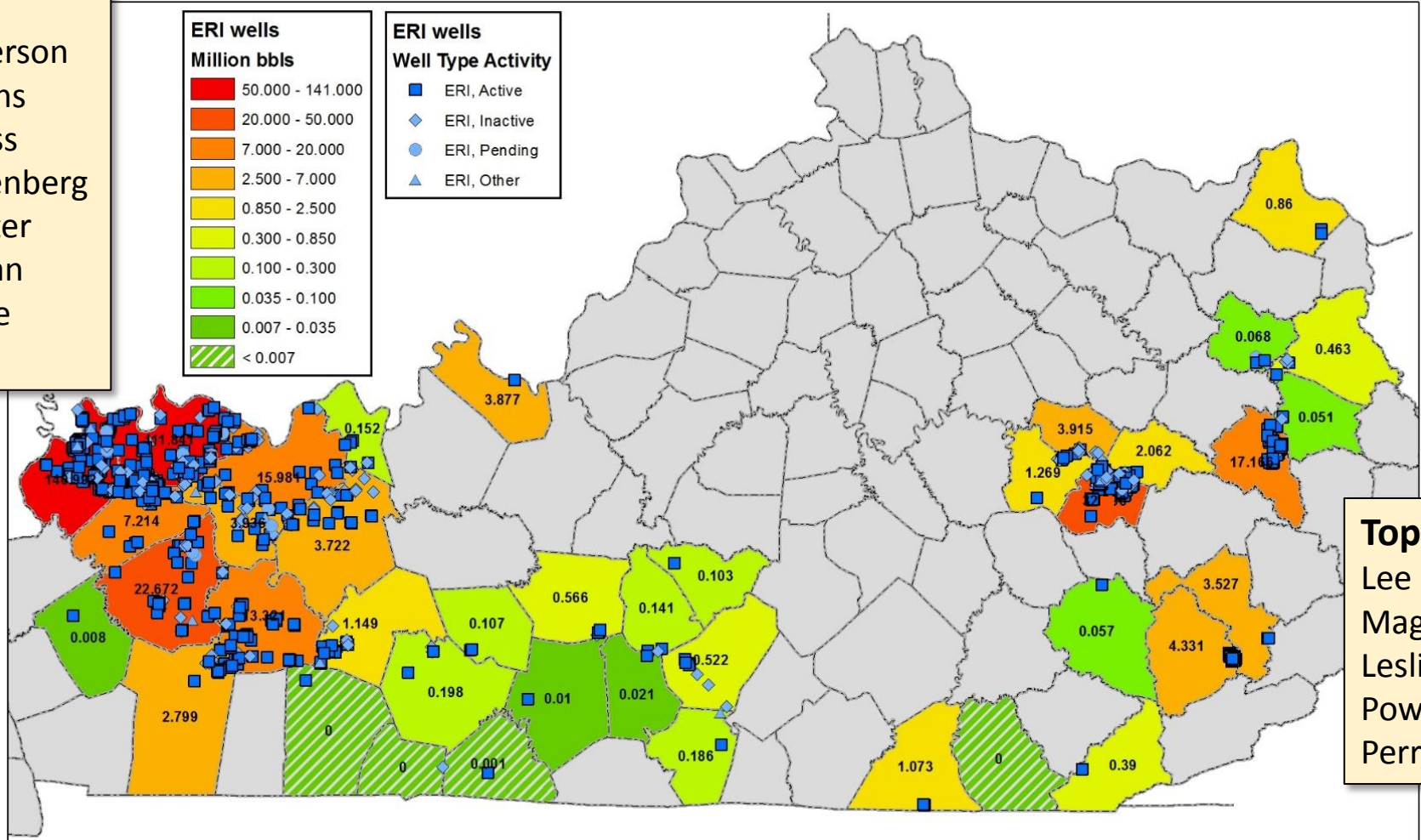
Class II Type R (ERI) wells County Totals

385.7 million barrels (1985-2014)

40 counties reported

1535 wells reported, 1119 displayed

Top WKY
Union
Henderson
Hopkins
Daviess
Muhlenberg
Webster
McLean
Meade
Ohio



Top EKY
Lee
Magoffin
Leslie
Powell
Perry

Insights and conclusions

- **Significant increase** in disposal and recovery injection volumes beginning in the late 1990s; drop off in recovery injection noted
- Volatility since 2000 is observed, overall high disposal rate **likely to continue** (horizontal drilling, deeper targets, fracking, potential commercial disposal operators)
- Brine disposal **1.25 MMB/year**; recovery injection **15 MMB/year**
- Injection volumes informative, **needs further review** (limited public data, incomplete reports, some duplicate and overlapping records)
- Kentucky would benefit with **Primacy of Class II wells** (direct permitting, reporting, oversight, greater access to data)
- **Kentucky Oil & Gas applied for primacy of Class II wells, Nov. 10, 2015, application currently USEPA Washington, approval expected**

Thank you!



Thomas N. Sparks

Sept. 25-27, 2016

www.esaapgmtg.org

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Geological Survey