United States Environmental Protection Agency

UST Finder: The National Underground Storage Tanks and Release Web Map

Region 5 Workshop
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Programmatic Use of UST Finder

Prevention

- Corrosion
  - Identify components early
  - Identify facilities vulnerable to corrosion
- Hazards
  - Prediction to minimize impacts
  - Identify impacted areas

Database

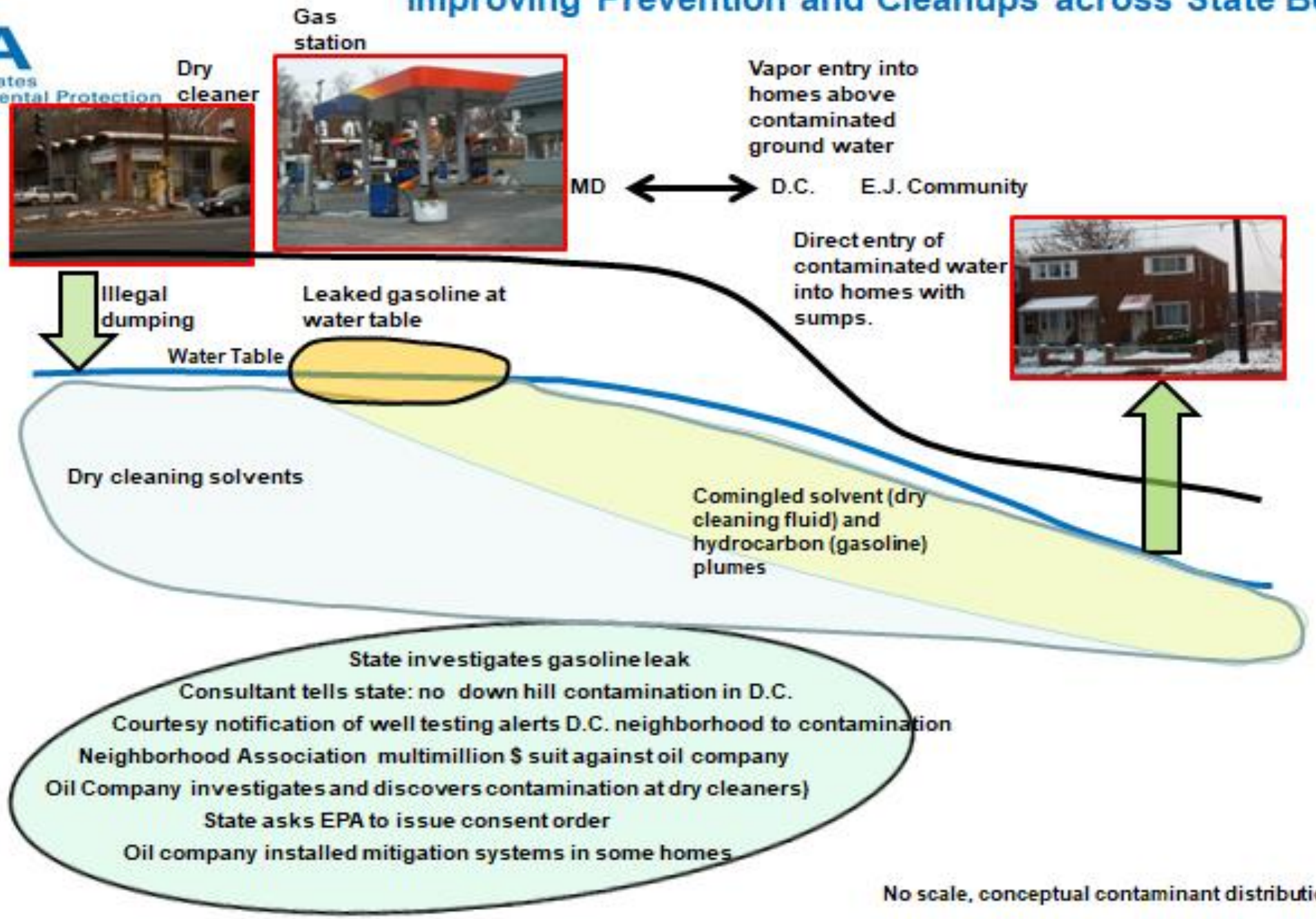
Cleanup

- Triage cleanups
  - Identify drinking water sources
  - Land use – risk
  - Population
- Screen technology selection
- Hazards
  - Identify facilities-
    - Potential new releases
    - Characterize and remediate new/existing releases

Utility of National Tanks Data

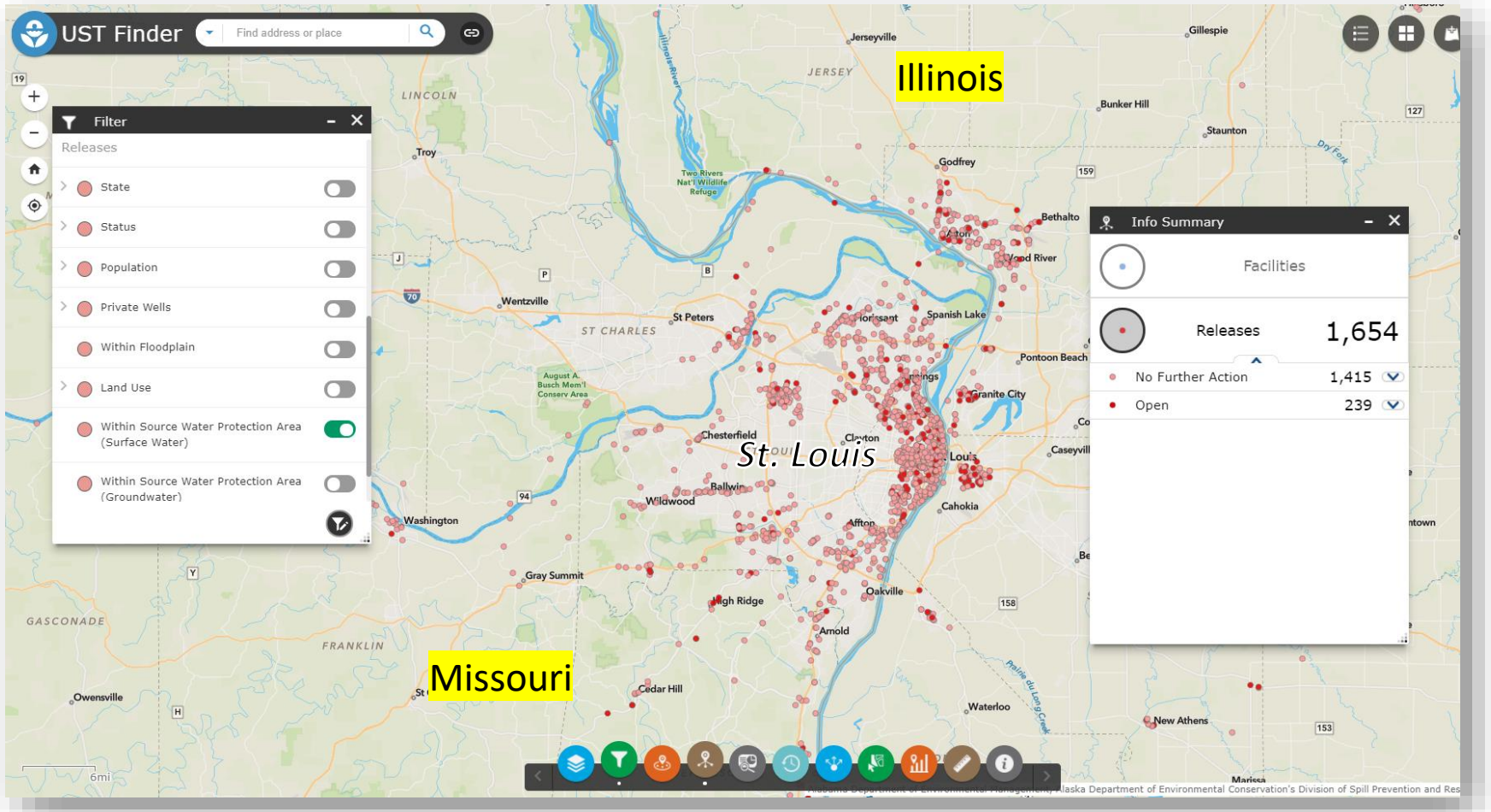
- Infrastructure data provides key information on:
  - Age of the infrastructure
  - Type of infrastructure
  - Identifying potential vulnerabilities
- Fuel
  - Volumes
  - Type
- Geospatial data provides potential impacts to water supplies and public health. Examples include:
  - Identify USTs/LUSTs in proximity to private domestic wells
  - Identify USTs/LUSTs potential impact to public drinking water supplies
  - Identify facilities in 100-year floodplain
  - Identify land use types for potential PVI risk
  - Identify population in proximity to facilities
- Provide readily accessible information for routine operations and for emergency response

Improving Prevention and Cleanups across State Boundarie



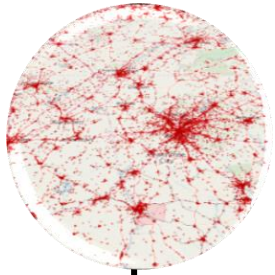
Improving Prevention and Cleanups across State Boundaries

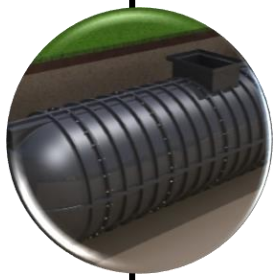
- Many state boundaries are divided by major waterways, amplifying importance of interstate analyses of LUST potential.



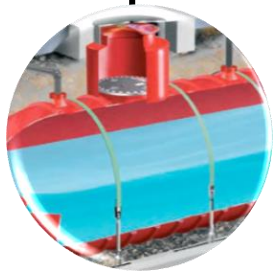
Database Structure

National UST and LUST Geospatial Database





UST Databases: 49 States & D.C.
-Installation Date
-Removal Date
-Status (open/closed/temp)
-Double/single walled
-Facility ID

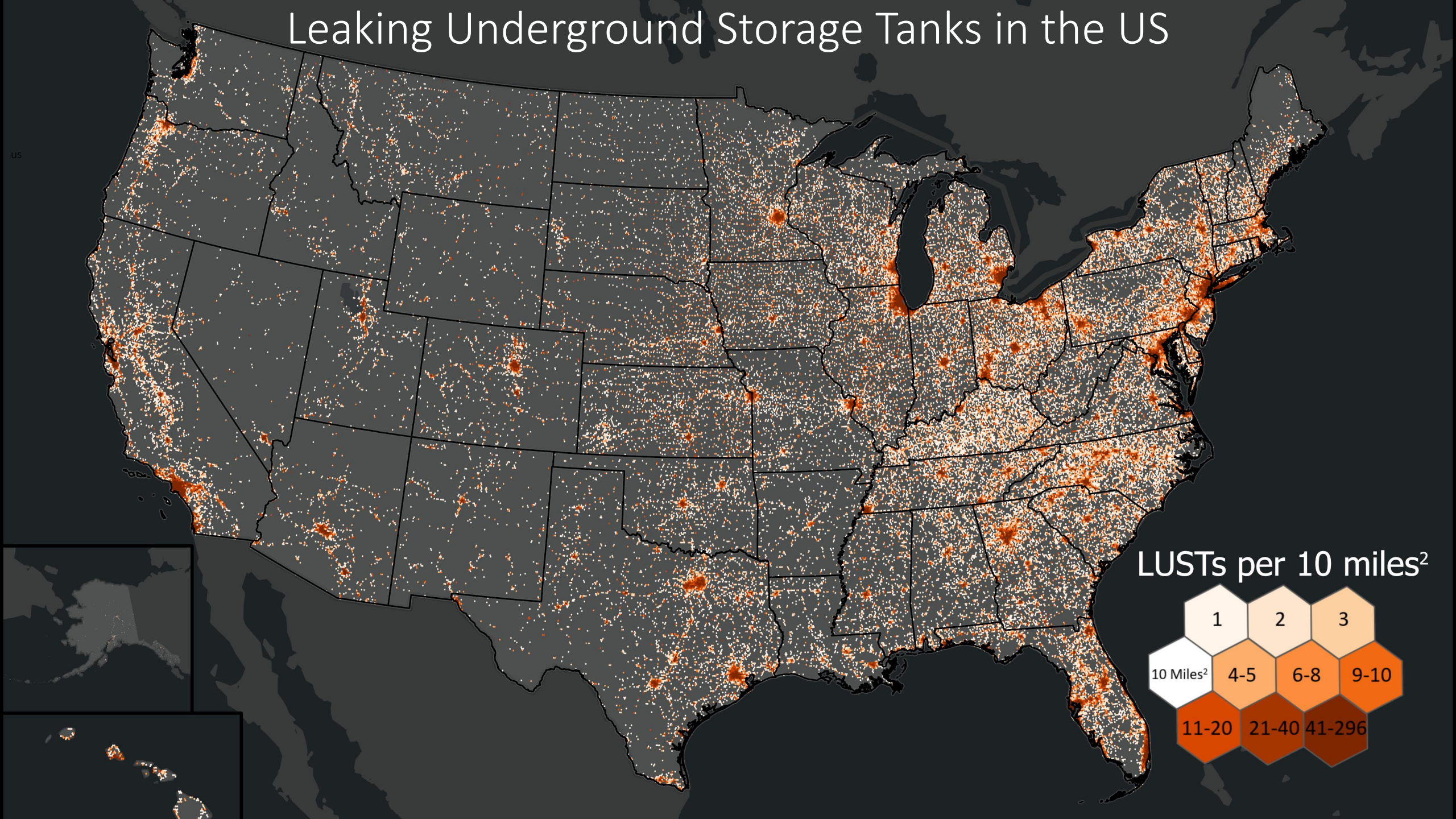


Compartment Database
-UST Capacity
-Fuel Type

Facility Databases: 50 State & D.C.
-Coordinates
-Count of open/closed/temp USTs

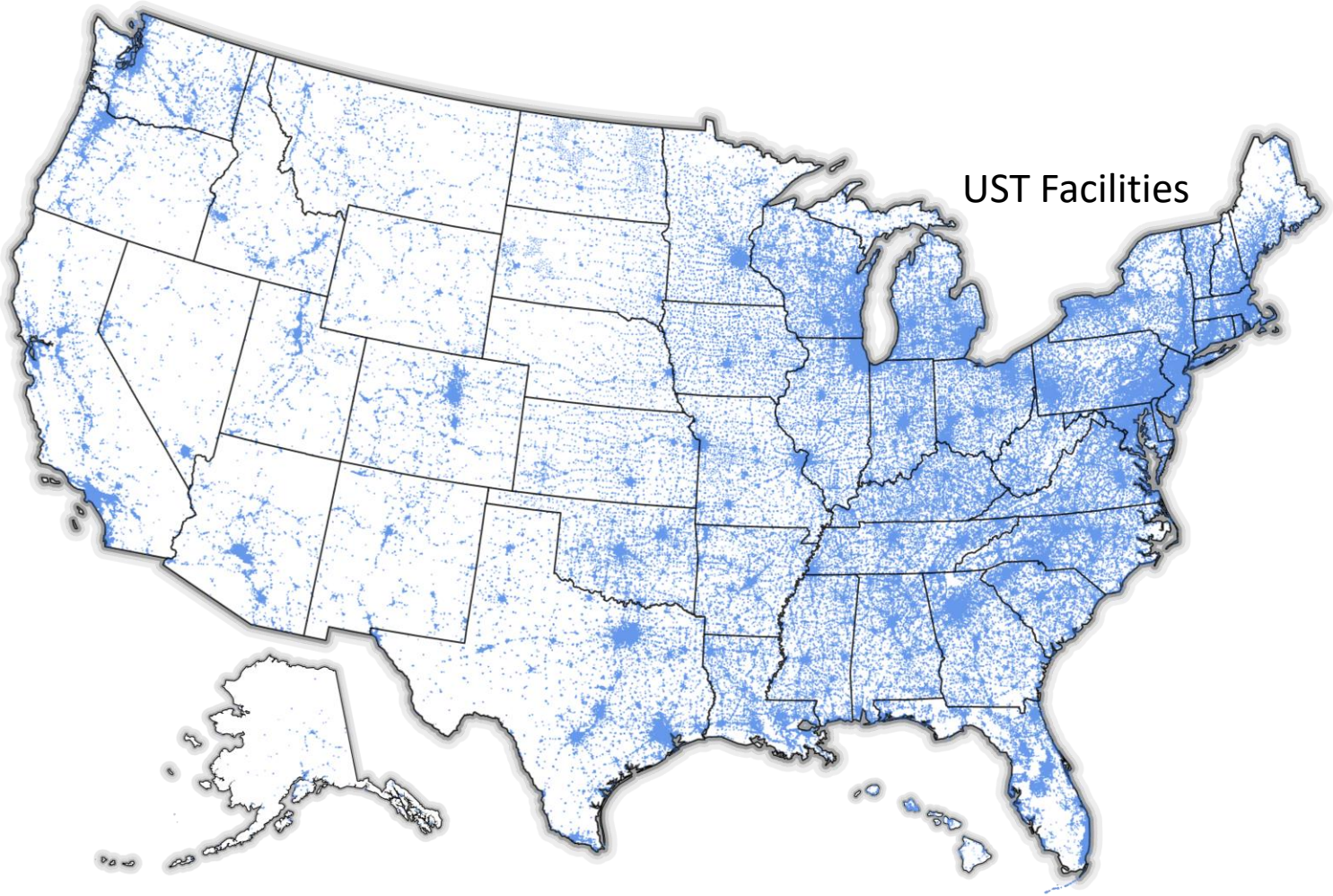
LUST Databases: 50 states & D.C.
-Coordinates
-Release Date
-NFA or Active
-Substance Released

Leaking Underground Storage Tanks in the US



Overview

- Routine operations
  - Prevention
  - Cleanup
  - Q/A and Case Study
- Extreme events
  - Advance information
  - Site assessment
  - Q&A and Case Study
- Database version 2



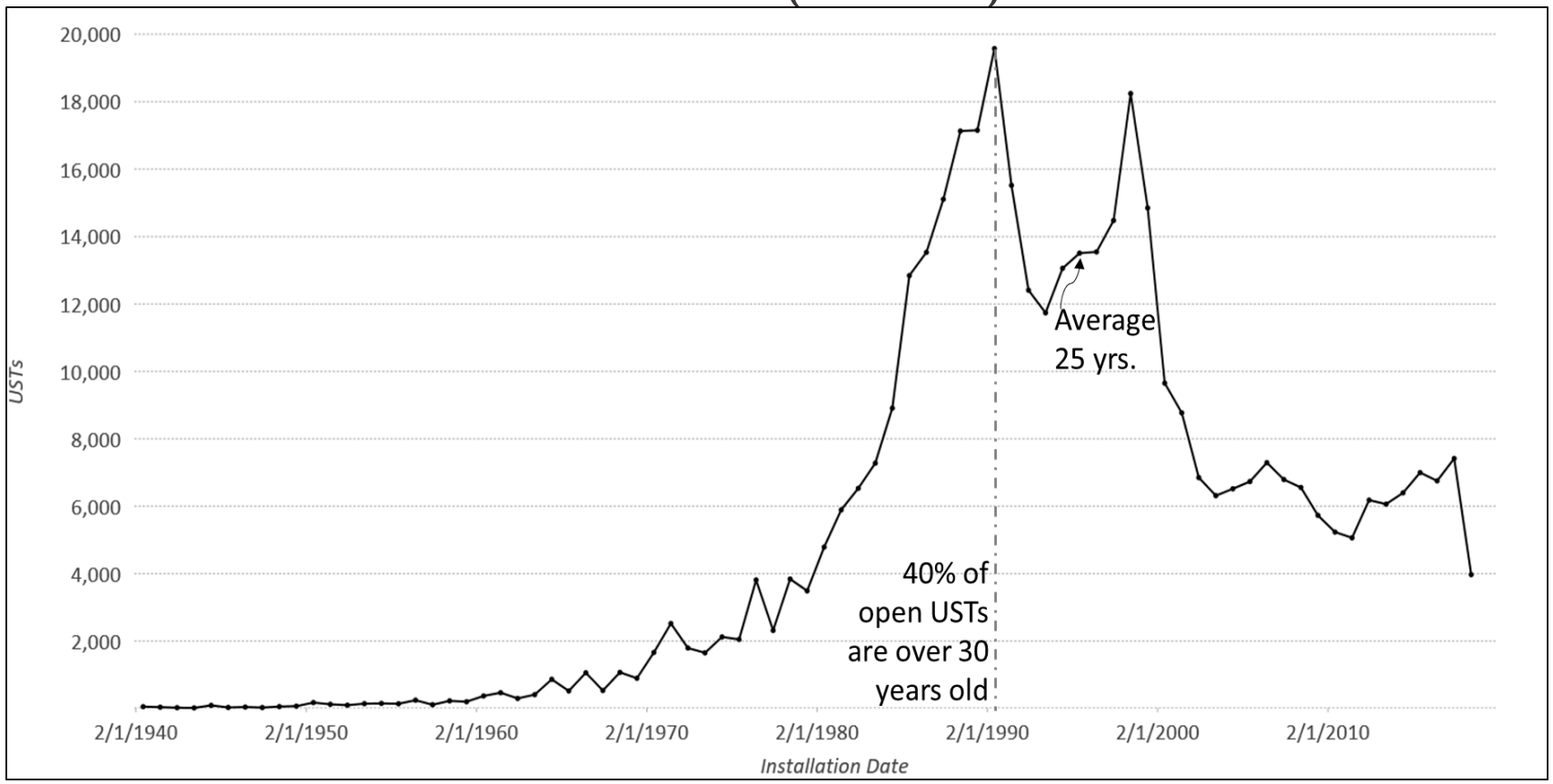
Infrastructure Data – National Overview

UST Age

Most manufacturer warranties cover USTs for 30 years. And many people within the petroleum industry believe properly maintained USTs can provide dependable service for 30 years or more. That notwithstanding, those views are likely now out of sync with the insurance industry. According to the Association of State and Territorial Solid Waste Management Officials' (ASTSWMO) Guide to Tank Insurance, "Some insurers have made a blanket decision not to sell insurance for tanks over 20 years of age, and even more importantly, not to renew any policies with tanks in excess of 26 years of age.

-Aging Underground Storage Tanks-Is 25 the New 30

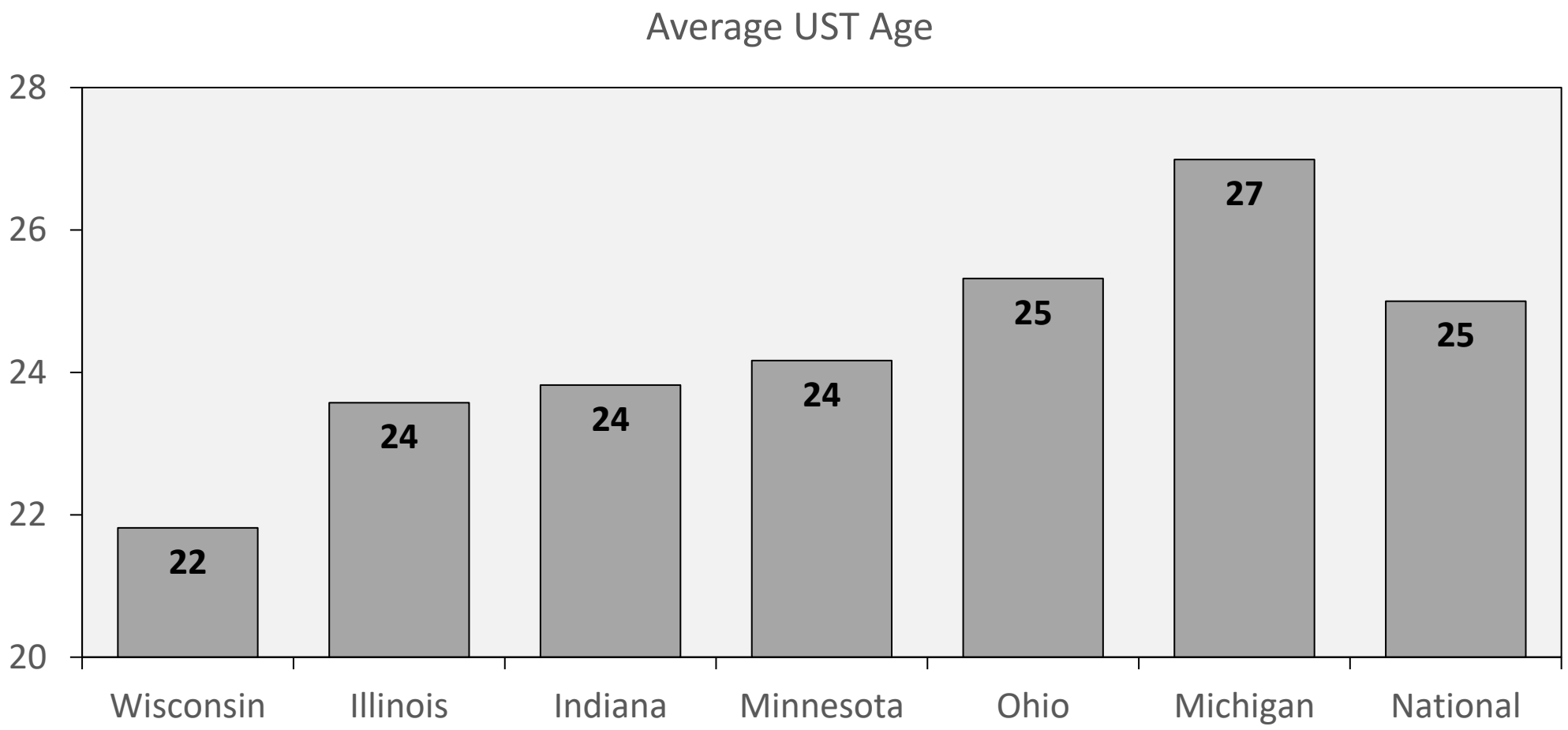
Installation Date of In-Use USTs (n=415k)



https://fuelsmarketnews.com/aging-underground-storage-tanks-is-25-the-new-30/

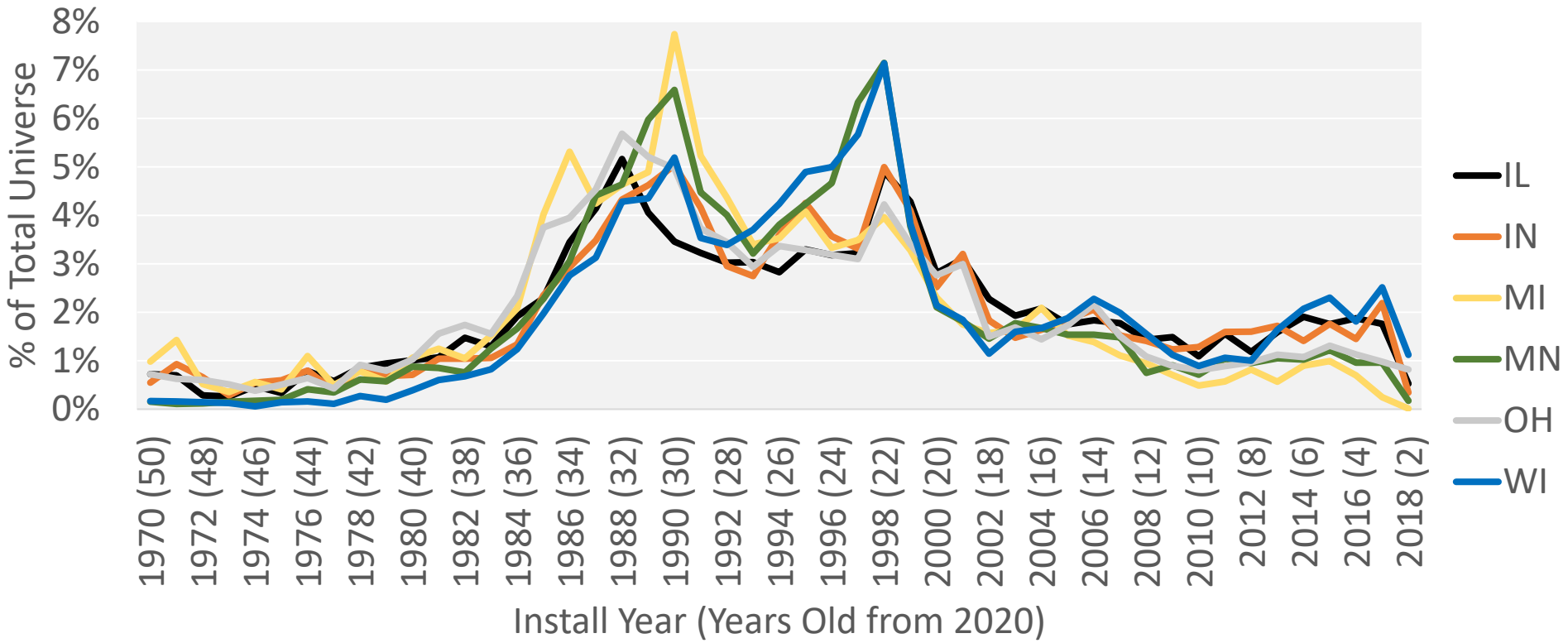
Infrastructure Data – National and R5 Overview

UST Age



Infrastructure Data

UST Age

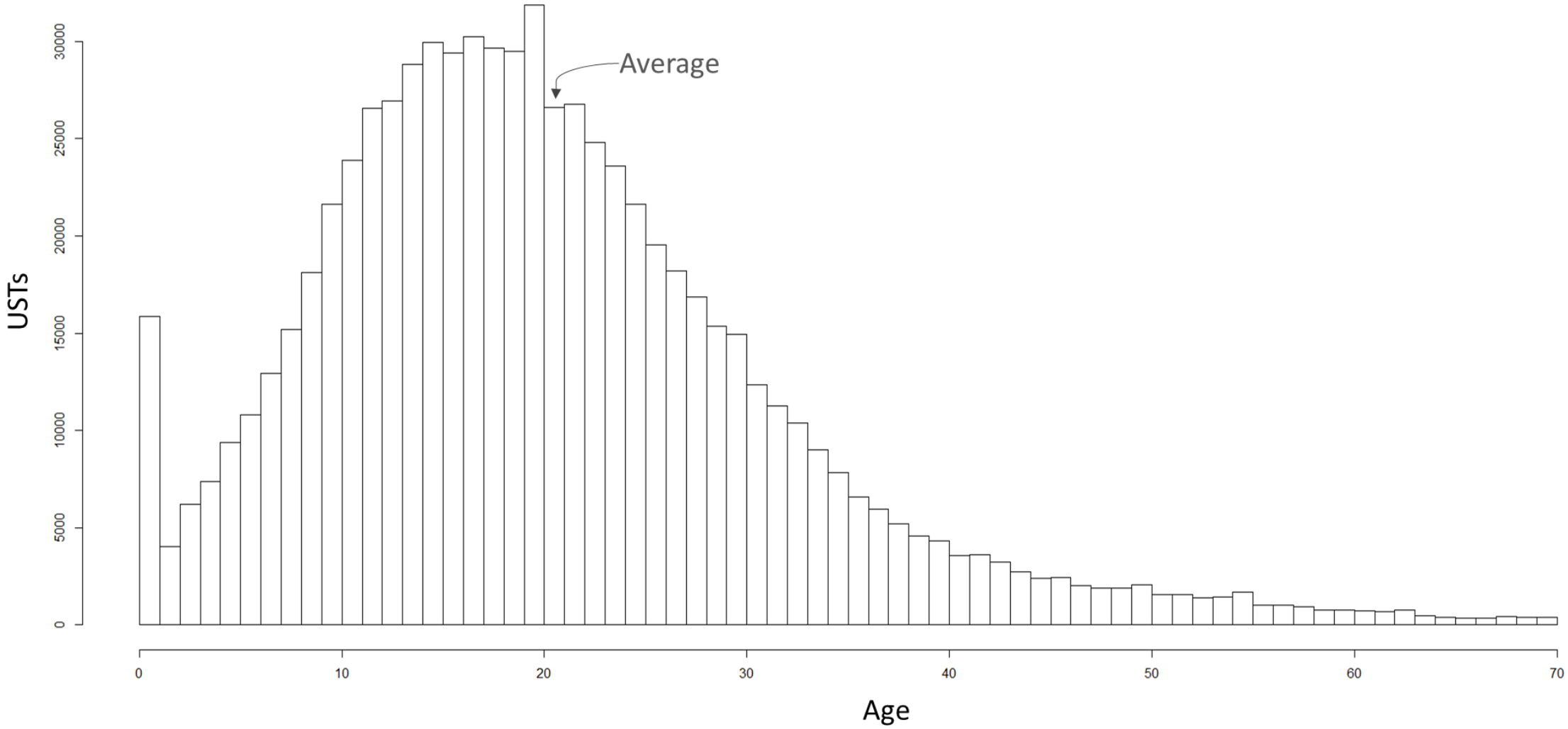


State	% Tanks >30 Years Old in 2020	% Tanks >30 Years Old in 2025*	% Tanks >30 Years Old in 2030*
IL	35	51	69
IN	34	52	70
MI	45	66	82
MN	35	55	79
OH	42	59	76
WI	27	47	70
*assuming no new installs or closures			

Infrastructure Data – National Overview

UST Lifespan

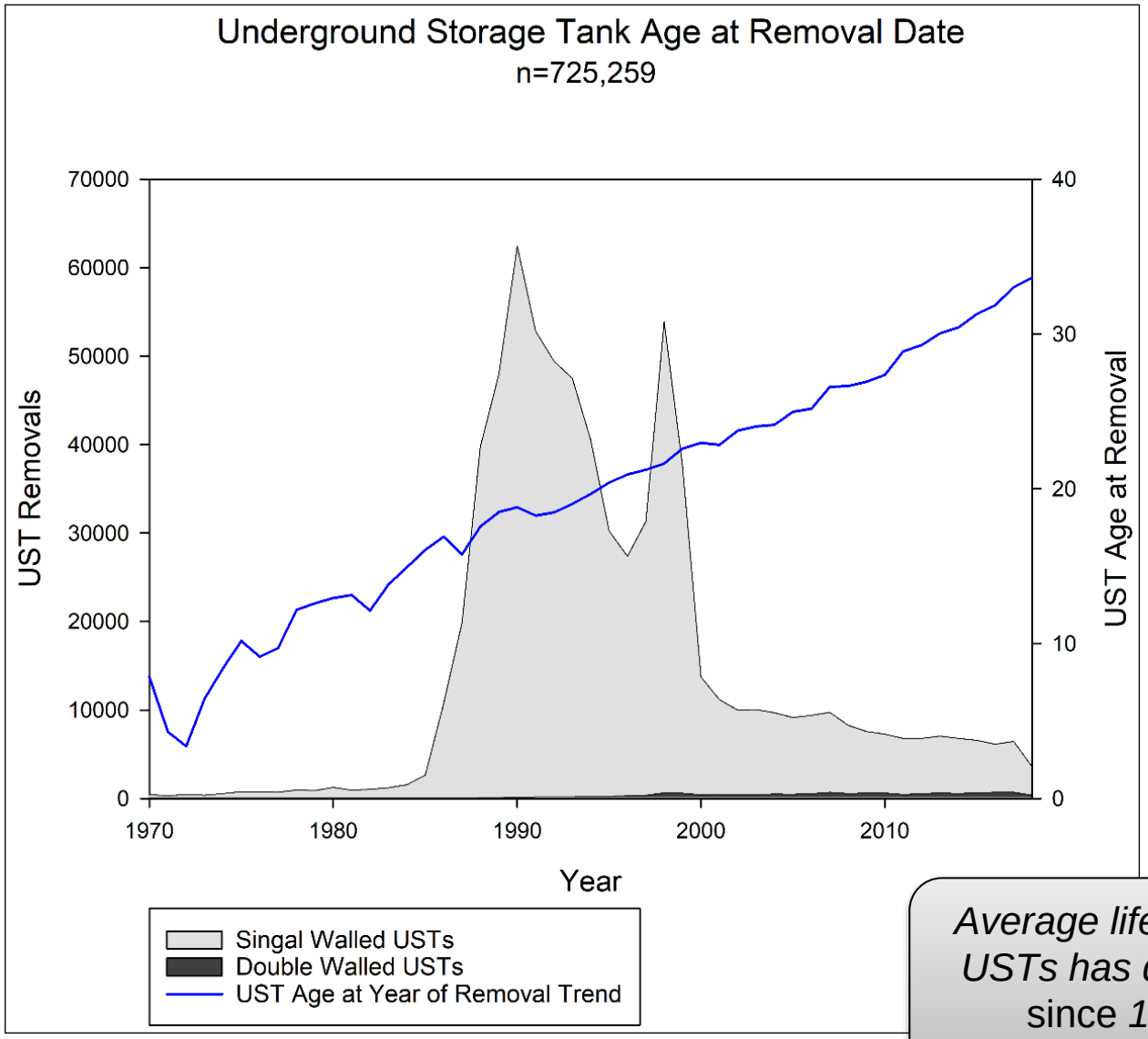
Historical UST Lifespan | Removal Date – Installation Date (n=736,757)



Infrastructure Data

UST Lifespan

National

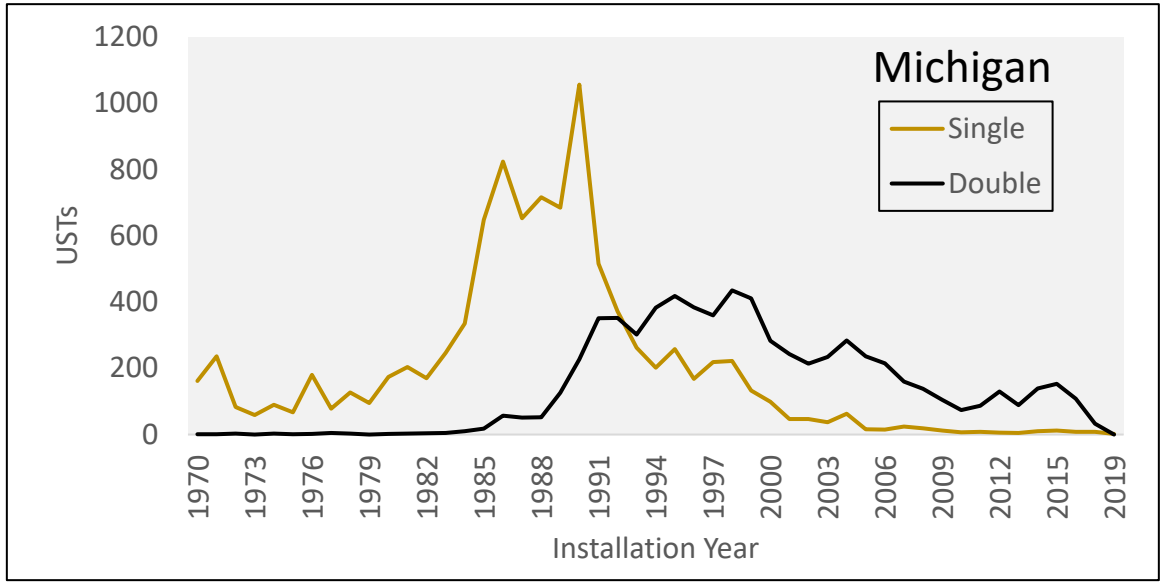


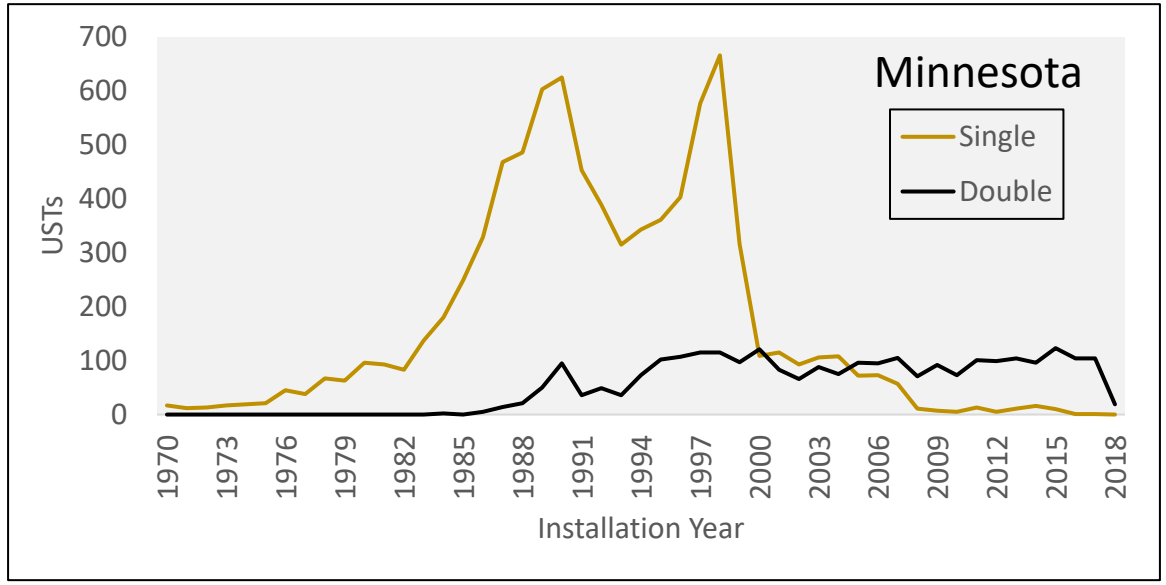
Average lifespan of USTs has doubled since *1989*

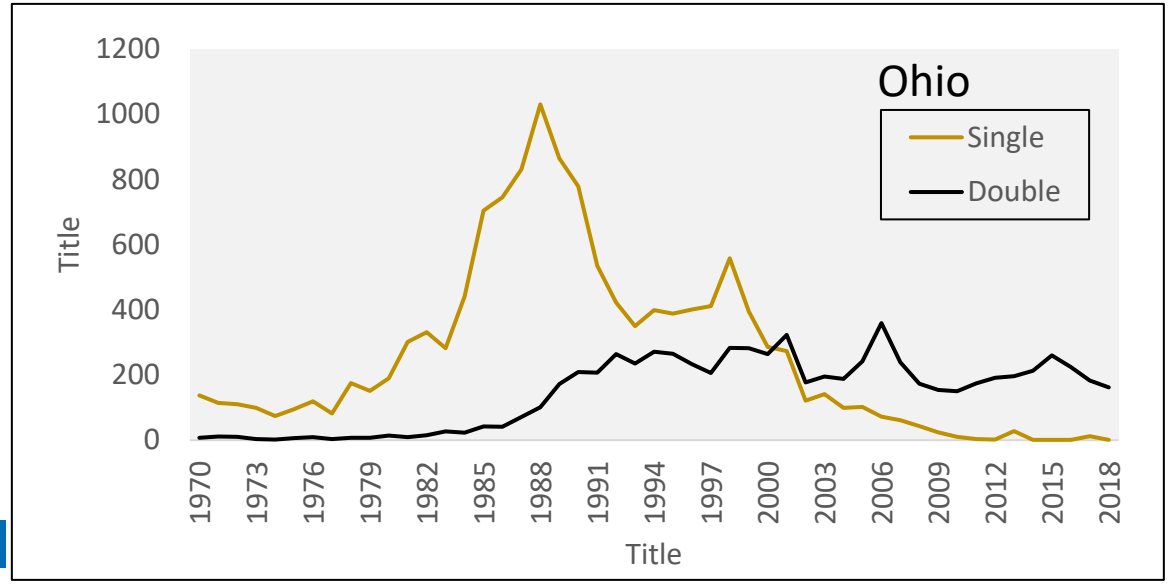
Infrastructure Data –States

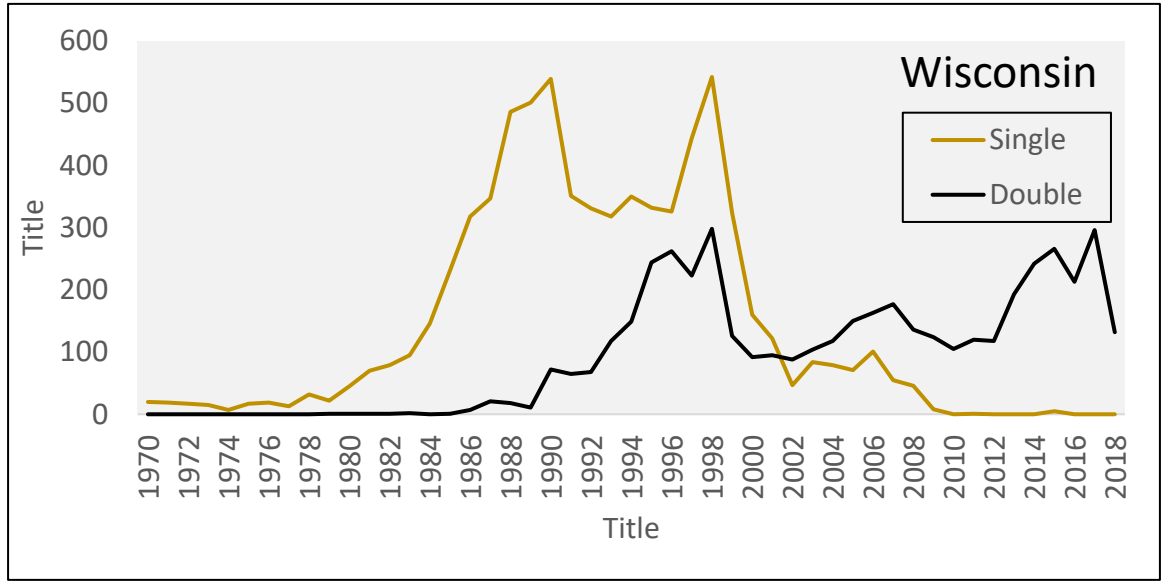
Wall Types

Count of Single vs Double Wall Installations by Installation Year for Active USTs



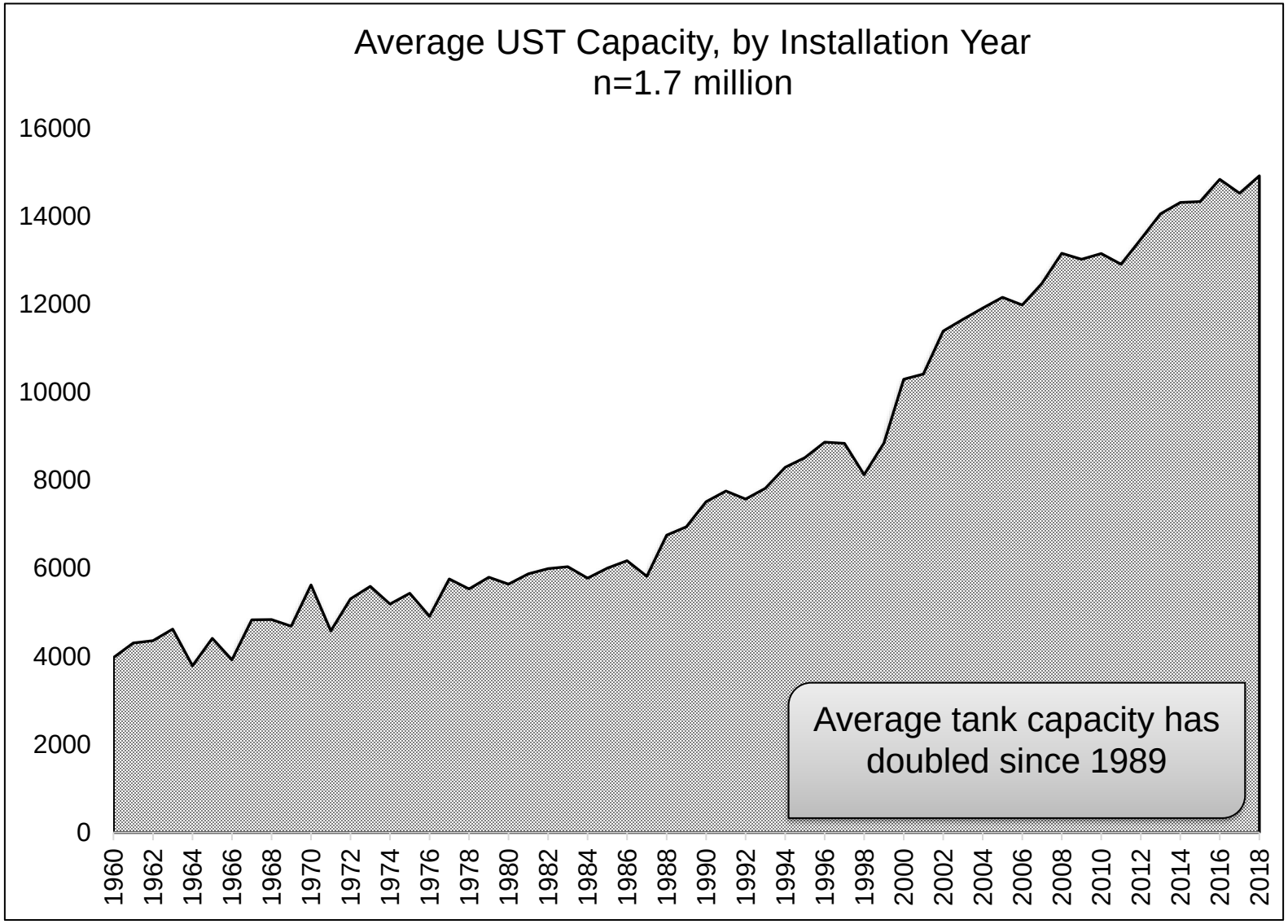






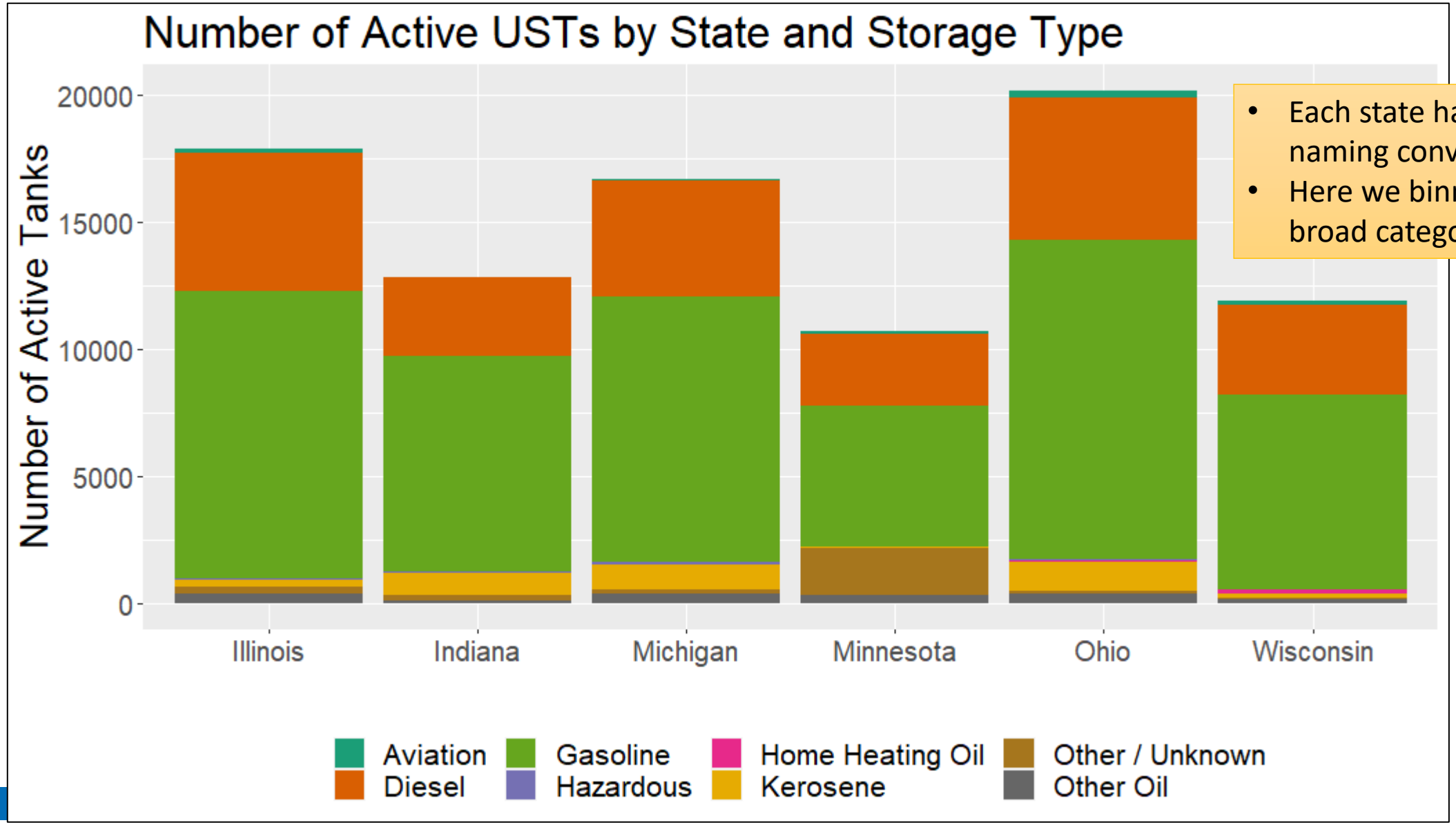
Infrastructure Data –National Overview

Capacity



Infrastructure Data

Fuel Types



- Each state has its own fuels naming convention
- Here we binned the fuels by broad categories

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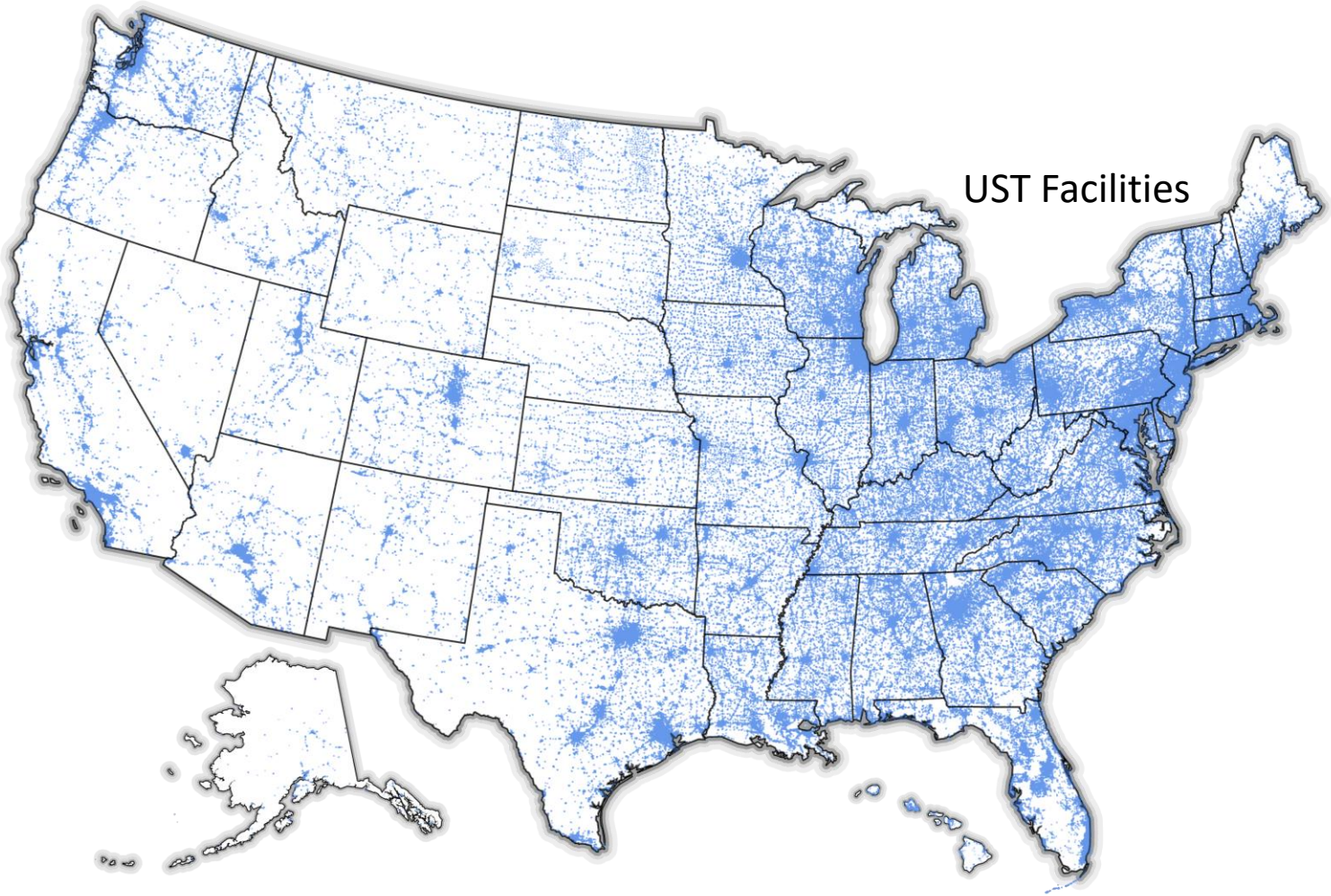
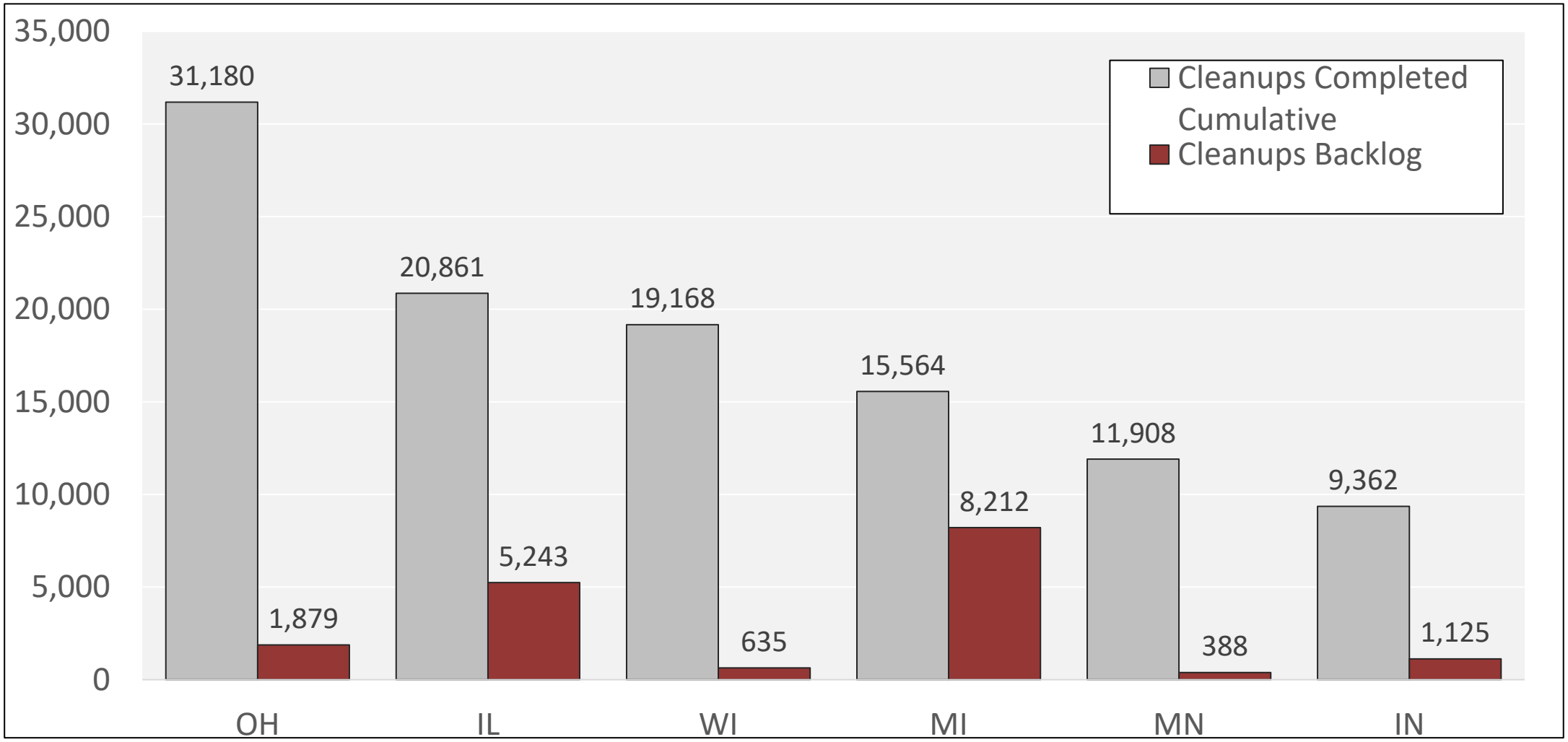


Corrective Actions-Region 5

LUST Corrective Actions (End of Year 2020



Data from: https://www.epa.gov/ust/ust-performance-measures

Assessing Risk

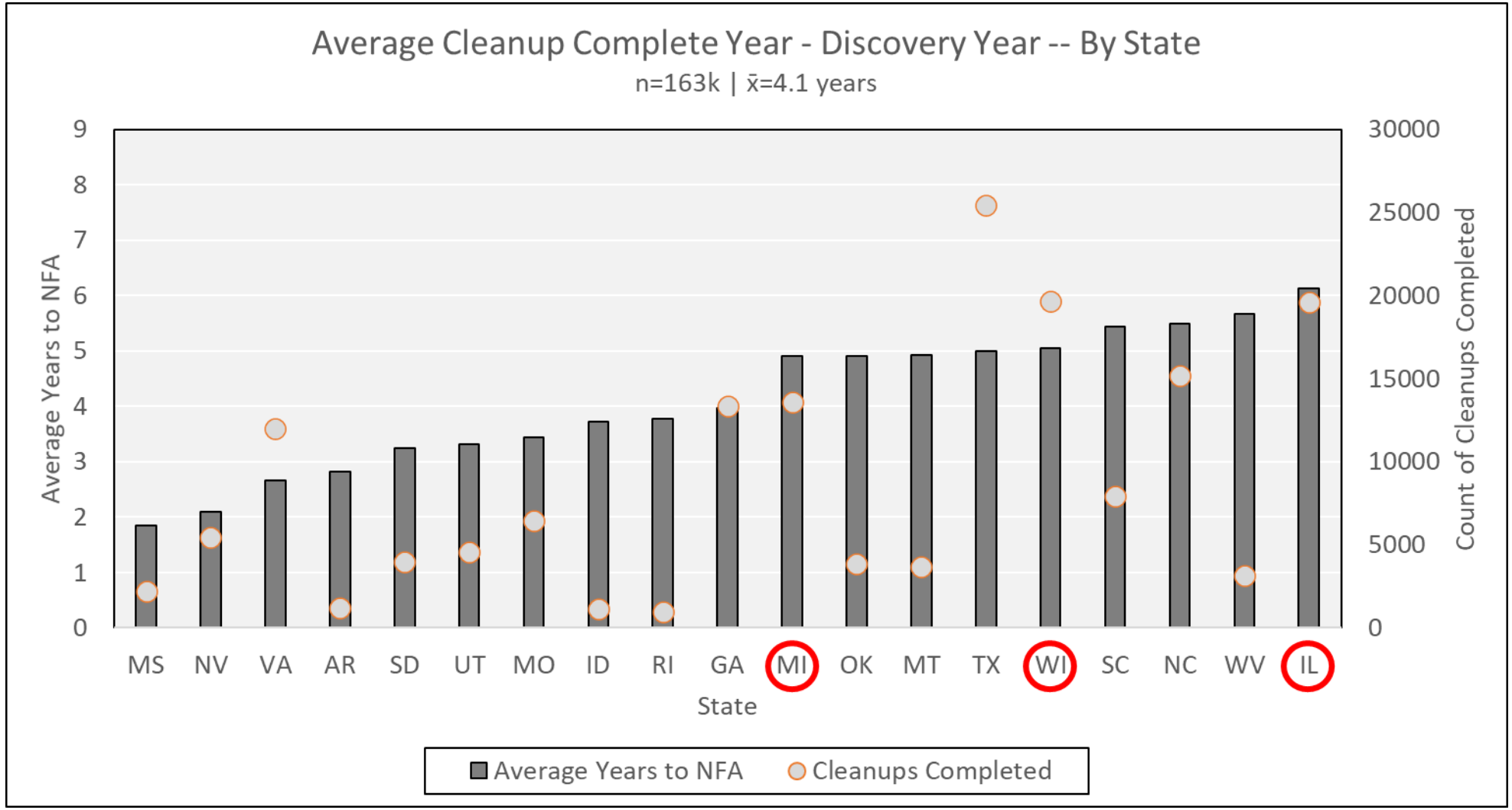
For every UST installed what is the likelihood it will become a LUST?

For every UST installed what is the is its exposure potential?

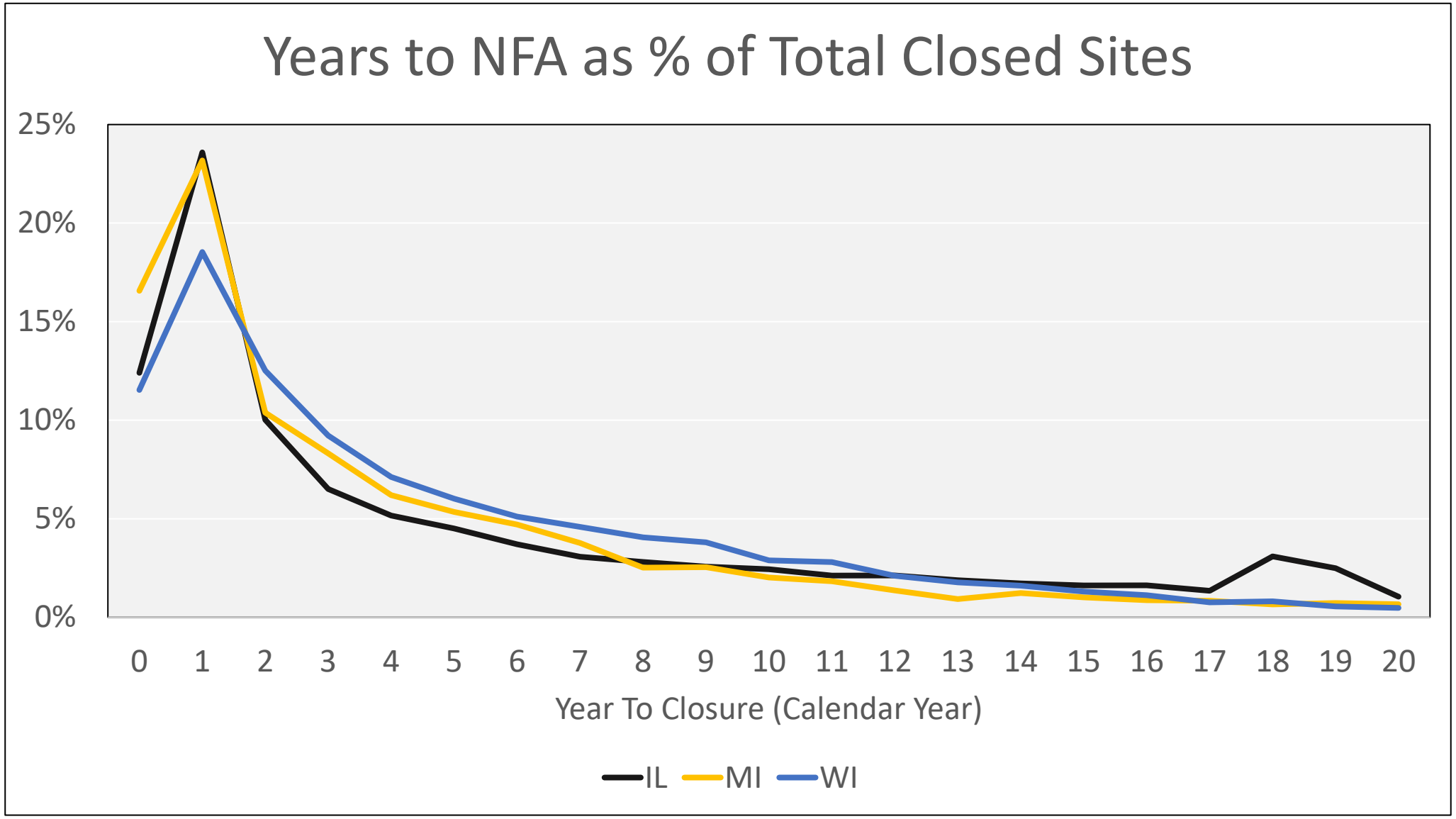
State	Average Annual Ratio Between Open USTs to Confirmed Releases (2011-2020)	Average Annual Ratio Between Open USTs to Cleanup Backlog (2011-2020)
MN	83:1	33:1
WI	157:1	13:1
MI	102:1	2:1
IL	59:1	4:1
IN	85:1	8:1
OH	46:1	11:1
National Average	**96:1**	**8:1**

Site Closure

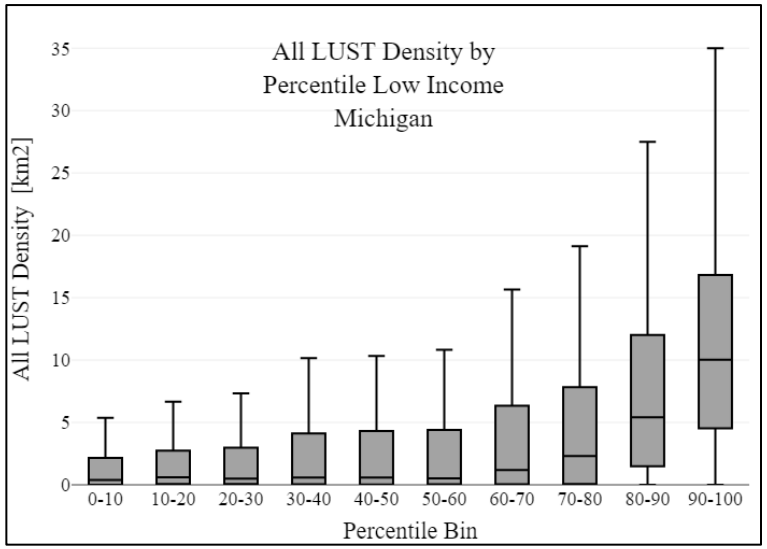
Exposure potential is determined by, in part, average cleanup time



Site Closure

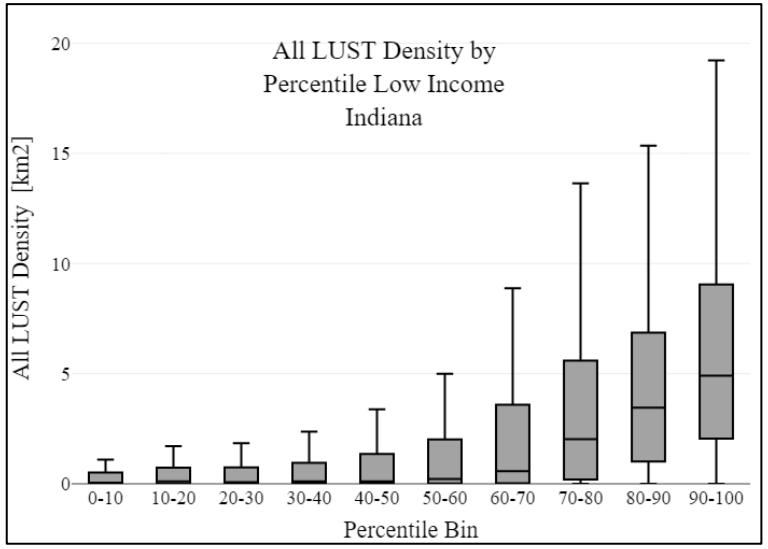


How is the environmental burden of LUST Sites distributed by Income?



Ratio between 90-100 & 0-10 percentile median

26:1



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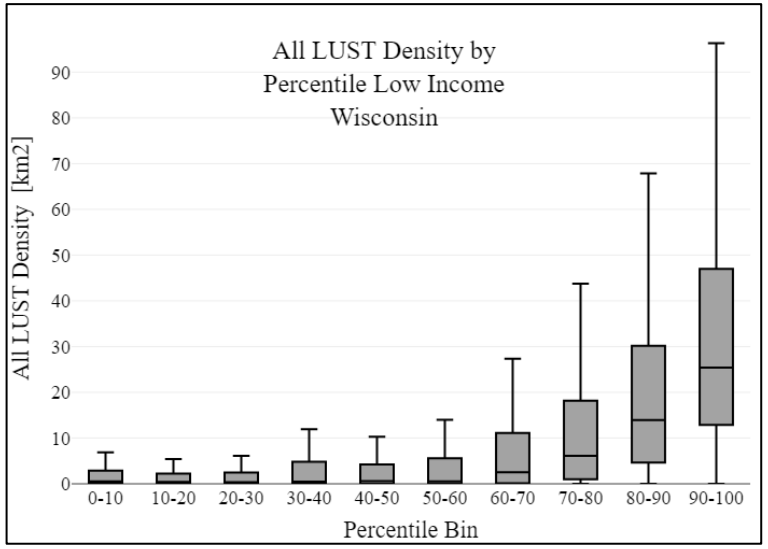
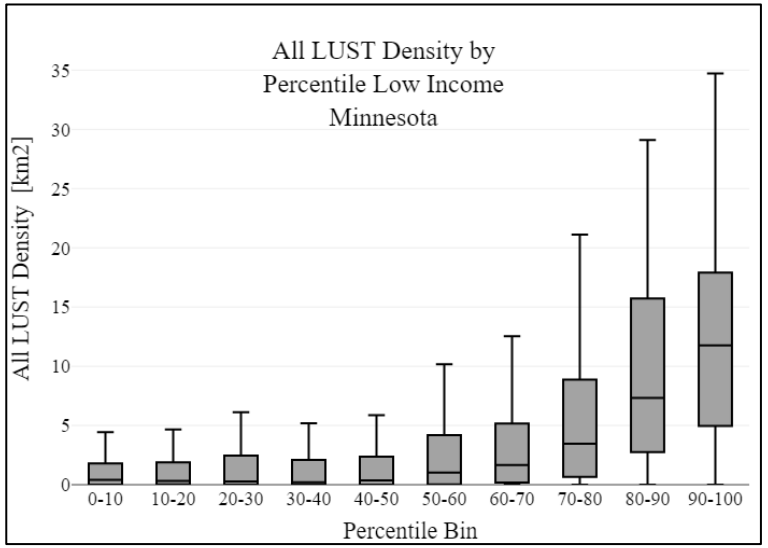
110:1



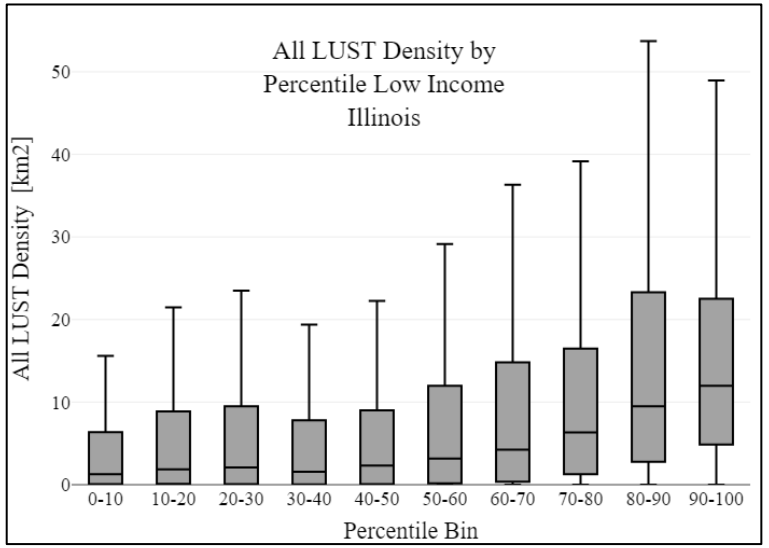
Ratio between 90-100 & 0-10 percentile median

51:1



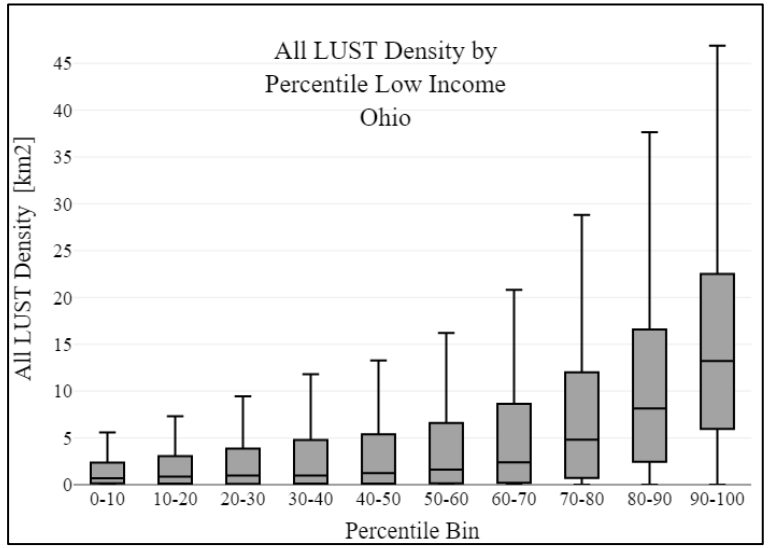
Ratio between 90-100 & 0-10 percentile median

28:1



Ratio between 90-100 & 0-10 percentile median

10:1



Ratio between 90-100 & 0-10 percentile median

19:1

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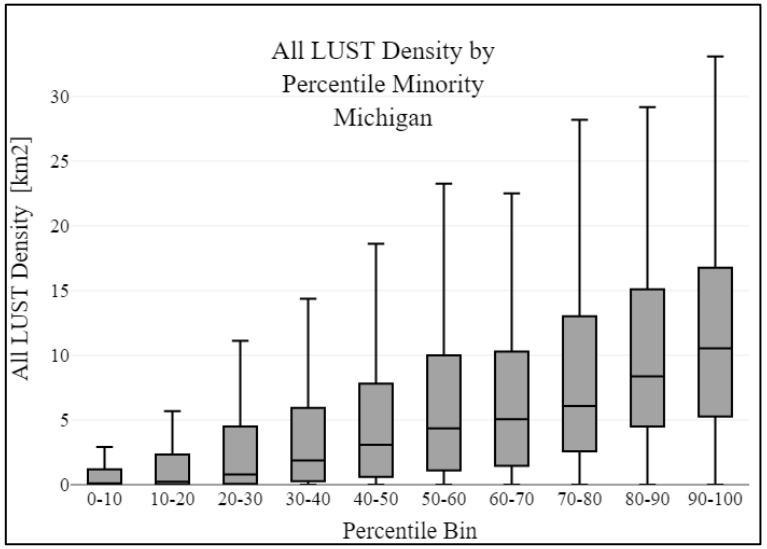
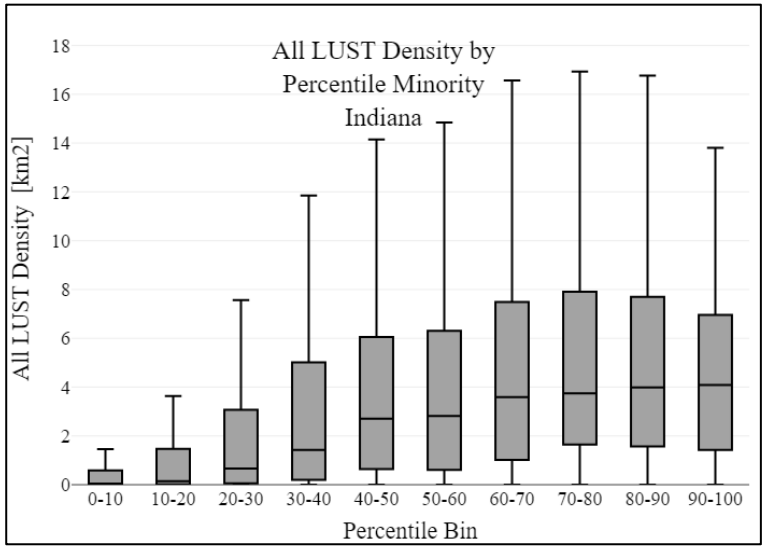


Ratio between 90-100 & 0-10 percentile median

111:1



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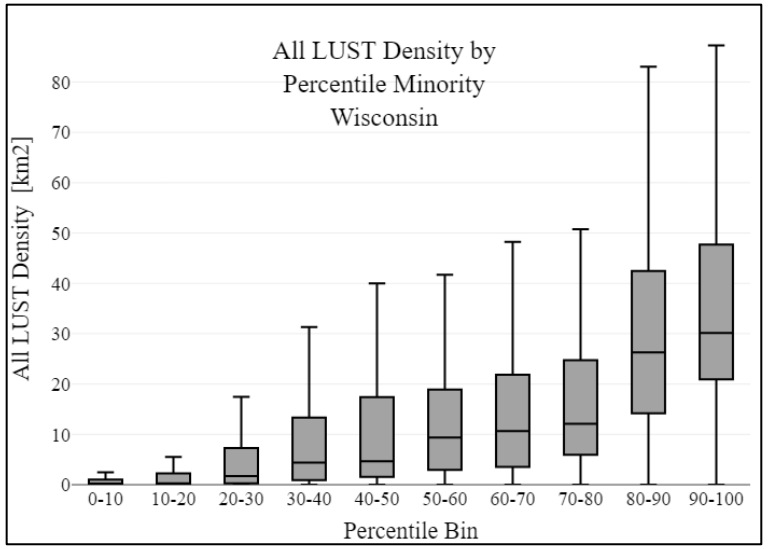
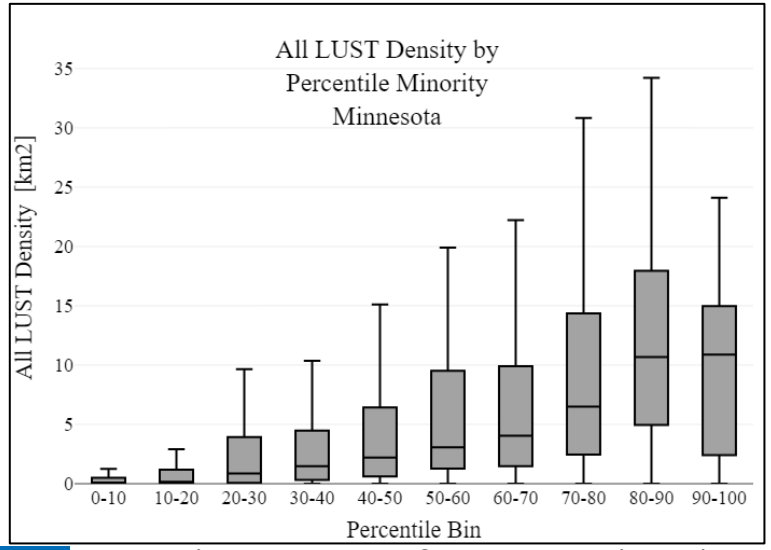
111:1



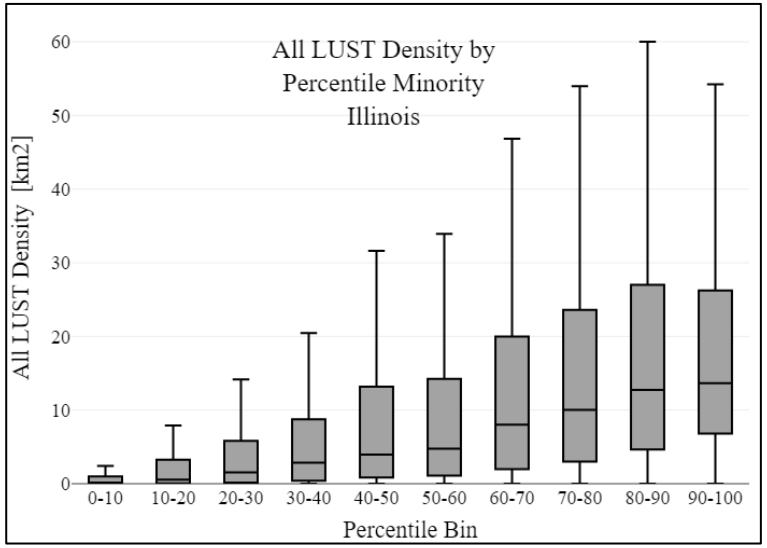
Ratio between 90-100 & 0-10 percentile median

503:1



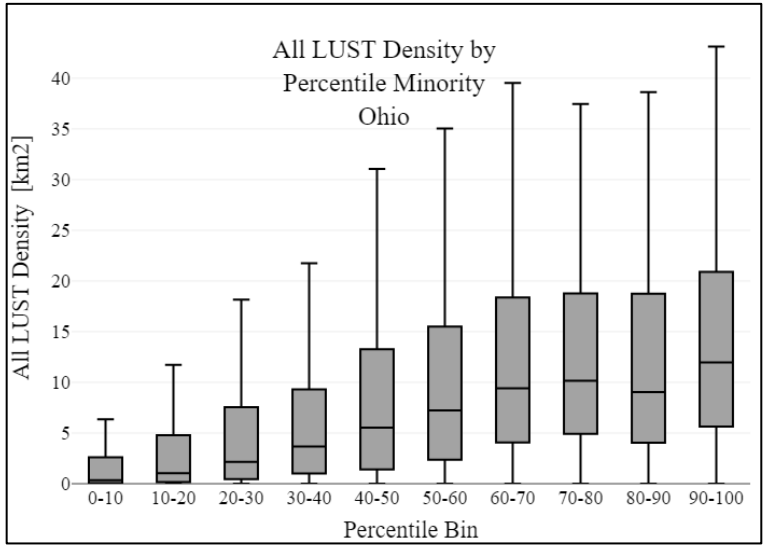
Ratio between 90-100 & 0-10 percentile median

409:1



Ratio between 90-100 & 0-10 percentile median

276:1



Ratio between 90-100 & 0-10 percentile median

35:1

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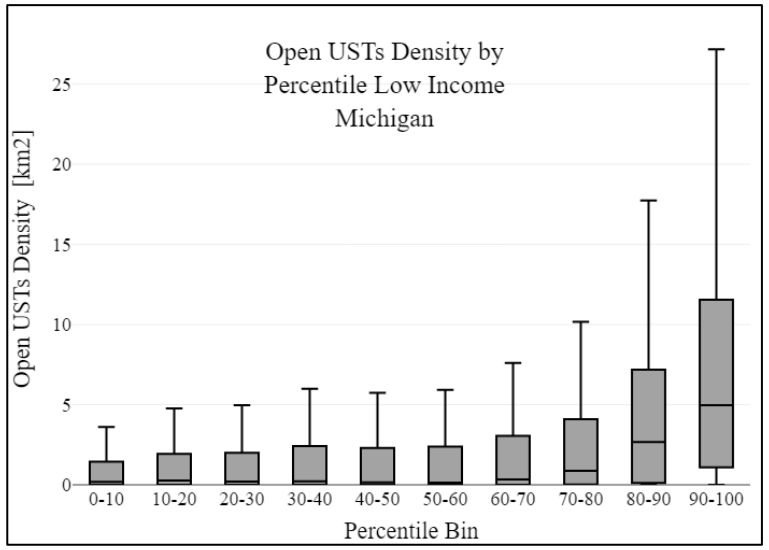

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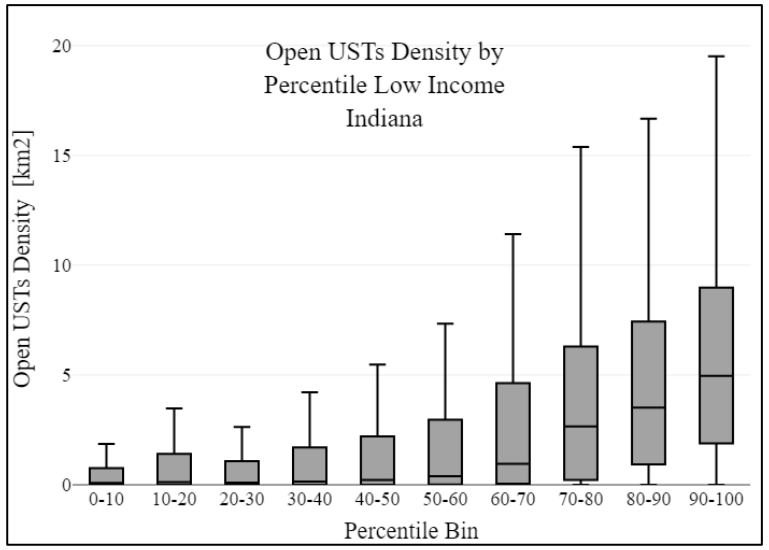
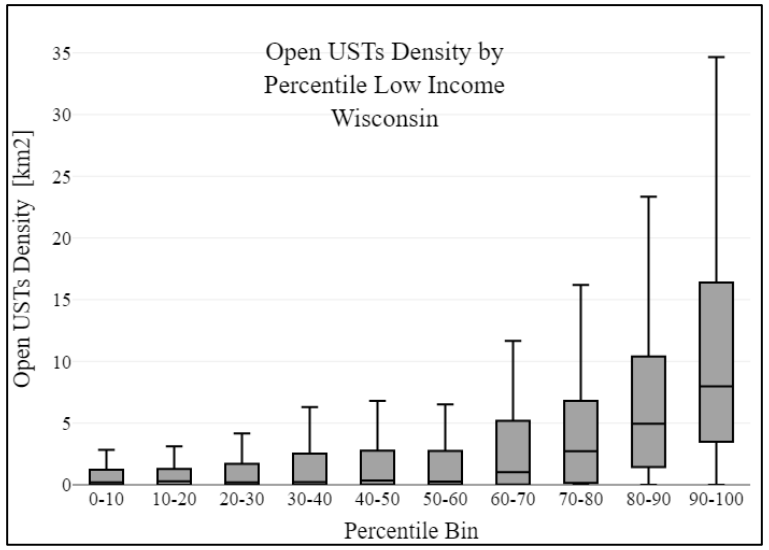


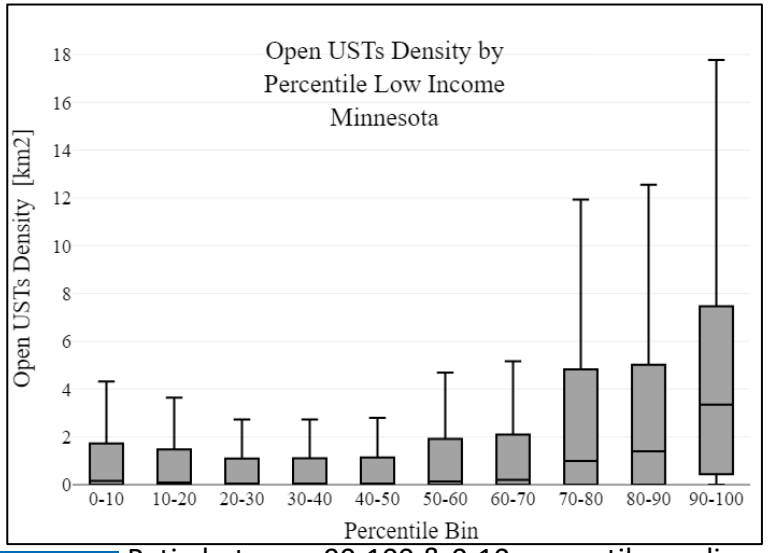
Ratio 90-100 & 0-10 percentile median

59:1



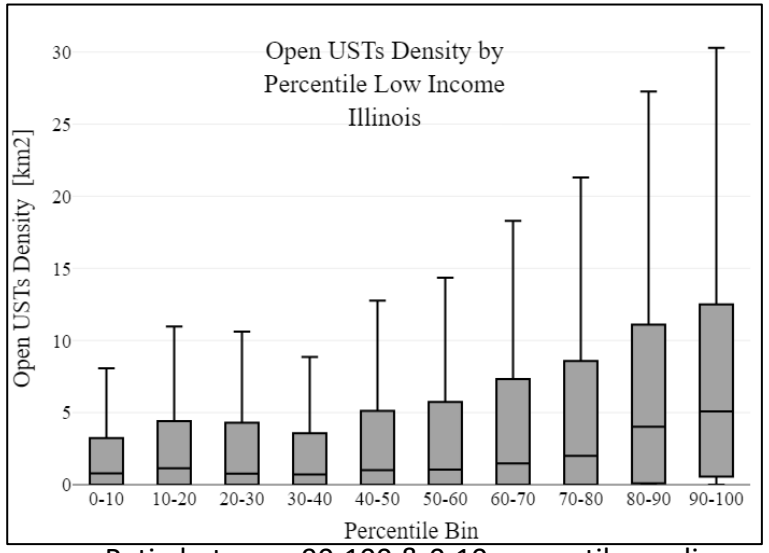
Ratio between 90-100 & 0-10 percentile median

41:1



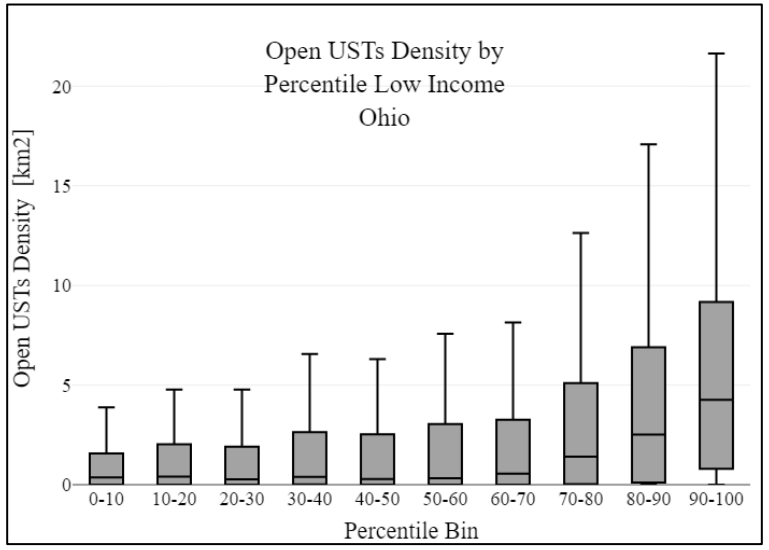
Ratio between 90-100 & 0-10 percentile median

21:1



Ratio between 90-100 & 0-10 percentile median

6:1



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12:1

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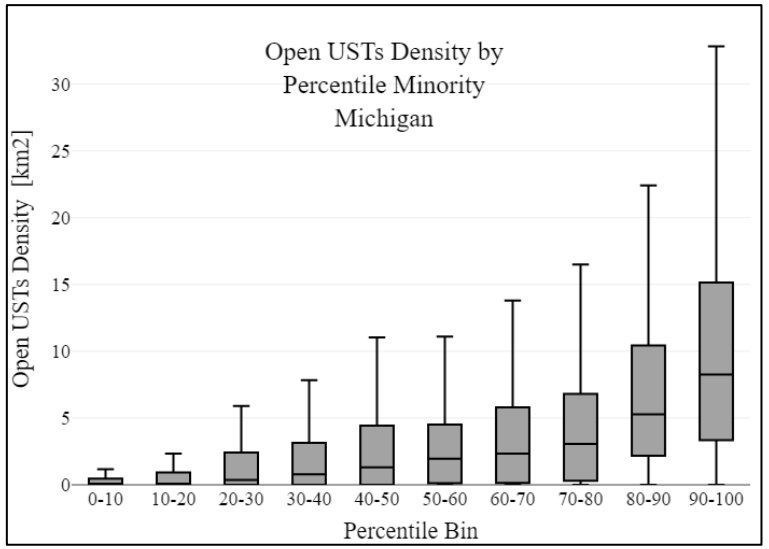
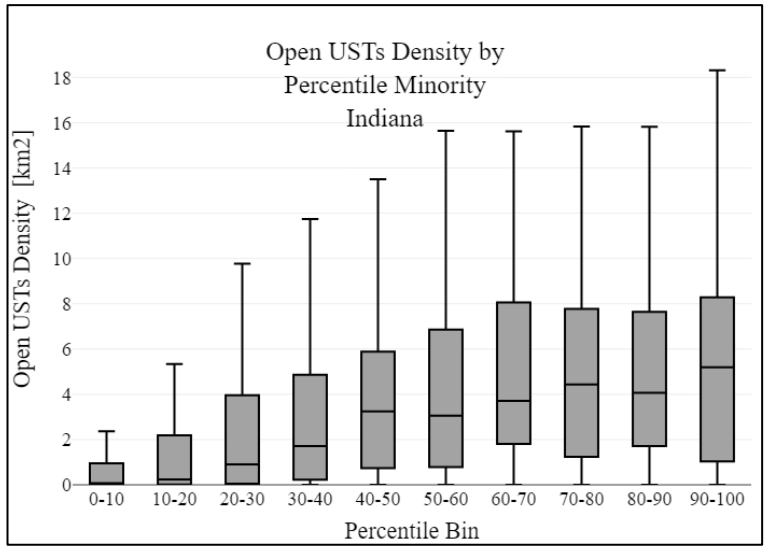


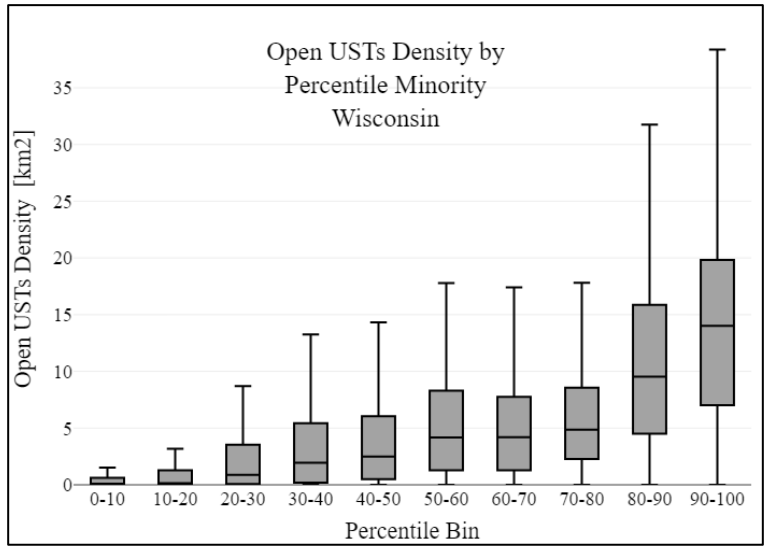
Ratio between 90-100 & 0-10 percentile median

264:1



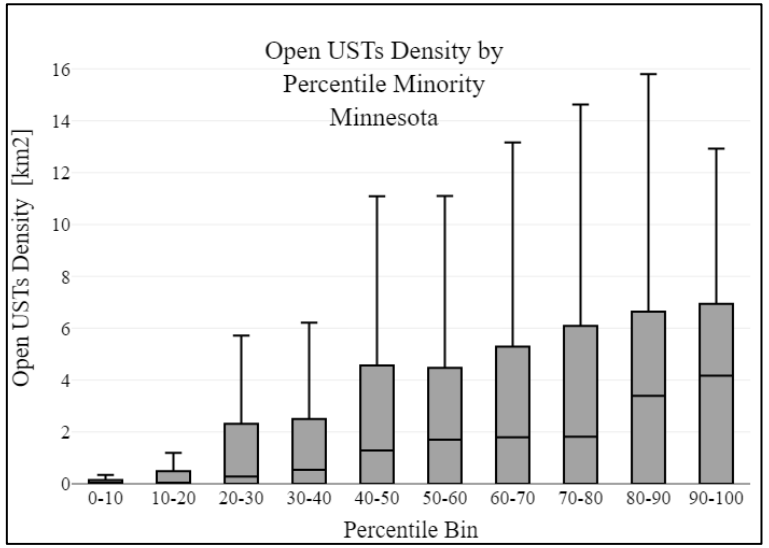
Ratio between 90-100 & 0-10 percentile median

73:1



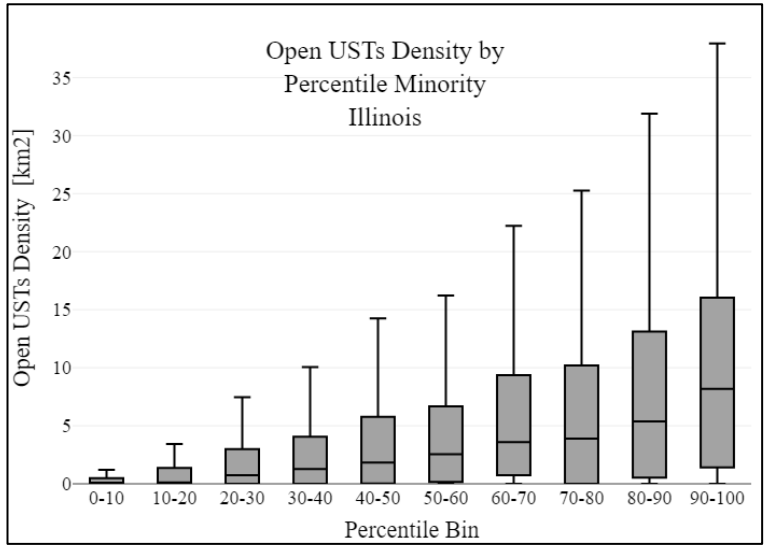
Ratio between 90-100 & 0-10 percentile median

297:1



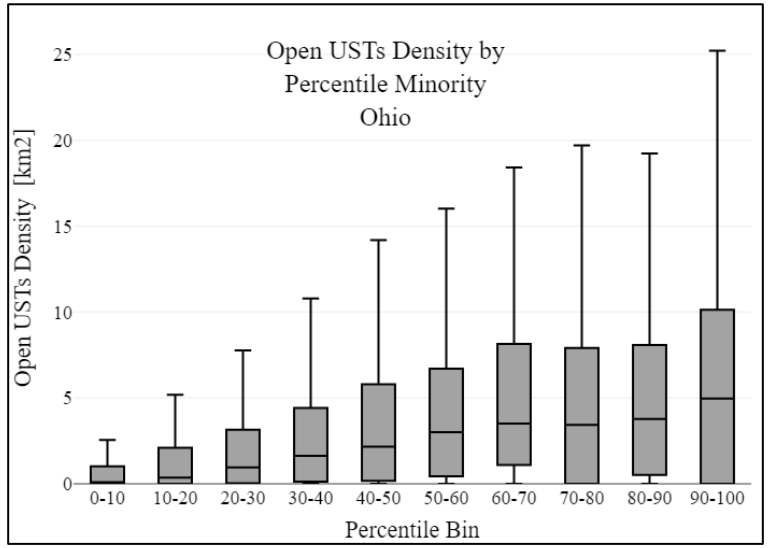
Ratio between 90-100 & 0-10 percentile median

322:1



Ratio between 90-100 & 0-10 percentile median

274:1



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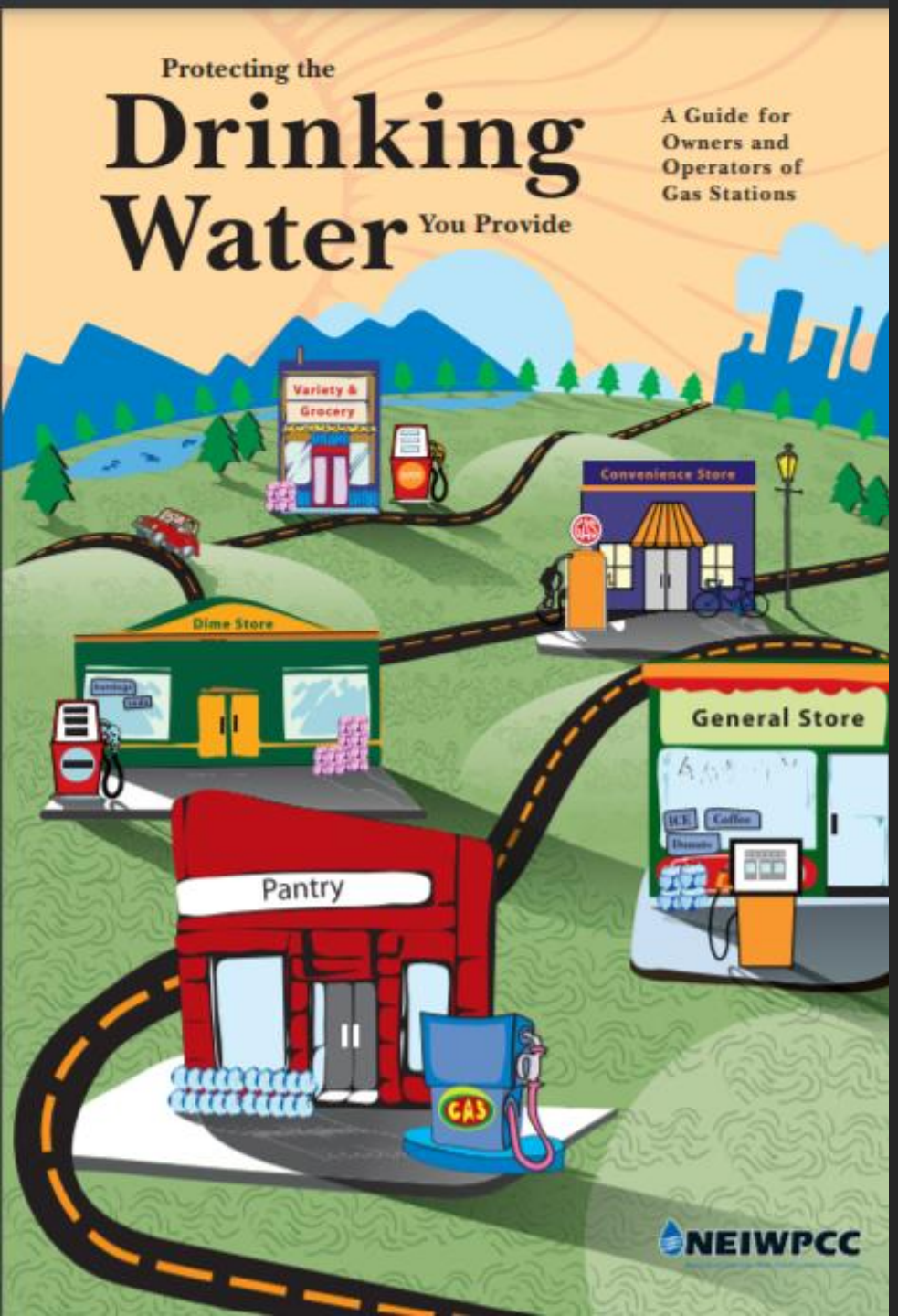


Assessment of impacts – public and private water supplies

Fuel Composition

Fuel Unit	Gasoline (mg L^{-1})	E85 (mg L^{-1})	E85/Gasoline (%)	Diesel (mg L^{-1})	B20 (mg L^{-1})	B20/Diesel (%)
Aromatics						
Benzene	6140	862	14	67	37	55
Toluene	15,400	4110	27	238	214	90
Ethylbenzene	3080	1990	65	124	186	150
p-Xylene, m-xylene	9120	6980	76	420	496	118
o-Xylene	4610	2790	60	185	212	115

Chin, J-Y., and Batterman, S., VOC composition of current motor vehicle fuels and vapors, and collinearity analyses for receptor modeling. Chemosphere. 2012 Mar; 86(9): 951–958.

BTEX - MCLs and Fuel Composition

Component	MCL (mg/L)	Gasoline Fuel Composition (mg/L)	Ratio of fuel composition/MCL
benzene	0.005	6140	1,228,000
toluene	1	15,400	15,400
ethylbenzene	0.7	3080	4,400
xylene	10	13,730	1373

Initial Dissolved Concentrations of Benzene (ug/L) That Can Be Degraded to MCL (5ug/L) Over Time

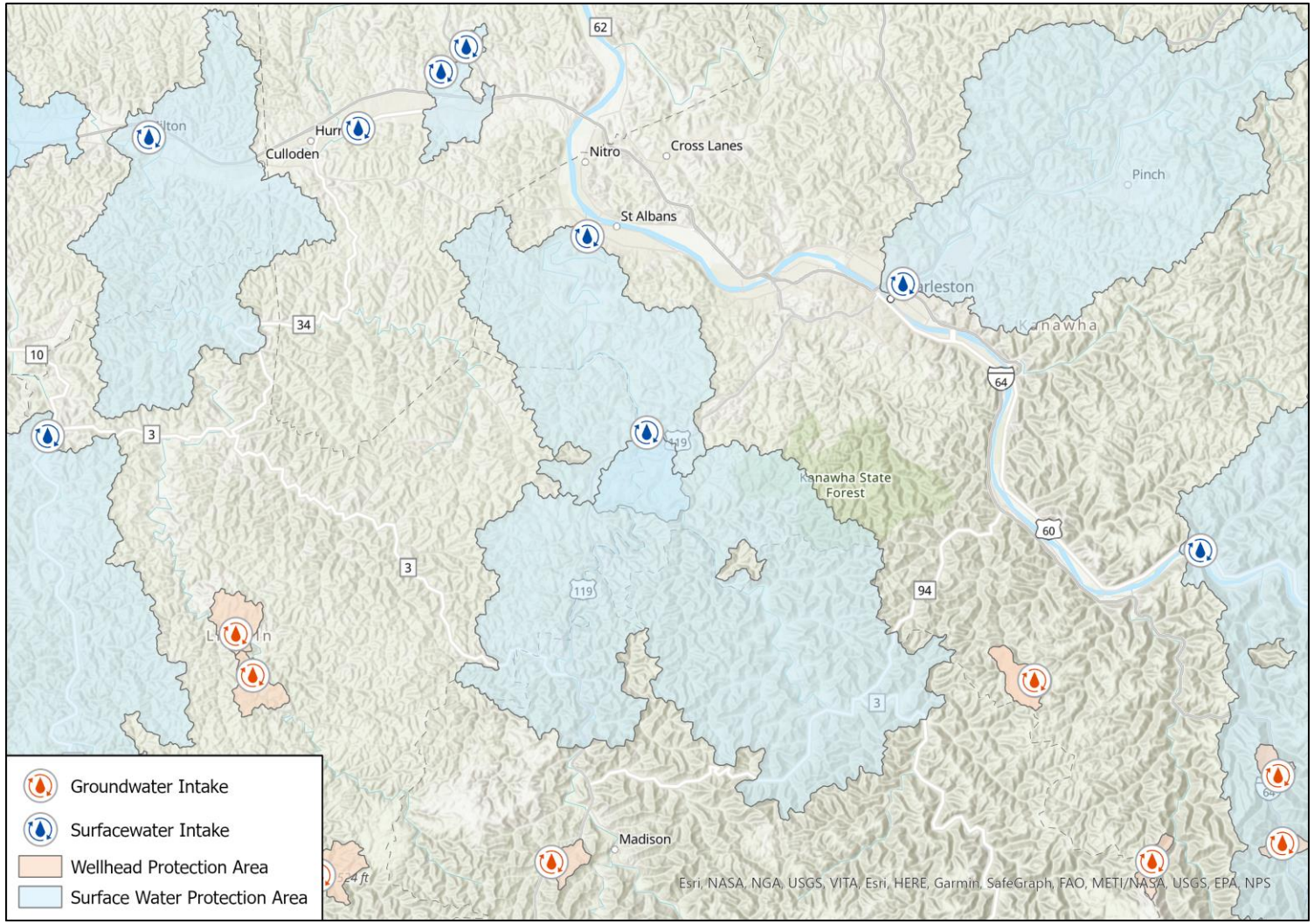
	1 year	2 years	5 years	10 years
Remediated source	11	25	280	15,000
Non-remediated source	6	7	10	20

USEPA, How to Evaluate Alternative Cleanup Technologies for Underground Storage Tanks, Chapter IX, Monitored Natural Attenuation, 2017, EPA 510-B-17-003.

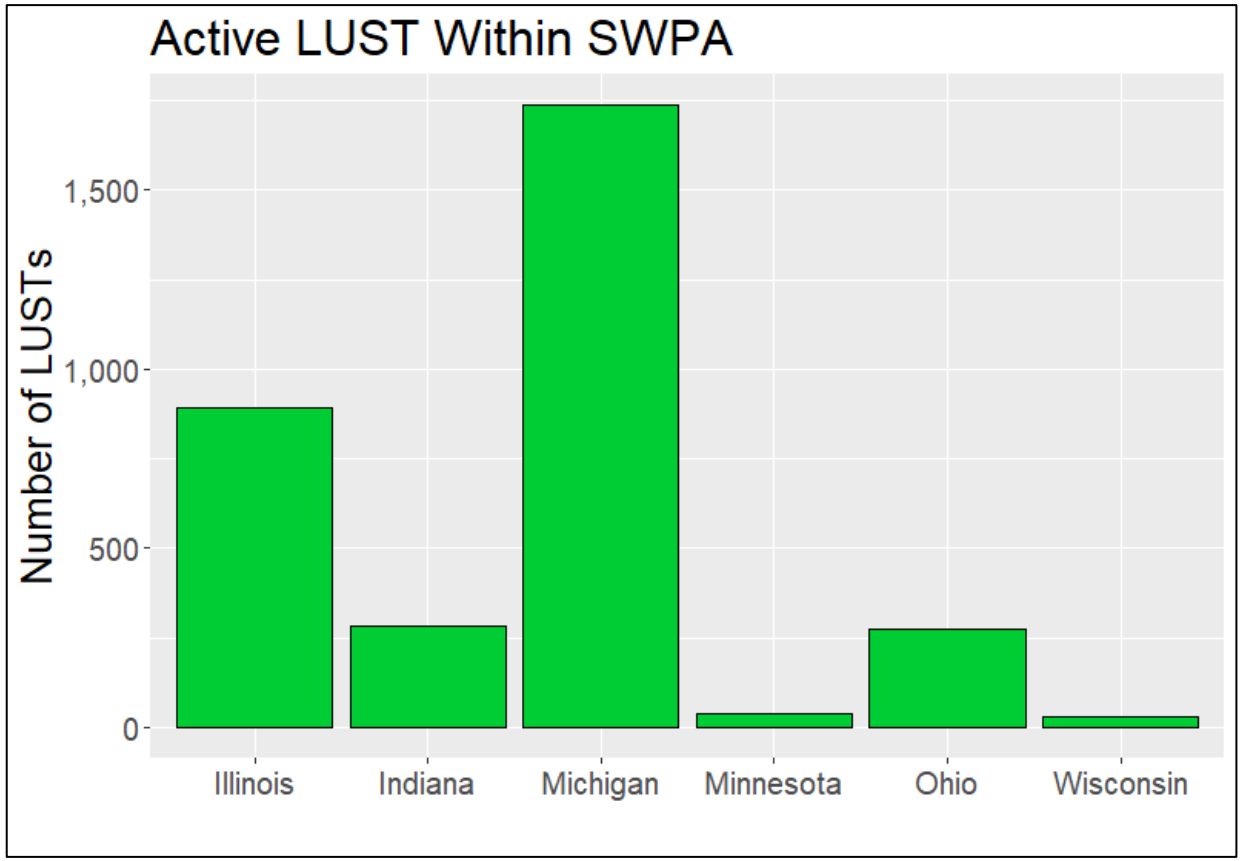
Benzene odor threshold – 60 ppm
Benzene taste threshold – 0.6 to 4.5 ppm
https://www.atsdr.cdc.gov/sites/toxzine/benzene_toxzine.html

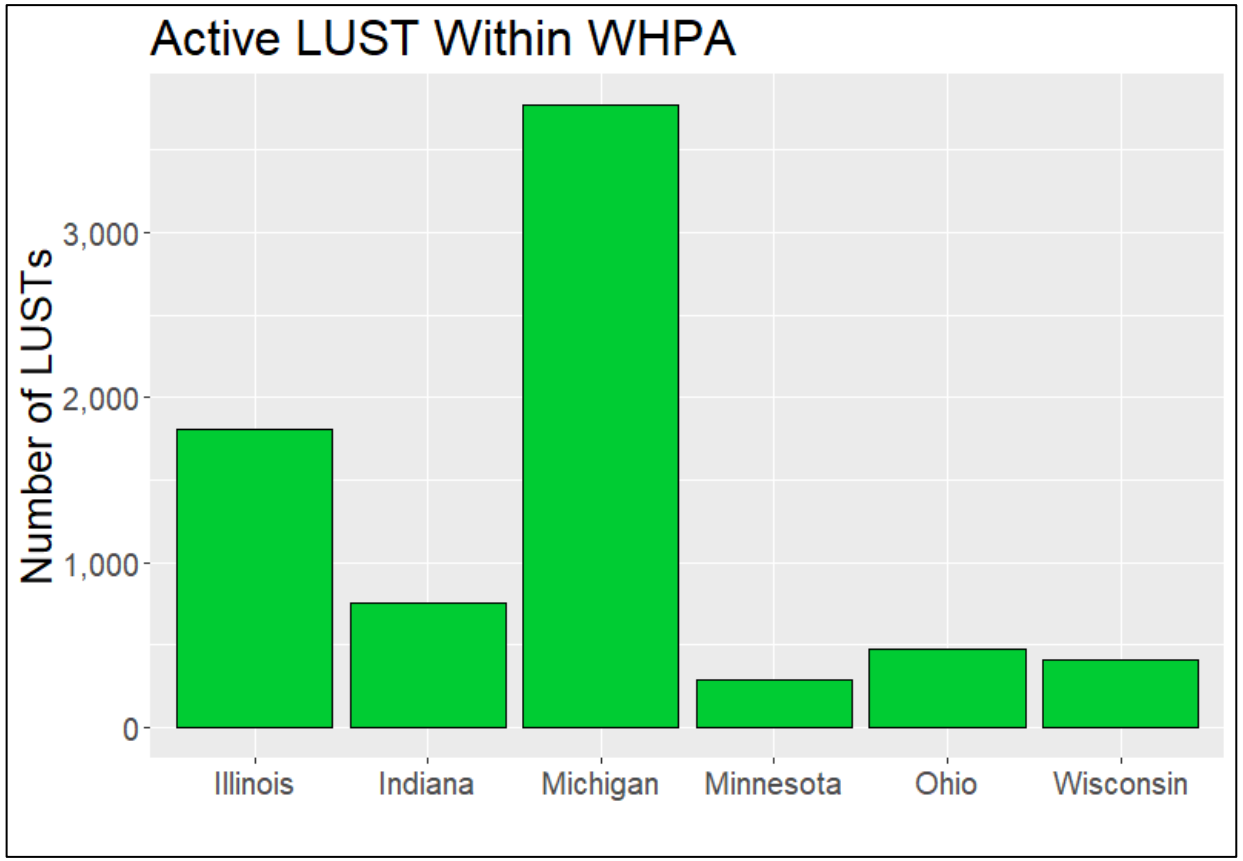
Source Water Protection Areas
Data Layer in UST Finder

- Information on ground water and surface water intakes is not available to the public
- However, if a contaminated site falls within a surface or wellhead protection area we can communicate that information to the public via UST Finder

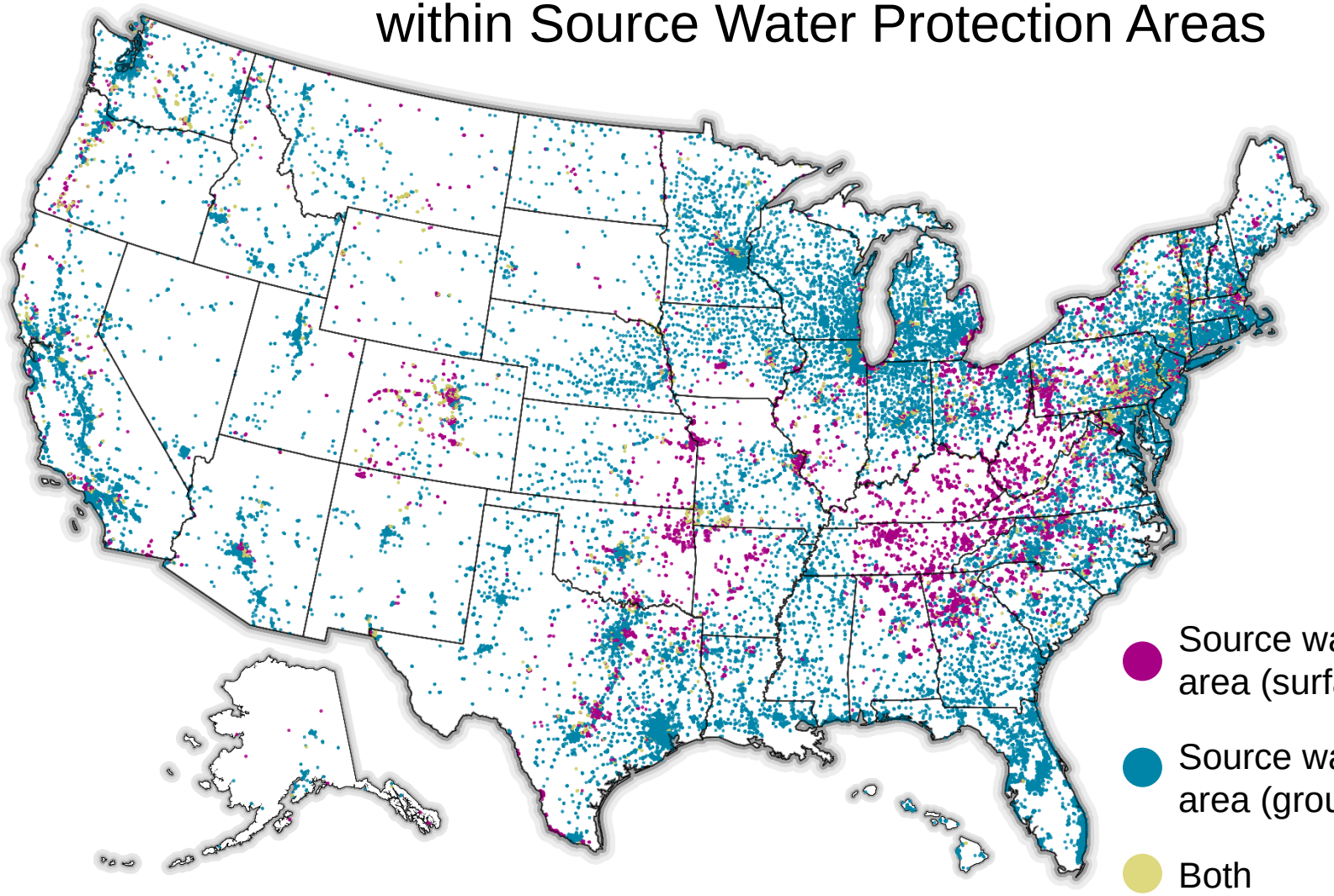


LUSTs within EPA Delineated Public Drinking Water Protection Areas





Underground Storage Tank Facilities within Source Water Protection Areas



- 210k active USTs are within a source water protection area
- 64k USTs within surface water protection areas
- 163k USTs within groundwater protection areas

United States Environmental Protection Agency

Public Drinking Water Supplies

- The larger the water system, the better its financial profile and monitoring record.
- Small water systems more than three times the per capita infrastructure investment needs of large water systems.
- The smallest water systems had the greatest percentage of monitoring and reporting violations
- Small systems not as robust monitoring systems, concerns about unmeasured water quality violations.
- Few small systems participate in wellhead or source water protection programs

US Environmental Protection Agency (USEPA), National Drinking Water Advisory Council Small Systems Implementation Working Group. 1999. National Characteristics of Drinking Water Systems serving Populations under 10,000. EPA 816-R-99-010. Washington, DC.

Transient Non-Community Water Systems (TNCWS) Gas Stations, Restaurants, Hotels

- Very small water systems specifically defined as a publicly or privately owned establishment that provides water to 25 or more people / day but not necessarily the same people every day for more than 60 days / year.
  - If a business has its own well and has the capacity to provide services for at least 25 customers and employees per day, generally called a TNCWS.

- Once a year monitoring

- https://www3.epa.gov/region1/eco/drinkwater/pdfs/SamplingGuideOperatorsVerySmallWaterSystems.pdf

Transient Non-Community Wells

Facilities with Transient Non-Community Water Systems		
Region 5	Facilities	Population Served
Illinois	62	9,894
Indiana	174	40,638
Michigan	272	47,793
Minnesota	120	18,828
Ohio	98	22,447
Wisconsin	422	39,401

United States Environmental Protection Agency

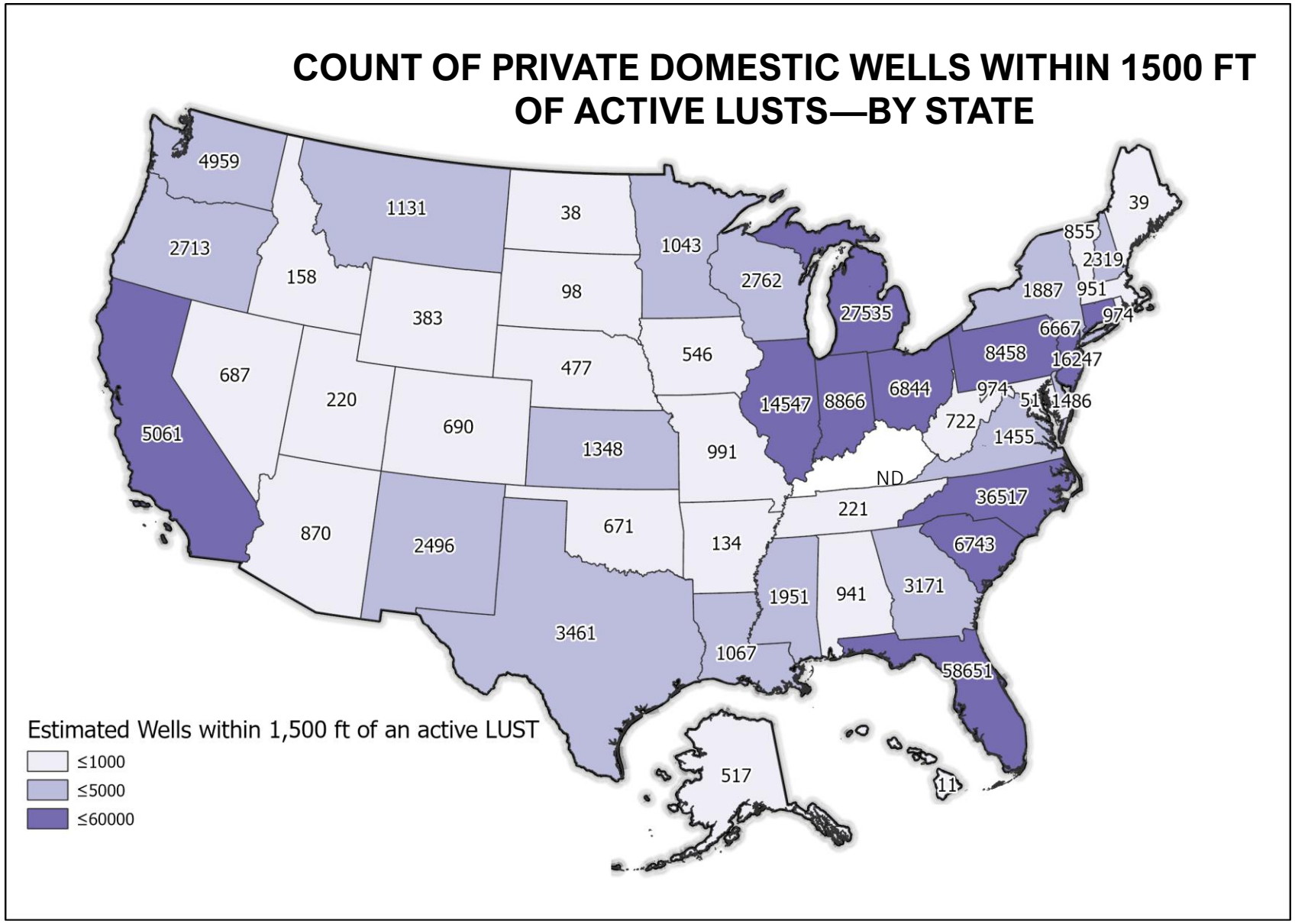
Protecting the Water Source

- Know where the well is located, especially on-site
- Test for contaminants associated with potential sources of contamination
- Identify sampling locations for fueling station on-site wells

PWS Public Notification Requirements 40CFR141.202

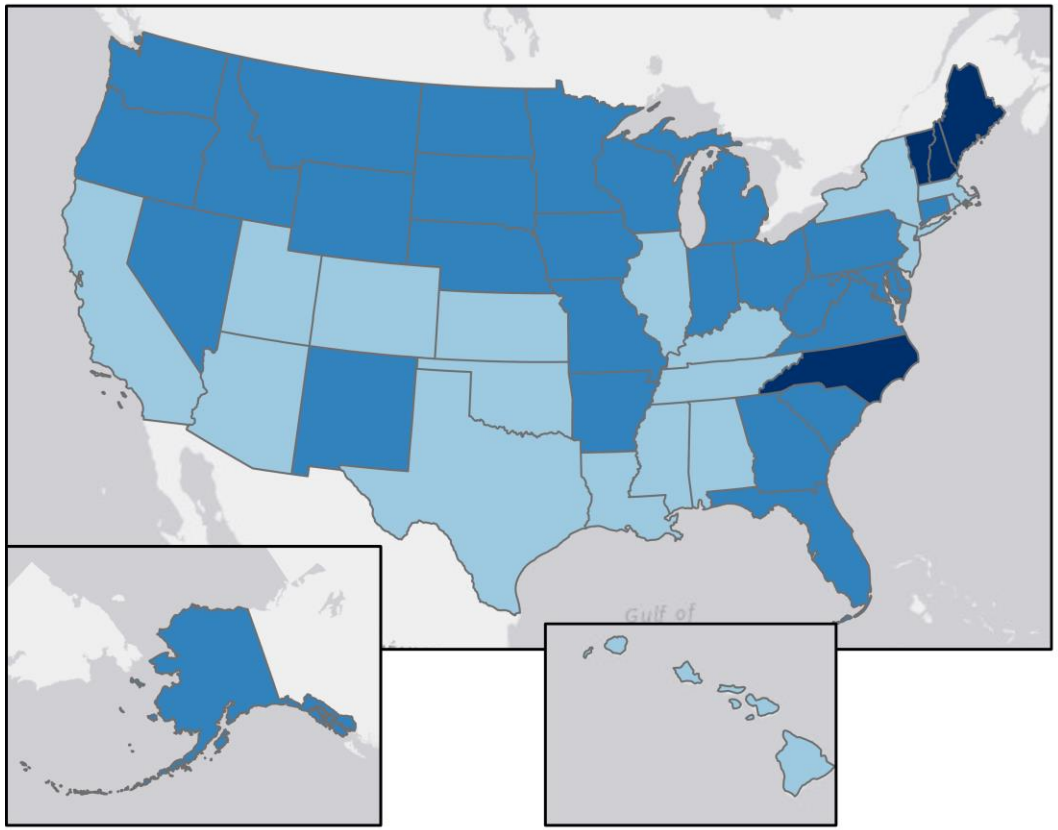
- Tier 1
  - Violation of MCL for total coliforms when fecal coliform or E. coli present
  - Nitrate, nitrite, or total nitrate and nitrite MCL violation or failure to take a confirmation sample within 24 hrs of first exceedance
  - Treatment technique violation involving single exceedance of the maximum turbidity limit, if elevated by state, or if a consultation does not occur
- Tier 2
  - All MCL, MRDL, and treatment technique violations not included in Tier 1

Private Domestic Well Vulnerability



- Estimated 250,000 private domestic wells within 1,500 feet of all active UST releases

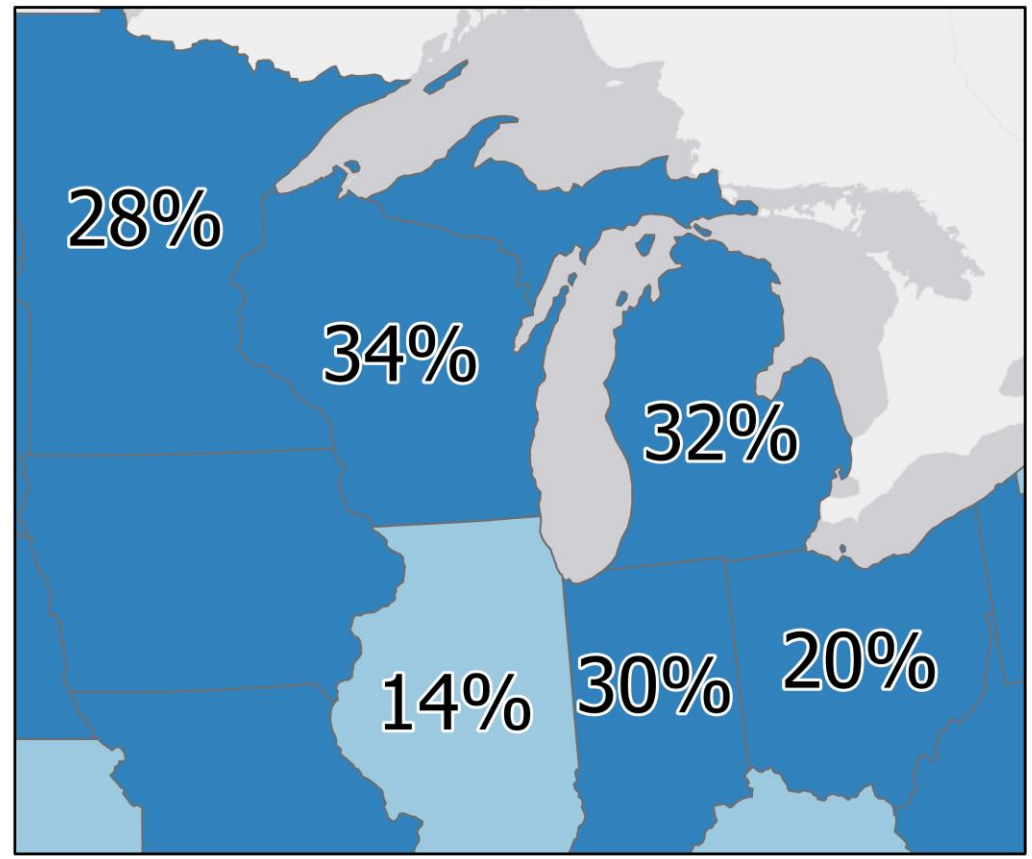
Percent of Population Served by Domestic Wells (2010)



Percent of Population Served

- < 15%
- 15% - 34.9%
- 35% - 44%

Region 5
Percent of Population Served by Domestic Wells (2010)



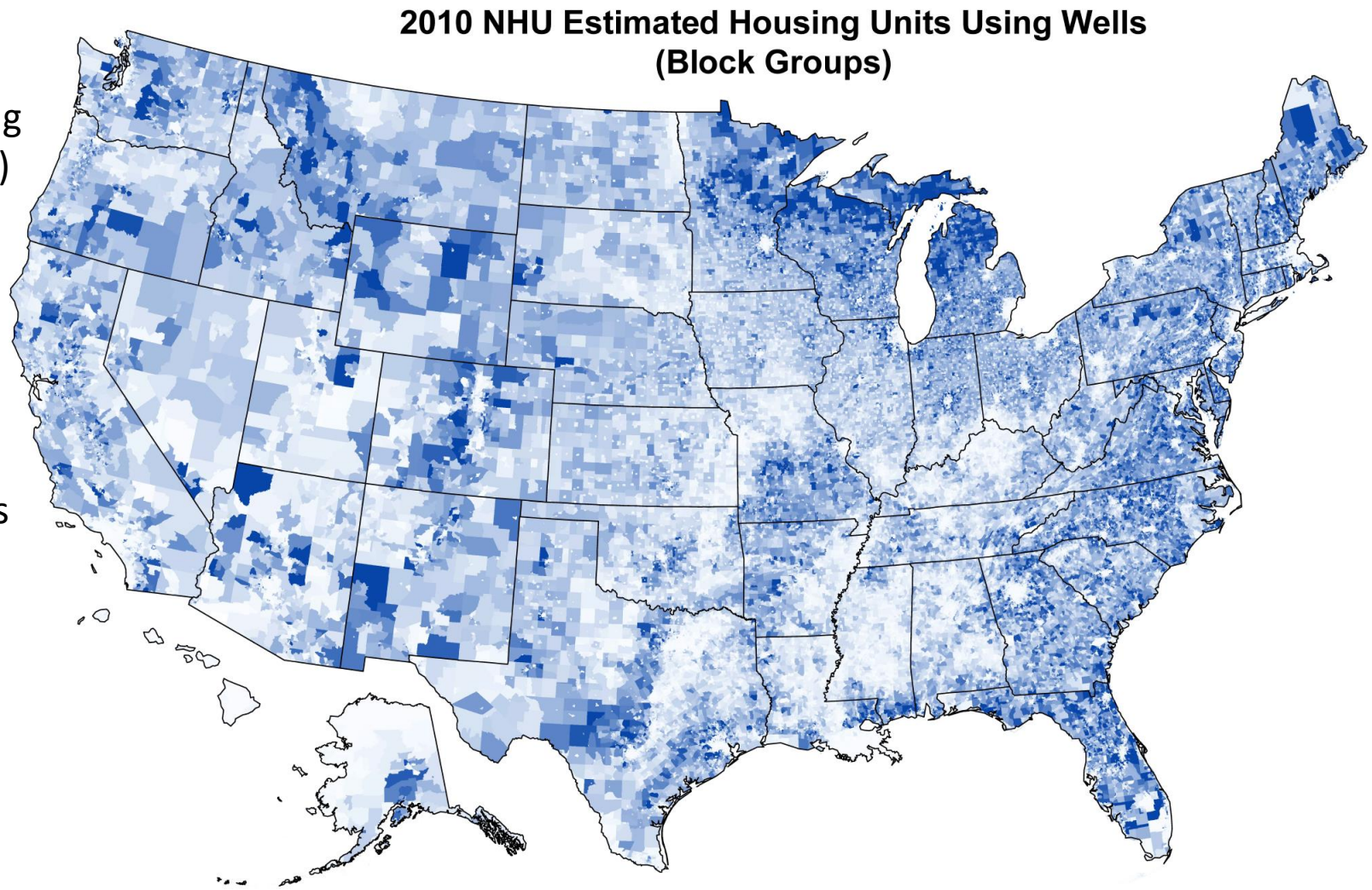
EPA 2010 Well Estimates

- Estimates of 2010 Housing Units using Domestic Water Wells (two methods)

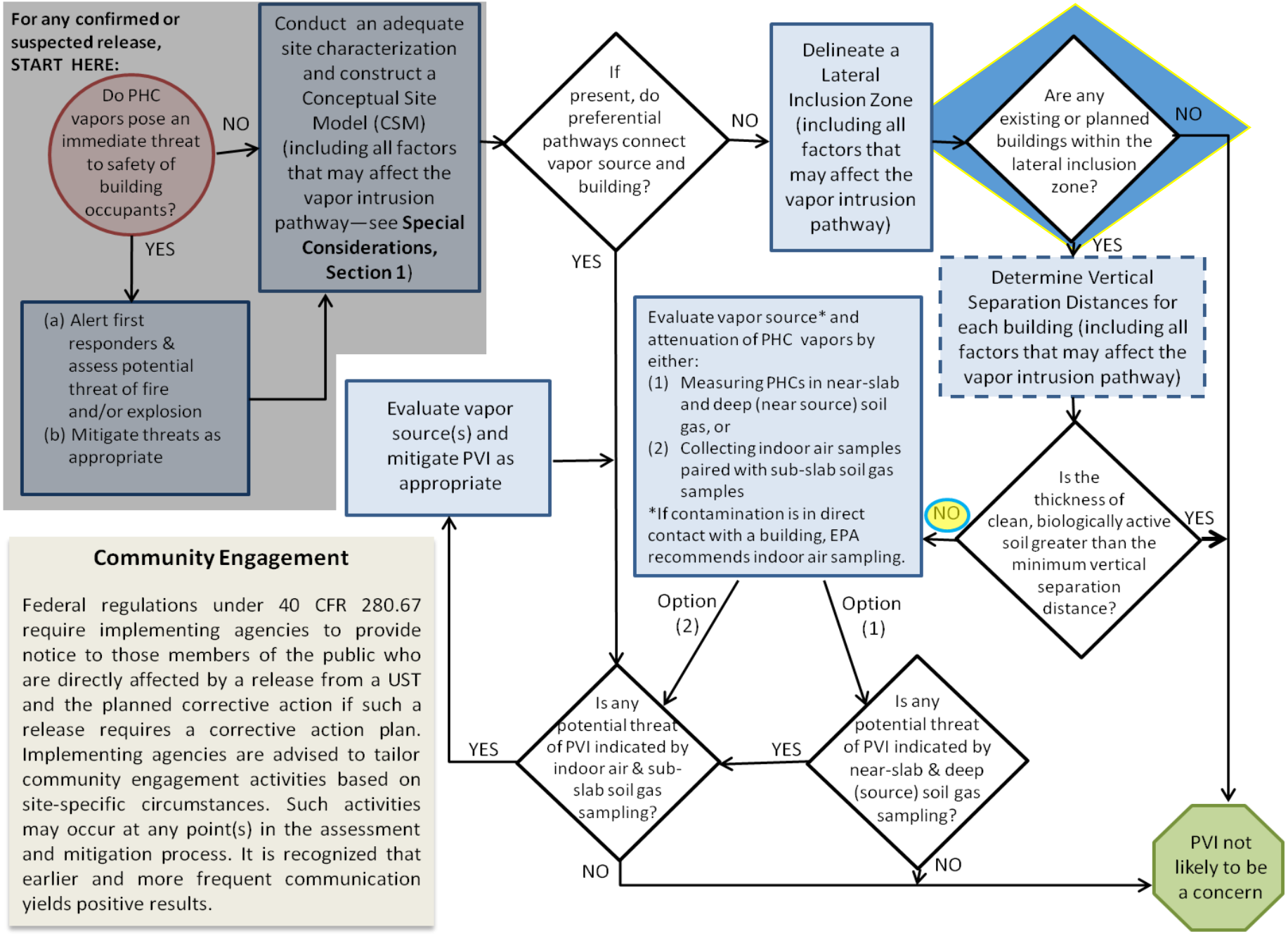
- Based on 1990 Census as Baseline

- NHU Method:
  - In states without drillers logs, uses housing unit change over time (assumes rate of well use is unchanged).

- RW Method:
  - In States where well logs were available, overlays them on top of 1990 Census and compared with NHU method.



PVI guidance framework

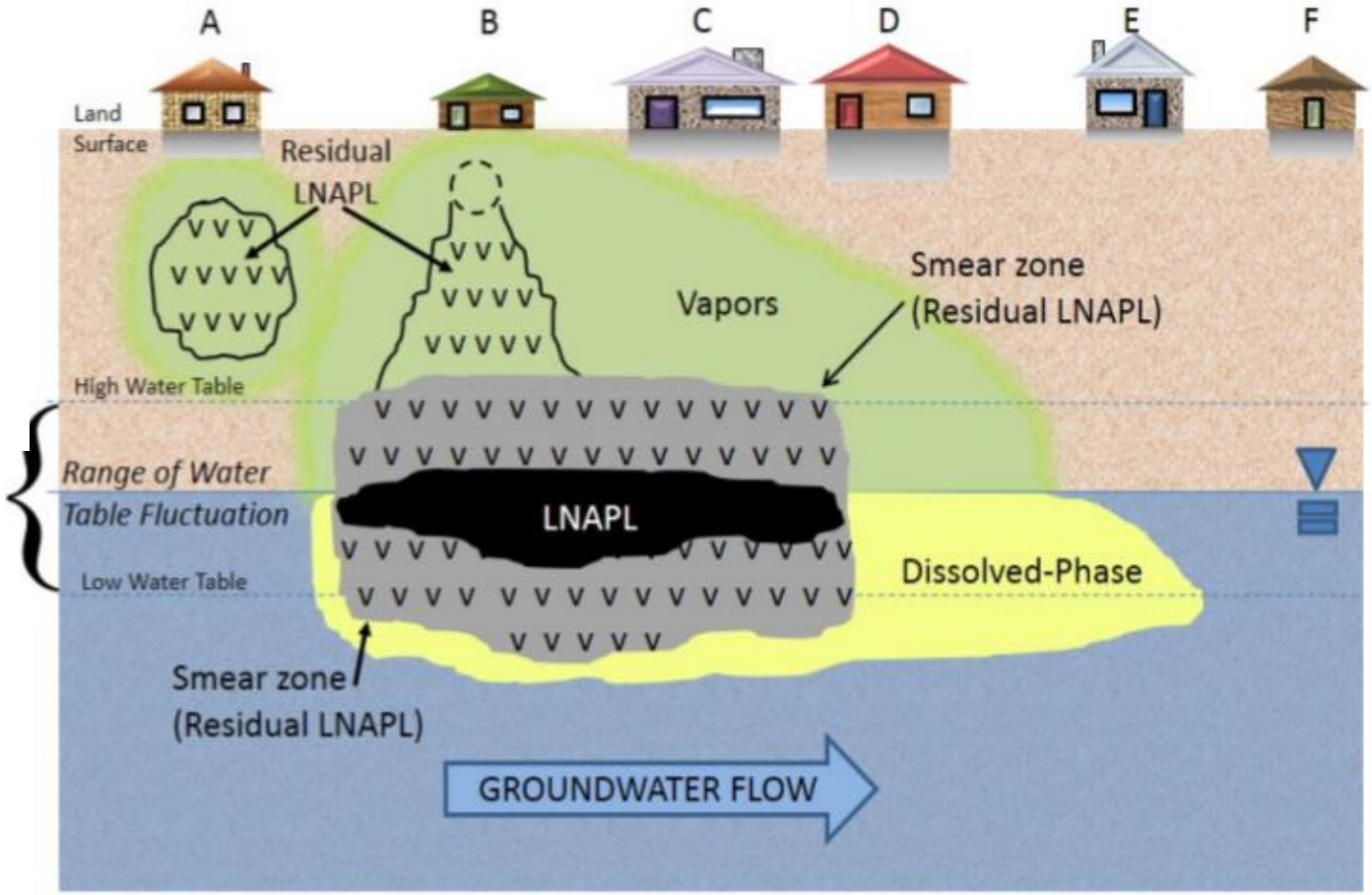


Technical Guide for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites, EPA 510-R-15-001

Potential PVI Sources and Potential Receptors

Table 3. Recommended Vertical Separation Distance Between Contamination And Building Basement Floor, Foundation, Or Crawlspace Surface.

Media	Benzene	TPH	Vertical Separation Distance (feet)*
Soil (mg/Kg)	≤10	≤ 100 (unweathered gasoline), or ≤ 250 (weathered gasoline, diesel)	6
	>10 (LNAPL)	> 100 (unweathered gasoline) >250 (weathered gasoline, diesel)	15
Groundwater (mg/L)	≤5	≤30	6
	>5 (LNAPL)	>30 (LNAPL)	15



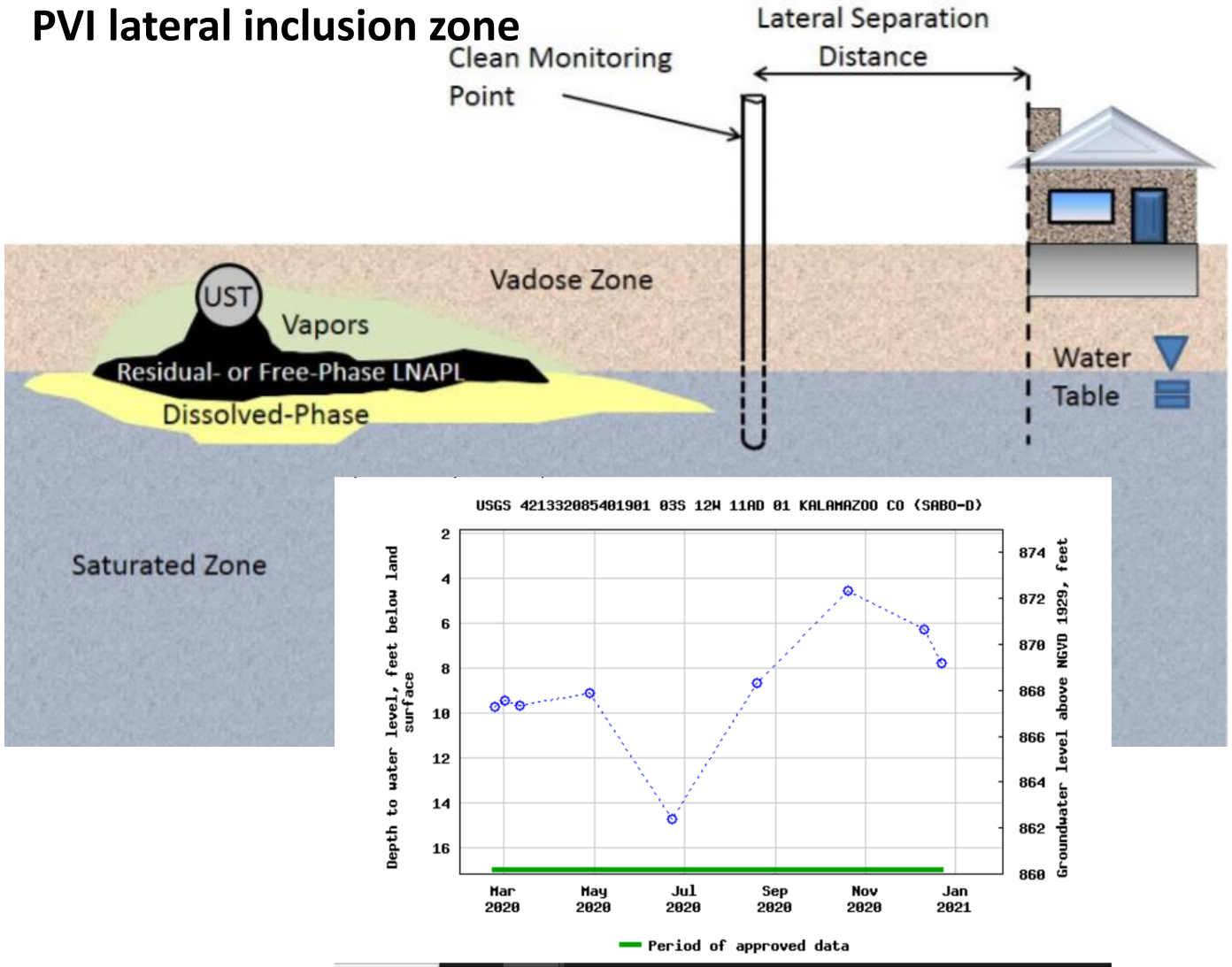
Technical Guide for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites, EPA 510-R-15-001

Assessment of impacts- land use, PVI and population

PVI a function of:

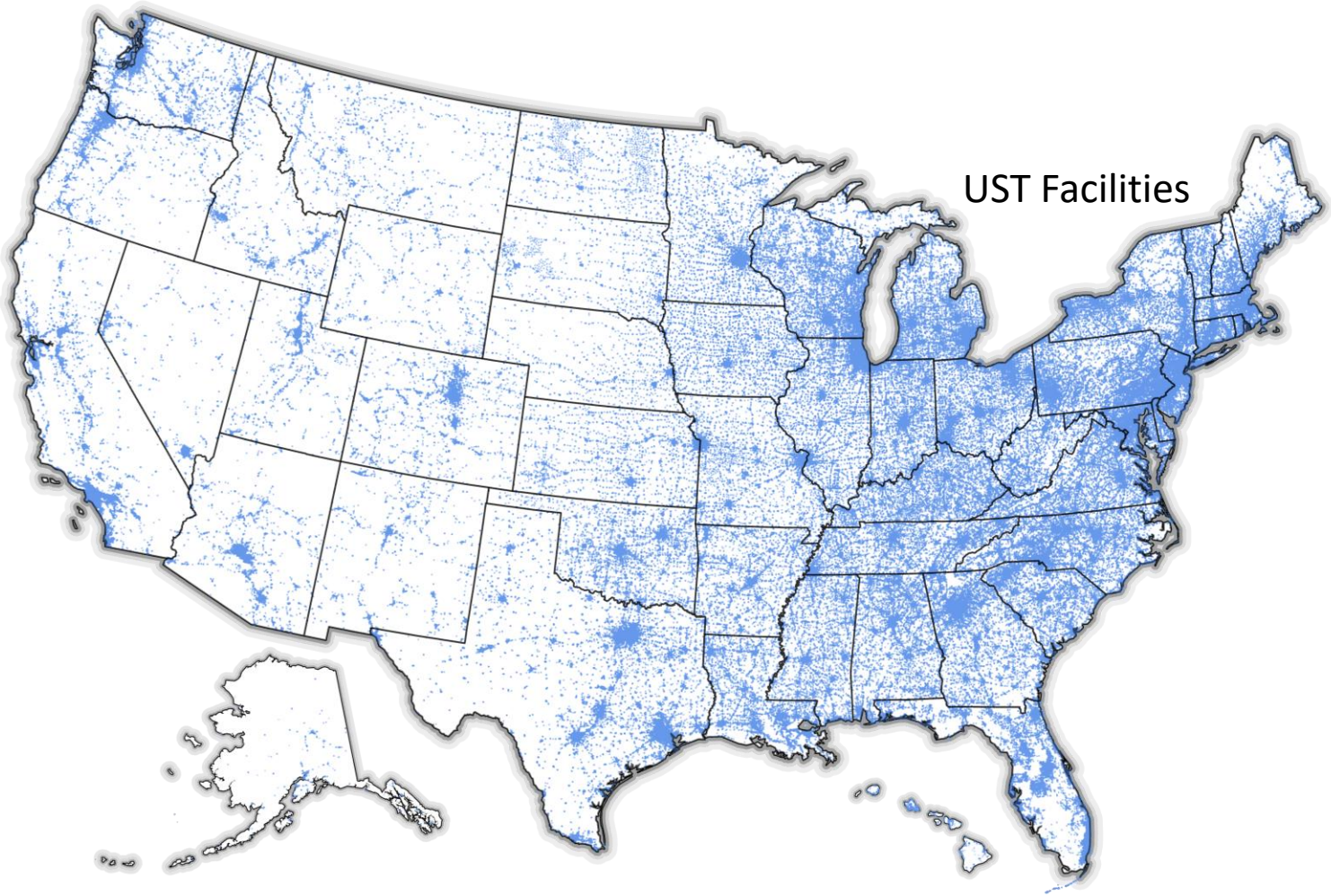
- distance to structures
- preferential transport pathways in geologic material **AND** utility lines
- concentration of source
- depth of contamination
- building characteristics
- dynamic nature of contaminant plumes (LNAPL/dissolved PHCs)
- presence of heterogeneities and preferential transport pathways in geologic material
- distance between monitoring points, i.e., soil borings, monitoring wells

PVI lateral inclusion zone



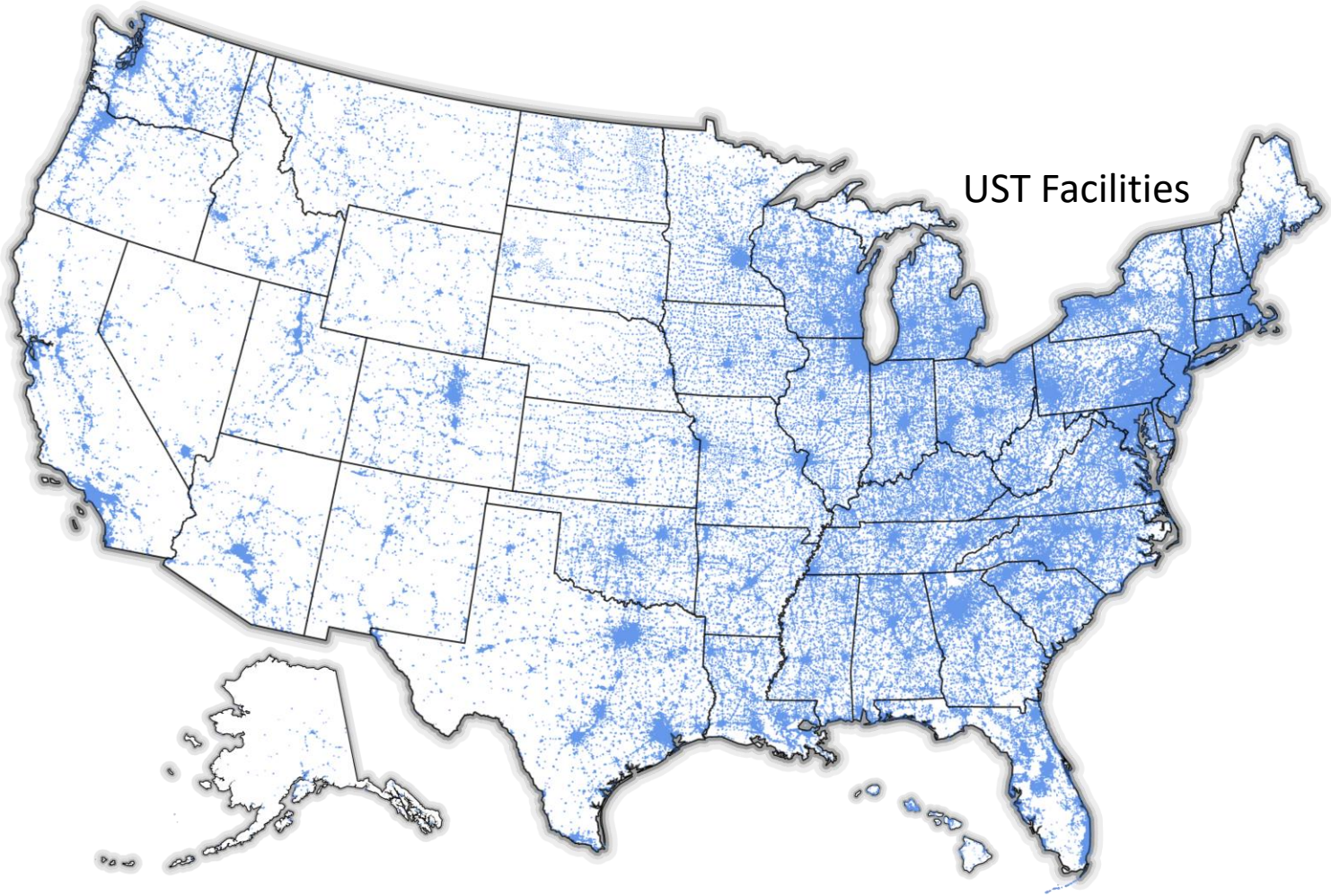
Overview

- Routine operations
  - Prevention
  - Cleanup
  - Q/A, case study
- Extreme events
  - Advance information
  - Site assessment
  - Q/A, case study
- Database version 2



Overview

- Range of geologic and environmental conditions in western states and territories
- Routine operations
  - Prevention
  - Cleanup
  - Q/A, case study
- Extreme events
  - Advance information
  - Site assessment
  - Q/A, case study
- Database version 2



United States Environmental Protection Agency

How do we assess and manage extreme events?

"We are colliding with a future of extremes. We base all our choices about risk management on what's occurred in the past, and that is no longer a safe guide."

Alice Hill, former Senior Director for Resilience Policy,

National Security Council

Preparing for Extreme Events

OUST Post-Severe Weather Checklist

Data from UST Finder

- Facility/Tank data – registration number, tank ID, fuel type
- GIS coordinates, address
- Extent of flooding, release occurrence (determine if in area of influence)
- Ongoing remediation
  - https://www.epa.gov/sites/production/files/2015-03/severe-weather-checklist-feb15.docx

Additional data needed

- Extent of damage, flooding
- Status of electricity
- Tank status – residual fuel, water in tank, power, release

State Feedback on Emergency Response to Natural Disasters

- Lessons learned from events
  - Need lat/long data, especially when landmarks are missing
  - Facilities along evacuation routes need to be able to continue to dispense fuel
  - In large surge, water enters tanks through the vent lines and displaces product
  - Contact facilities in advance, especially flooding, with information to take action
- What would have been useful prior to the event?
  - Data collection tool
  - Getting information to UST owners sooner
- What changes were made as a result of the event?
  - Obtaining GPS data on all active and temporarily closed facilities
  - Highest priority sites to check those not flooded but may be out of power – usually first back in service, important to visually check hose/piping leaks under dispensers due ot high winds
- What would be helpful in addressing events?
  - Develop a data collection tool
  - Ensure interstate communication
    - https://www.epa.gov/sites/production/files/2015-03/documents/climate-change-summary-feb2015.pdf

Fueling Stations are Critical in Disaster Response

- Categories of Critical Facilities includes
  - Facilities involved in the production, storage and/or transport of corrosives, explosives, flammable materials, radioactive materials and toxins.
- Systematically assess the storm risk and identifying protection strategies to “harden” facilities against damage for each location
- Essential for providing
  - Adequate fuel for evacuees
  - Assistance for first responders
    - After Hurricane Harvey, responders found a convenience store on higher ground

    “every one of the roughly 120 fueling pumps had an emergency response vehicle stationed at it”

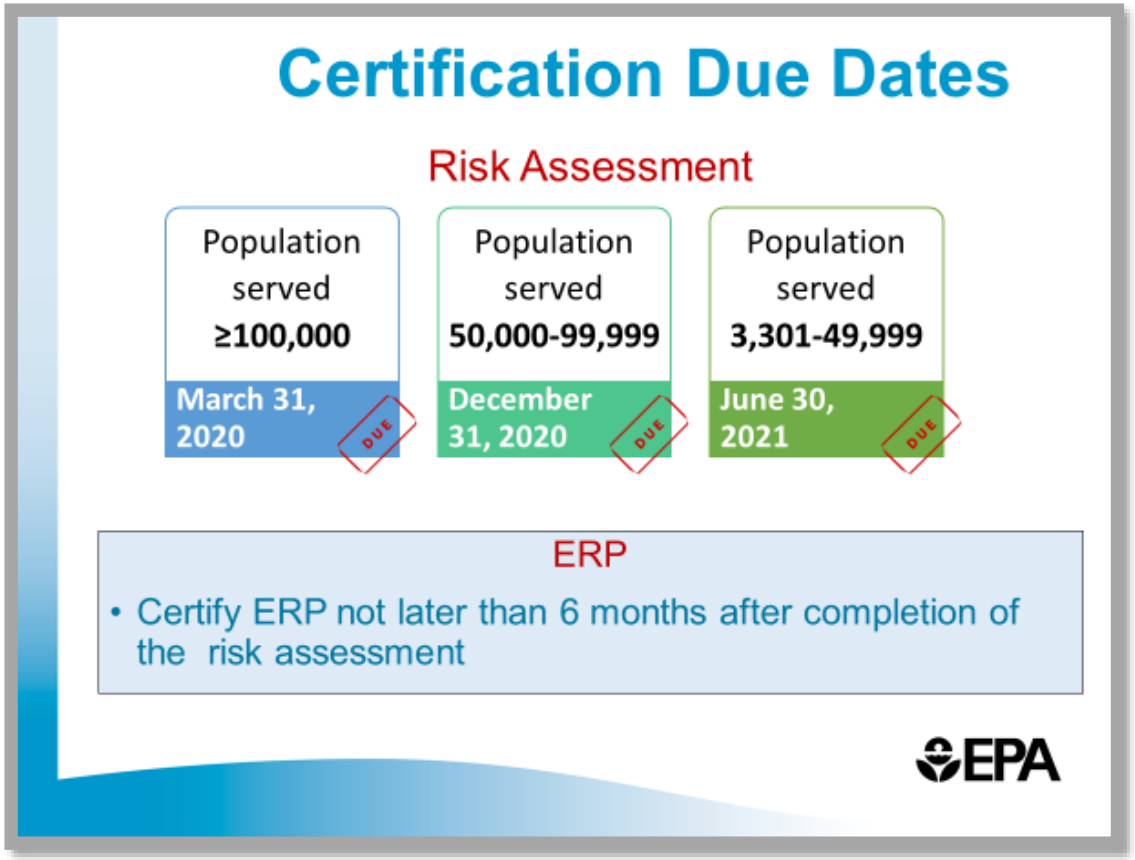
      - “Eye of the Storm, Report of the Governor’s Commission to Rebuild Texas”, 2018
- Vital in recovery

Midwest Flooding

- Fluvial or river floods - excessive runoff from longer-lasting rainstorms or melting snow causes a slower water-level rise over a larger area
- Pluvial floods – extreme rainfall, precipitation cannot be absorbed into the soil
- Ground water floods - sub-surface water emerges to the surface or in structures due to persistent rainfall, high river levels or tides

America's Water Infrastructure Act 2018 Overview

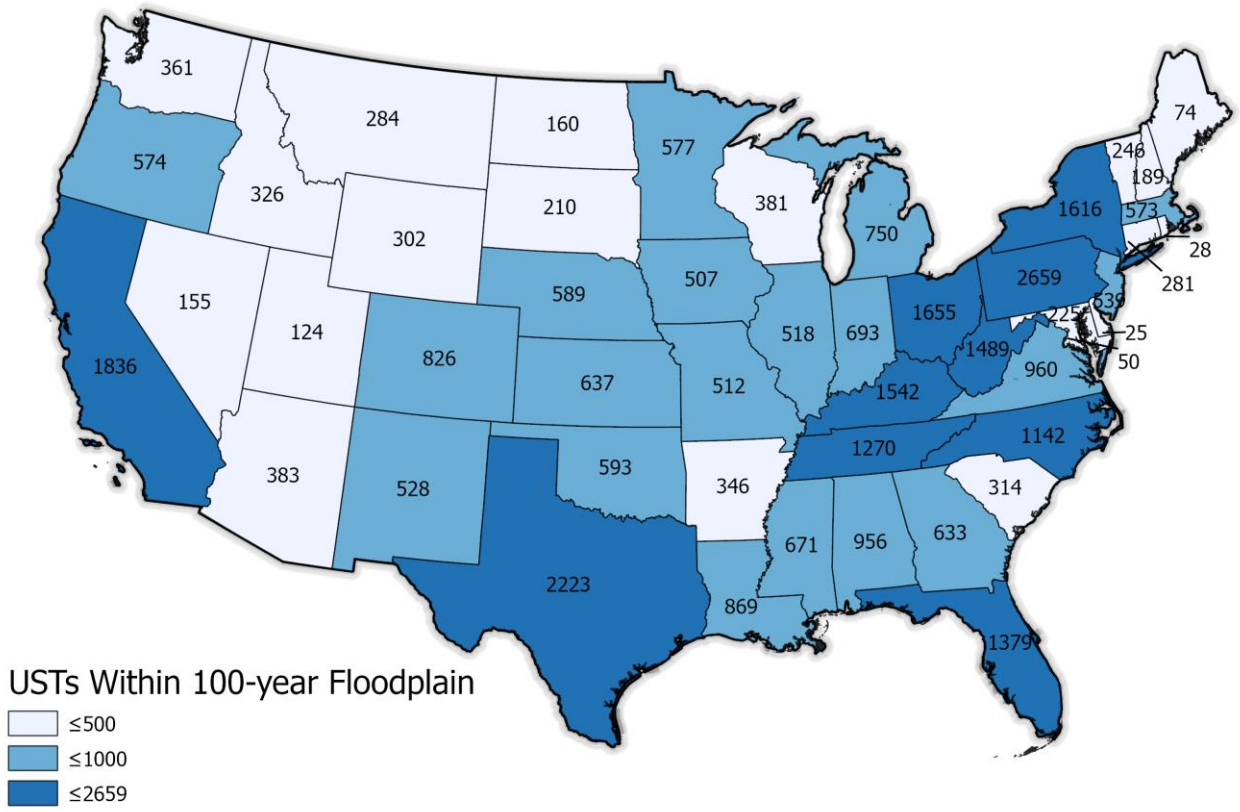
- Applies to all community water systems serving more than 3,300 people
- Conduct Risk and Resilience Assessments and update Emergency Response Plans
- Submit **certifications to EPA** by specified deadlines
- Review risk assessments and ERPs every five years
- Coordinate with local emergency planning committees
- Maintain records



Fluvial Flooding: National UST Flood Vulnerability

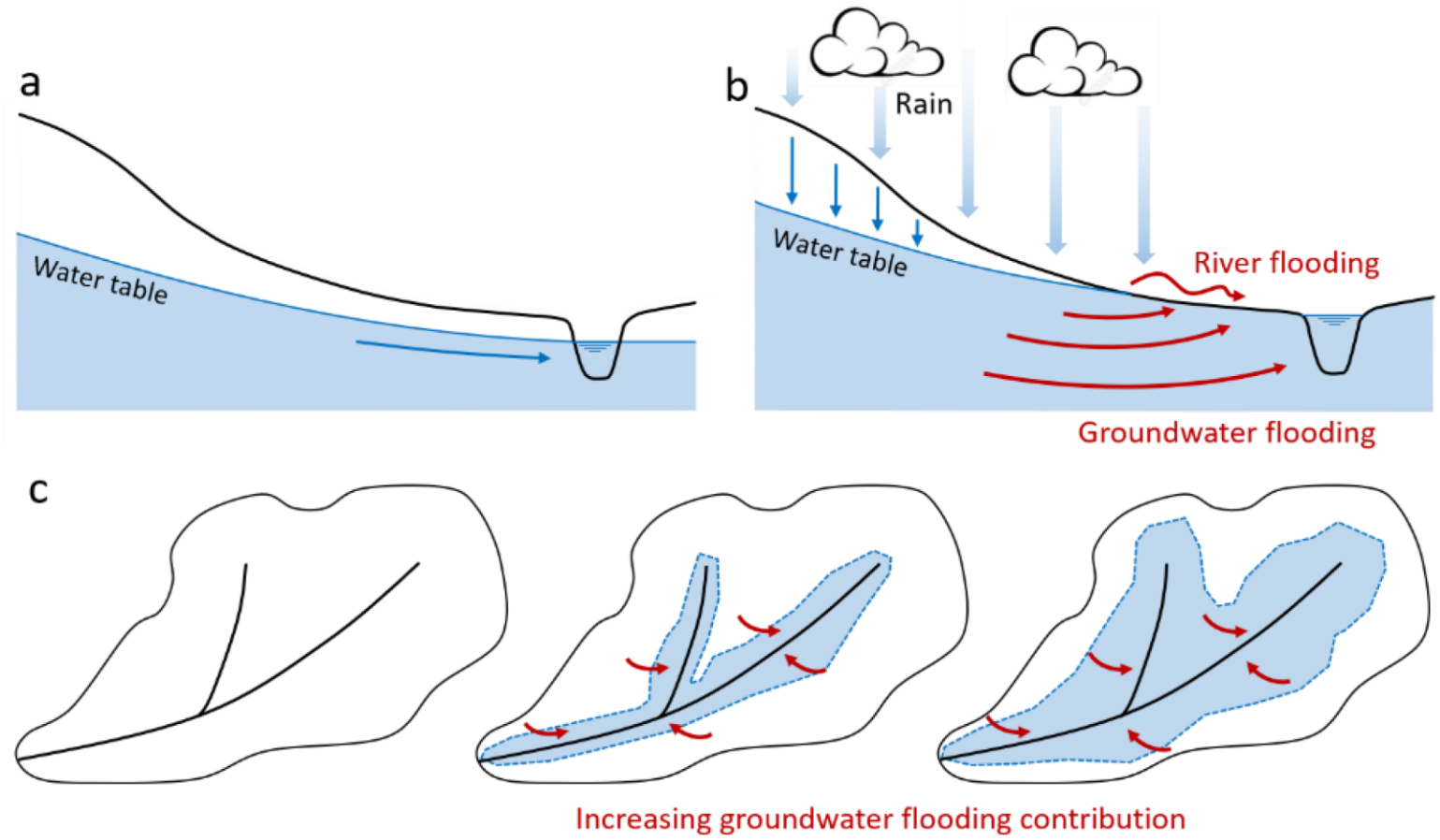
- ~33,000 USTs within FEMA's estimated 100 yr. floodplain
- Totaling a potential of 250 million gallons of fuel/hazardous substance
- With an average UST age of 25 years

COUNT OF OPEN USTs WITHIN EPA ESTIMATED 100 YR FLOODPLAIN—BY STATE*



Ground Water Flooding

- Extreme rainfall events and high infiltration rates cause water tables to rise
- Elevated river stages during flooding are rapidly propagated into permeable aquifer



Mancini, C., et al https://doi.org/10.3390/w12072030

Impacts of Fluctuating Water Table

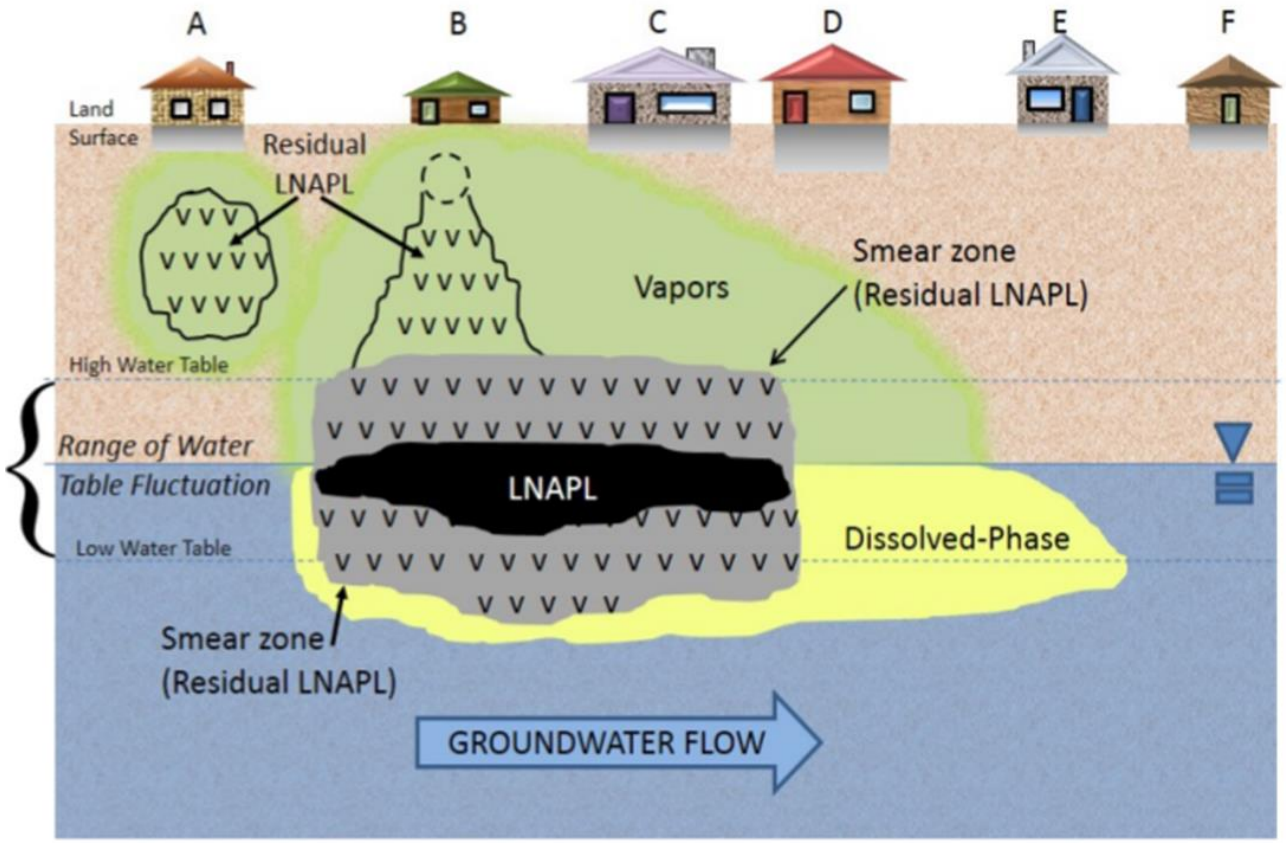
Smear zone - free product mobilization

- WI - closed sites that have residual soil contamination above standards must be included in the GIS Registry
  - https://dnrmaps.wi.gov/H5/?viewer=rrsites

PVI impacts – vertical inclusion zone

- distance between the lowest part of the structure of concern and the highest historical elevation of the water table

When closing a site with residuals in place, acquire core samples that represent the entire interval from receptor to the lowest potential location of the water table

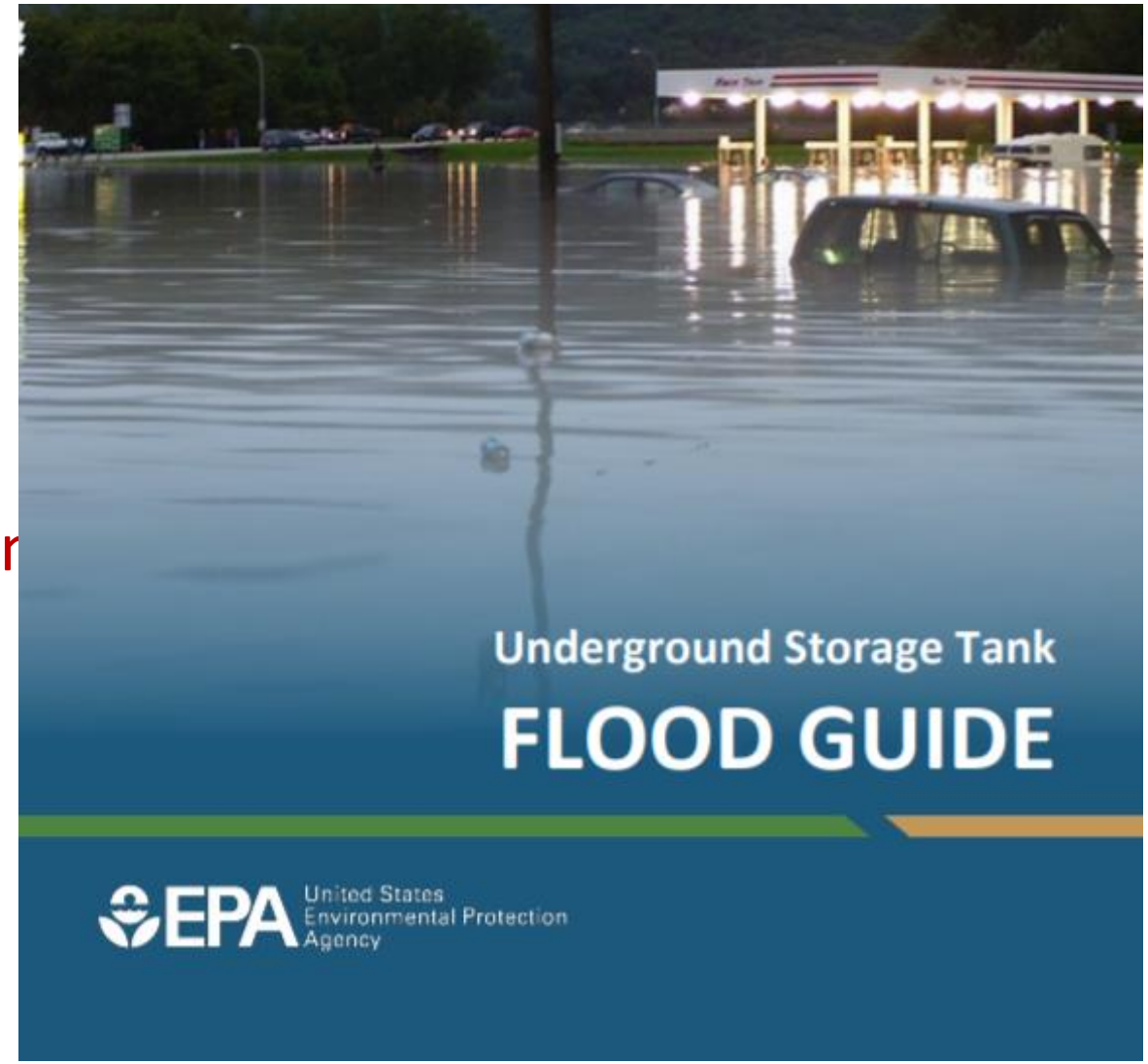


Water in Tank Systems

- Water entry
  - delivered product
  - damaged fill boxes or fill cap gaskets,
  - loose fittings or plugs,
  - poor practices relating to spill buckets,
  - rainwater accumulated within tank sumps and which enter via any tank orifices that are not water/vapor tight

Approach to Flood Resilience – How We can Assist the States

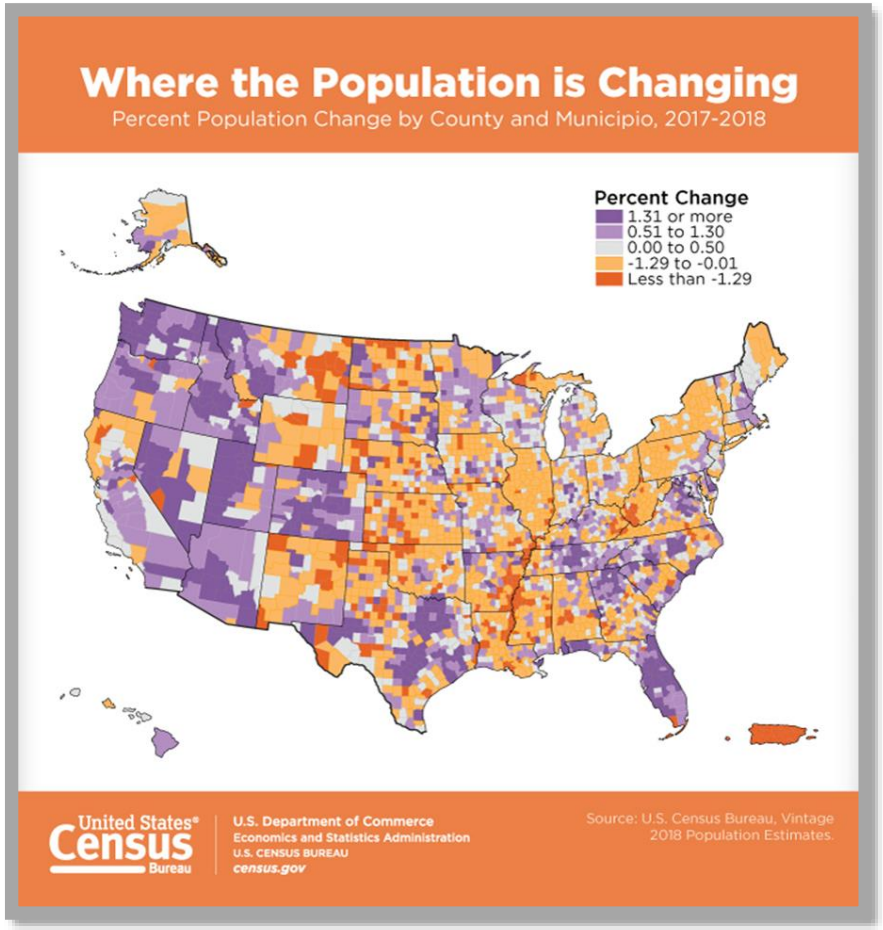
- STEP 1 Understand the Threat of Flooding
- STEP 2 Identify Vulnerable Assets & Determine Consequences
- STEP 3 Identify & Evaluate Mitigation Measures
- STEP 4 Develop Plan to Implement Mitigation Measures



https://www.epa.gov/sites/production/files/2014-03/documents/ustfloodguide.pdf

Roles of Federal, State, and Local Govts in Preparing for Floods National Response Framework, National Preparedness System

- Federal
  - Precipitation and flood forecasts
  - Flood hazard and analysis maps
  - Outreach/education
- State/Local
  - Infrastructure improvements
  - Storm water system design and maintenance
  - Land use policies and plans
  - Building codes, development plans

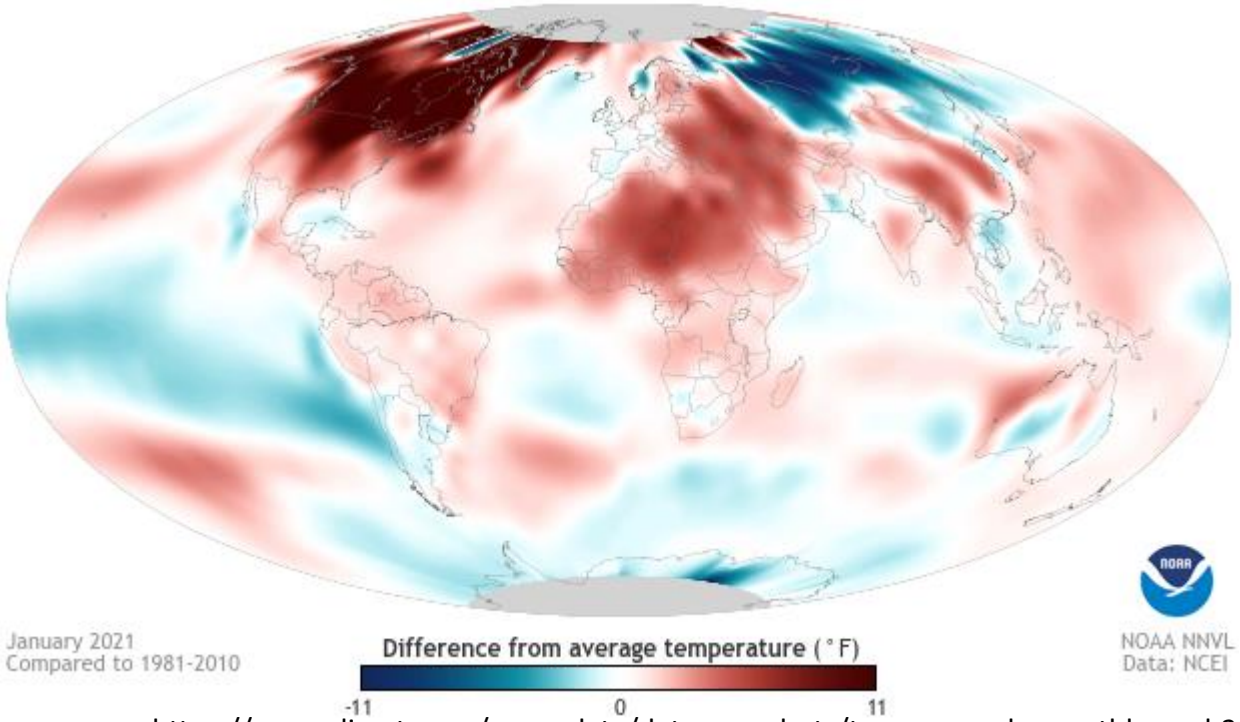


Wildfires

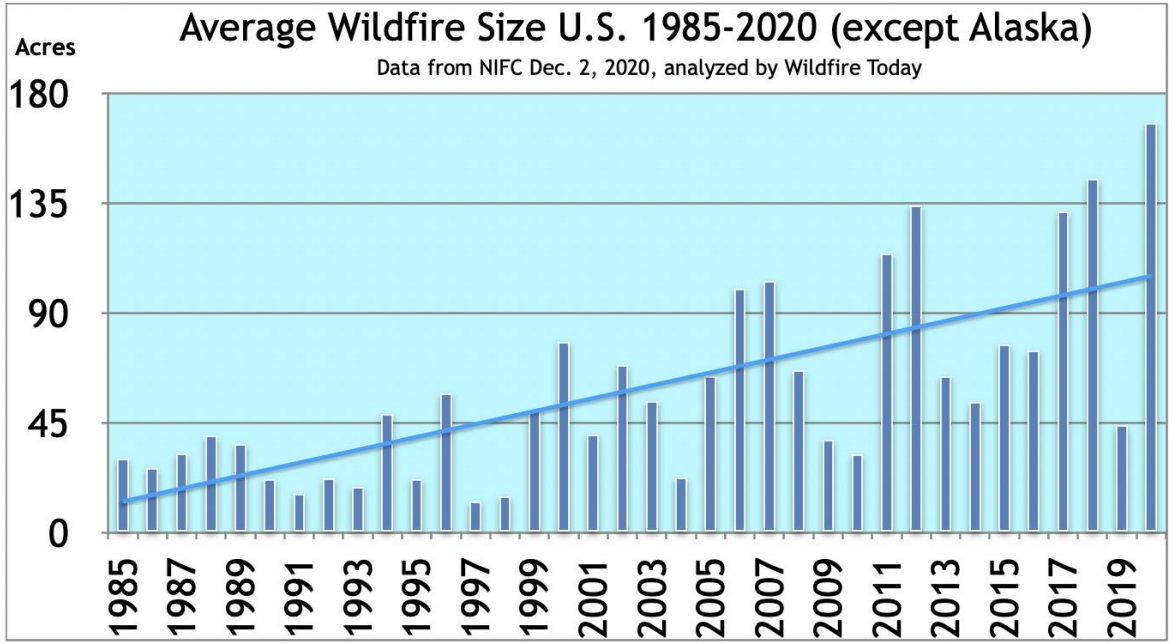
Northern climates greatest increase in temperature

Alaska 2019 Fire Season

- 700+ wildfires burned >2 M acres
- 3-fold increased risk of fire in recent decades

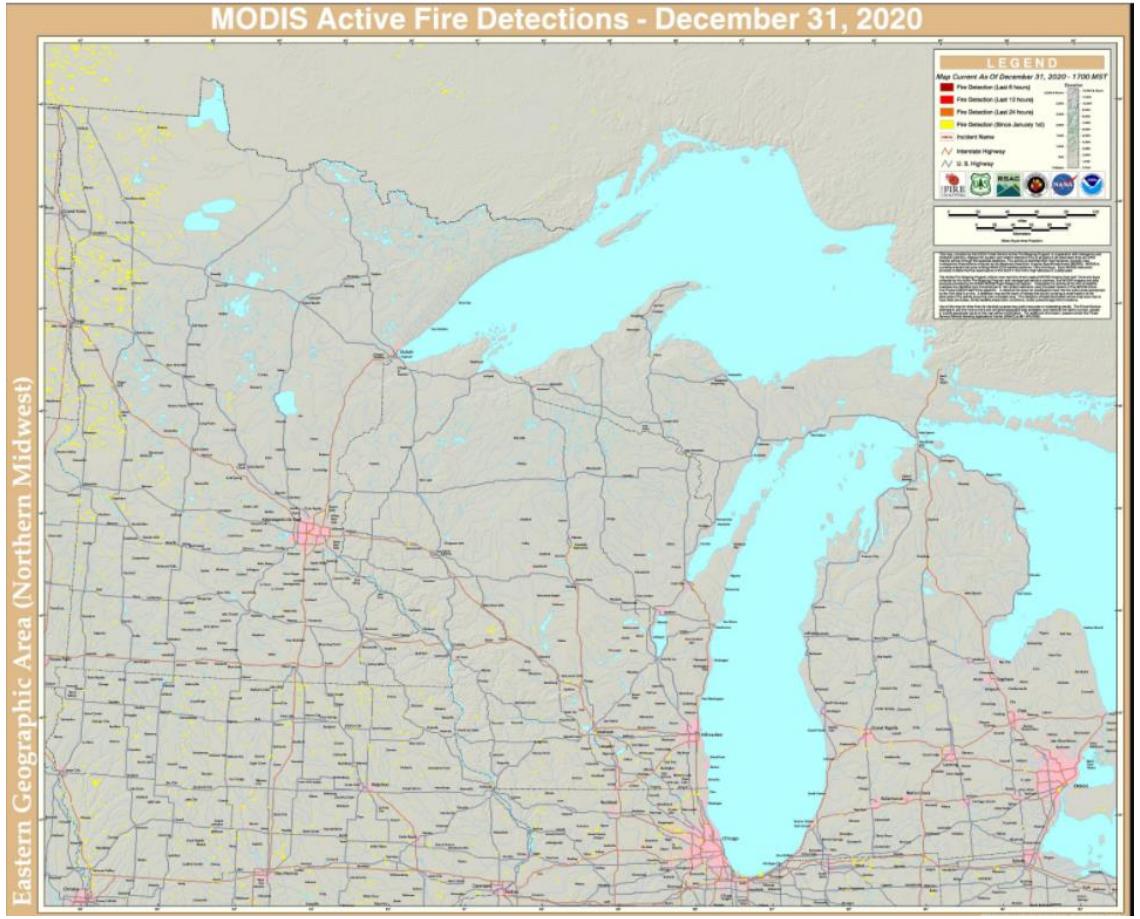


https://www.climate.gov/maps-data/data-snapshots/tempanomaly-monthly-nnvl-2021-01-00?theme=Temperature

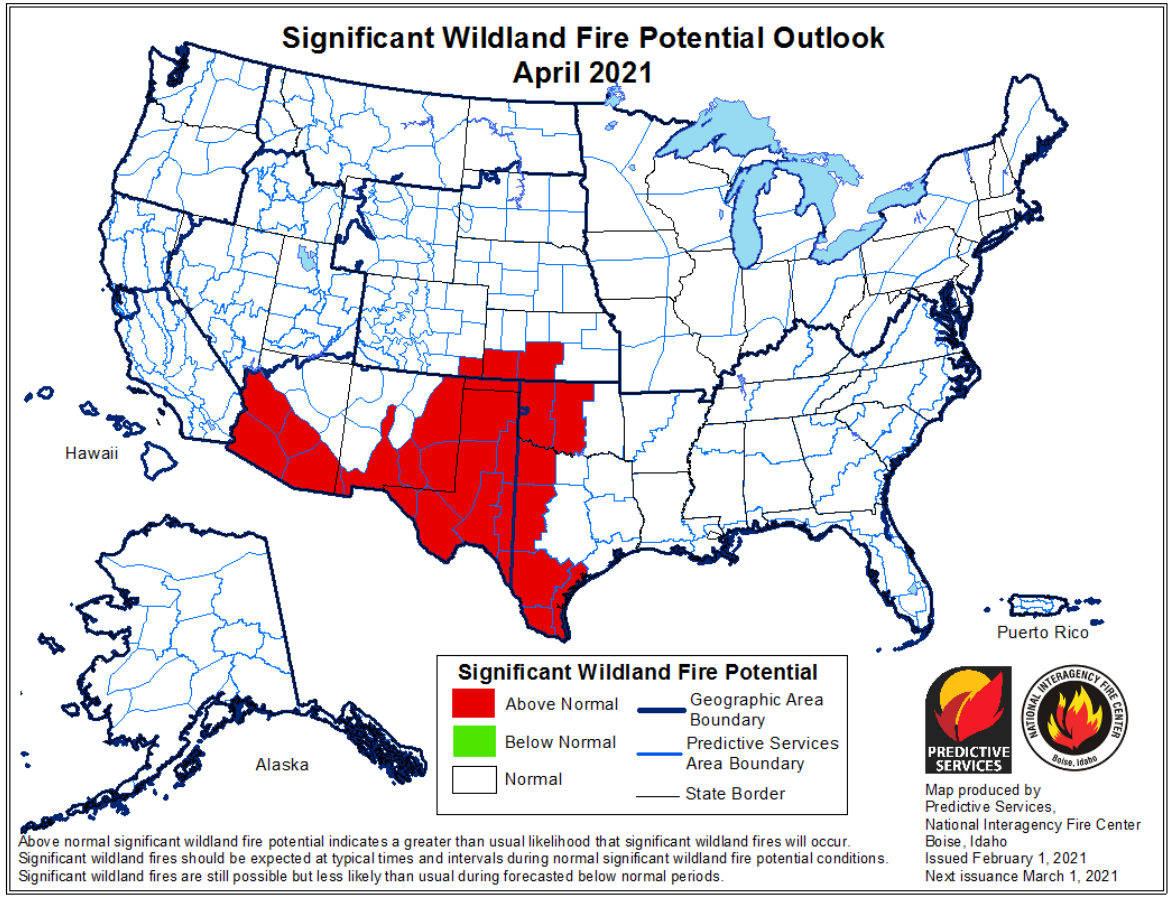


Temporal Assessment of Wildfires

Wildfires 2020
Northern Midwest - IA, MI, MN, WI



https://fsapps.nwcg.gov/afm/activefiremaps.php?sensor=modis&op=archive&rCode=enm&month=12&year=2020

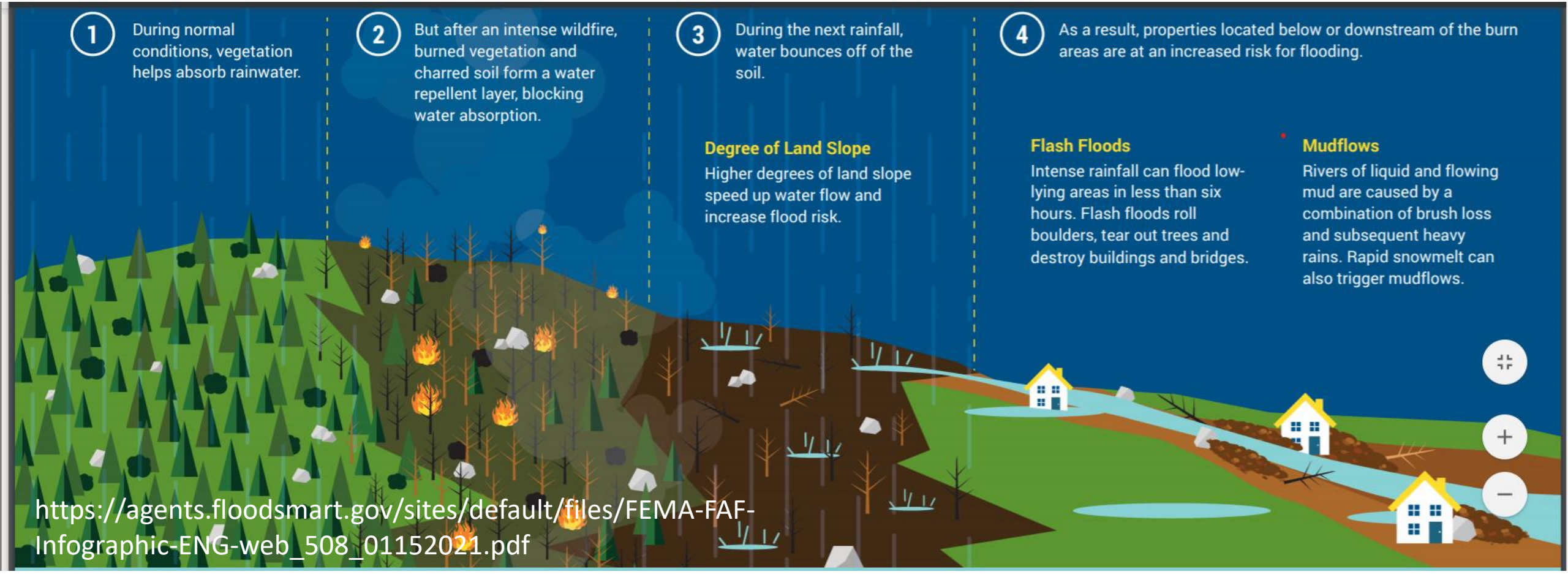


https://www.predictiveservices.nifc.gov/outlooks/month3_outlook.png

View 2020 data live
https://fsapps.nwcg.gov/afm/gisdata.php

Debris Flow Fields – Post-Wildfires and Precipitation

- Wildfires can significantly alter the hydrologic response of a watershed, even moderate rainstorms can produce dangerous flash floods and debris flows
- Wildfires leave soil charred, barren, and unable to absorb water, creating conditions for flash flooding and debris flow (mudflow)

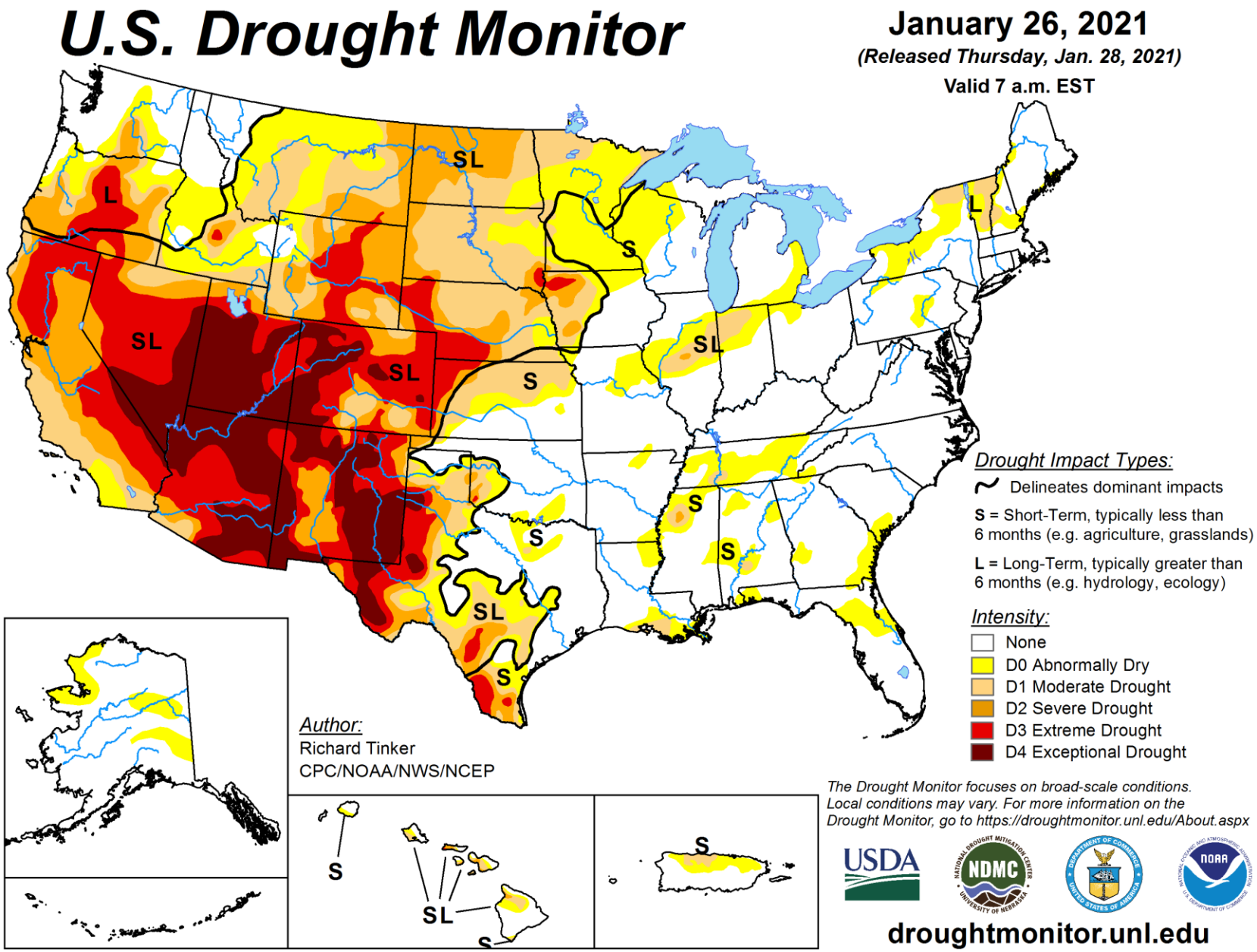


https://agents.floodsmart.gov/sites/default/files/FEMA-FAF-Infographic-ENG-web_508_01152021.pdf

Temperature and Tank Systems

- Temperature extremes - 5°C increase doubles corrosion rate
  - 55°F to 65°F (13°C to 18°C) can double corrosion rate
  - While tank systems are somewhat insulated underground, they are open to the atmosphere and subject to temperature extremes
- Cause buildup of water resulting in corrosion in system due to condensation caused by fuel temperature swings or air entering via vents.
- Certain fuels are also more prone to retaining moisture and separating out when subject to temperature swings

Assessing Drought Conditions

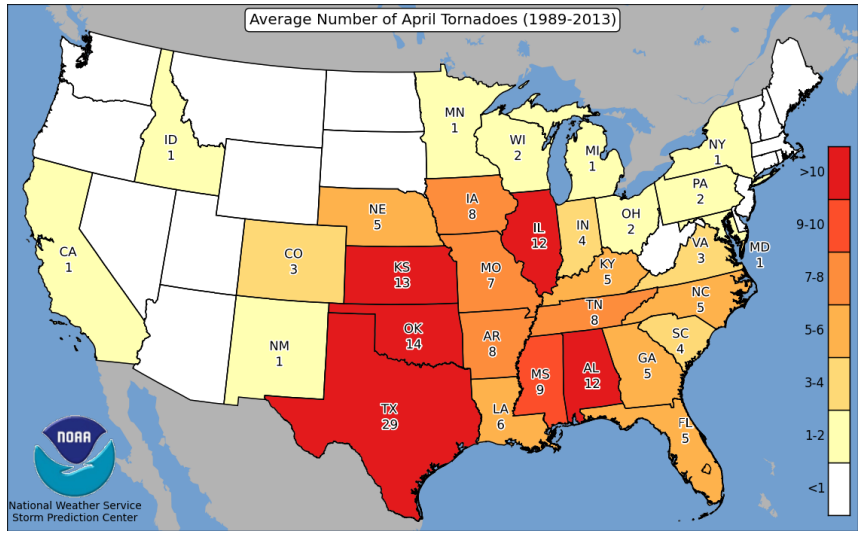


Impacts of Extreme Weather

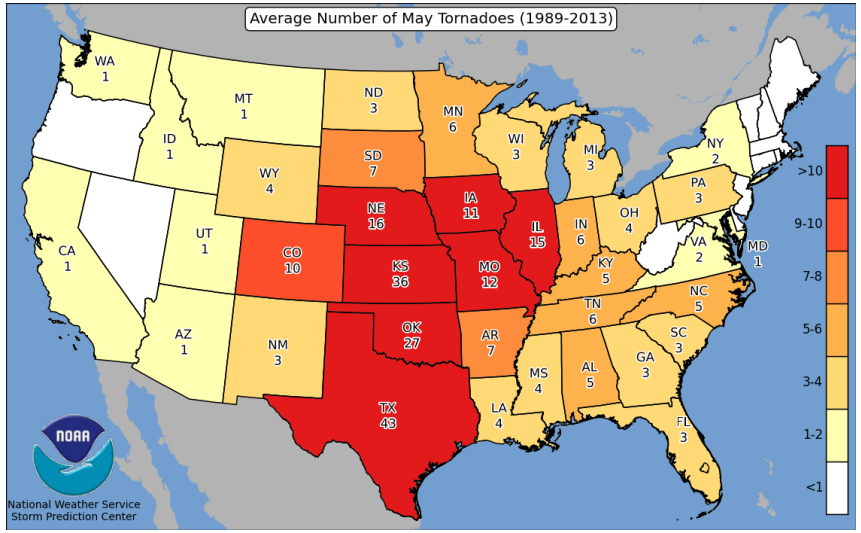
- Electrical outages
- Dam failures

25-Year Average Number of Tornadoes by Month

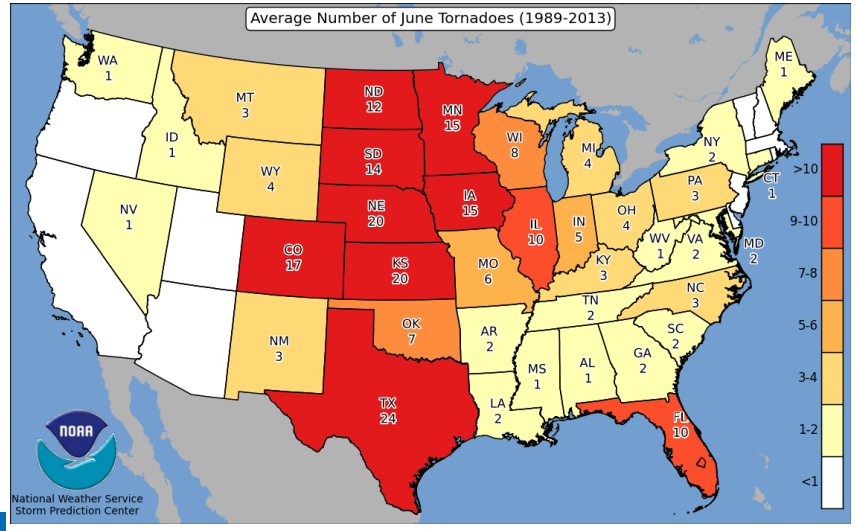
April



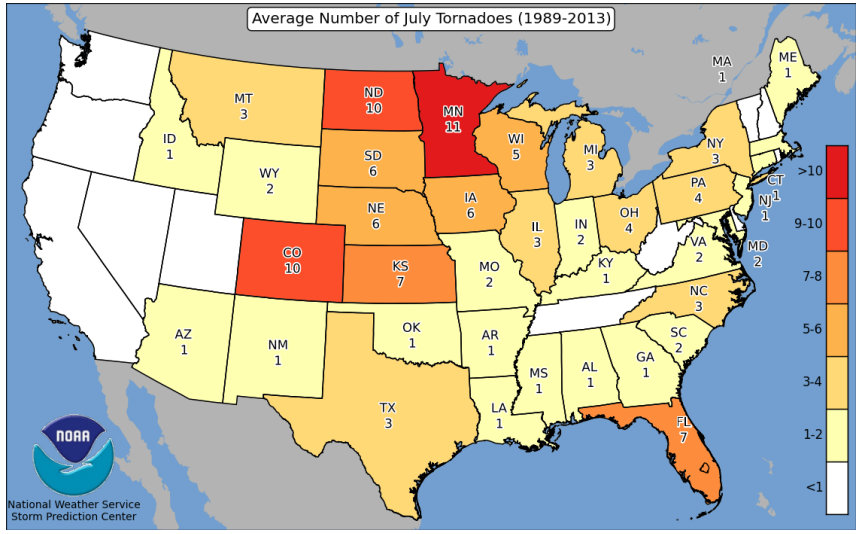
May



June

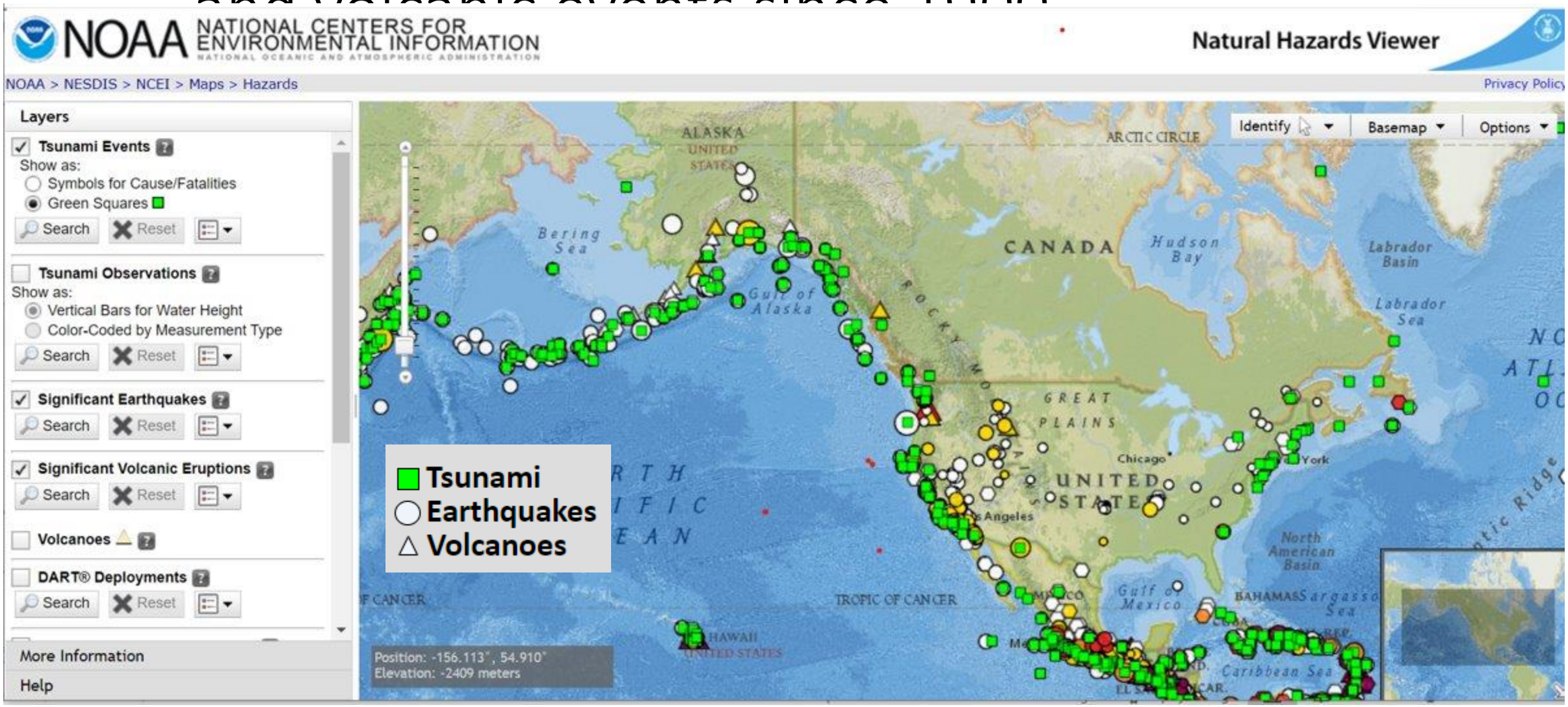


July



https://www.spc.noaa.gov/wcm/permonth_by_state/

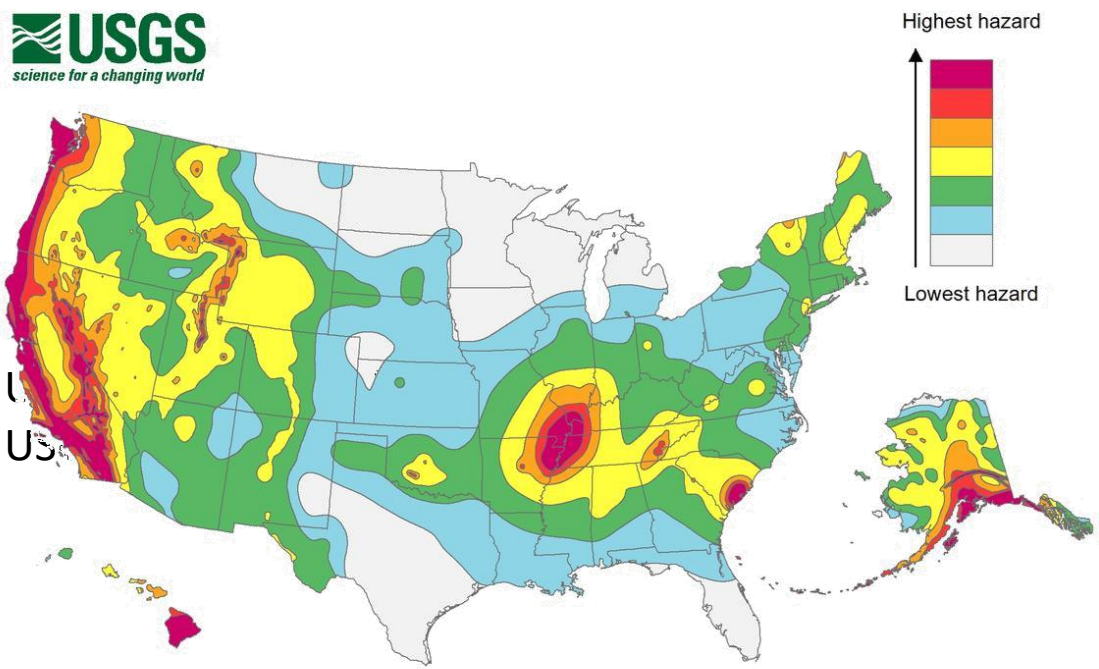
Cumulative earthquake, tsunamis, and volcanic events since 1900

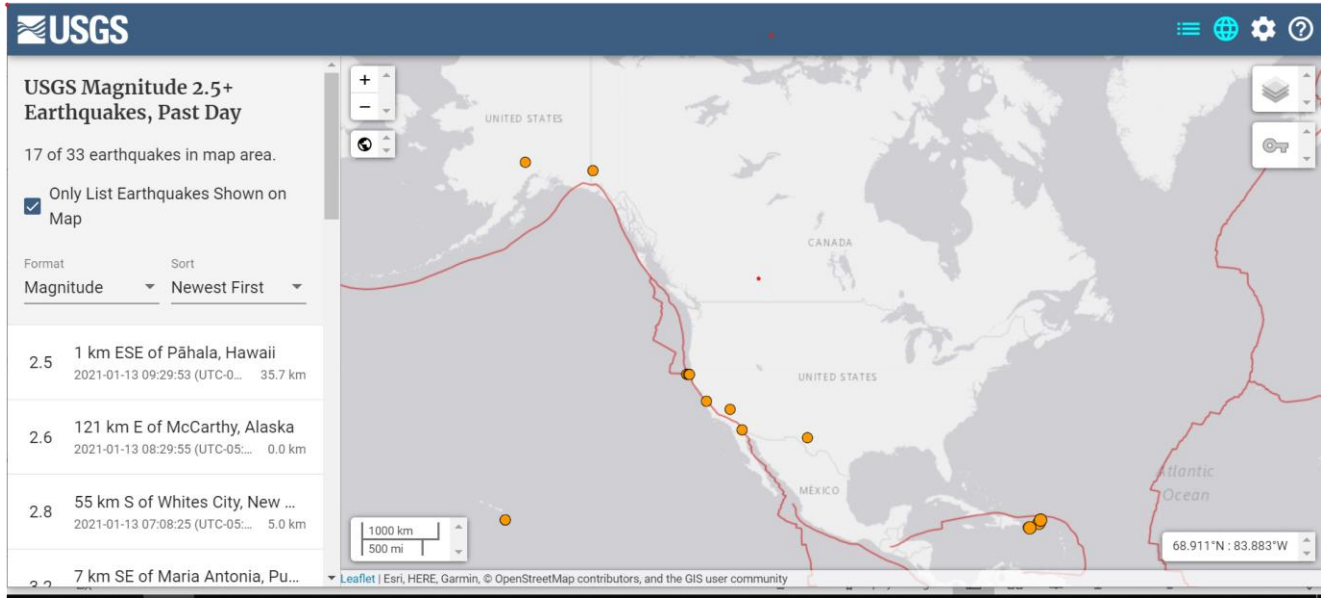


https://maps.ngdc.noaa.gov/viewers/hazards/?layers=0

Earthquakes

- **Alaska** - more large earthquakes than the rest of US combined, > 3/4 of state's population in areas that can experience a magnitude 7 earthquake
- **Pacific Northwest** - heavily populated urban corridor
- **San Francisco Bay Area** - highest density of active faults of any urban area in the US, probability of one or more large (M6.7) urban earthquakes in the next 30 years is high (62%)
- **Southern California** - highest level of earthquake risk in US, with half of the expected financial losses from earthquakes in US expected to occur in southern California, greatest urban risk in the United States
- CA Water Board - Assessing Underground Storage Tanks for Earthquake Damage
  - https://www.waterboards.ca.gov/ust/tech_notices/ust_earthquake_assess.pdf
- ASCE Hazard Tool
  - https://asce7hazardtool.online/



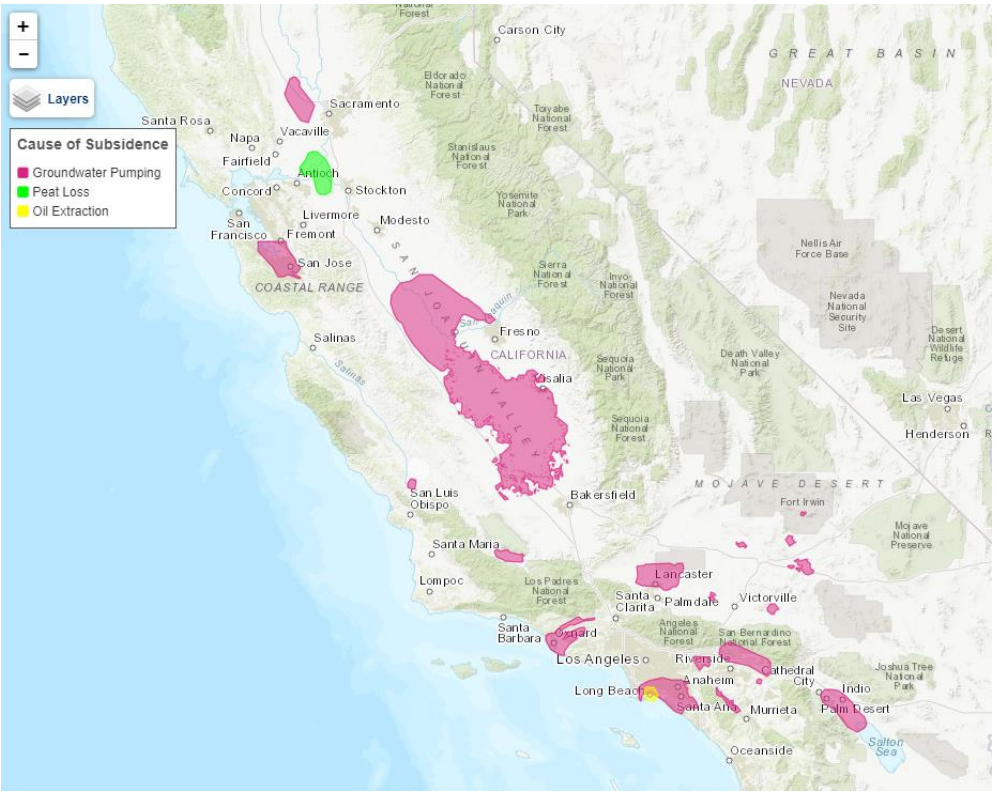


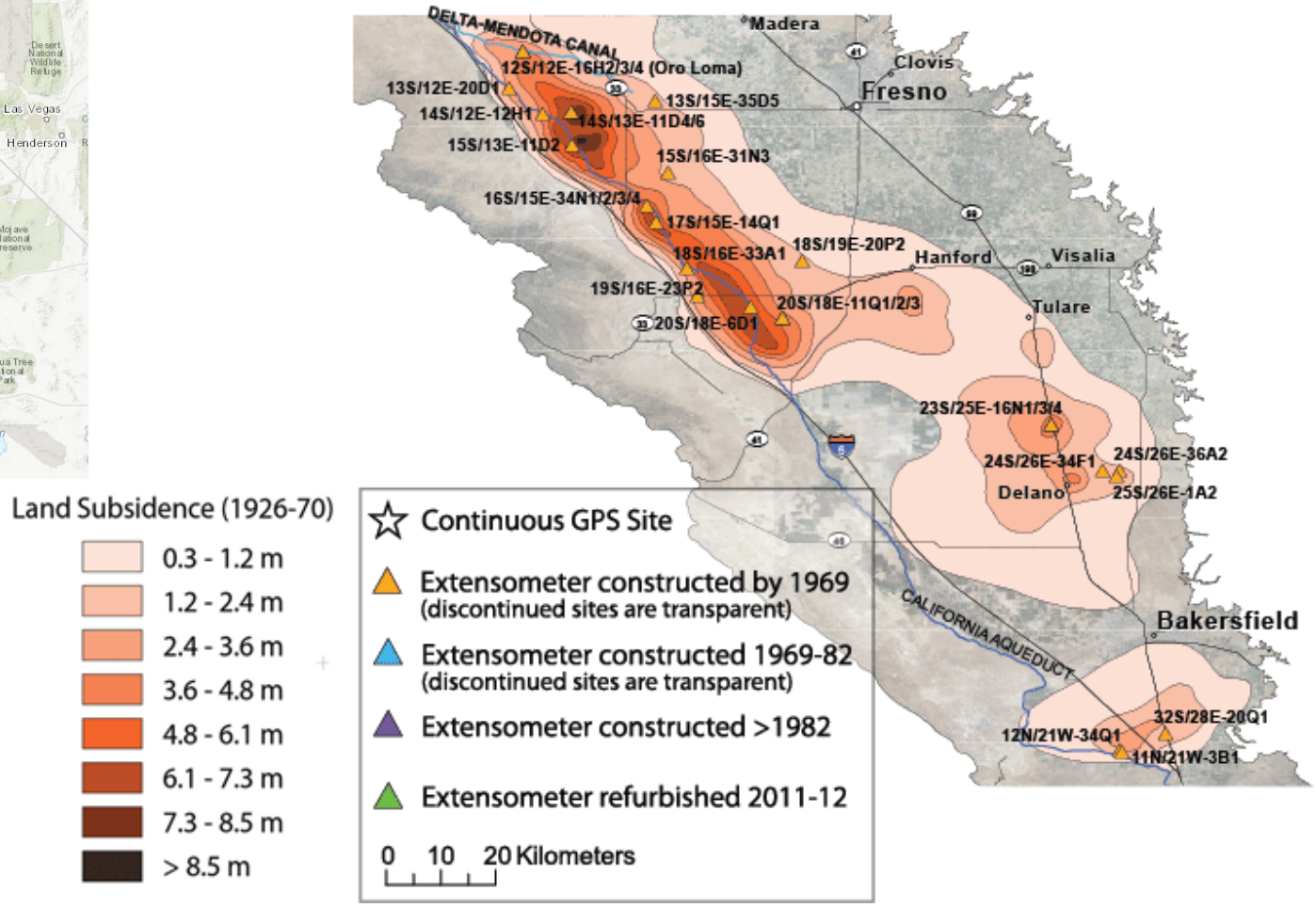
https://earthquake.usgs.gov/earthquakes/map/?extent=-21.61658,-273.16406&extent=79.74993,61.52344

Subsidence

- Gradual settling or sudden sinking of land surface due to removal or displacement of subsurface earth materials
- Key causes
  - aquifer-system compaction associated with groundwater withdrawals (80%)
  - drainage of organic soils
  - underground mining
  - natural compaction or collapse, such as with sinkholes or thawing permafrost
- Increase in population, economic growth and droughts will further affect subsidence
- More than 17,000 square miles in 45 States have been directly affected by subsidence

Subsidence in the Central Valley Driven by Groundwater Pumping



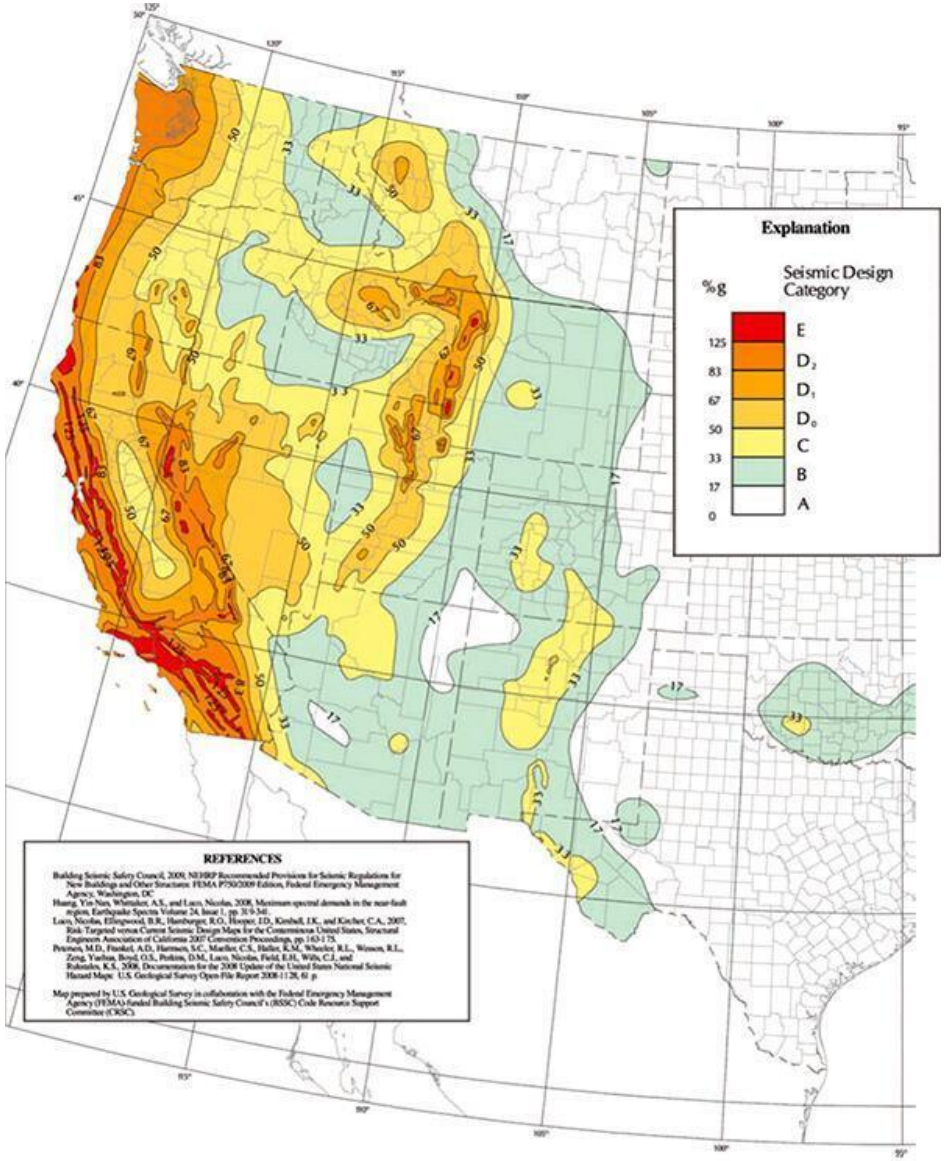


Some places in the San Joaquin Valley have lost more than 30 feet to subsidence since the 1920s

https://www.usgs.gov/media/images/san-joaquin-valley-land-subsidence-monitoring-network-1926-1970

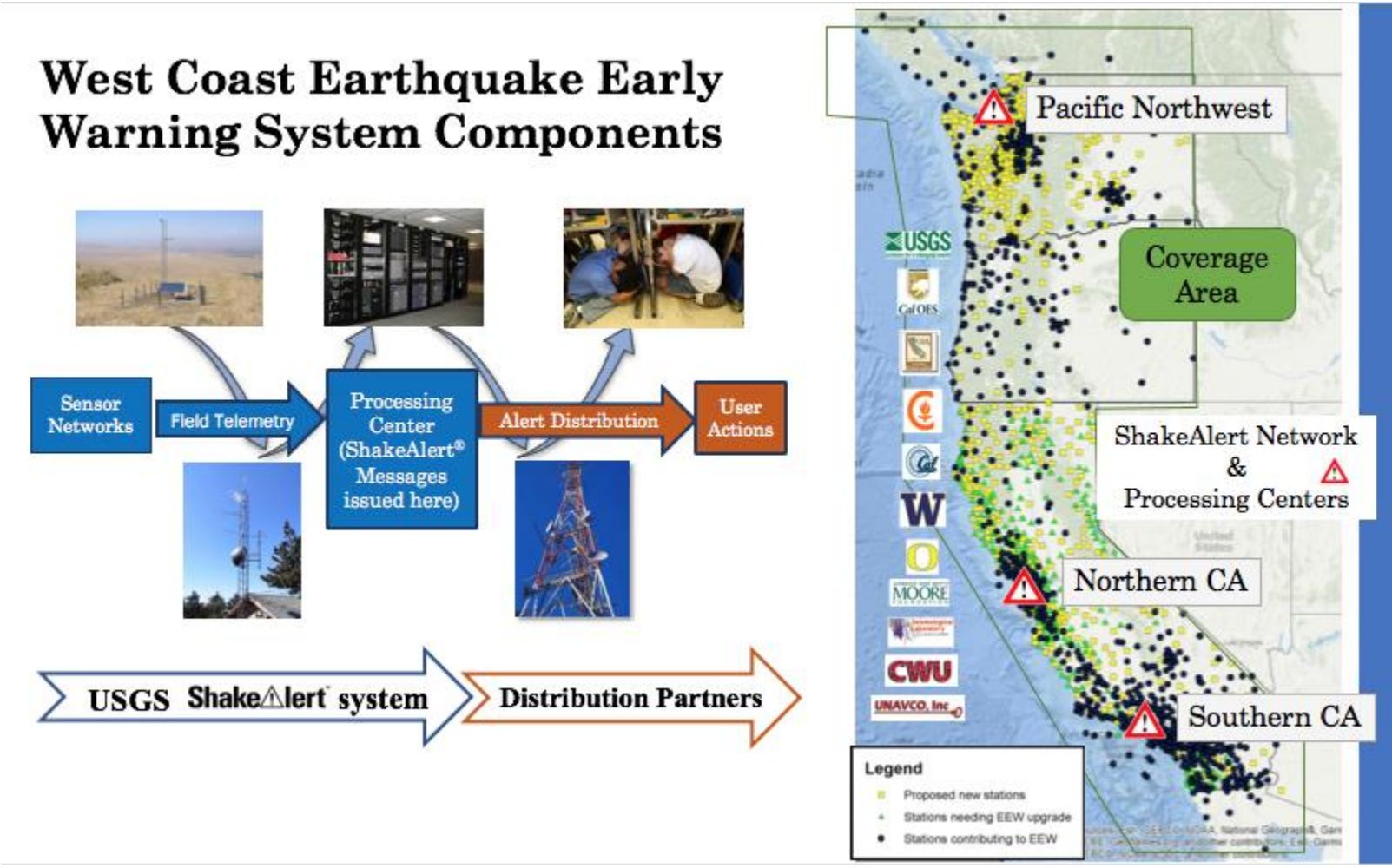
During An Earthquake

- *Seiche* occurs when water sloshes back and forth in an enclosed area, including USTs, causing overflow
- *Fault slip* (movement) below ground surface and surface - surface fault slip damage on or near the fault which can continue over time, delay/undo repairs
- *Landslides* are common on wet or dry slopes, depends on how high and steep the slope is, and how strong or stable the slope's material is
- *Liquefaction* a ground failure, solid ground temporarily behaves like a liquid, destructive to underground infrastructure, ground water liquefies sediment



Wireless Emergency Alert:
Severe weather, floods, earthquakes, tsunamis

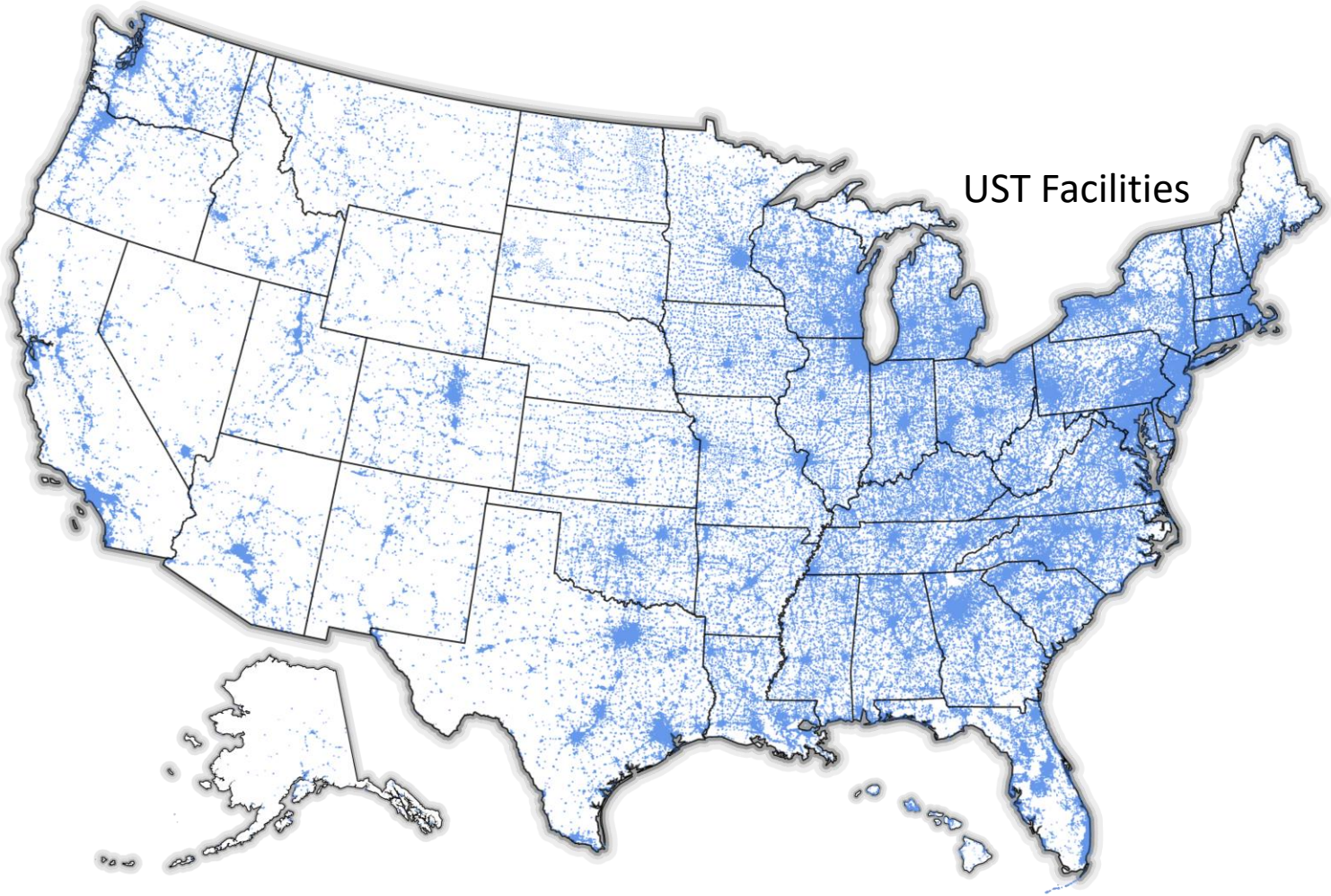
- Broadcasts public safety messages over commercial cellular system
- With compatible smartphones, tablets or other mobile devices can receive geographically targeted, text-like messages with alerts to threats to safety in their area.
- Messages sent by alert authorities through FEMA's Integrated Public Alert and Warning System (IPAWS)



ShakeAlert Earthquake Warning System

Overview

- Routine operations
  - Prevention
  - Cleanup
  - Q/A, case study
- Extreme events
  - Advance information
  - Site assessment
  - Q/A, case study
- Q&A
- Database version 2

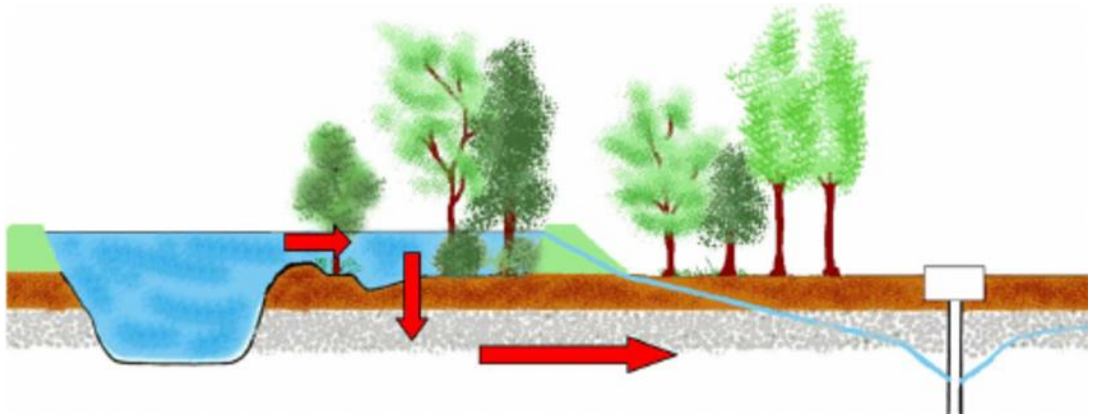


California - Assessing Underground Storage Tanks for Earthquake Damage

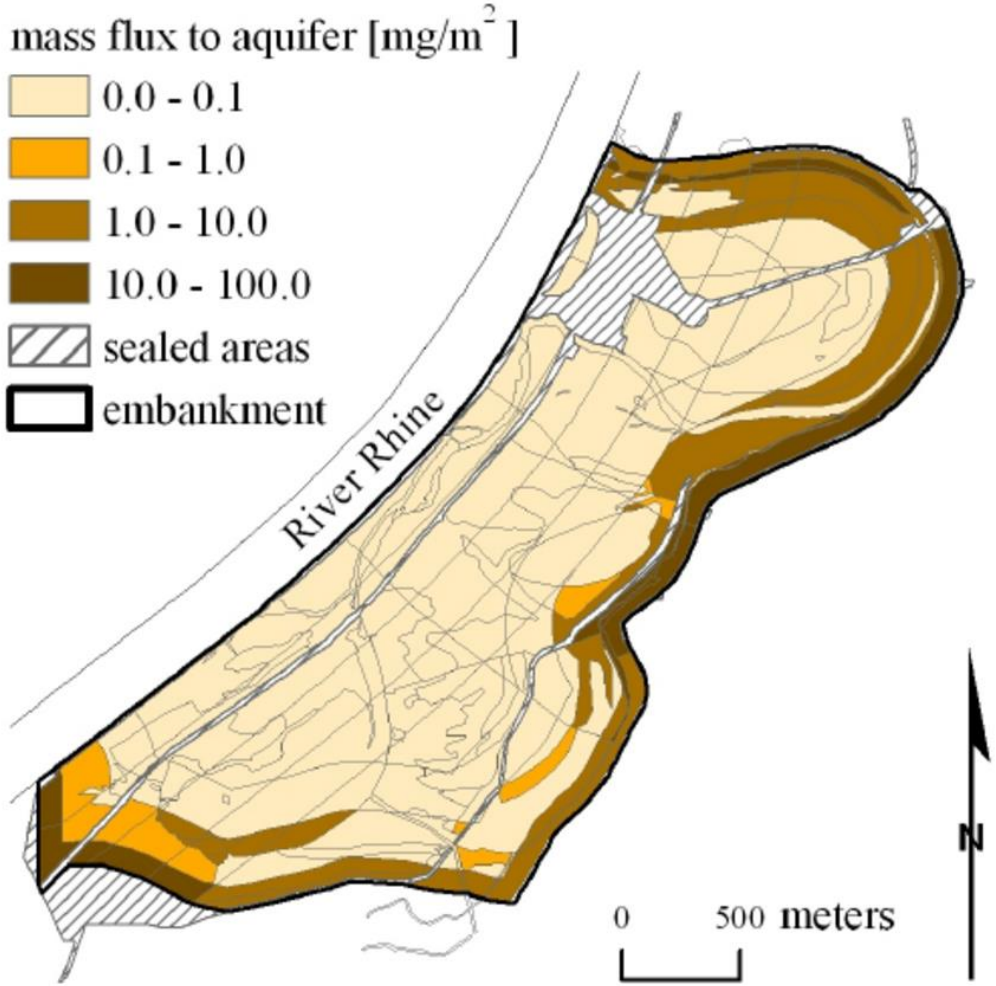
- Walk around the site and look for obvious signs that the UST system is compromised. If you smell strong odors of gasoline and/or diesel immediately close the site, block it off to traffic, and turn off the electricity to the UST system.
- Observe the UST leak detection console to determine if leak detection components are in alarm mode (ATG, interstitial sensor, line leak detector). UST owners/operators should contact their UST Service Technician to perform an alarm check to confirm that alarm program is working properly, and to run an inventory check to determine if there are any unusual results
- https://www.waterboards.ca.gov/ust/tech_notices/ust_earthquake_assess.pdf

Contaminant Transport During Flooding

Contaminant transport from a river to a well

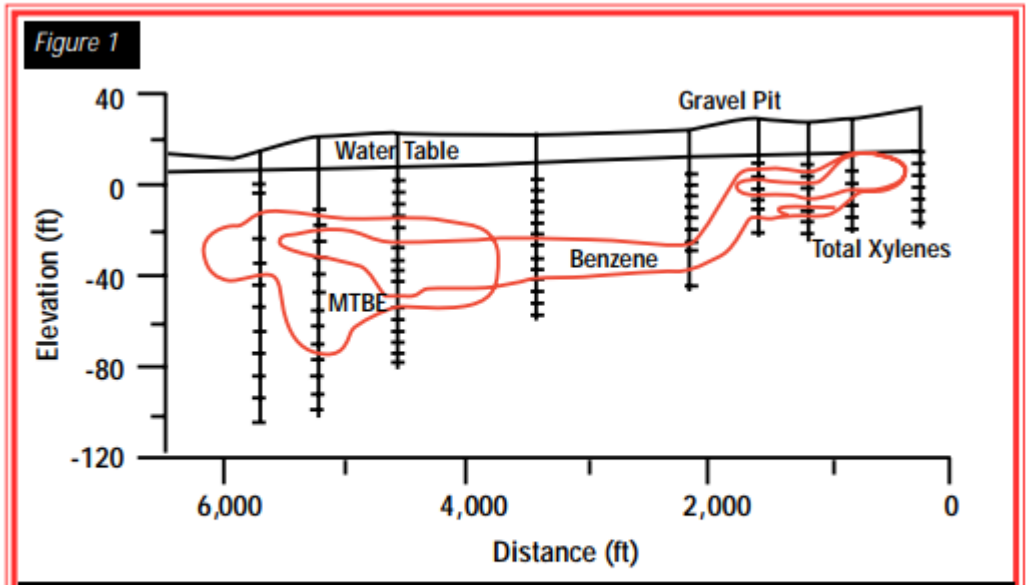


Contaminant mass flux



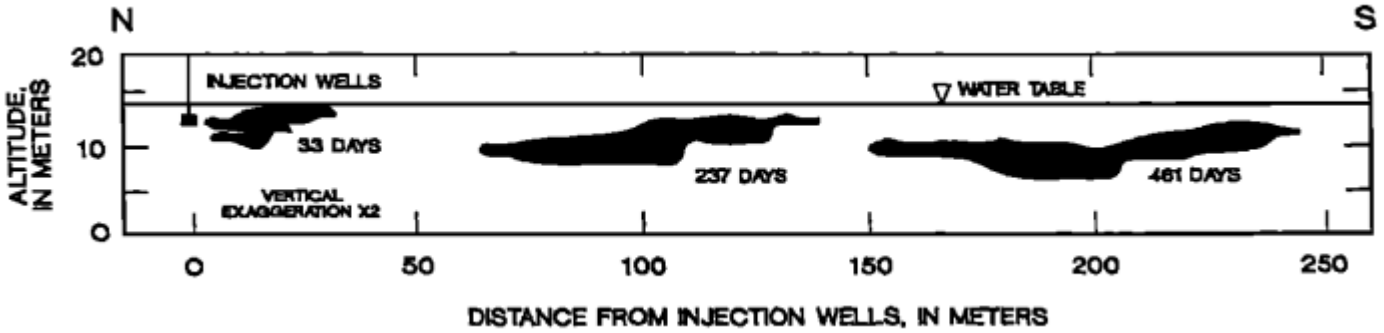
Kuhlers et al., Contaminant Transport to public water supply wells via flood water retention areas. Natural Hazards Earth Systems. 9, 1047-1058, 2009.

Pluvial and Fluvial Floods
Areal Recharge and Diving Plumes



A vertical cross section through the MTBE, benzene, and total xylene plumes at East Patchogue, New York. The gasoline source is located at the right-hand edge of the sections, and flow is to the left. Each of the plumes dives into the aquifer with transport in the aquifer.

https://clu-in.org/download/contaminantfocus/mtbe/EPA-Plume-Dive-LL36DvPlm.pdf

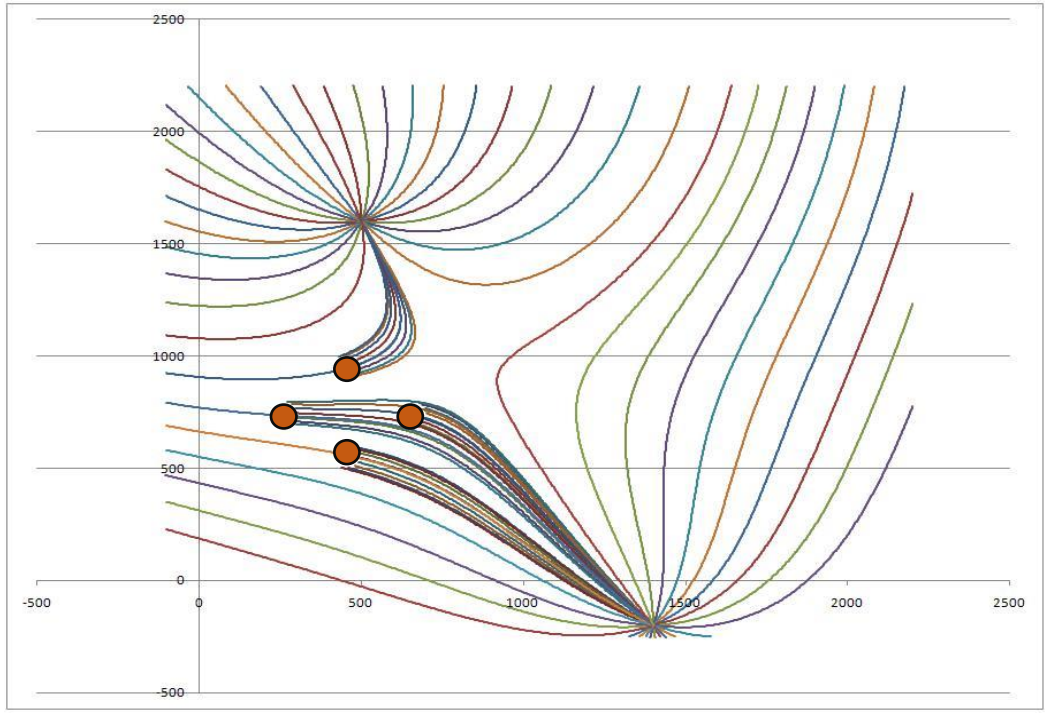


Center of mass moved downward >3 m in 237 days with recharge having a significant affect

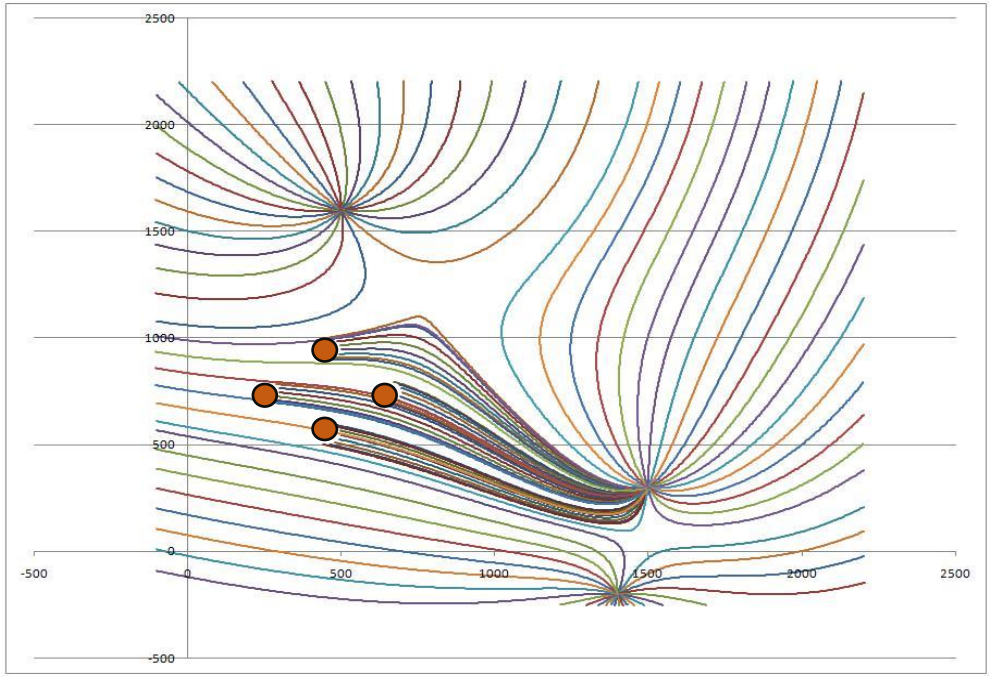
LeBlanc, D et al, https://doi.org/10.1029/91WR00241

Understanding the Spatial Implications of Contaminants Impacting Ground Water Supplies

Base Scenario with 2 pumping wells and 4 sources



- Contaminant source



3rd well is vulnerable to all sources, one original well no longer vulnerable

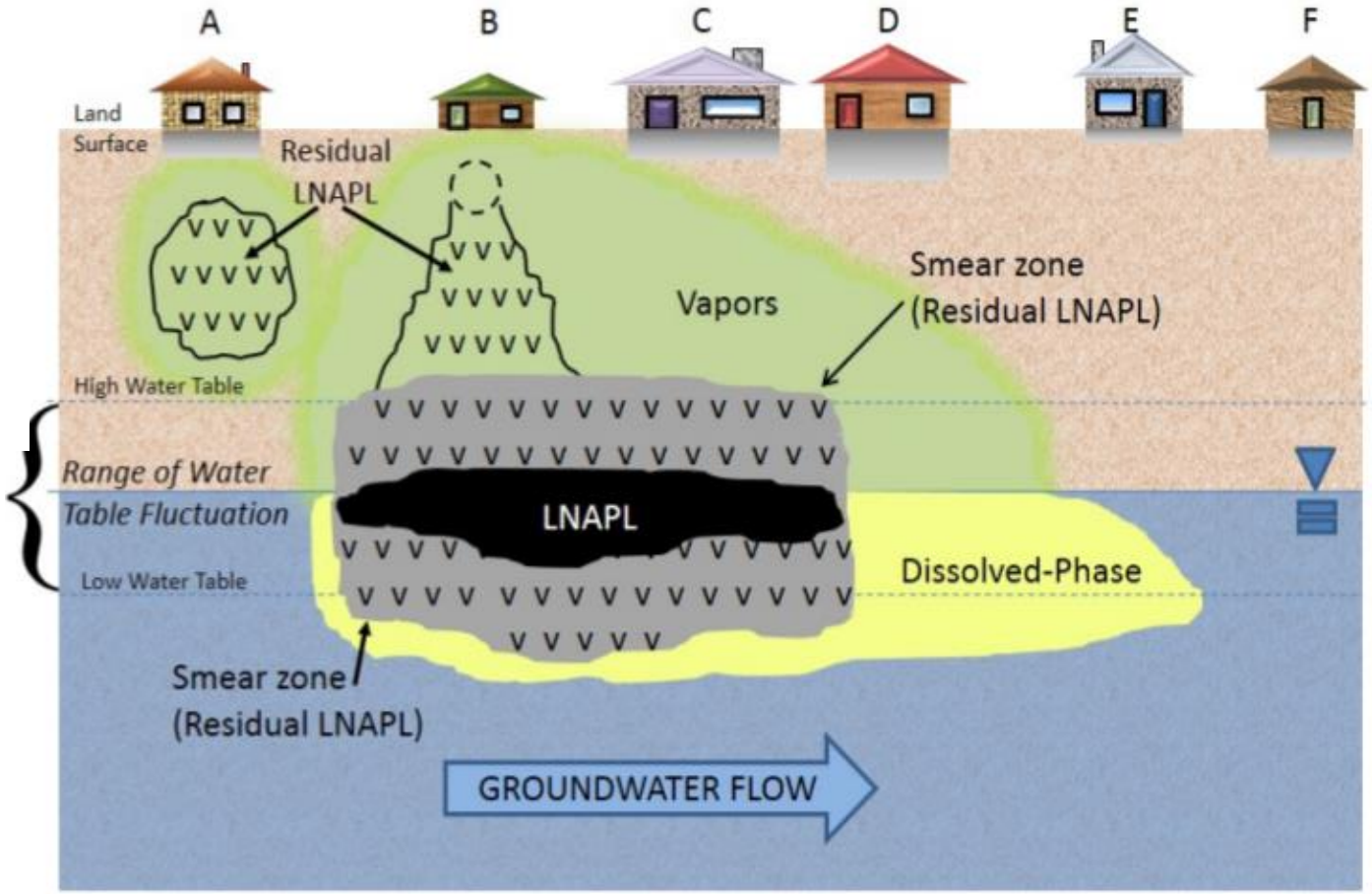
Jim Weaver, USEPA, ORD

Potential PVI Sources and Potential Receptors

Table 3. Recommended Vertical Separation Distance Between Contamination And Building Basement Floor, Foundation, Or Crawlspace Surface.

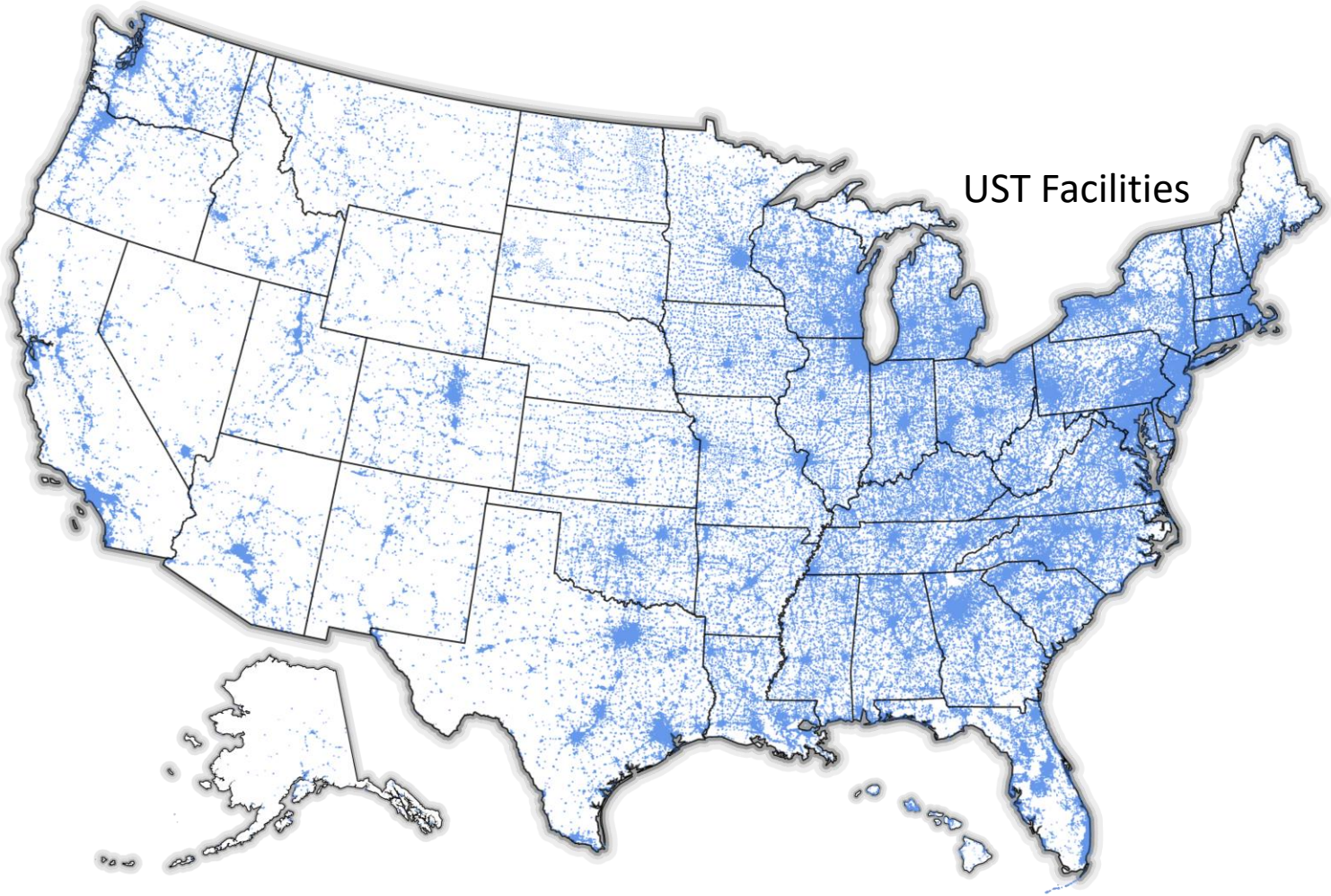
Media	Benzene	TPH	Vertical Separation Distance (feet)*
Soil (mg/Kg)	≤10	≤ 100 (unweathered gasoline), or ≤ 250 (weathered gasoline, diesel)	6
	>10 (LNAPL)	> 100 (unweathered gasoline) >250 (weathered gasoline, diesel)	15
Groundwater (mg/L)	≤5	≤30	6
	>5 (LNAPL)	>30 (LNAPL)	15

Technical Guide for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites, EPA 510-R-15-001



Overview

- Range of geologic and environmental conditions in western states and territories
- Routine operations
  - Prevention
  - Cleanup
  - Q/A/ case study
- Extreme events
  - Advance information
  - Site assessment
  - Q/A, case study
- Database version 2



United States Environmental Protection Agency

Case studies

Overview

- Range of geologic and environmental conditions in western states and territories
- Routine operations
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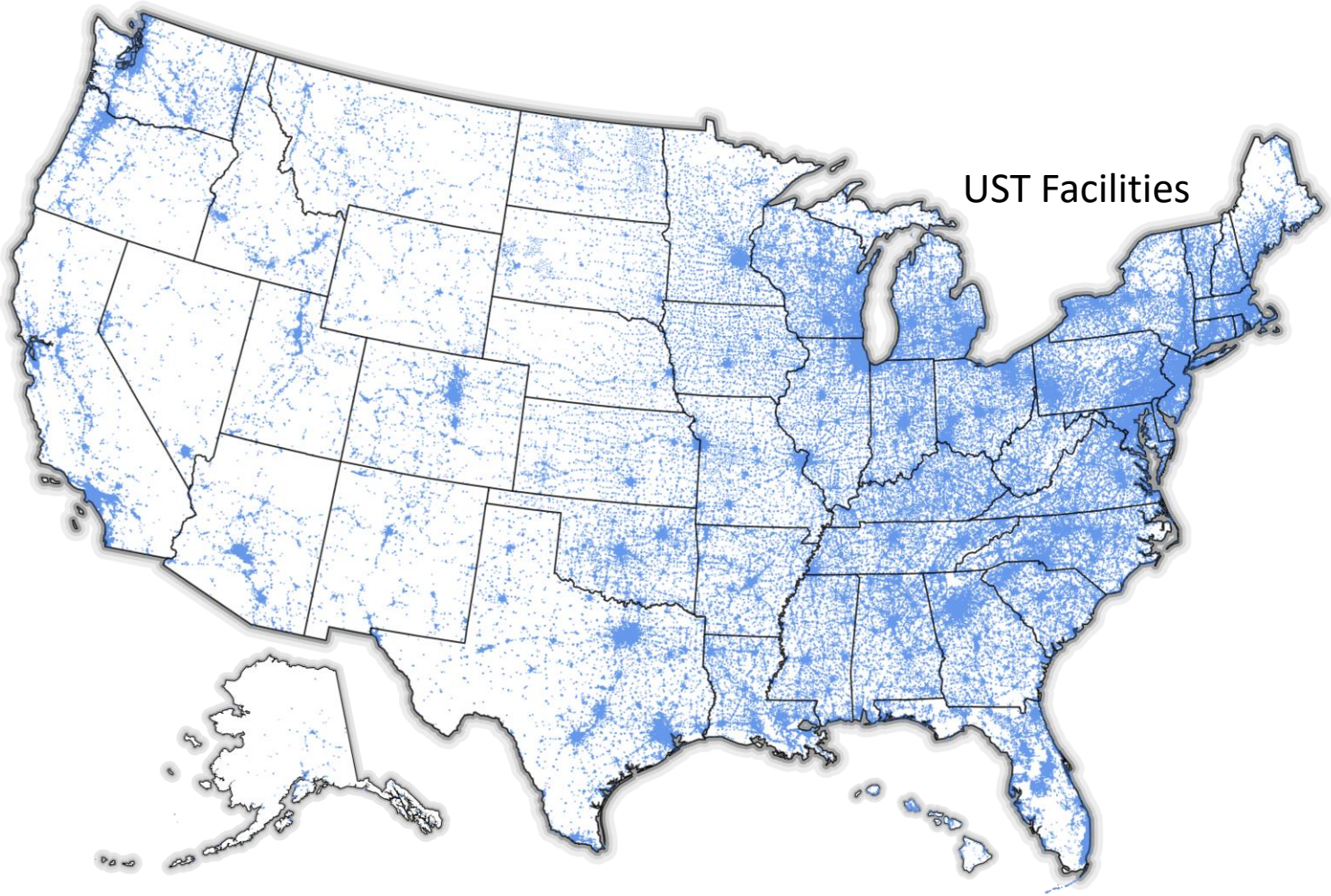
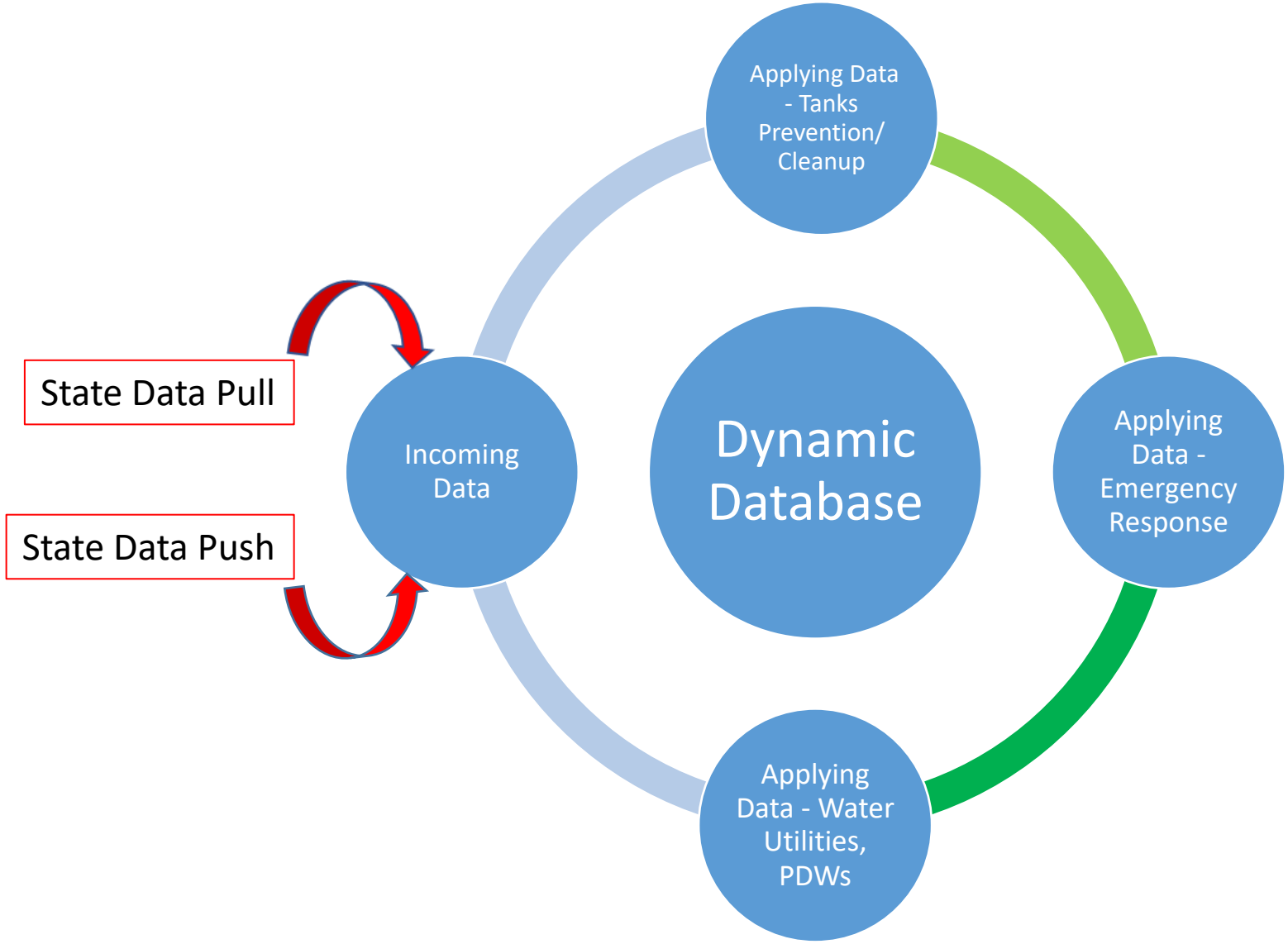


National Tanks Database V2



Programmatic Importance of UST Finder V2

Prevention

- Corrosion
  - Identify components early
  - Identify facilities vulnerable to corrosion
- Hazards
  - Prediction to minimize impacts
  - Identify impacted areas

Database

Cleanup

- Triage cleanups
  - Identify drinking water sources
  - Land use – risk
  - Population
- Screen technology selection
- Hazards
  - Identify facilities-
    - Potential new releases
    - Characterize and remediate new/existing releases