



# **Nebraska's Wellhead Protection Program**

**Rising Nitrates in Municipal Well  
What Really Can Be Done?  
Thursday, October 13<sup>th</sup>, 2011 10am-2pm  
Community Building, Deweese NE**

**Ryan Chapman – WHP Program Coordinator  
Nebraska Department of Environmental Quality (NDEQ)**

# Groundwater In Nebraska

A topographic map of Nebraska with a light tan background and blue lines representing major water bodies like the Missouri and Platte rivers. Numerous small red dots are scattered across the state, representing the locations of public water systems wells. The dots are more densely clustered in the eastern and central parts of the state.

- **1319 Public Water Systems (PWS)**
- **592 Community PWS**
- **5000+ PWS wells**
- **85% of Nebraskan's Drink GW**
- **Subtract Omaha and 99% Drink GW**

**Delineation**



**Contaminant  
Source  
Inventory**



**Contaminant  
Source  
Management**



**Five Steps of the  
Wellhead Protection  
Program**

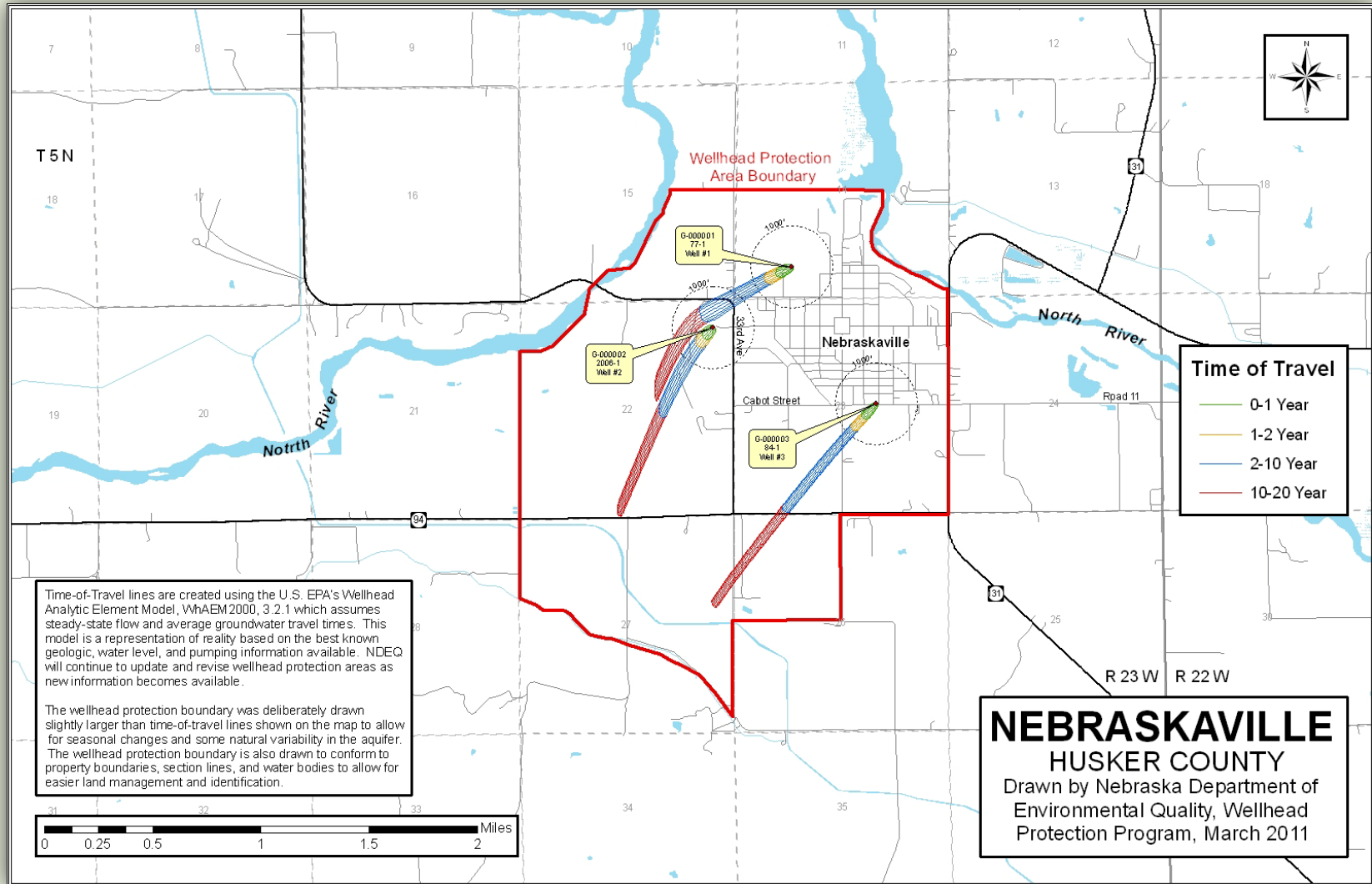
**Public  
Education**



**Contingency  
Planning**



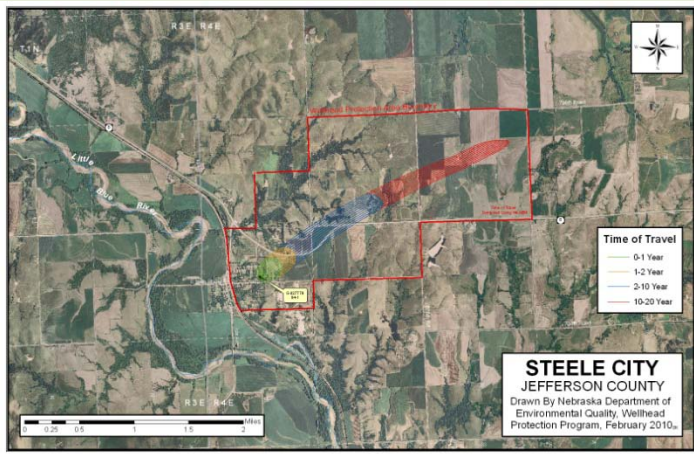
# Delineation



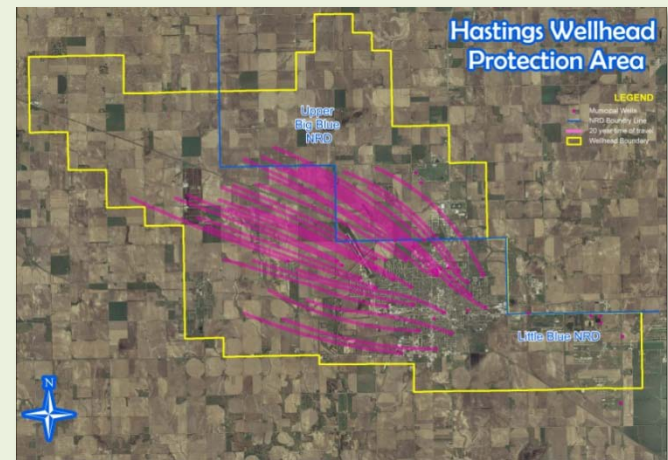


# Who

- Licensed Nebraska geologist
- NDEQ provides this service for free
- Need to be approved by NDEQ



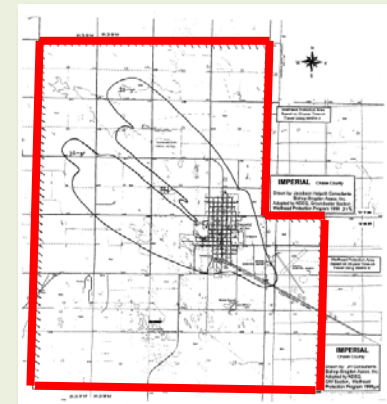
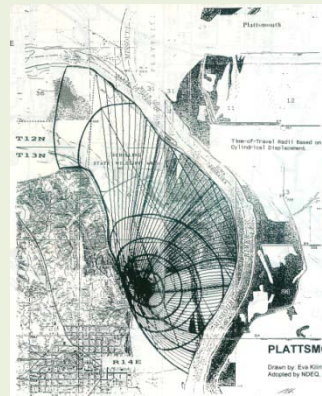
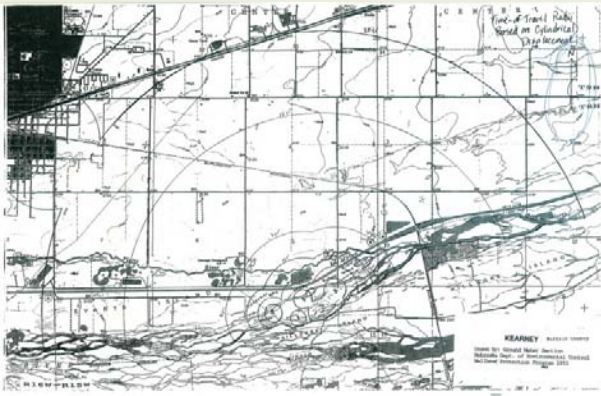
Steele City – NDEQ



Hastings – Layne GeoSciences

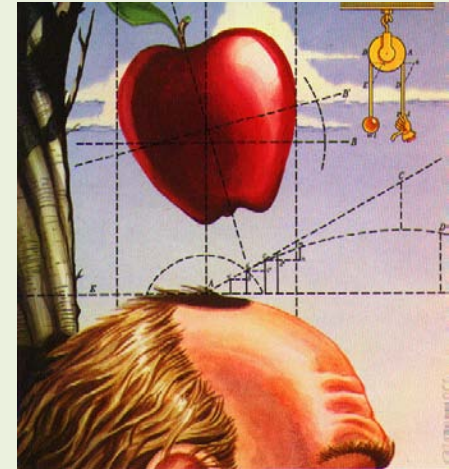
# Methods/History

- Arbitrary fixed radius (*1000'*)
- Calculated fixed radius (*Cylindrical Displacement*)
- Simplified variable shapes
- Well in a uniform flow (*WHPA*)
- Analytical method (*WhAEM*)
- Hydrogeologic mapping
- Numerical flow & transport models (*MODFLOW*)

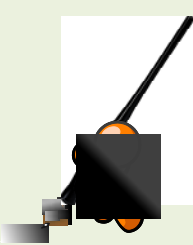


# Delineation - Models

- **Mathematical abstractions of the real world**
- **All abstractions are simplifications**



# Accuracy - WhAEM Model



- **Assumptions**
  - Steady-state (average) flow conditions
  - Averages groundwater travel times
  - 2D flow (Dupuit assumption)
  - Averages aquifer bottom
  - One aquifer
  - Contaminants move with the groundwater
    - Dispersion/Adsorption/(bio)chemical reactions
- **Conclusions**
  - The most sophisticated models will not do us any good if we don't have data to feed them.



# Accuracy - Available Data

- **Well Locations**
  - Latitude & Longitude
  - Elevations!
- **Well Construction**
- **Aquifer Characteristics**
  - Pumping tests/aquifer stress tests
  - Not pump efficiency tests



# Accuracy - Conclusion

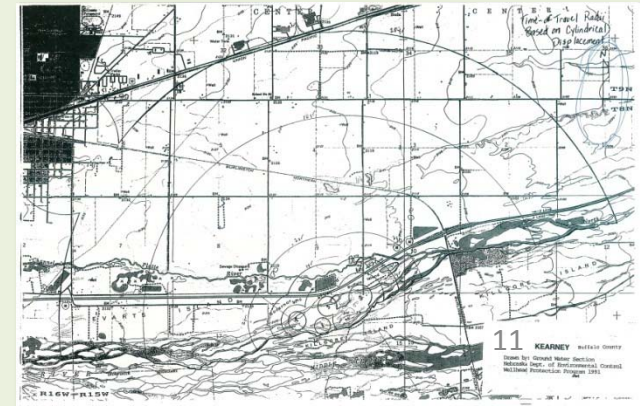
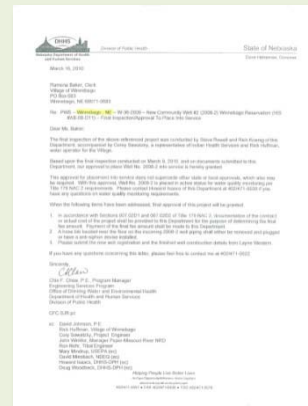
- **Time & Budget?**
  - Is the extra time/money going to affect the capture zone?
- **Better to define a less than perfect WHP zone than none at all**
- **Trading uncertainty into conservative/protective assumptions**

The wellhead protection boundary was deliberately drawn slightly larger than time-of-travel lines shown on the map to allow for seasonal changes and some natural variability in the aquifer. The wellhead protection boundary is also drawn to conform to property boundaries, section lines, and water bodies to allow for easier land management and identification.

# Delineation - Updates



- Via Request
- Focusing On
  - 1) Requests
  - 2) PWS with new wells/decommissioned wells (~ 100)
  - 3) Older models
    - Not modeled with WhAEM (~30)
    - Modeled before 2000 (~50)
  - 4) New hydrogeologic information becomes available
- Currently
  - 532 Total WHP Maps
  - 25 to do
  - ~2 per week



# Availability

- Email or Call the WHP Program @ NDEQ
- Online:
  - State Agencies
  - NRDs
  - Counties

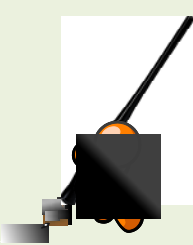
The screenshot displays the NDEQ website's 'Wellhead Protection Area List -Private' page. It features a search bar with the text 'Enter keyword(s) to search:' and a 'Search' button. Below the search bar is a table listing various Wellhead Protection Areas (PWAs) with columns for PWS Name, NE ID, County, NRD, and Map Date. To the left of the main table is a 'Wellhead Protection Area Data Sheet -Private' for the Beatrice, City Of PWS, which includes details such as NE ID (NE3106705), County (Gage), NRD (Lower Big Blue), and Map Date (May 12, 2003).

PWS Name	NE ID	County	NRD	Map Date
133 Estates	NE3120574	Washington	Papio-Missouri River	Nov 9, 2010
1733 Estates Associates	NE3120018	Buffalo	Central Platte	Aug 11, 2000
Abie, Village Of	NE3102305	Butler	Lower Platte North	Feb 17, 2000
Adams, Village Of	NE3106712	Gage	Nemaha	Jul 3, 2003
Ainsworth, City Of	NE3101702	Brown	Middle Niobrara	Apr 7, 2010
Albion, City Of	NE3101102	Boone	Lower Loup	Aug 21, 2002
Alda, Village Of	NE3107909	Hall	Central Platte	Jan 3, 2002
Alexandria, Village Of	NE3116910	Thayer	Little Blue	Jan 1, 2005
Allen, Village Of	NE3105101	Dixon	Lewis & Clark	Jan 20, 2010
Alliance, City Of	NE3101302	Box Butte	Upper Niobrara White	Jul 9, 2009
Alma, City Of	NE3108307	Harlan	Lower Republican	Jan 1, 2002
Alvo, Village Of	NE3102508	Cass	Lower Platte South	Jun 3, 2005
Amherst, Village Of	NE3120041	Buffalo	Central Platte	Nov 23, 2003
Anselmo, Village Of	NE3104103	Custer	Lower Loup	Jul 3, 2001

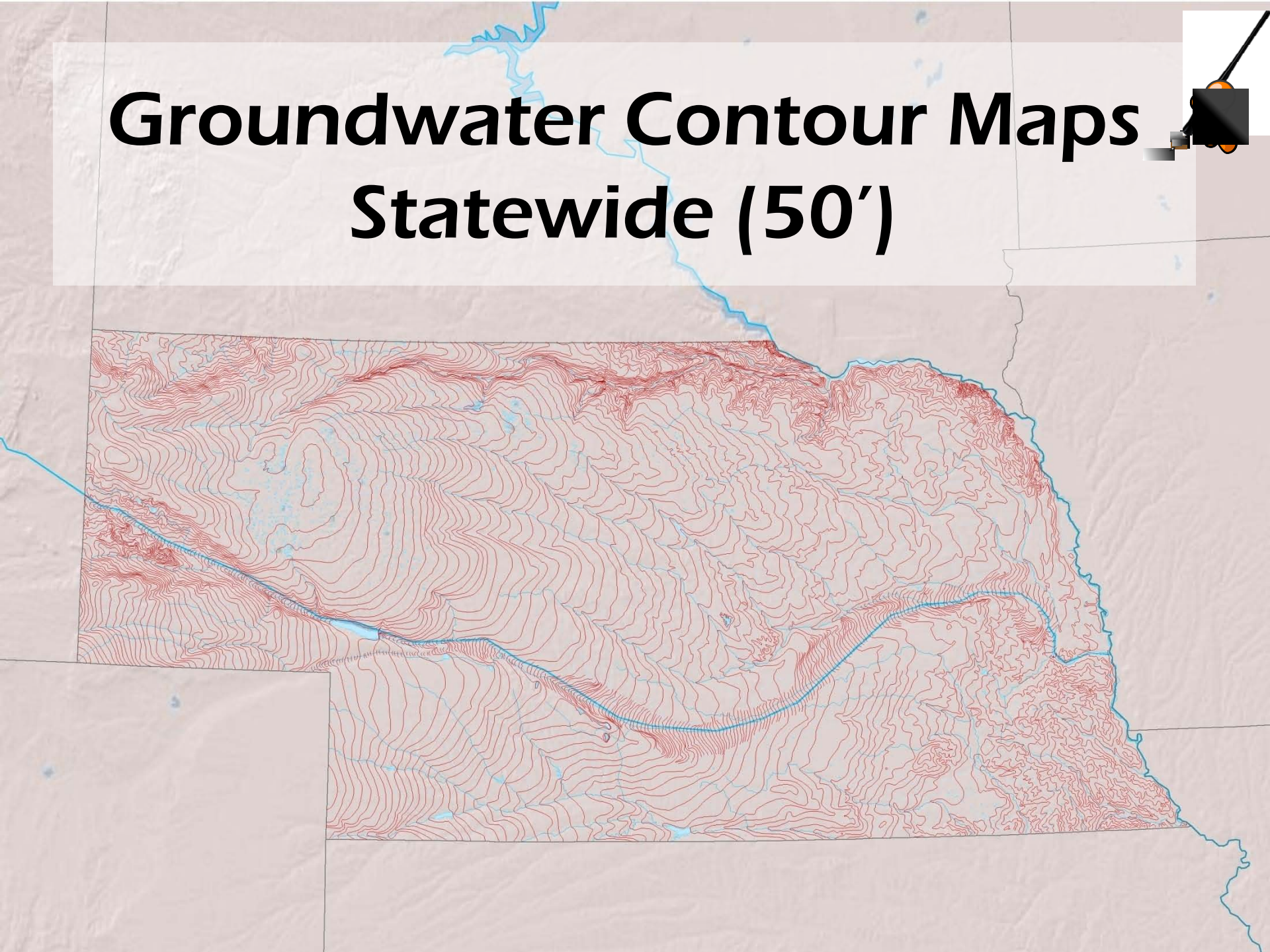
PWS Name:	Beatrice, City Of
NE ID:	NE3106705
County:	Gage
County 2:	
County 3:	
County 4:	
NRD:	Lower Big Blue
NRD 2:	
Map Published:	May 12, 2003
Plan Approved:	10/19/09
CSI Last Updated:	1/1/06
Draft Submitted:	8/26/09
Plan Progress Notes:	Approved
Map PWS Notes:	Reverse Osmosis Treatment
PDF Map:	<a href="#">Beatrice.pdf</a>



# Generalized Effects of Pumpage Changes

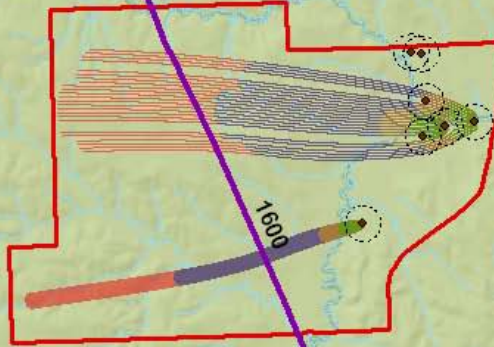


# Groundwater Contour Maps Statewide (50')





# Groundwater Contour Maps Statewide (50')

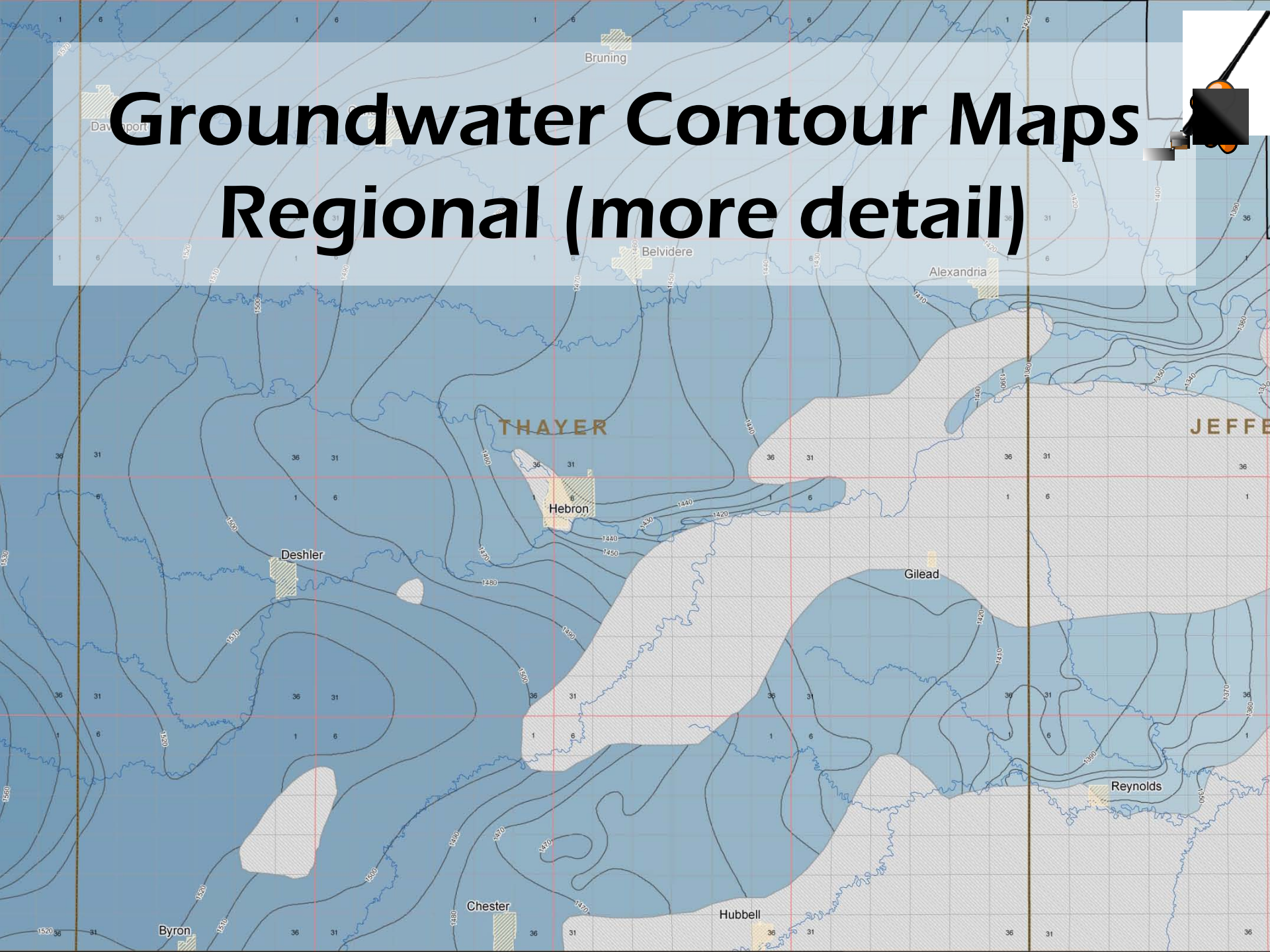


Madison



# Groundwater Contour Maps

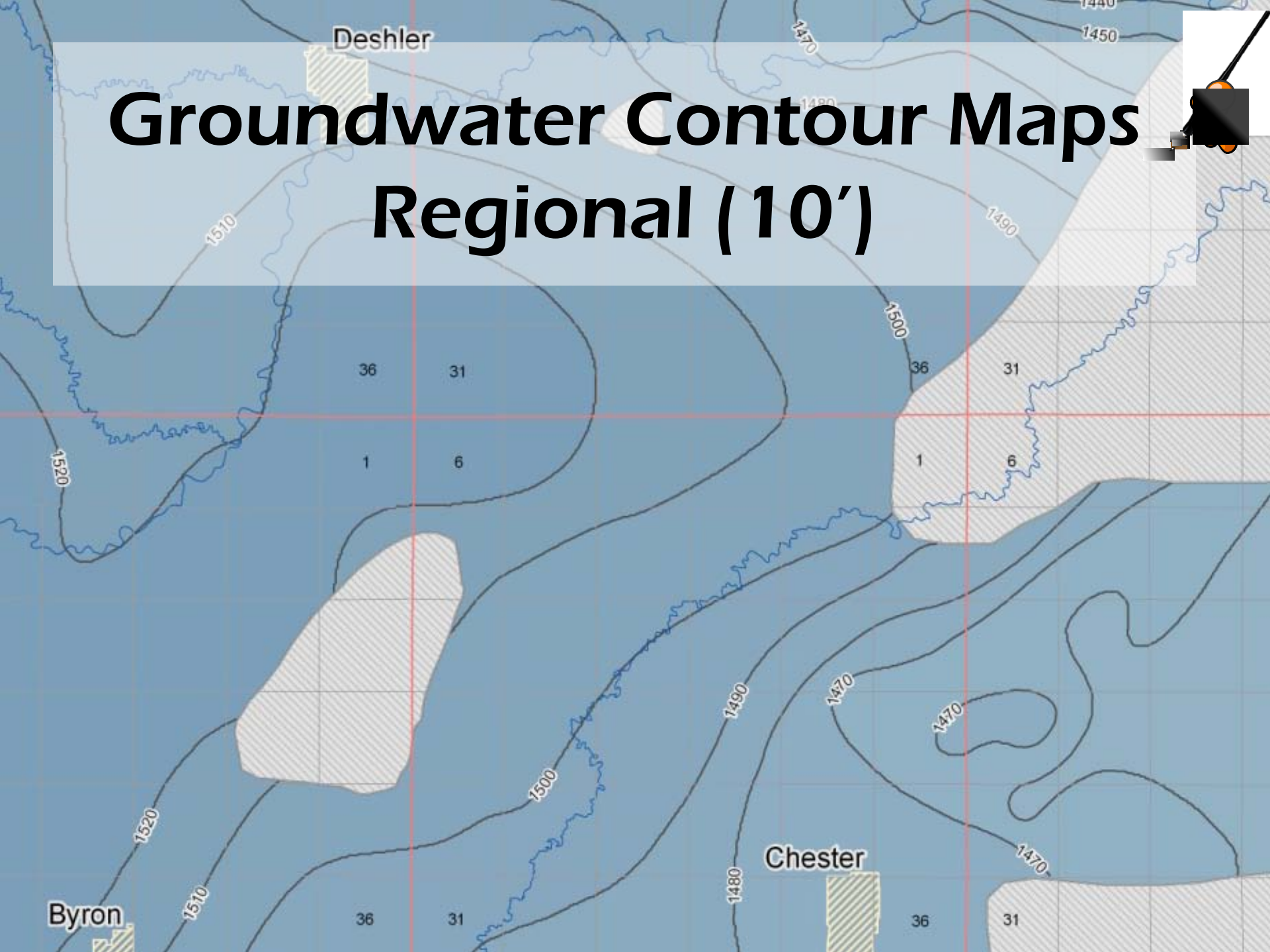
## Regional (more detail)





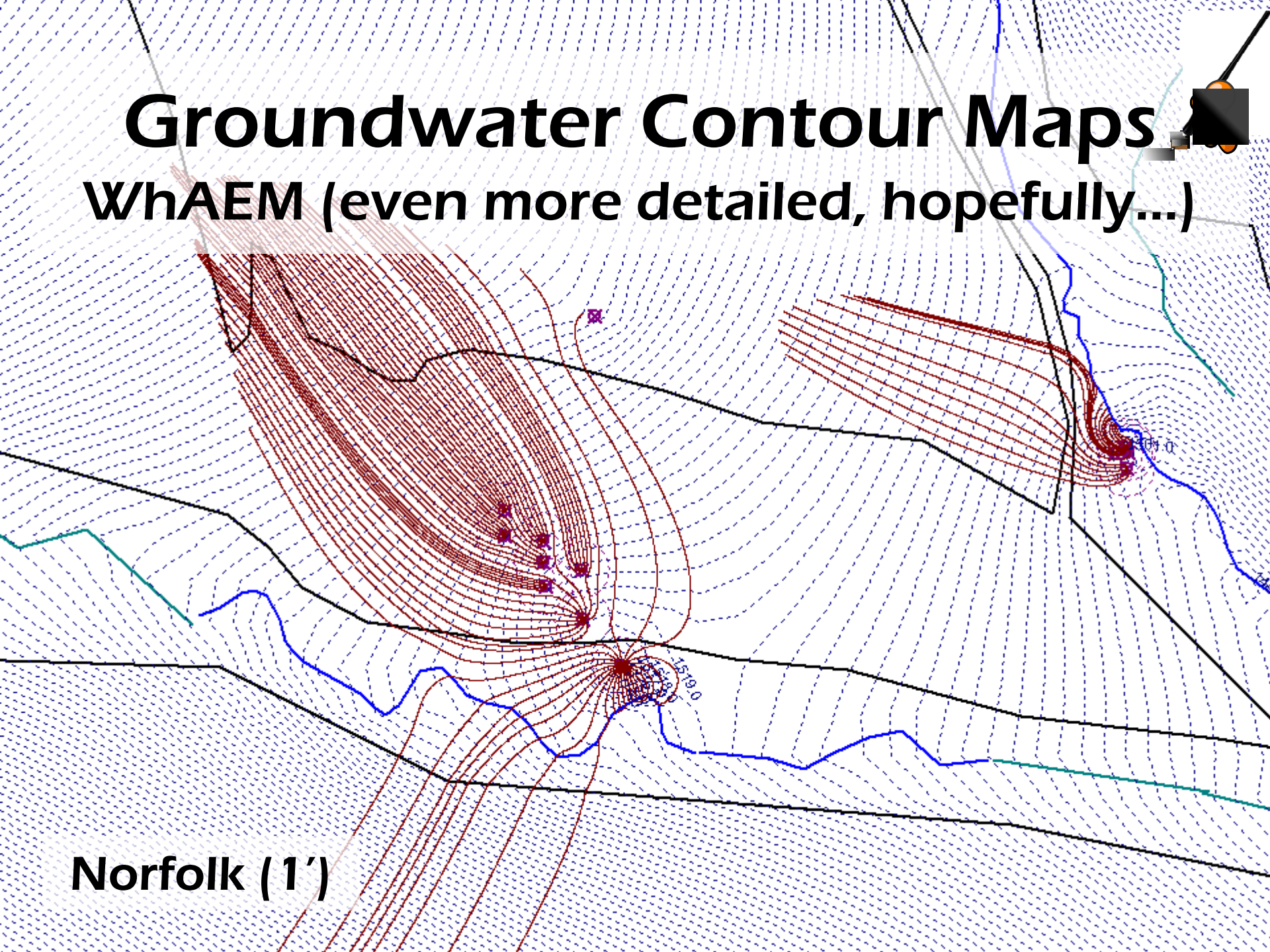
# Groundwater Contour Maps

## Regional (10')



# Groundwater Contour Maps

WhAEM (even more detailed, hopefully...)



Norfolk (1')

# **We Have a Map!**

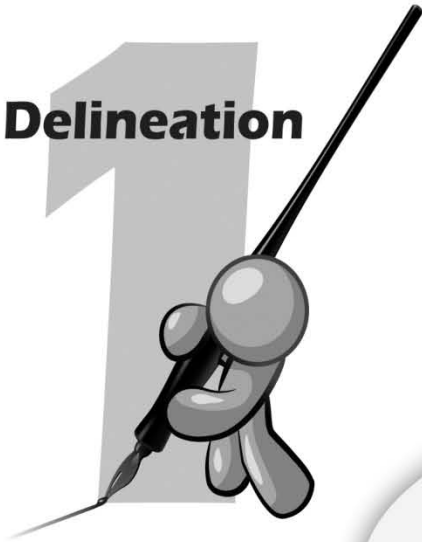


**So Our Drinking  
Water Is Protected**

**NO**



**Delineation**



**Contaminant  
Source  
Inventory**



**Contaminant  
Source  
Management**



**Five Steps of the  
Wellhead Protection  
Program**

**Public  
Education**



**Contingency  
Planning**





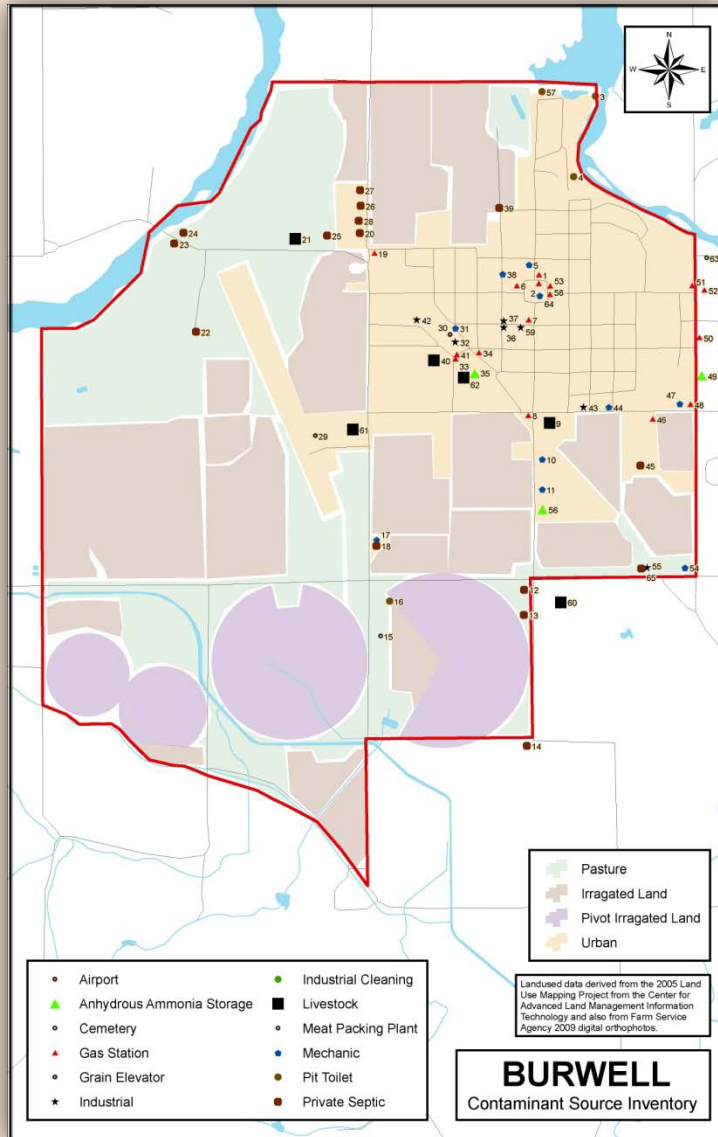
# **POTENTIAL Contaminant Source Inventory (CSI)**



- **Locating all Potential sources of contamination within the WHPA**
- **To help prioritize and focus efforts**



# CSI - Final Product



Id	Type	Former Use	Current	Notes
1		Gas Station	No	
2		Gas Station	No	Tanks Removed
3		Pit Toilet	Yes	
4		Pit Toilet	Yes	
5	Ray Brown	Mechanic	Yes	
6		Gas Station	No	Tanks Removed
7		Gas Station	No	Tanks Removed
8		Gas Station	No	Tanks Removed
9		Livestock	Yes	About 20 Cows, not present all year
10	Thoene Farm Service	Mechanic	Yes	
11	Bob's Used Car and Repair	Mechanic	Yes	
12		Private Septic	Yes	
13		Private Septic	Yes	
14		Private Septic	Yes	
15	City Cemetery	Cemetery	Yes	
16		Pit Toilet	Yes	
17	Lee's Body Shop	Mechanic	Yes	
18		Private Septic	Yes	
19	Dad's	Gas Station	Yes	
20		Private Septic	Yes	
21		Livestock	Yes	Future Feed Lot
22		Private Septic	Yes	
23		Private Septic	Yes	
24		Private Septic	No	
25		Private Septic	Yes	
26		Private Septic	Yes	
27		Private Septic	Yes	
28		Private Septic	Yes	
29	Cram Field	Airport	Yes	Mechanical, Industrial, Private Septic
31		Mechanic	No	
30		Grain Elevator	No	
32	Redi-Mix	Industrial	Yes	
33		Gas Station	No	Bulk Fuel Storage
34		Gas Station	No	Diesel Storage
35	Maverik Fertilizer	Anhydrous Ammonia Storage	Yes	
36		Industrial	No	Electrical Cleaning
37		Industrial	Yes	Electrical Cleaning
38		Mechanic	No	Fuel Storage
39		Private Septic	Yes	
40	Burwell Livestock Market	Livestock	Yes	
41		Gas Station	Yes	
42		Industrial	No	Garbage Hauling
43	City Shop	Industrial	Yes	Electical
44		Mechanic	No	Burnt down
45		Private Septic	Yes	
46	Burwell Independent Oil	Gas Station	Yes	Bulk Fuel Storage
47		Mechanic	Yes	
48	Sinclair	Gas Station	Yes	
49		Anhydrous Ammonia Storage	Yes	
50	Maverik Truck Stop	Gas Station	Yes	
51	We Mart	Gas Station	Yes	
52	Great Western Gas Co	Gas Station	Yes	Fuel Storage
53		Gas Station	No	
54	Department of Roads	Mechanic	Yes	Fuel Storage
55		Industrial	Yes	Alfalfa Mill
65		Private Septic	Yes	
56		Anhydrous Ammonia Storage	No	Bulk Fertilizer Plant
57		Pit Toilet	Yes	4
58		Gas Station	No	
59	Light Plant	Industrial	Yes	Fuel Storage
60		Livestock	Yes	
61		Livestock	Yes	around 10 animals
62	Performance Center	Livestock	Yes	
63		Meat Packing Plant	Yes	
64		Mechanic	No	old car dealer, industrial

# Available Resources



- **Help**
  - Regional, State, and Local Agencies
  - Non-Profits
  - Consultants
- **Databases**
- **Current & historic aerial photos/maps**

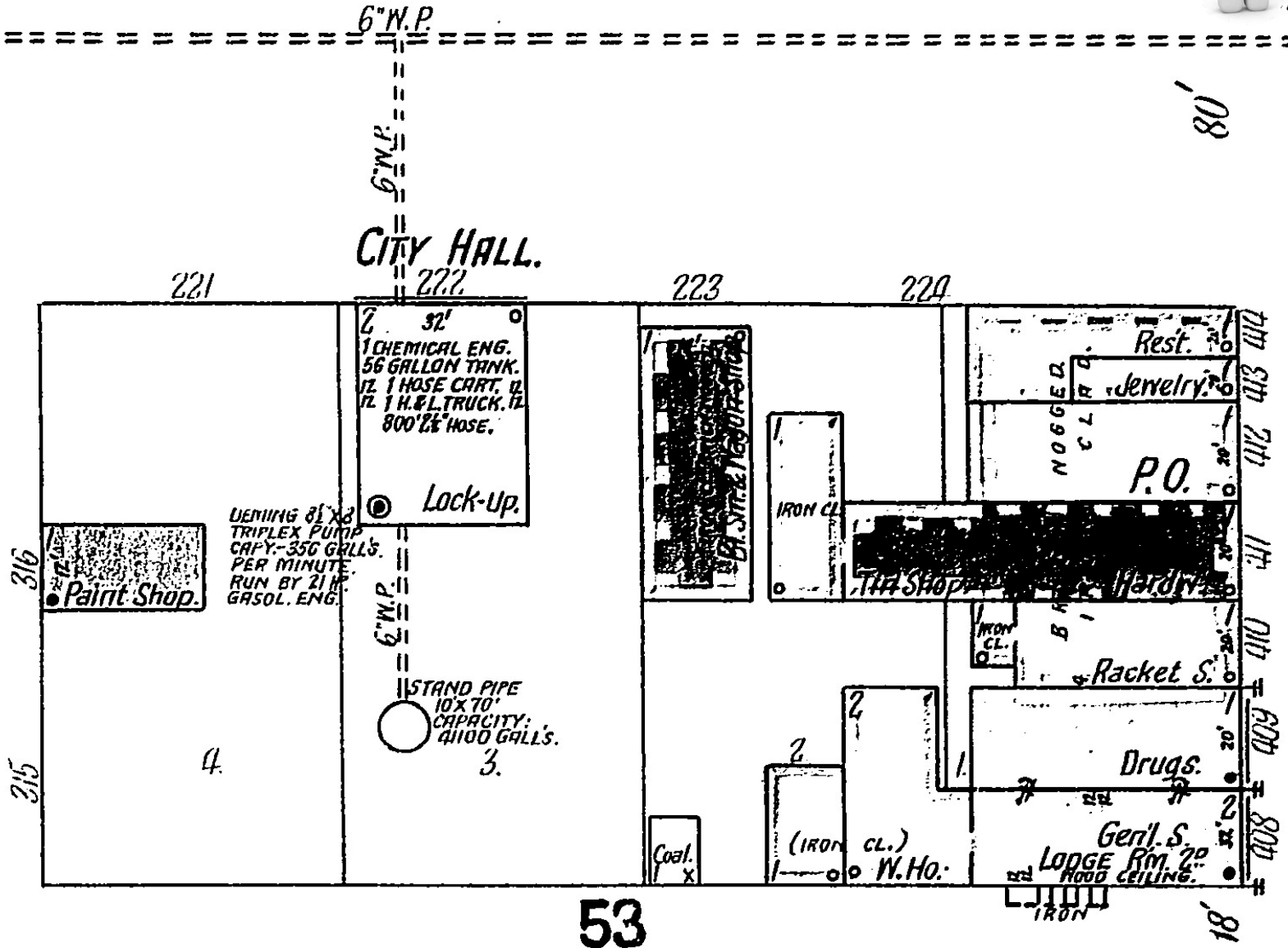


# Sanborn Fire Insurance Maps



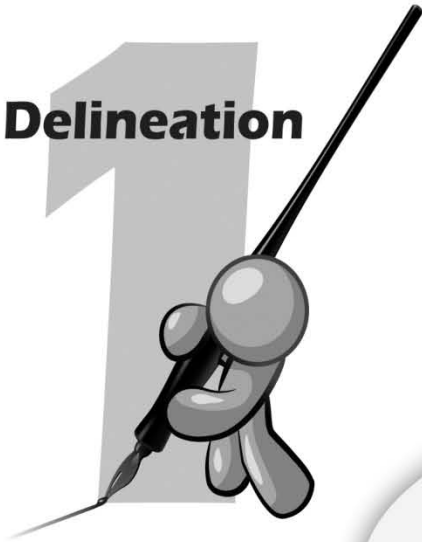
MAPLE

FIRE





**Delineation**



**Contaminant  
Source  
Inventory**



**Contaminant  
Source  
Management**



**Five Steps of the  
Wellhead Protection  
Program**

**Public  
Education**



**Contingency  
Planning**





# Management Planning

- Assemble Stakeholders
- Deciding on the best strategies
  - Ordinances/Zoning
  - Inspections
  - Interlocal Agreements
  - Education
  - BMPs on WHPA land





# Ordinances

- **Prohibition on drilling private wells**
- **Require permits for specific activities**
- **Prohibit specific activities**
- **Adopt setback rules**





# Well Setback Distances

EFFECTIVE DATE  
APRIL 4, 2010

NEBRASKA DEPARTMENT OF  
HEALTH AND HUMAN SERVICES

179 NAC 7

CATEGORY	DISTANCE Feet
Water Well	1,000
Sewage Lagoon	1,000
Land application of municipal/industrial waste material	1,000
Feedlot or Feedlot Runoff	1,000
Underground disposal system (septic system, cesspool, etc.)	500
Corral	500
Pit Toilet/Vault Toilet	500
Wastewater Holding Tanks	500
Sanitary Landfill/Dump	500
Chemical or Petroleum Product Storage	500
Sewage Treatment Plant	500
Sewage Wet Well	500
Sanitary Sewer Connection	100
Sanitary Sewer Manhole	100
Sanitary Sewer Line	50

**NOTE:** If the distance requirements in 179 NAC 13 Attachment 2 are not met, the well is subject to testing to determine if it is ground water under the direct influence of surface water. If a well meets that definition, it is treated as a surface water source subject to all the requirements of the rules regarding surface water.

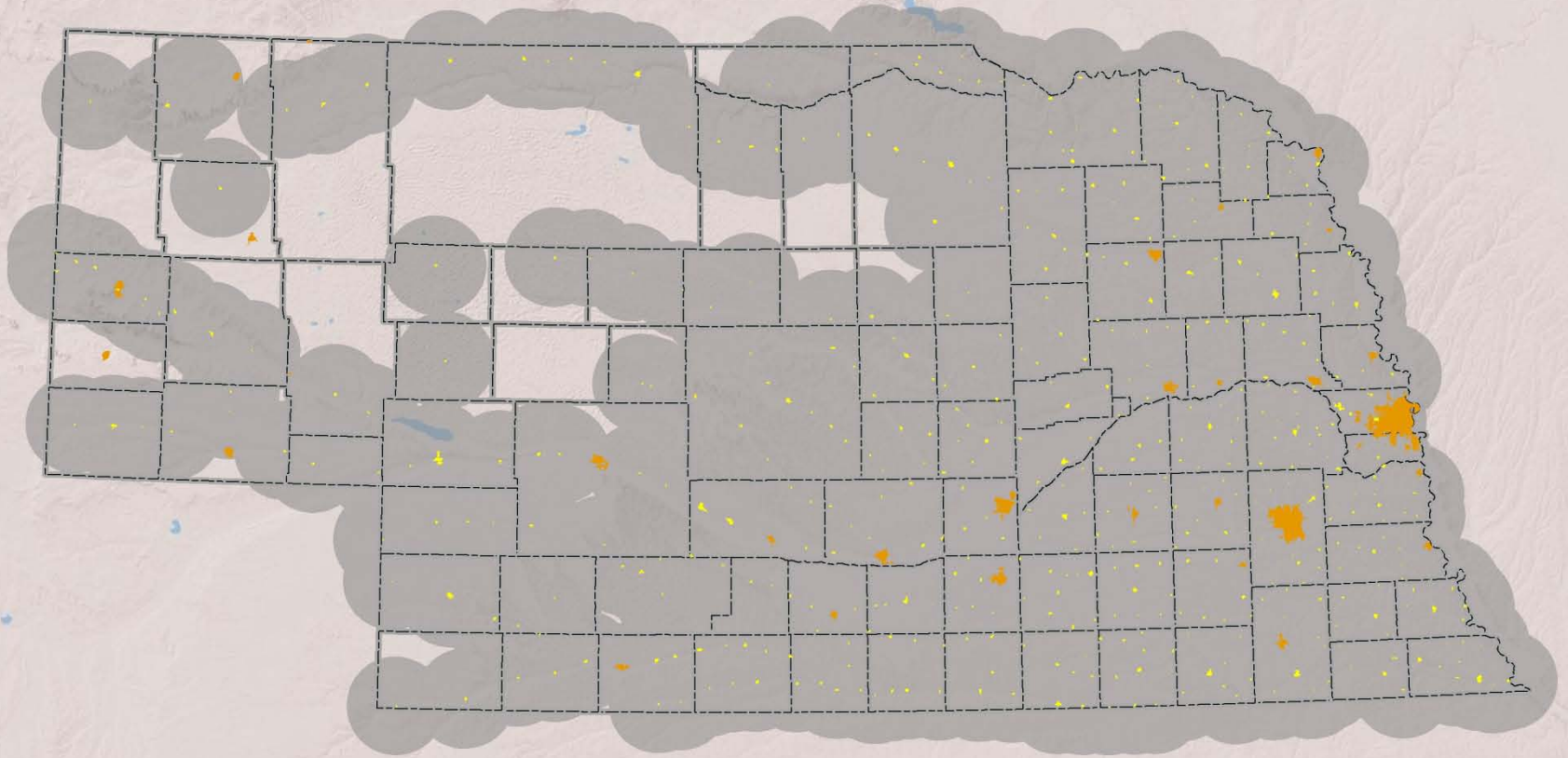




# The Problem

- **Public Water Systems (PWS) lack the ability to regulate their 'Source Waters'**
- **Extraterritorial Jurisdiction**
  - 1, 2, or 3 mile
  - Cities authority overrides the Counties
- **"15 mile" rule**
  - **Section 17-536 The jurisdiction of such city or village, to prevent any pollution or injury to the stream or source of water for the supply of such waterworks, shall extend fifteen miles beyond its corporate limits.**

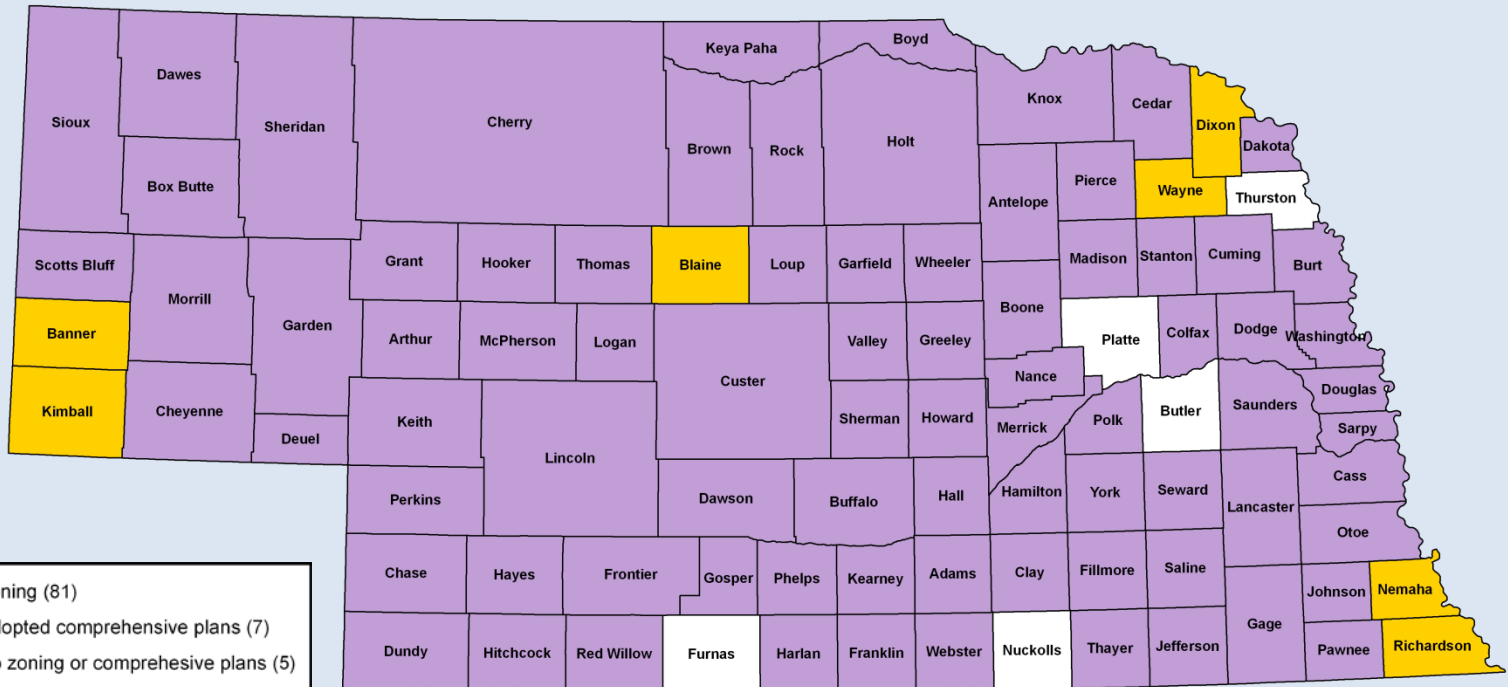
# 15 Mile Radius – Towns <5,000





# County Zoning in Nebraska

- Counties w/ Zoning (81)
- Counties w/ Comprehensive Plans (7)
- Counties w/ No Zoning or Comp Plan (5)



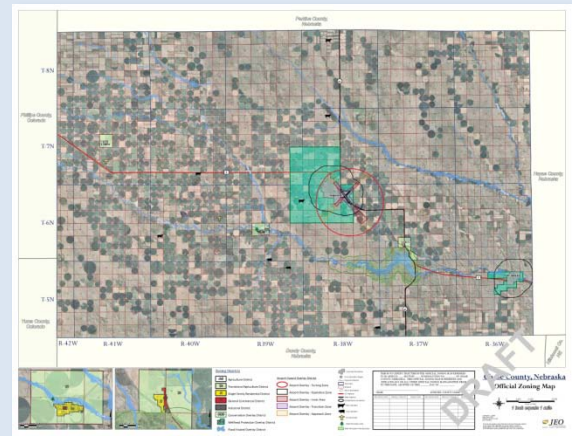
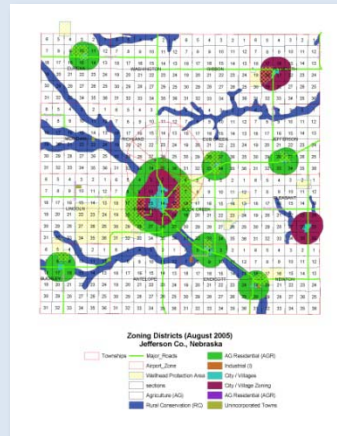




# Counties with Zoning

- **Overlay Districts**

- Specify permitted, conditional, and prohibited structures
- Allow only permitted uses
- \*Spell out how this will be enforced!\*
- Generally... the allowance of variances is discouraged



# Examples of Prohibited Structures



- Concentrated Animal Feeding Operations and associated waste handling facility uses
- Stockpiling of livestock manure, paunch, or sludge.
- Containment of liquid livestock waste, manure, paunch, or sludge
- Landfills and refuse recycling centers
- Sand, gravel or limestone mining operations
- Chemical reclamation facilities
- Hazardous waste impoundment facilities
- Salvage (junk) yards of all types





# Examples of Requirements & Restrictions

- Fuel storage
- Hazardous materials
- Illegal wells to be abandoned prior to development
- No septic tanks within 1000' of PWS wells
- No new water wells
- ?? - Fertilizers, manure, pesticides, and herbicides to be applied at agronomic rates - ??
- Chemigation & Fertigation
- Etc.







# Counties Without Zoning

- **No Zoning with Comprehensive Plan**
  - **Must create a zoning regulation**
    - **Can simplify it with WHP area zoning and everything else AG with no restrictions**
    - **Same process as with any other zoning**
      - **Public meeting/comments**
- **No Zoning or Comprehensive Plan**
  - 😞



# Voluntary Activities

- **Agricultural**
  - Alternative crops
  - Conservation Reserve Program
  - No-Till Cultivation
  - Nutrient Management Programs
  - Strip Cropping
  - Terracing
  - Water Management Program





# Voluntary Activities



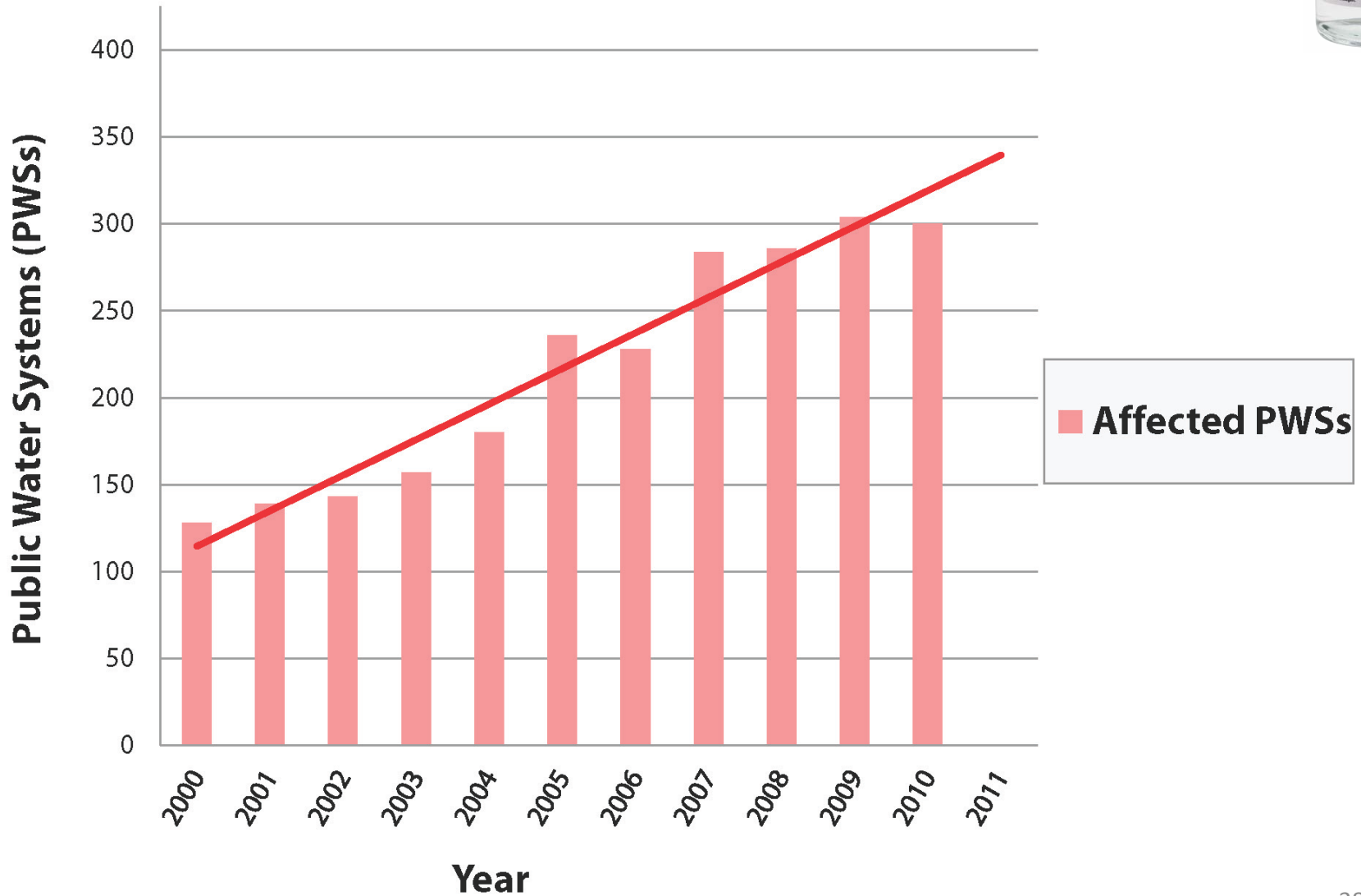
- **Urban**

- Alternative Lawn Options
- Improving Soil Structure
- Installing Water Meters
- Low Flow Nozzles
- Mulching Lawn Clippings
- Permeable Pavement
- Rain Barrels/Rain Gardens
- Rain Sensors for Lawn Irrigation

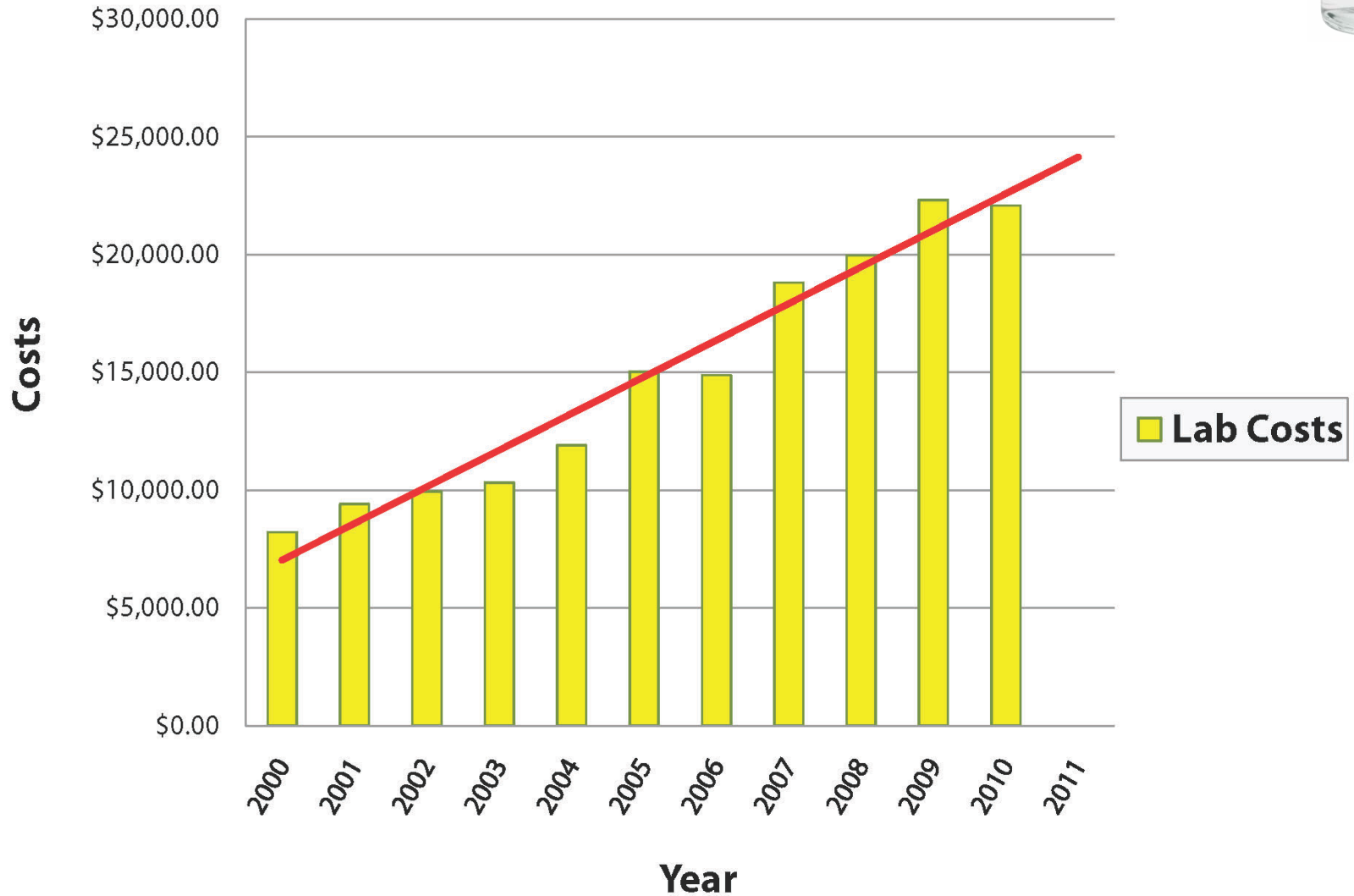




# Nitrates – Affected PWS



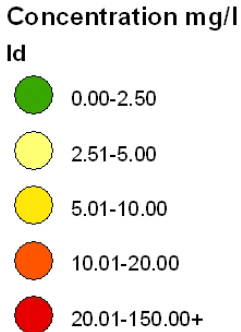
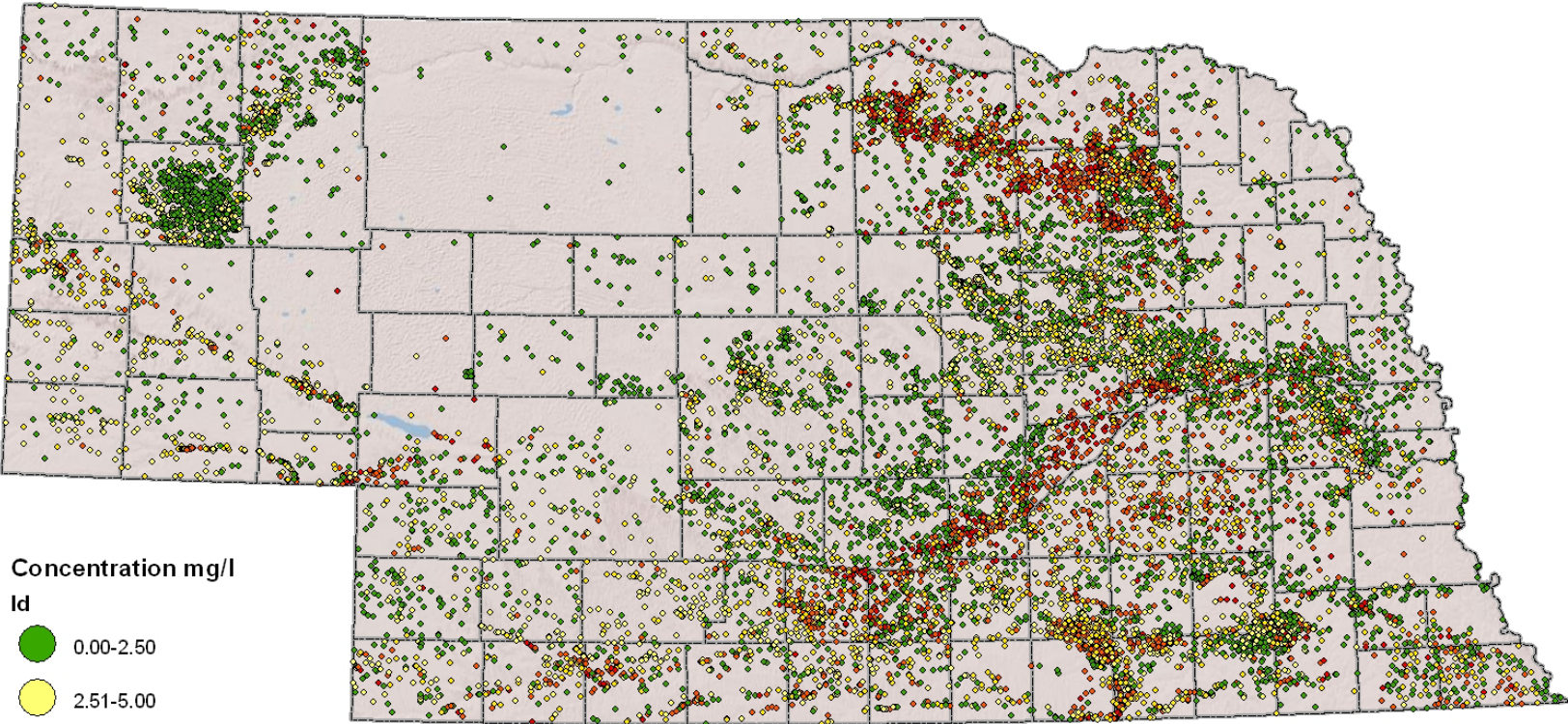
# Nitrates – Sampling Costs



# Nitrates



- **Generalized Concentrations in NE**





# Typical Options

- **Drill a new well**
- **Hook up to another system**
- **Treatment – Reverse Osmosis (RO) / Ion Exchange (IE)**
- **Dissolve your Public Water System**
- **Get a State Approved WHP Plan (Nitrates Only) and more...**

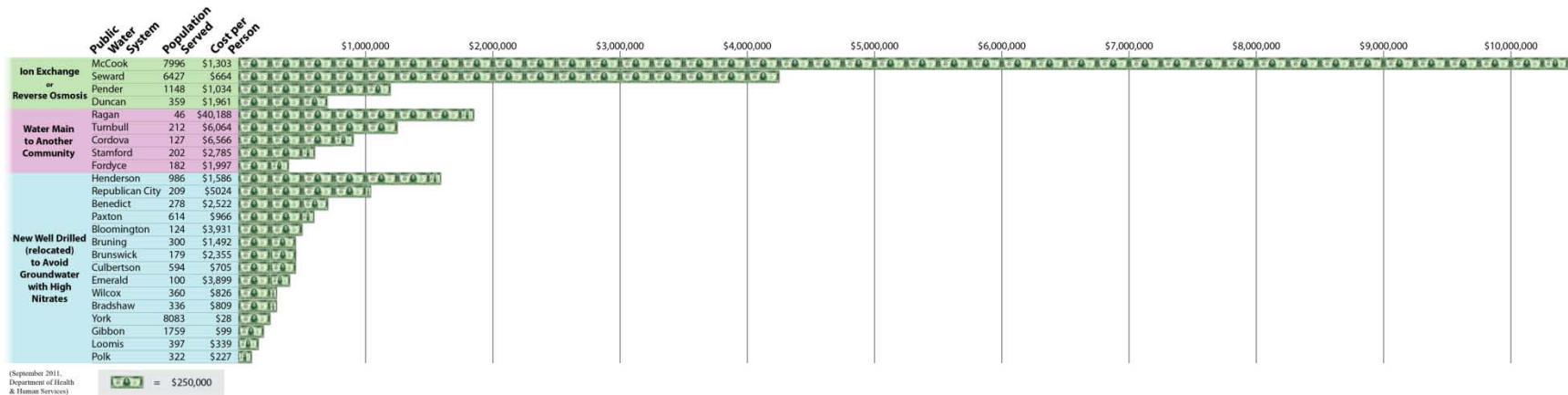




# Administrative Order



## • Project Costs (Nitrate AOs)



- **McCook – Ion Exchange , 2 wells, pump station**
  - **\$10,424,000 / pop 7,996 = \$1,303 per person**
- **Seward – Reverse Osmosis**
  - **\$4,272,000 / pop 6,425 = \$664 per person**
- **Ragan – Connection to Wilcox, tank**
  - **\$1,848,626 / pop 46 = \$40,187 per person**
- **Hastings (projected) = \$72M (RO) or \$57M (IE)**

# WHP Option for Nitrate AO



- **Nitrate Administrative Order - Using the Wellhead Protection Option to Address the Problem**

**Using the Wellhead Protection (WHP) Option to Address the Problem**

**Nitrate Administrative Order**

The Nebraska Department of Health and Human Services (DHHS) issues Administrative Orders to Public Water Systems (PWSs) when contaminant concentrations exceed State and Federal drinking water standards. The drinking water standard for nitrate is 10 milligrams per liter (mg/L) Nitrate (as N). PWSs must pursue corrective action to bring their drinking water back to within State and Federal standards.

**Solutions Most Commonly Used to Address an Administrative Order:**

- Drilling a new well
- Blending water from wells with lower nitrate
- Connecting with another PWS
- Building a nitrate treatment plant
- Wellhead protection (WHP) program option

**Conditions of Using the WHP Option**

Managing water contamination, rather than immediately bringing a new water source on-line, is the backbone of the WHP Option to address the Administrative Order. The primary conditions of use are:

1. Develop a local WHP Plan, approved by the Nebraska Department of Environmental Quality (NDEQ).
2. Cannot be combined with any other Administrative Order.
3. Provide sensitive populations (mainly pregnant women, nursing mothers, and babies less than 6 months in age) with a safe source of drinking water (bottled, water service, etc).
4. Continuous program shown toward a natural cleanup of the agricultural non-point-source contamination.
5. Nitrate (as N) levels must remain below 15 mg/L.

Nebraska Department of Environmental Quality

**Delineation**



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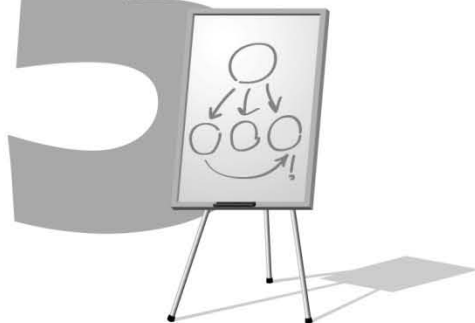


**Contaminant  
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**Five Steps of the  
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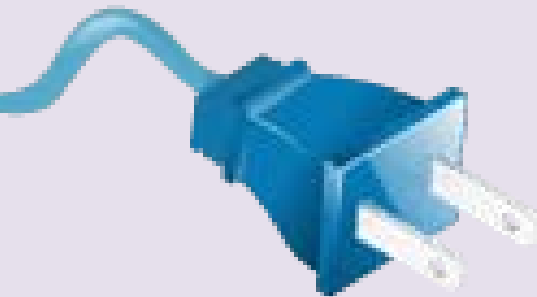


# Contingency Planning

## *Emergencies*



- Planning for:
  - Well failure
  - Natural disasters
  - Mechanical problems
  - Etc.
- Long & short term





# **Contingency Planning**

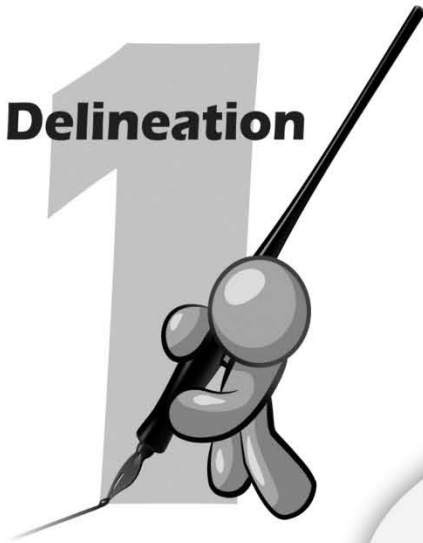
## ***New Well(s)***



- **Why**
  - Growth of community
  - Replace old wells
  - Contamination
- **Land (purchase, easements)**
- **Potential contaminants**



**Delineation**



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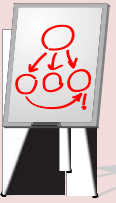
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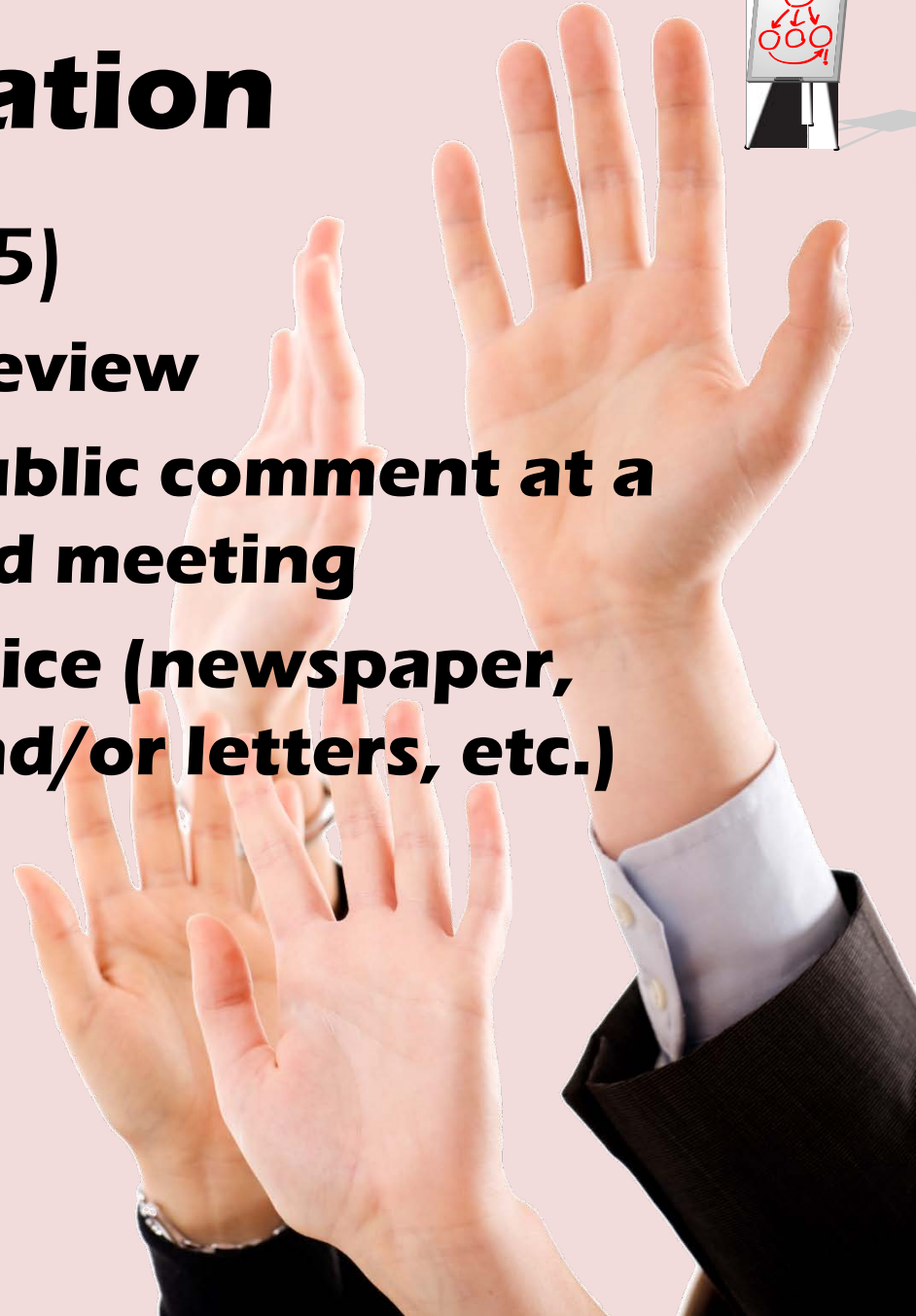
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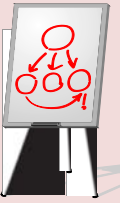


# Education

- **Required (§46-1505)**
  - **30 days of public review**
  - **Opportunity for public comment at a regularly scheduled meeting**
  - **Publish official notice (newspaper, posting notices, and/or letters, etc.)**



# Education

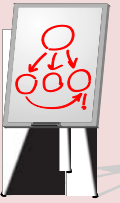


- **Suggested**
  - **Handouts, brochures, posters**
  - **Public involvement and buy in throughout the process**
  - **Signs**





# Sign Changes



# Success Stories

- **91 state approved WHP Plans**
- **6 using WHP to address Nitrate AO**
- **Increased awareness**
- **Focused BMPs (Edgar, Hastings, Sidney, etc.)**
- **“Fixing” Nitrate Takes Time!**





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