Hydrogeologic Study and Groundwater Sustainability Risk Evaluation

Prepared for

2014 ESRI INTERNATIONAL USER CONFERENCE

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Michael C. Plante, PG, GISP

Roscoe F. Sopiwnik, GISP

Leggette, Brashears & Graham, Inc.

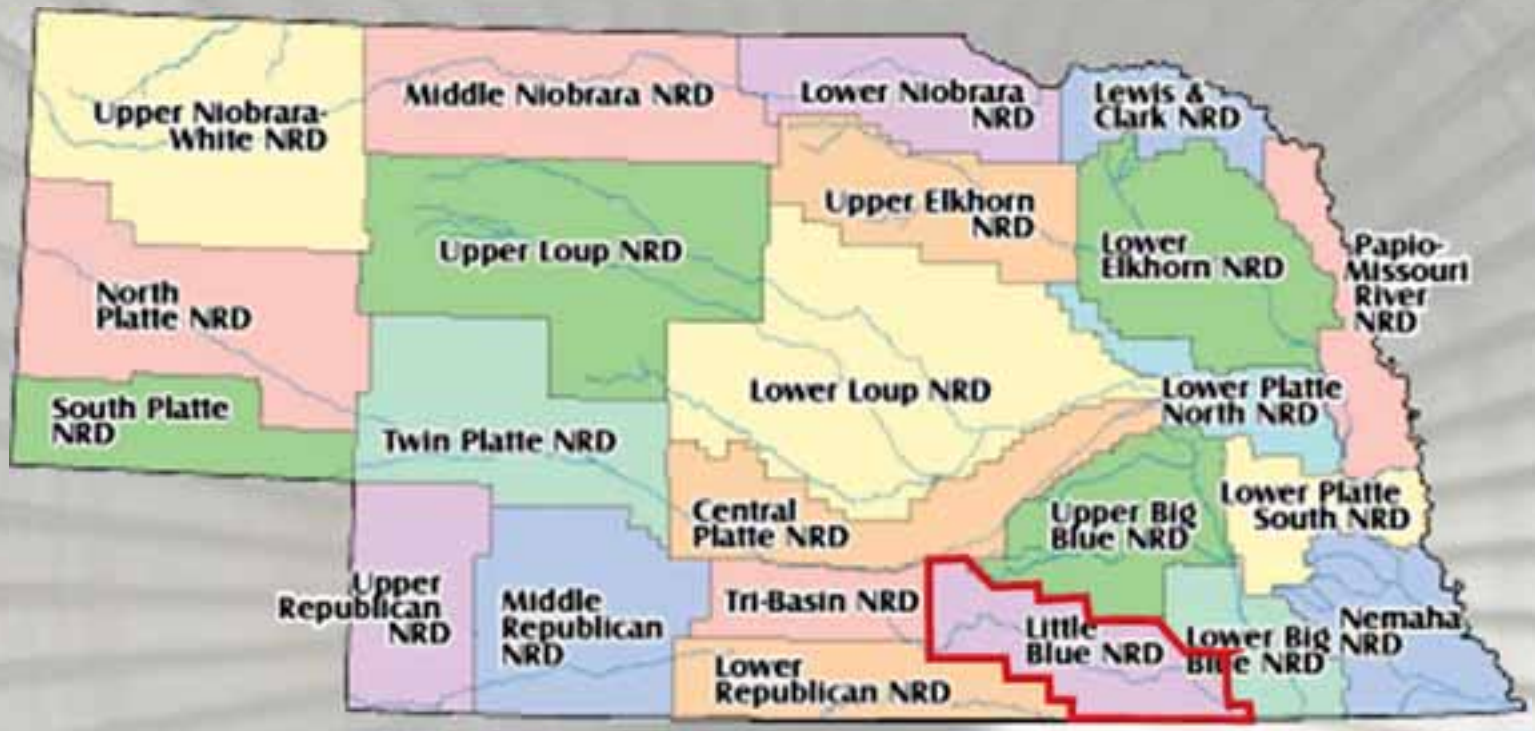
www.lbgweb.com

Outline

- Project Background and Objective
- Topographic and Hydrogeologic Setting
- Hydrogeologic Data Analysis and Mapping
- Hydrogeologic Unit Delineation
- Aquifer Risk-Level Mapping

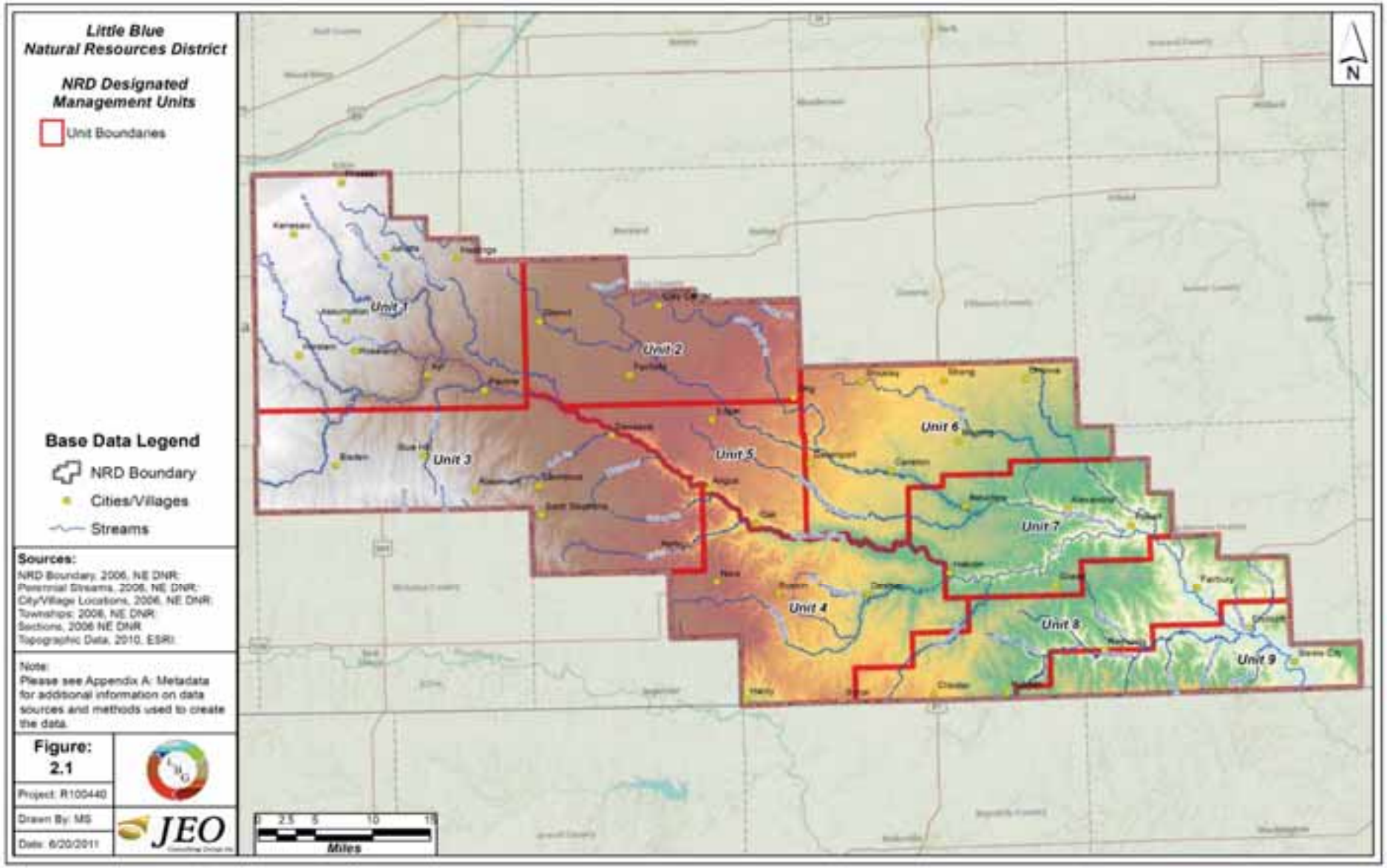
Initiation of Hydrogeologic Study

- In 1995, Little Blue Natural Resource District (LBNRD) developed nine water management units.
- Delineated based on political boundaries and aquifer saturated thickness.
- Board objective to compile current hydrogeologic data into consolidated report.
- **Goal** - Hydrogeologic Study used to redefine units for future management decisions.

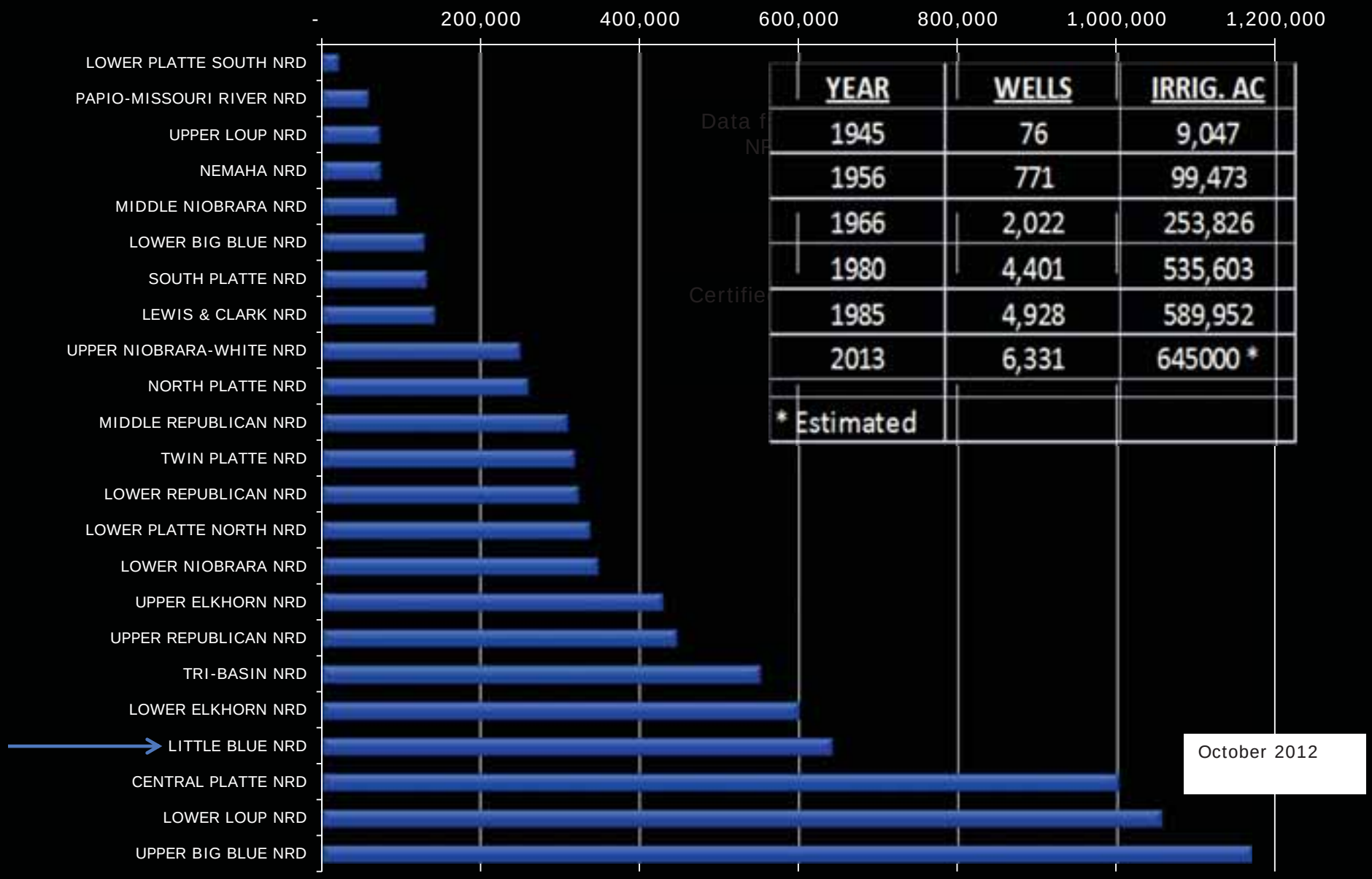


- Portions of Adams, Clay, Fillmore, Jefferson, Thayer, Nuckolls and Webster Counties
- ~ 100 miles long x 25 miles wide
- ~2,500 mi^2 or ~ 1,500,000 acres

GWMP Designated Management Units (Pre-2010)



Groundwater Irrigated Acres Listed by Natural Resources Districts



YEAR	WELLS	IRRIG. AC
1945	76	9,047
1956	771	99,473
1966	2,022	253,826
1980	4,401	535,603
1985	4,928	589,952
2013	6,331	645000 *

* Estimated

Work Flow

Obtain Data

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Evaluate Data

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Map Hydrogeologic Data Sets

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Delineate Hydrogeologic Units

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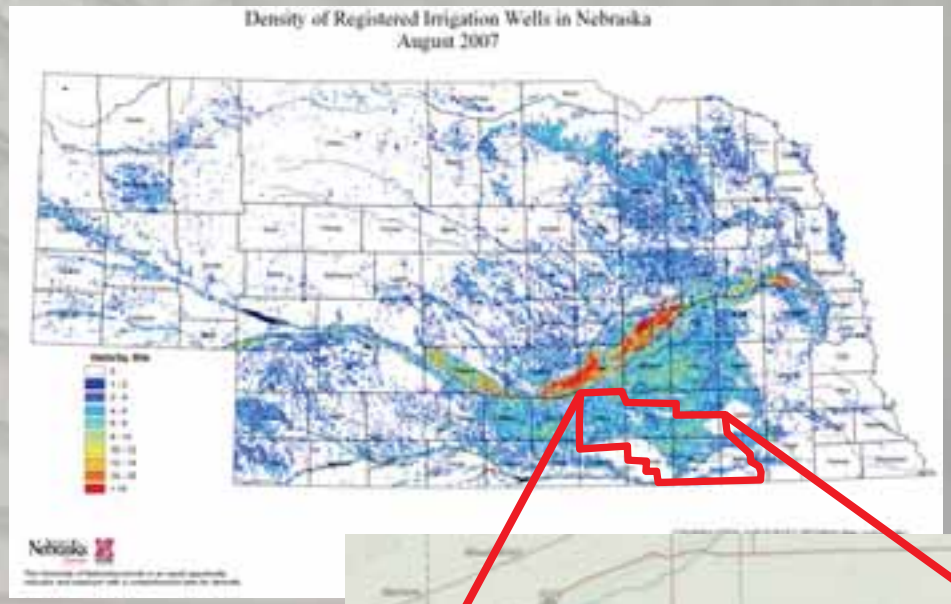
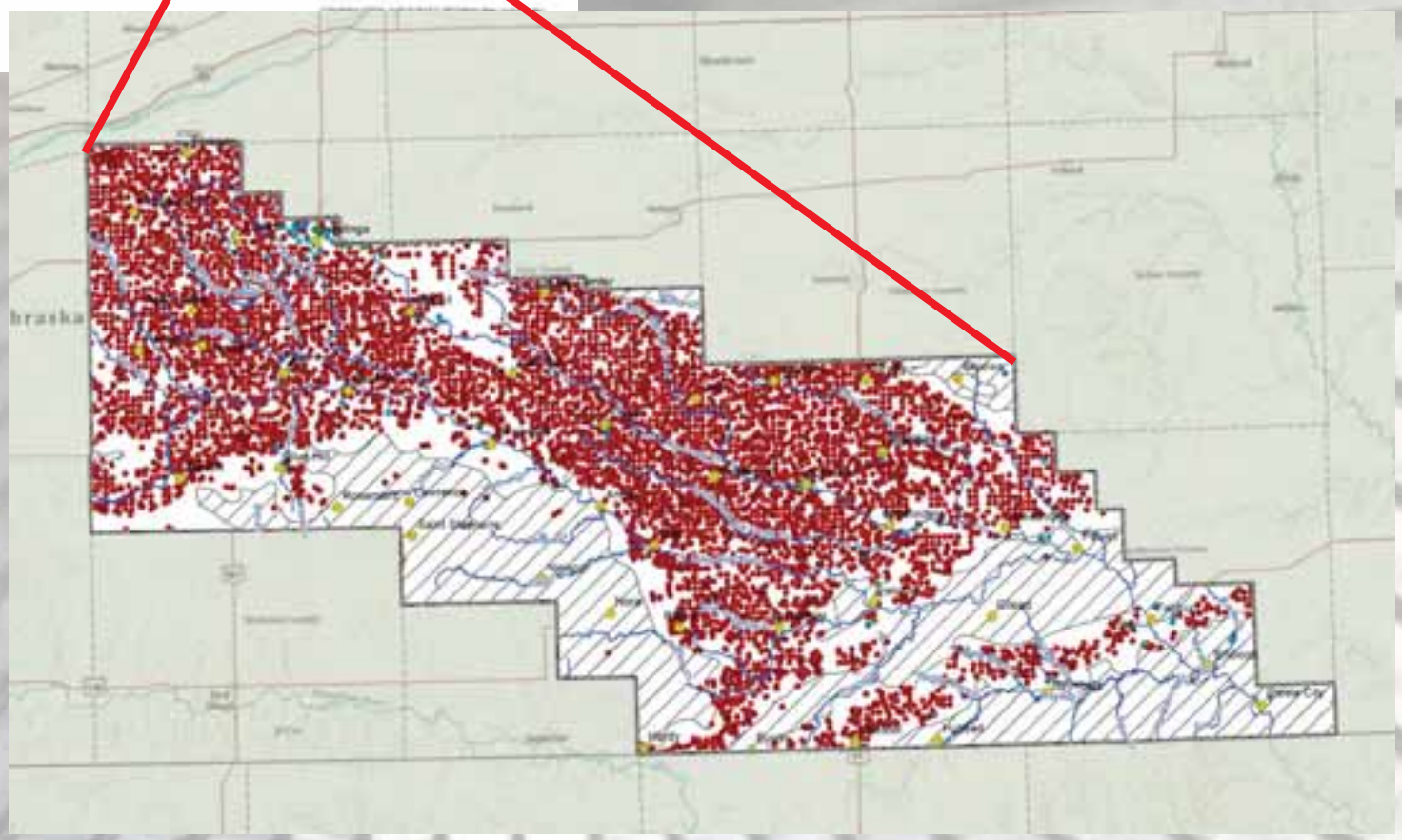
Complete Risk Model

Data Resources for Mapping

- LBNRD
- UNL-CSD
- USGS
- NE DNR
- NE DEQ
- LiDAR
- ESRI GIS software
- Evaluated ~ 10,000 well logs

High Capacity Wells NE and Little Blue NRD (6,455)





Work Flow

Obtain Data

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Evaluate Data

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Map Hydrogeologic Data Sets

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Delineate Hydrogeologic Units

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Complete Risk Model

Geologic Log Analysis

- Queried locations from state databases within a 5-mile buffer of the NRD boundary
  - To ensure interpolated surfaces encompass the whole NRD
- Lithology descriptions were available for most logs in tabular format
- Used Excel to format, tabulate, and develop analysis equations to “boil down” the data from 104,000 rows to something manageable

Geologic Log Analysis

- Determined from the geologic logs
  - Boring depth
  - Cumulative sand thickness
  - Cumulative clay thickness
  - Bedrock depth
  - Water level elevations for drought vs. pluvial
  - Saturated sand thickness

- Queried LiDAR at all locations for improved grade elevation.

Work Flow

Obtain Data

↓

Evaluate Data

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Map Hydrogeologic Data Sets

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Delineate Hydrogeologic Units

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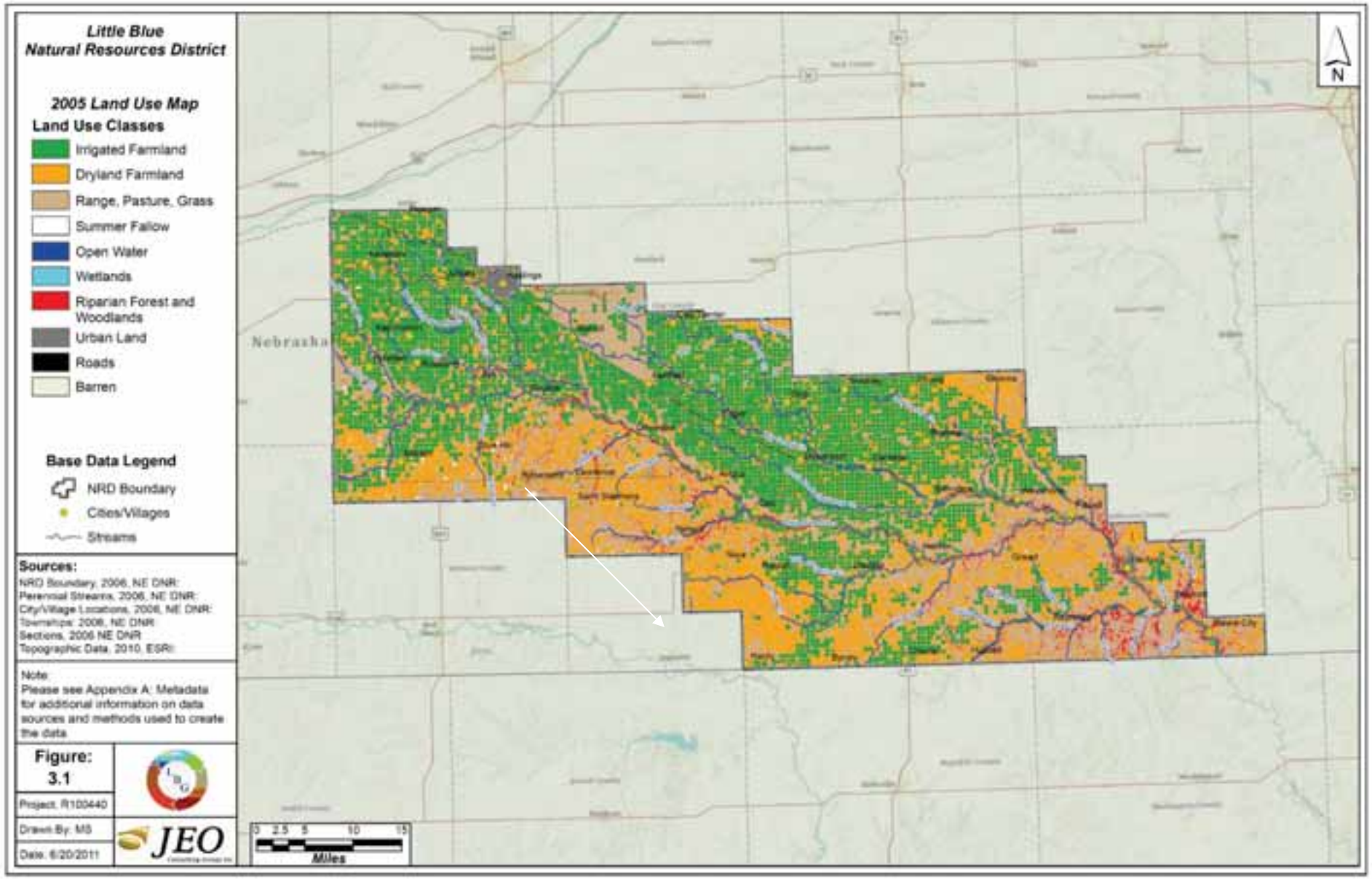
Complete Risk Model

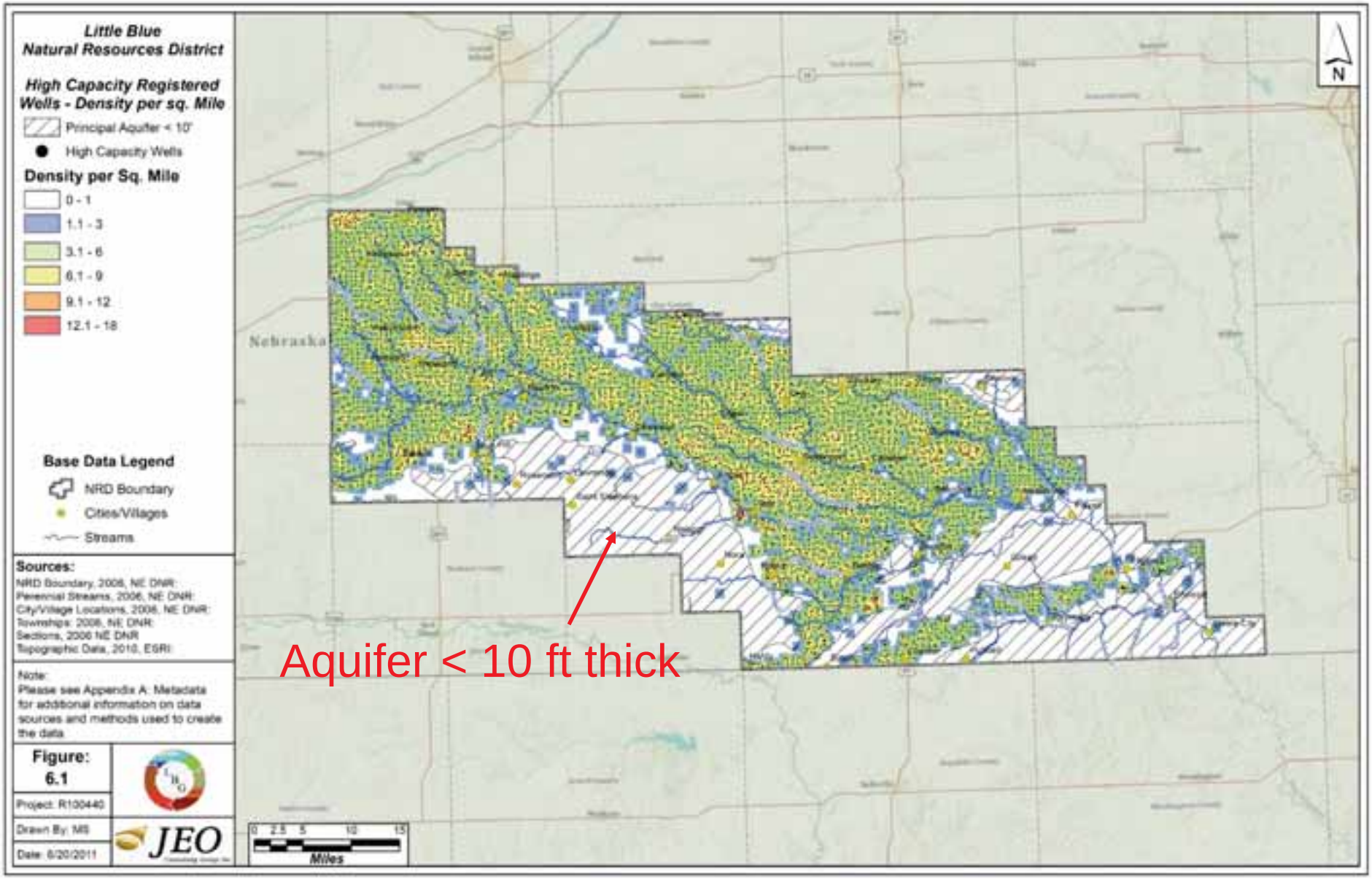
Generated Maps and Deliverables

- Land use
- High-capacity registered well density
- Surface topography
- Bedrock geology and surface topography
- Thickness and extent of principal aquifer
- Groundwater / surface water connectivity
- Depth to groundwater and surface elevation
- Groundwater level change over time
- Groundwater recharge
- Specific capacity (Q/s), specific yield (Sy) and transmissivity (T)
- Hydrogeologic units
- Aquifer risk levels

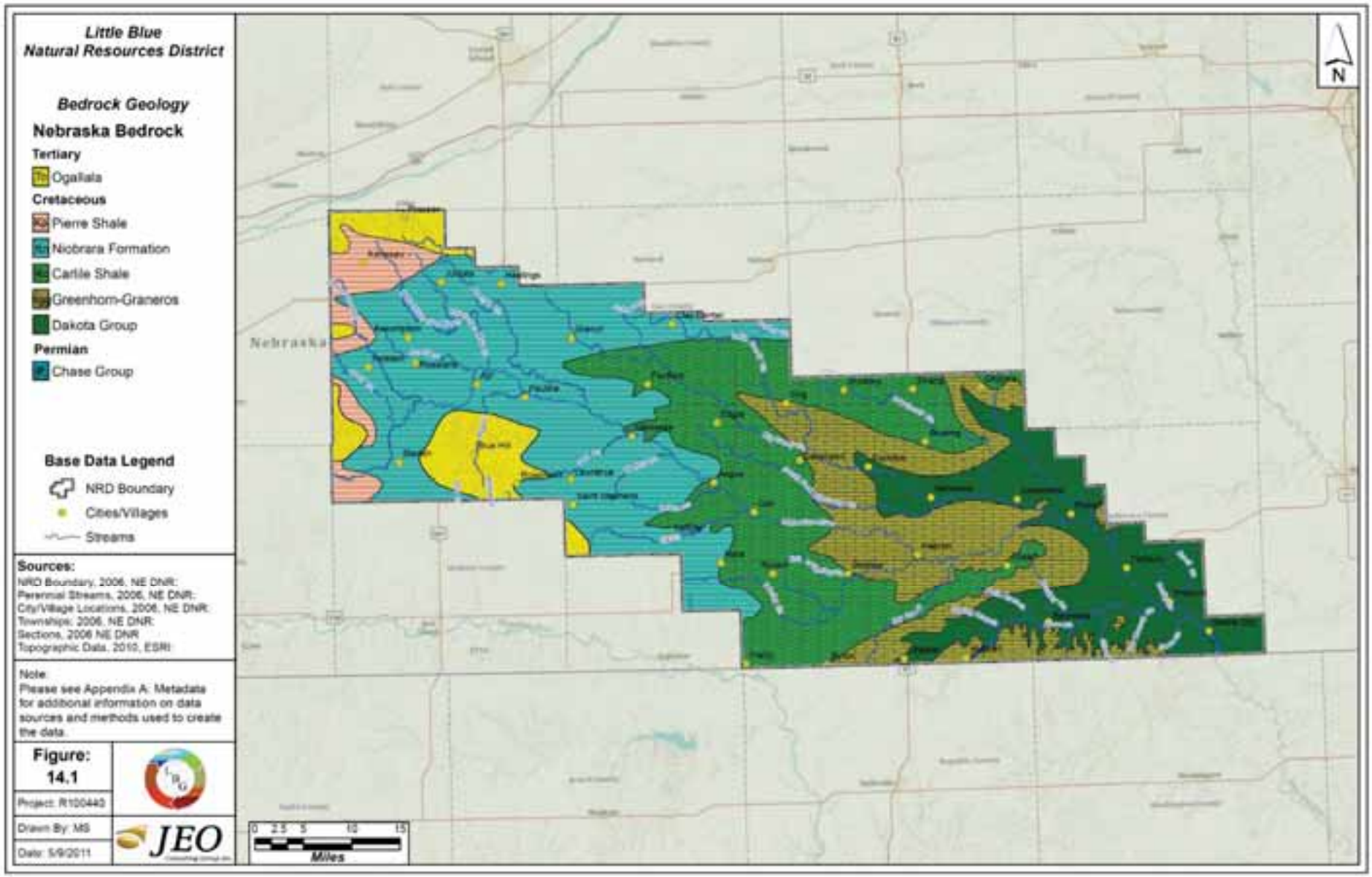
Land Use 2005



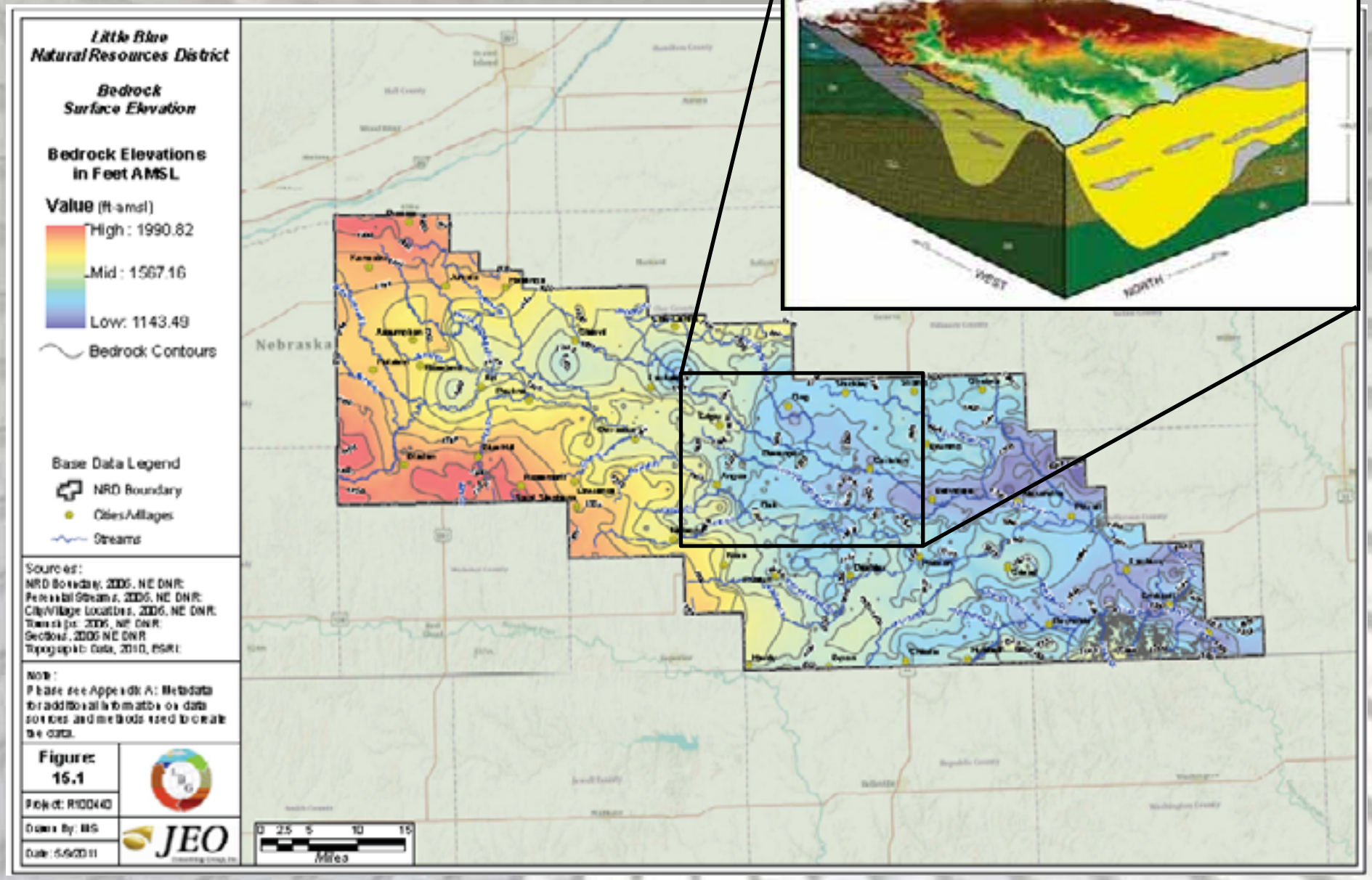
High-Capacity Well Density



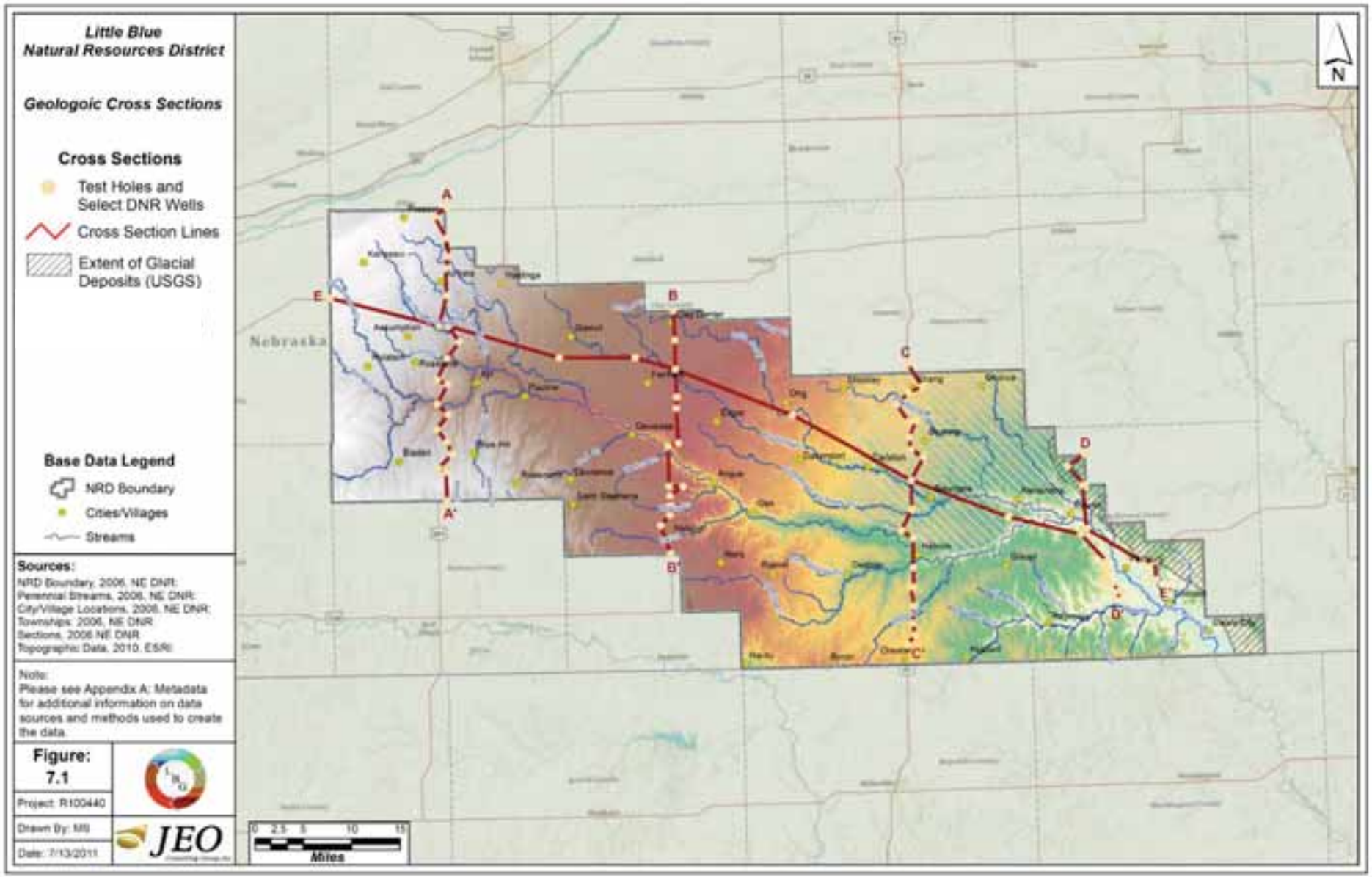
Bedrock Geology

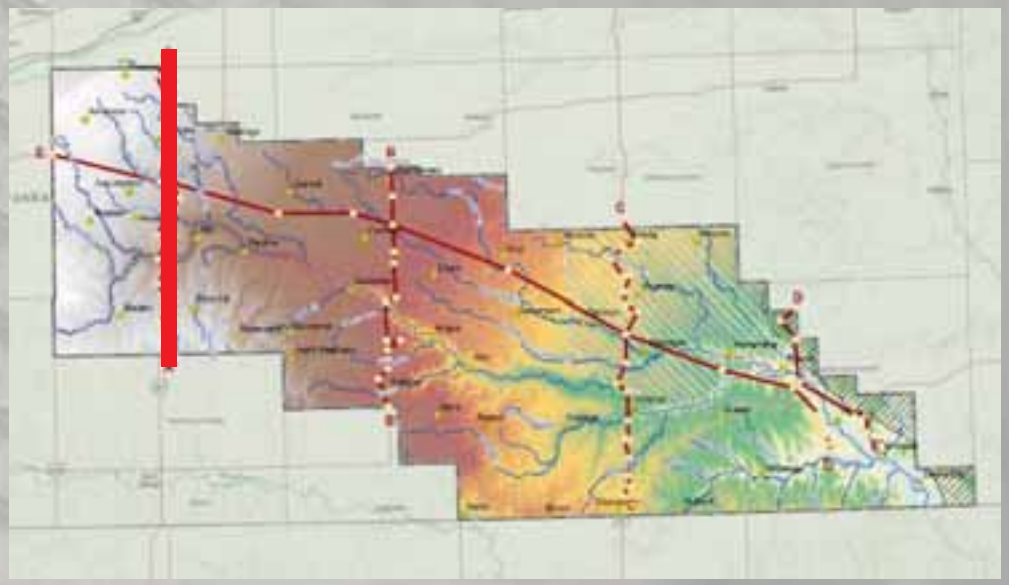


Bedrock Geology

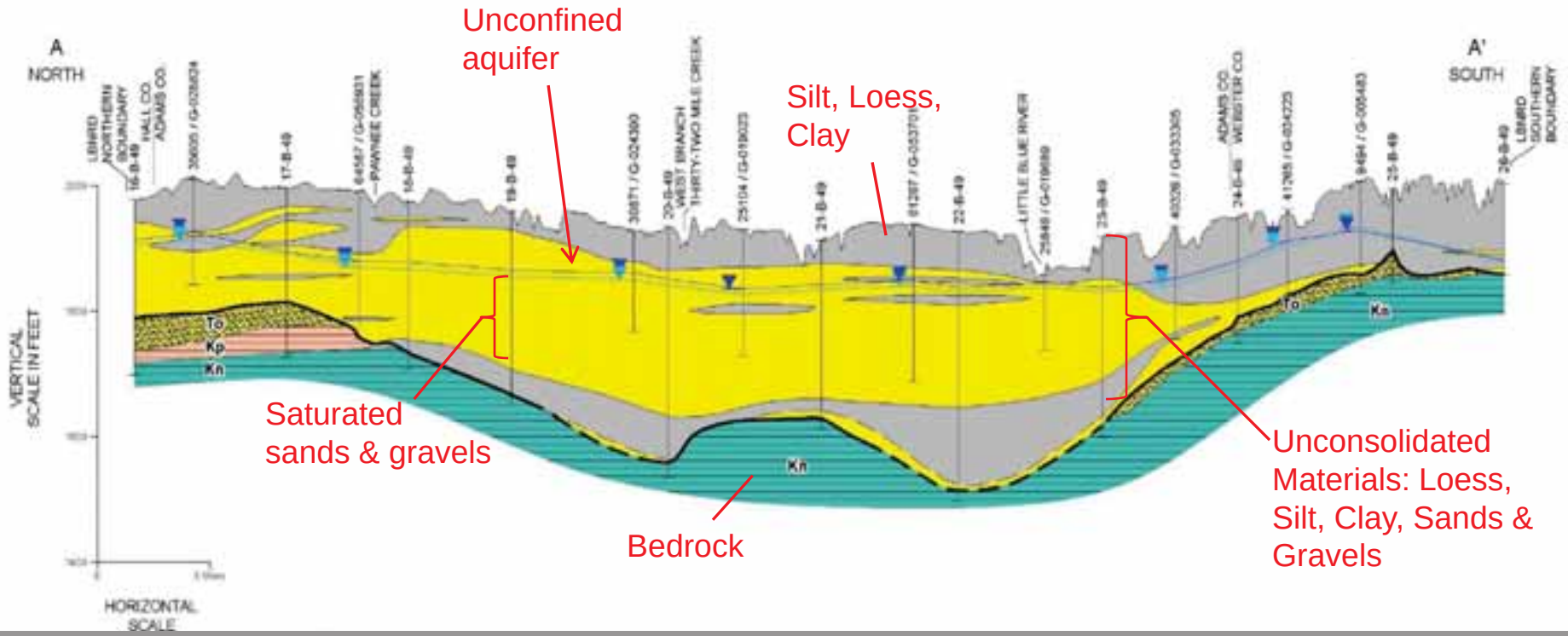


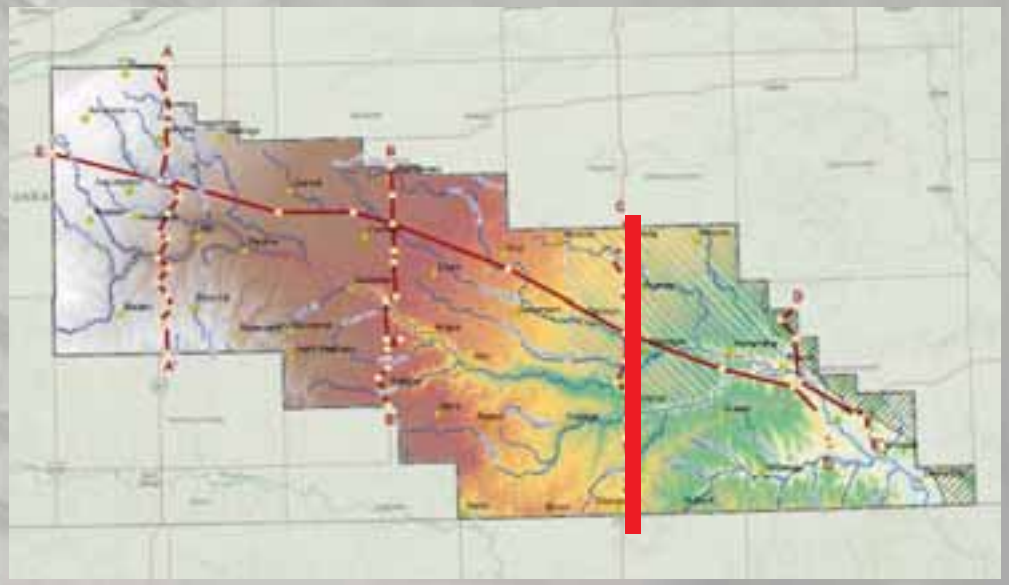
Hydrogeologic Cross Section Locations



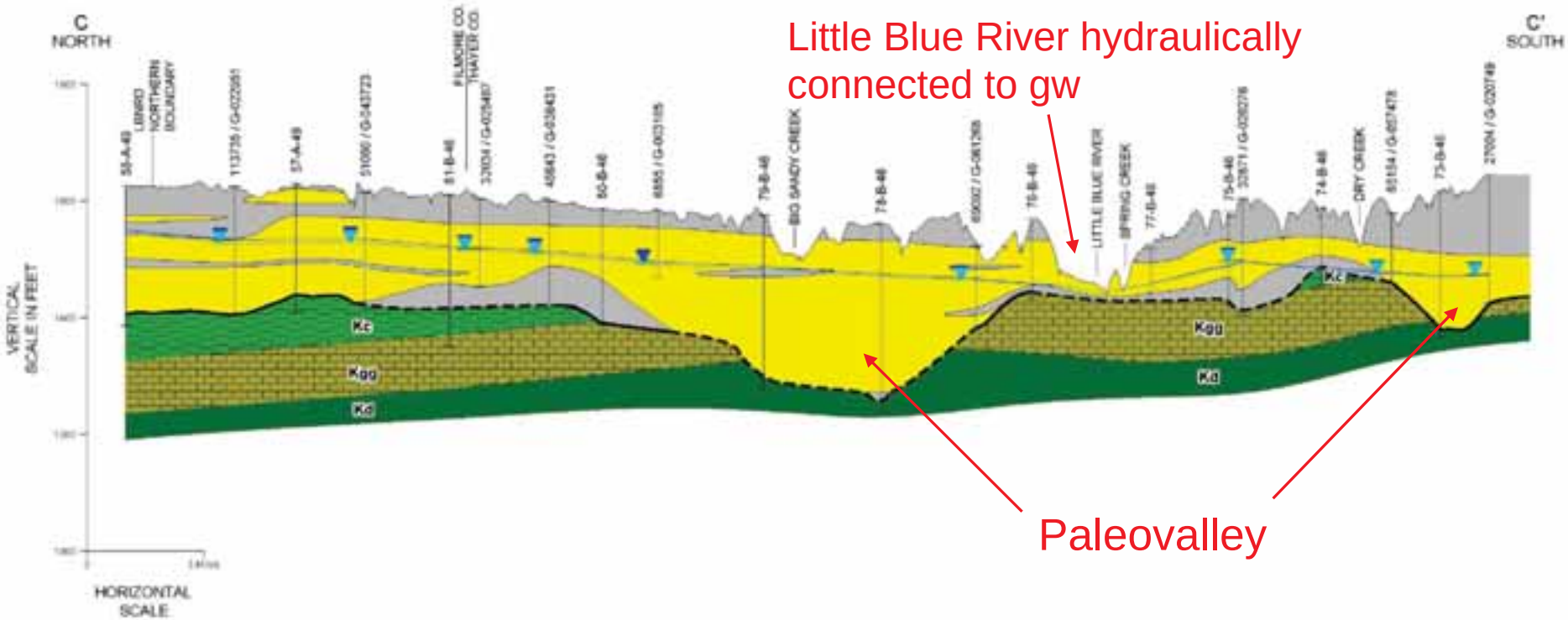


Cross Section A-A′

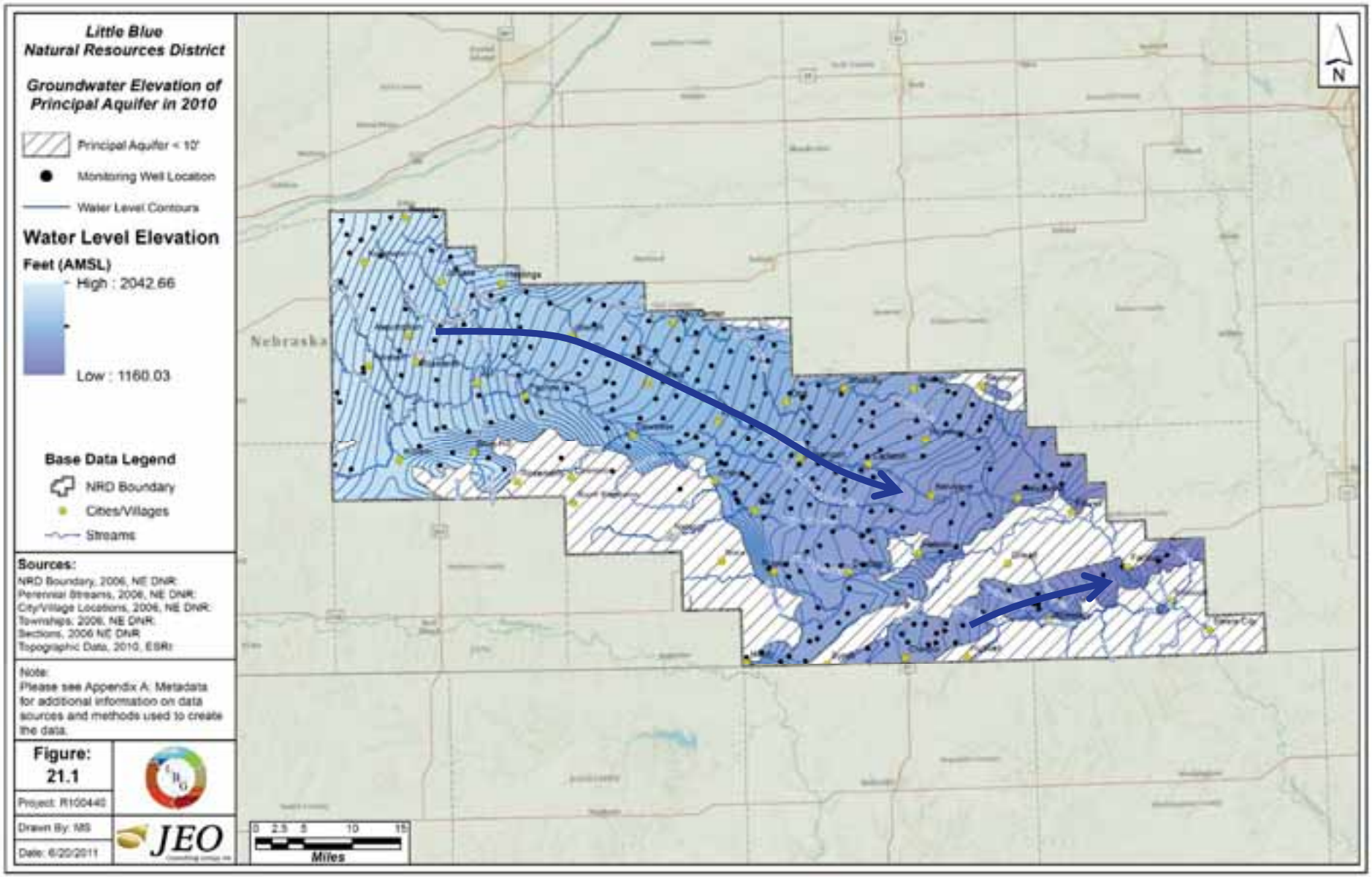




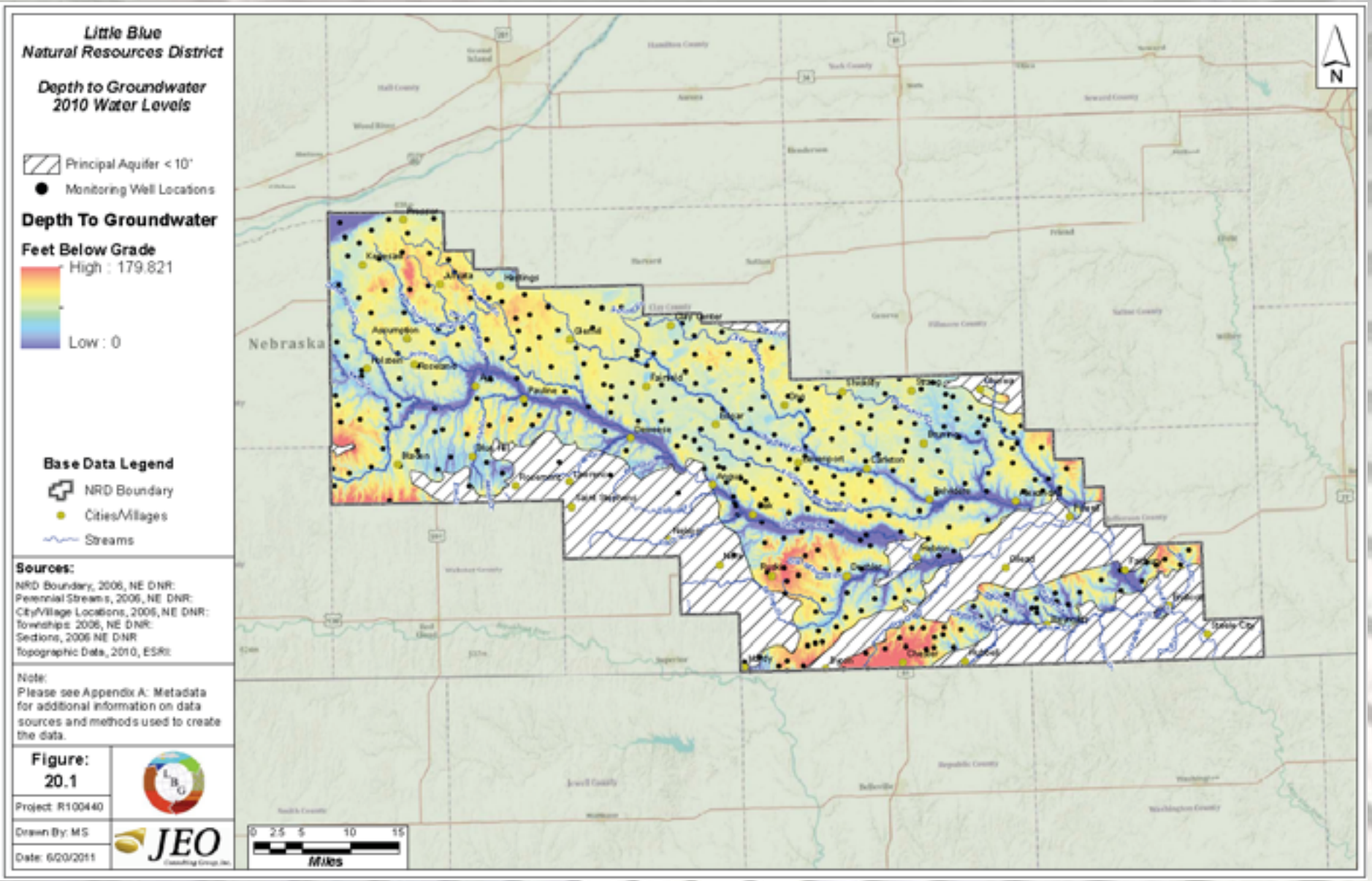
Cross Section C-C′



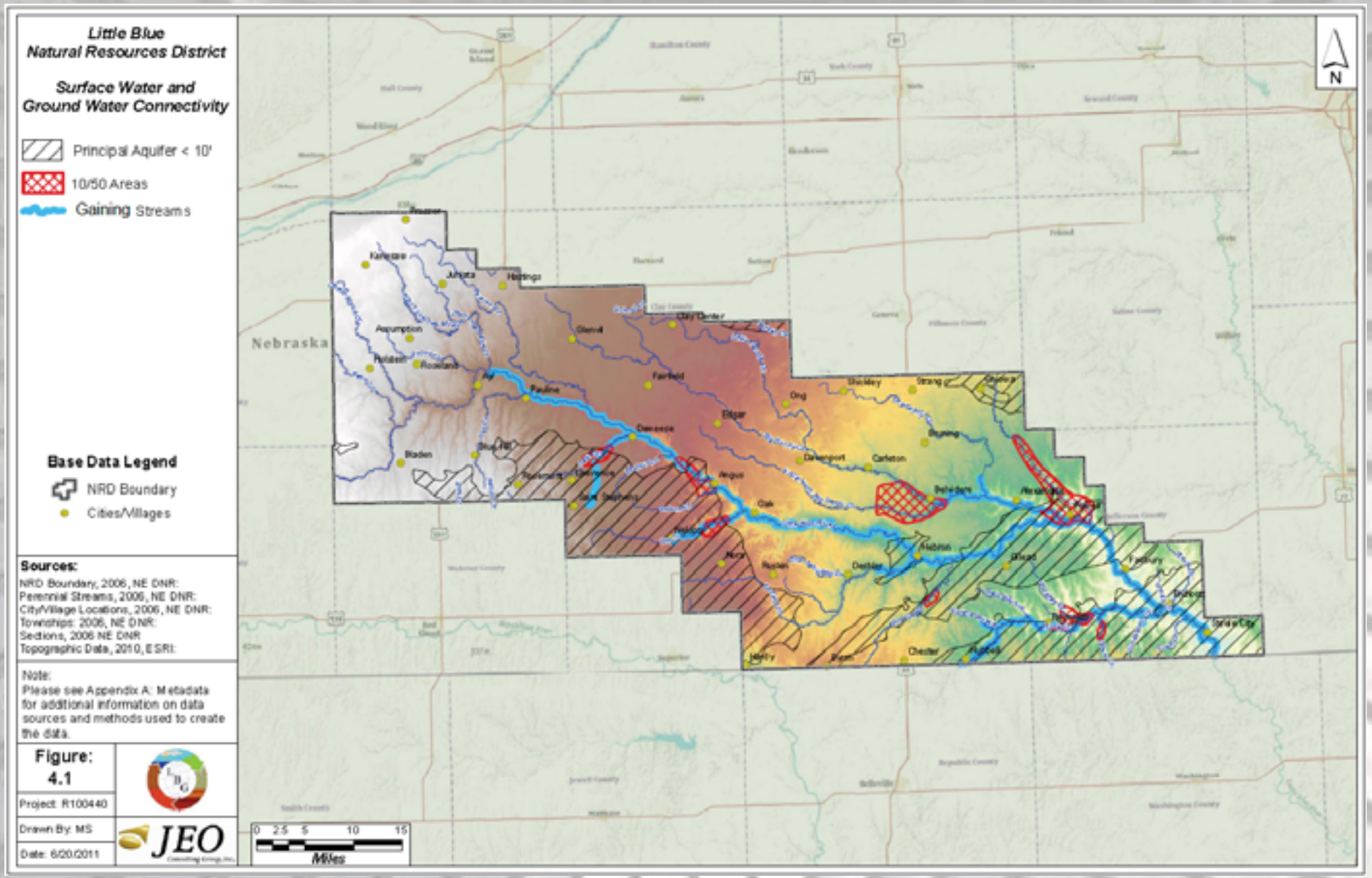
Groundwater Surface of Principal Aquifer (2010)



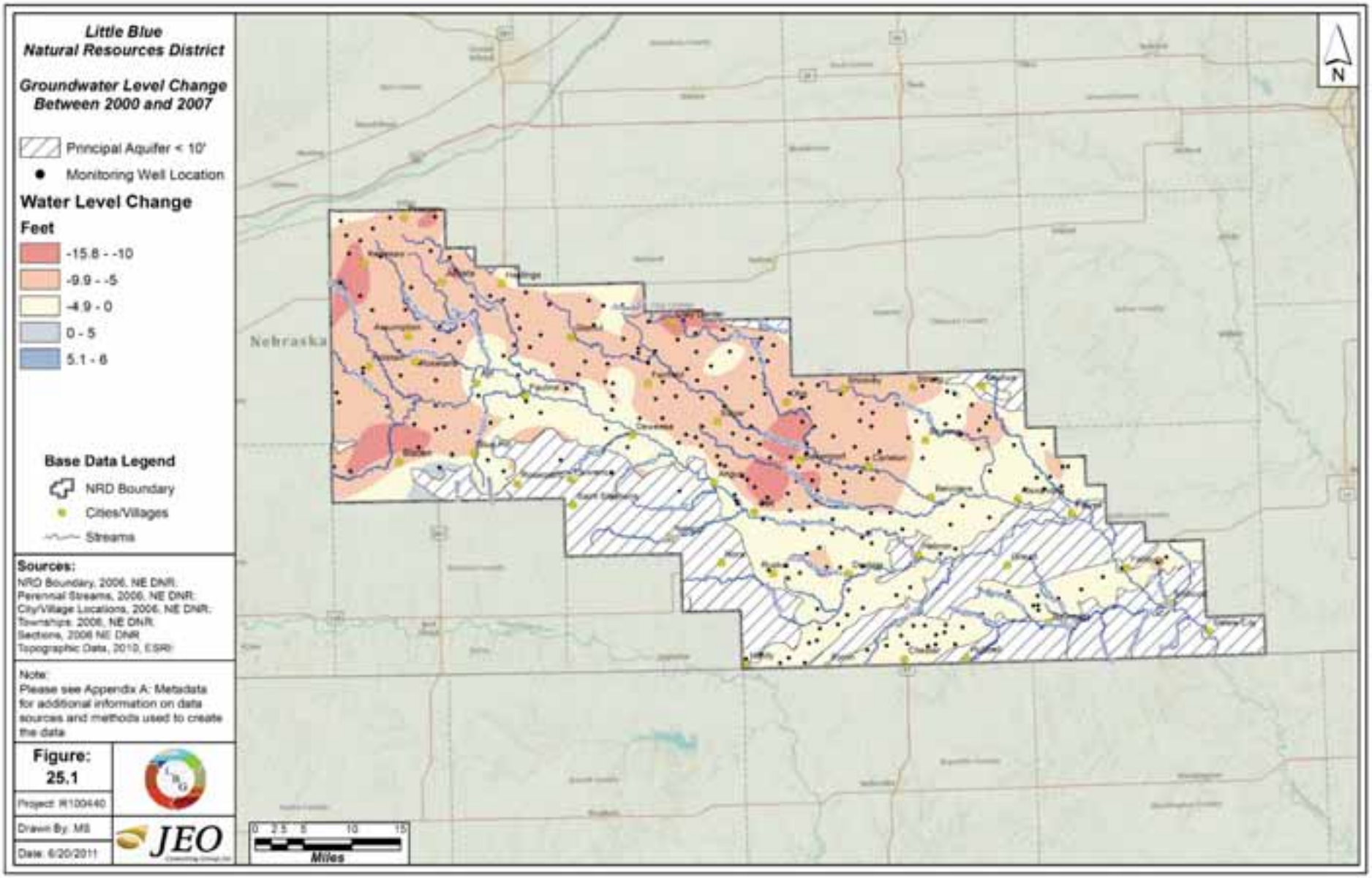
Depth to Groundwater of Principal Aquifer



Groundwater / Surface Water Connectivity

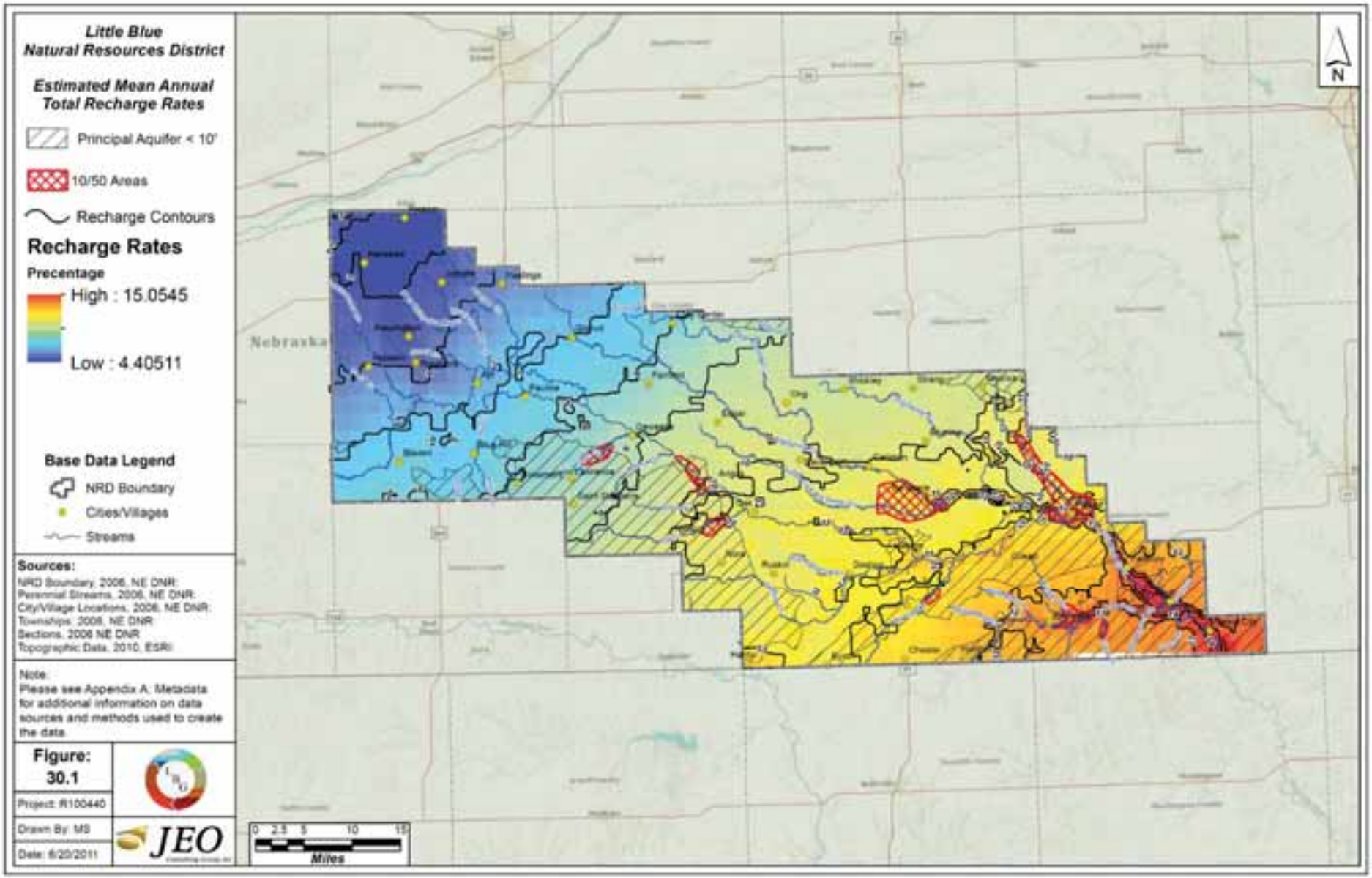


Groundwater Level Change in Principal Aquifer (2000-2007)

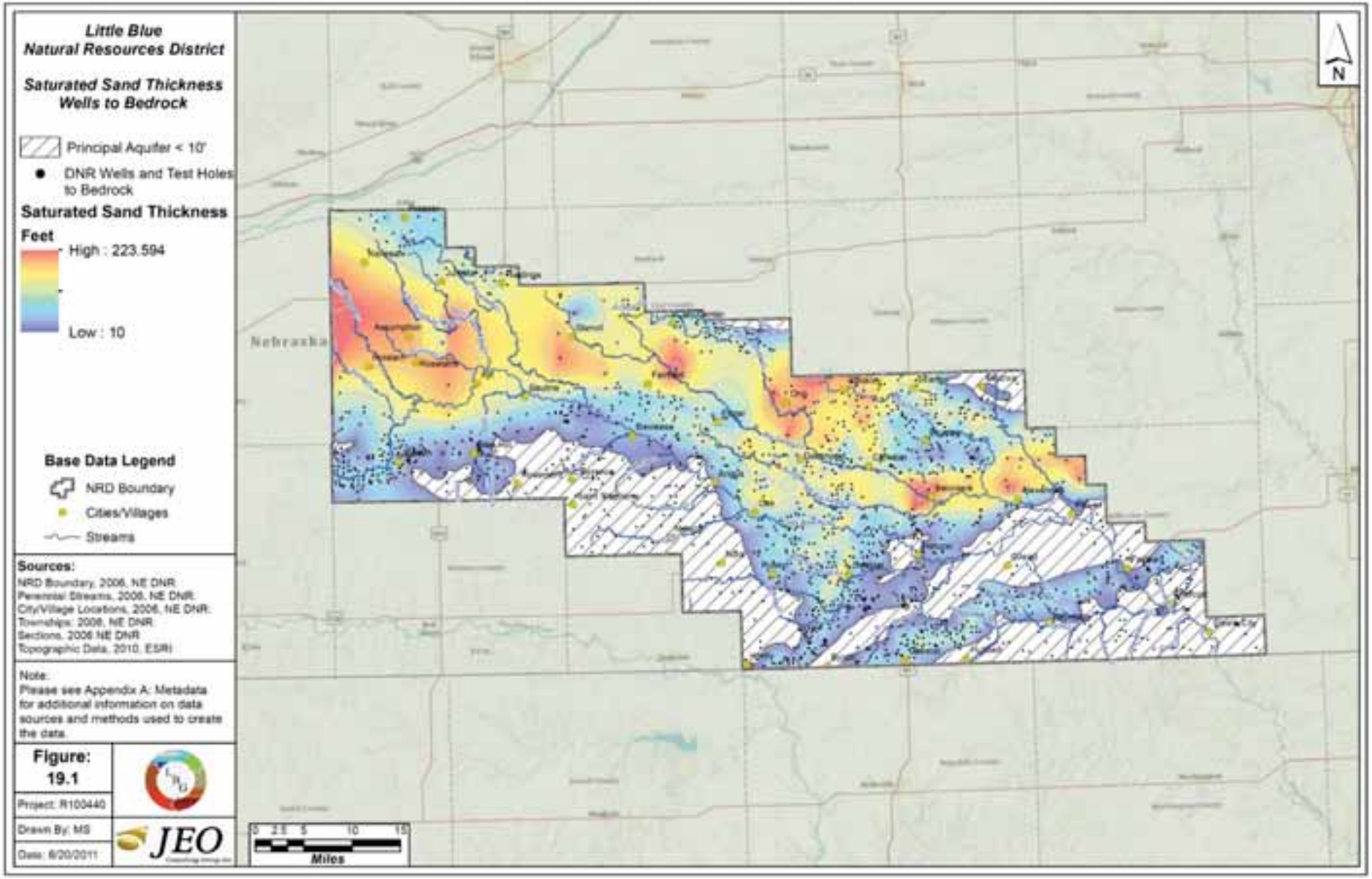


Annual Recharge to Groundwater

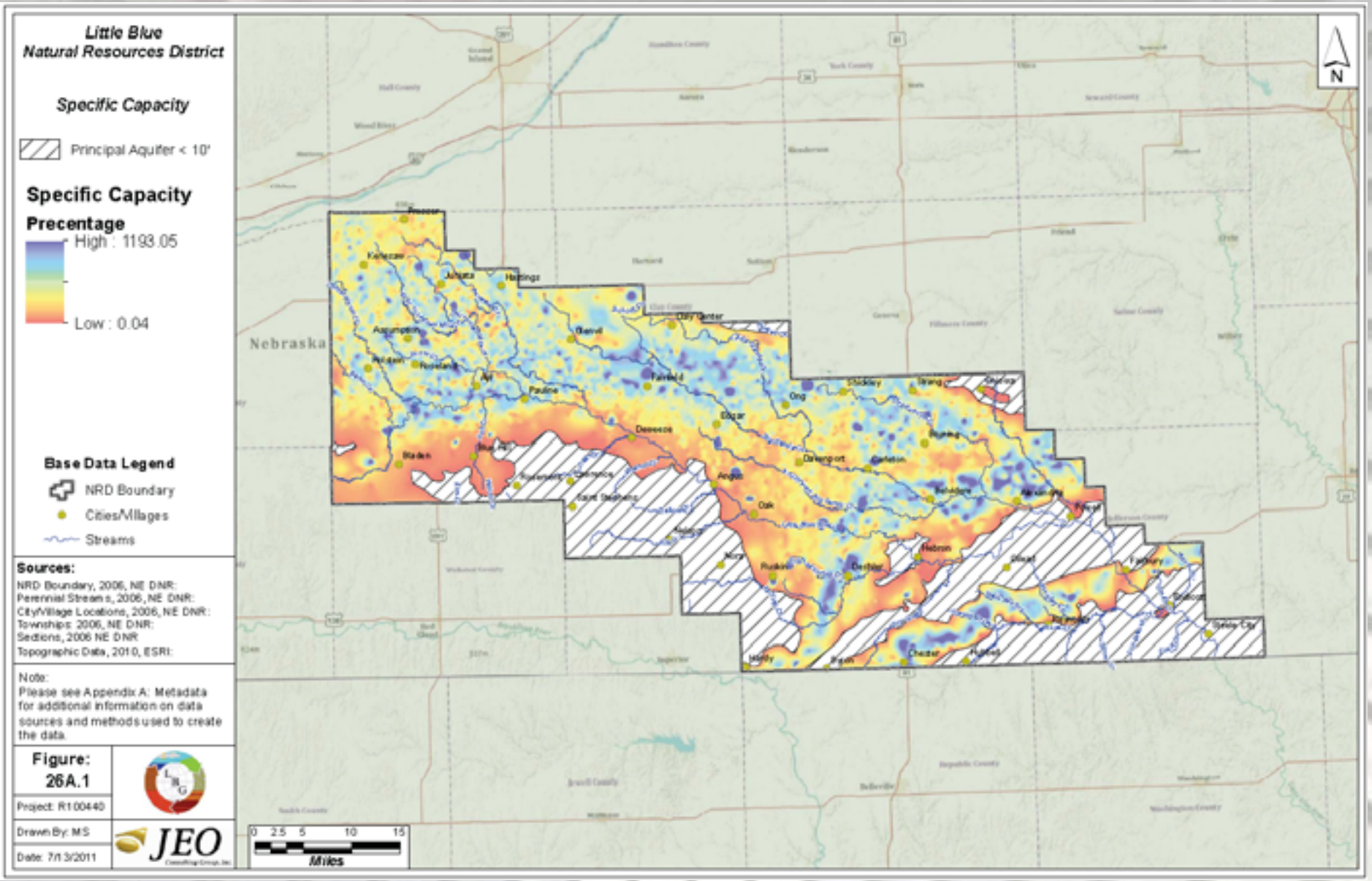
(from Szilagvi et al., 2005)



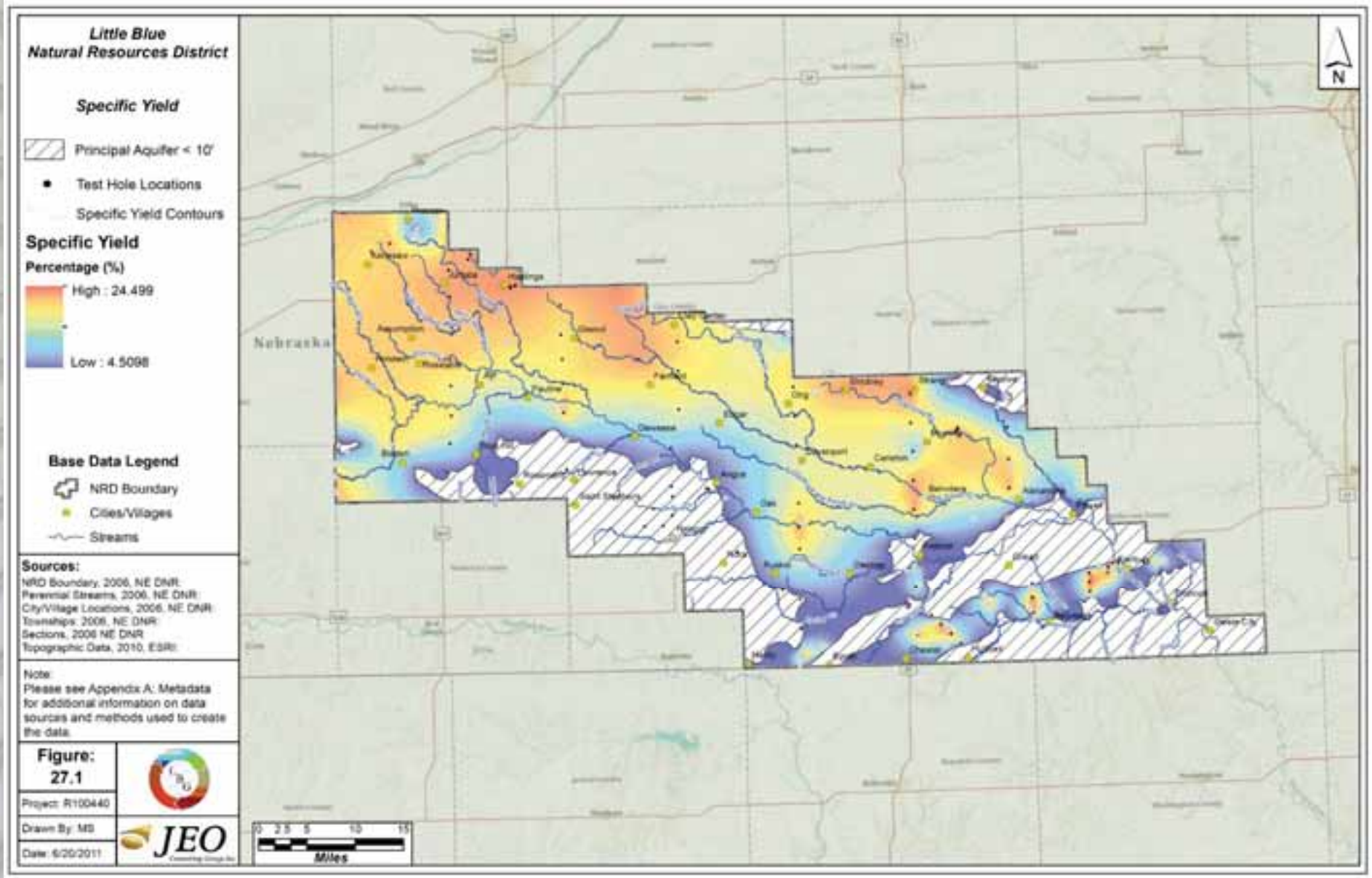
Saturated Thickness of Principal Aquifer



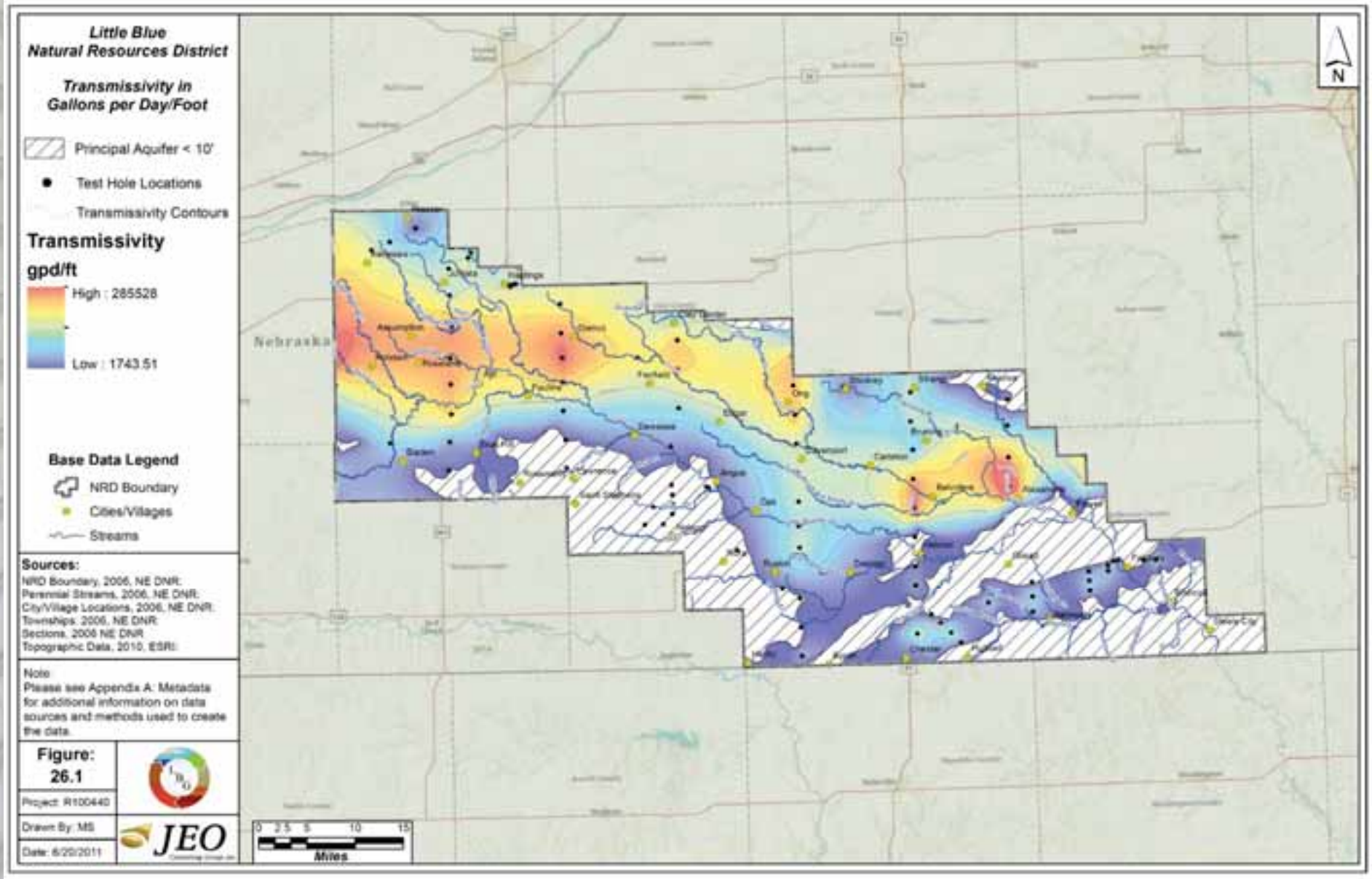
Specific Capacity (Q/s) of Principal Aquifer



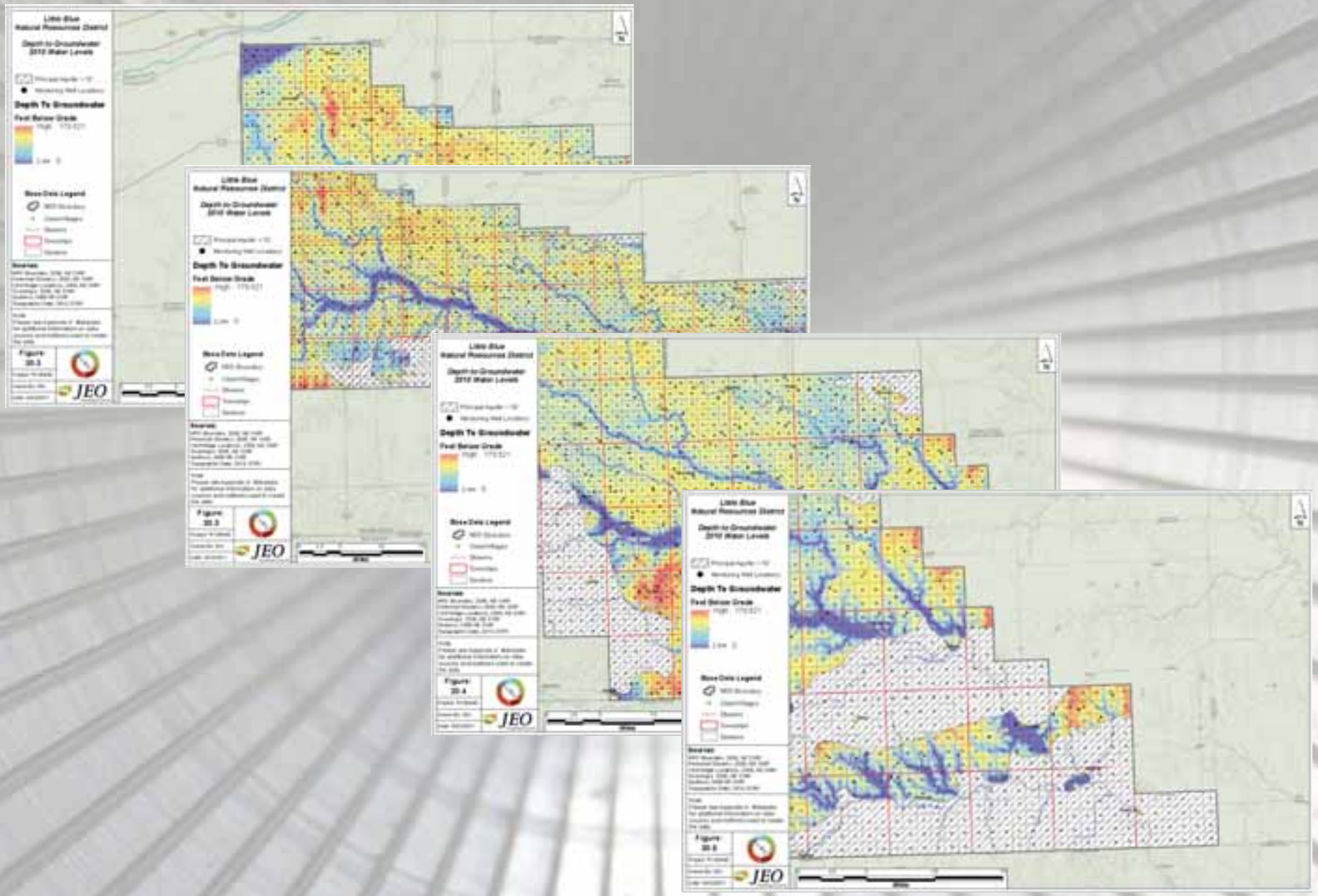
Specific Yield (Sy) of Principal Aquifer



Transmissivity (T) of Principal Aquifer



Map Book


Little Blue
Natural Resources District
Depth to Groundwater
2010 Water Levels
Depth To Groundwater
Feet Below Grade
Base Data Legend
Figure
JEO

Work Flow

Obtain Data

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Evaluate Data

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Map Hydrogeologic Data Sets

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Delineate Hydrogeologic Units

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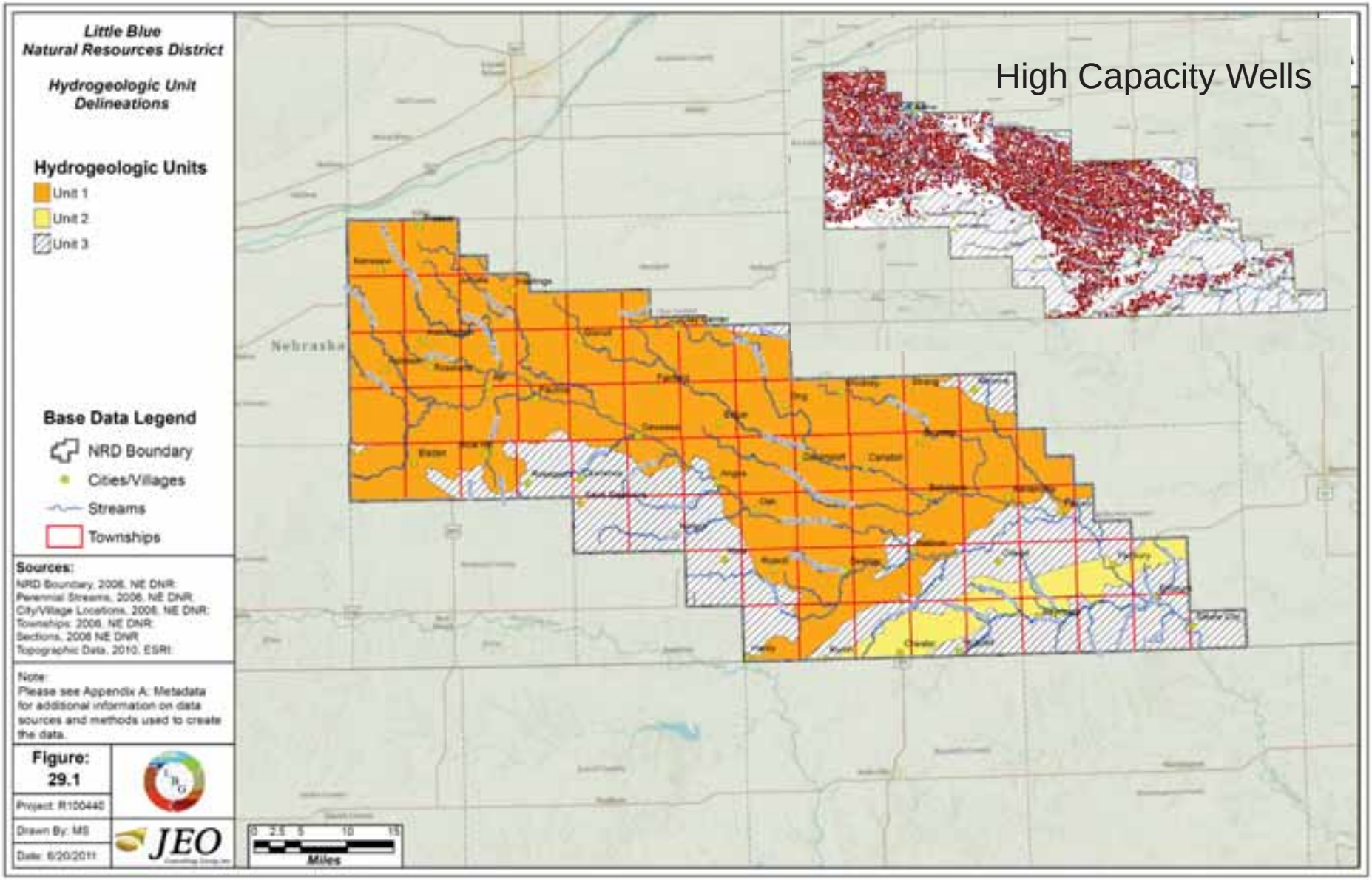
Complete Risk Model

Hydrogeologic Unit Delineation

- Rather than nine units based on political boundaries, data analysis showed the NRD is delineated by three dominant hydrogeologic systems
- Did not consider political boundaries other than the NRD boundary

Hydrogeologic Units



Work Flow

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Delineate Hydrogeologic Units

↓

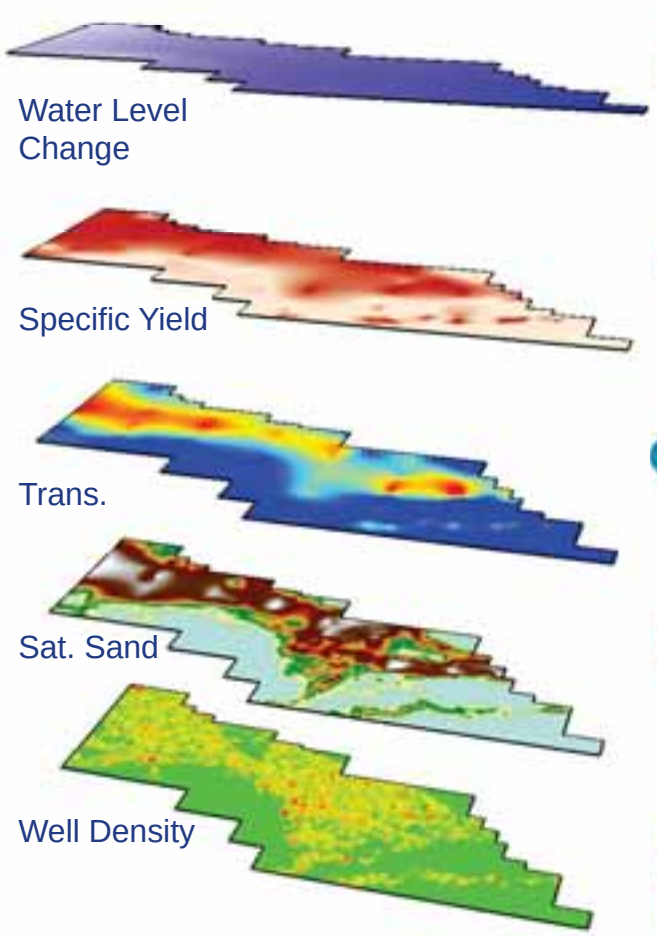
Complete Risk Model

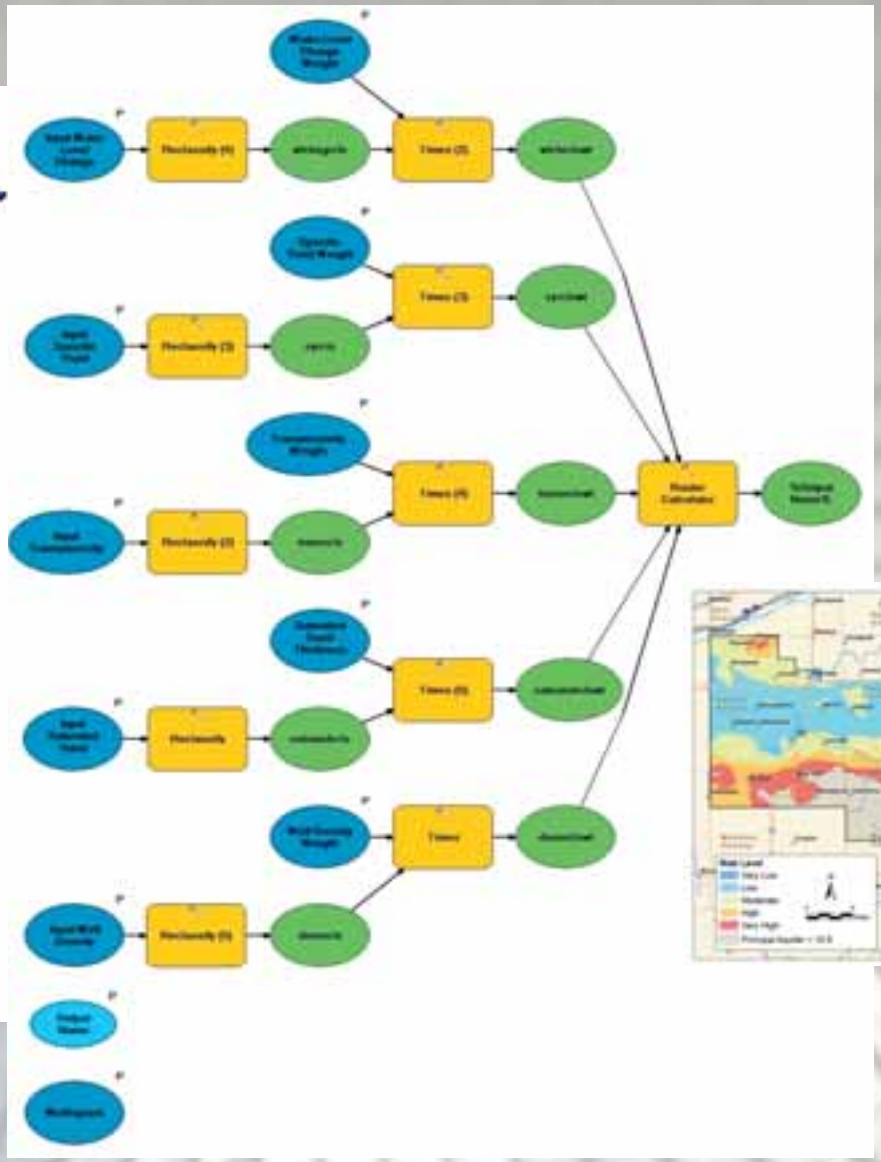
Aquifer Risk Model Criteria

Purpose: Identify Potential Target Areas of Concern and Future Development

- Water level change - Drought (2000 – 2007)
- Specific Yield – Measure of water available to wells
- Transmissivity – How much water moves laterally in the aquifer
- Saturated Sand and Gravel – Aquifer Thickness
- Well Density – potential areas of over production

First three criteria were weighted 25% each, the last two were weighted 12.5% each.

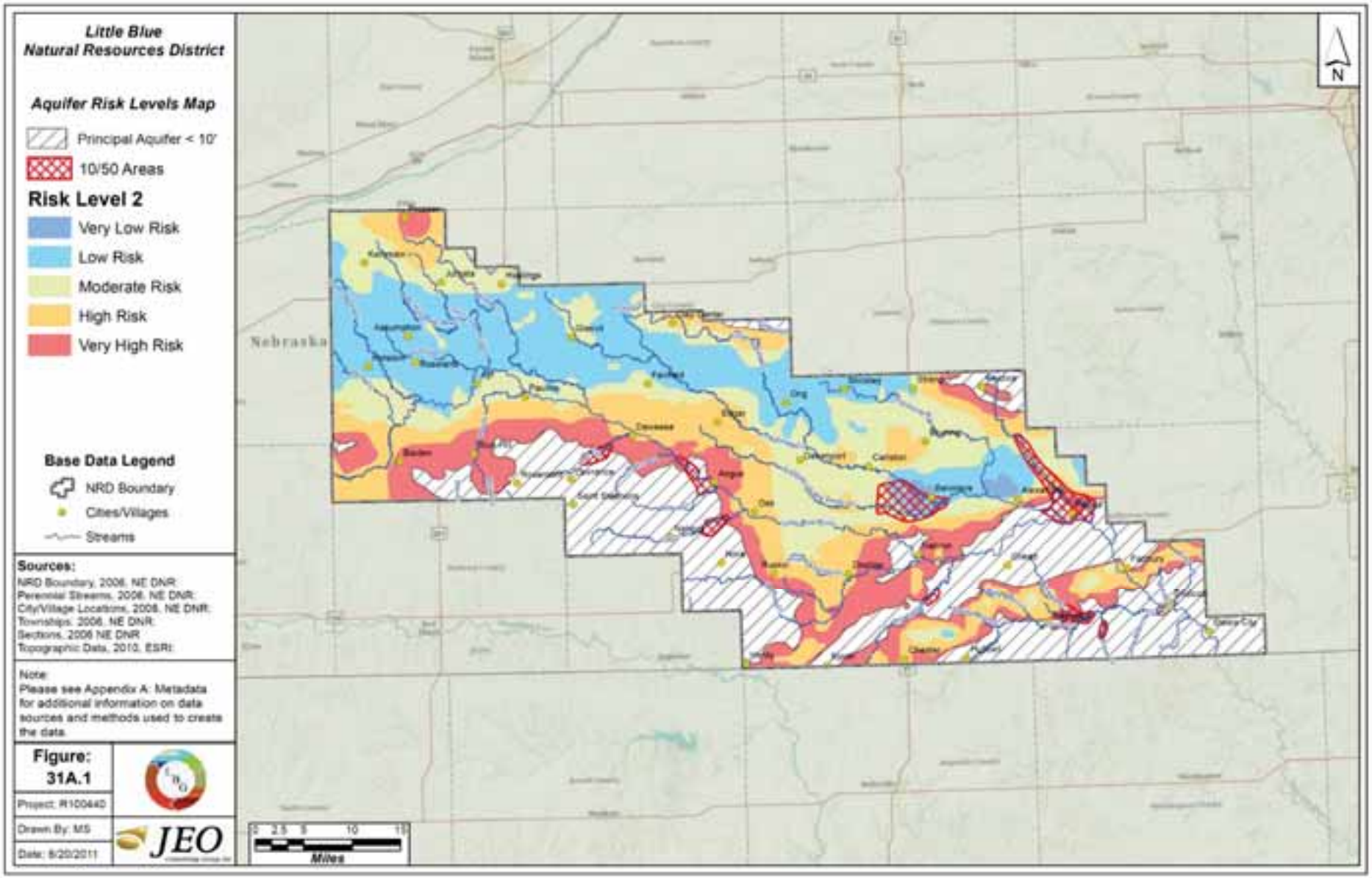




Output

Input → Reclass Inputs → Weighted → Raster Calculator

Potential Risk Levels of Principal Aquifer



Summary and Conclusions

- The most recent and currently available hydrogeologic data were obtained and evaluated.
- Three hydrogeologic units were identified within the NRD.
- The project deliverables provided the NRD with the following:
  - A better understanding of the hydrogeology.
  - Identified areas of potential concern for development
  - Tools that assist the NRD in developing water management policies.

Thank You

Michael C. Plante, PG, GISP
mike.plante@lbgmn.com

Roscoe F. Sopiwnik, GISP
Roscoe.sopiwnik@lbgmn.com

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