Hydrogeologic Study and Groundwater Sustainability Risk Evaluation

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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 mi² or ~ 1,500,000 acres
GWMP Designated Management Units (Pre-2010)
# Groundwater Irrigated Acres Listed by Natural Resources Districts

## Data from NRDs' records of certification or from NRDs' best estimates of irrigated acres.

### Certified - Official verification of irrigated acres by the regulatory authorities (NRDs)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>WELLS</th>
<th>IRRIG. AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945</td>
<td>76</td>
<td>9,047</td>
</tr>
<tr>
<td>1956</td>
<td>771</td>
<td>99,473</td>
</tr>
<tr>
<td>1966</td>
<td>2,022</td>
<td>253,826</td>
</tr>
<tr>
<td>1980</td>
<td>4,401</td>
<td>535,603</td>
</tr>
<tr>
<td>1985</td>
<td>4,928</td>
<td>589,952</td>
</tr>
<tr>
<td>2013</td>
<td>6,331</td>
<td>645000*</td>
</tr>
</tbody>
</table>

*Estimated

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October 2012
Work Flow

1. Obtain Data
2. Evaluate Data
3. Map Hydrogeologic Data Sets
4. Delineate Hydrogeologic Units
5. 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

1. Obtain Data
2. Evaluate Data
3. Map Hydrogeologic Data Sets
4. Delineate Hydrogeologic Units
5. 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

1. Obtain Data
2. Evaluate Data
3. Map Hydrogeologic Data Sets
4. Delineate Hydrogeologic Units
5. 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
Aquifer < 10 ft thick
Bedrock Geology
Hydrogeologic Cross Section Locations
Unconsolidated Materials: Loess, Silt, Clay, Sands & Gravels

Saturated sands & gravels

Unconfined aquifer

Silt, Loess, Clay

Bedrock

Unconsolidated Materials: Loess, Silt, Clay, Sands & Gravels

Cross Section A-A’
Paleovalley

Little Blue River hydraulically connected to gw

Cross Section C-C’
Groundwater Surface of Principal Aquifer (2010)
Depth to Groundwater of Principal Aquifer
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

Little Blue Natural Resources District

Transmissivity in Gallons per Day/foot

- Principal Aquifer < 10'
- Test Hole Locations
- Transmissivity Contours

Transmissivity gpd/ft
- High : 285528
- Low : 1743.51

Base Data Legend
- NRD Boundary
- Cities/Villages
- Streams

Sources:
- NRD Boundary, 2006, NE DNR
- Perennial Streams, 2006, NE DNR
- City/Village Locations, 2006, NE DNR
- Townships, 2006, NE DNR
- Sections, 2006 NE DNR
- Topographic Data, 2010, ESRI

Note:
Please see Appendix A: Metadata for additional information on data sources and methods used to create the data.

Figure: 26.1
Project: R100040
Drawn By: MS
Date: 6/20/2011

Miles
Work Flow

Obtain Data

Evaluate Data

Map Hydrogeologic Data Sets

Delineate Hydrogeologic Units

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

High Capacity Wells
Obtain Data

Evaluate Data

Map Hydrogeologic Data Sets

Delineate Hydrogeologic Units

Complete Risk Model
Aquifer Risk Model Criteria

Purpose: Identify Potential Target Areas of Concern and Future Development

- 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.
Reclass Inputs
Input Weighted Raster Calculator

Output

Water Level Change
Specific Yield
Trans.
Sat. Sand
Well Density

Input → Reclass → 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

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