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Providing the sound science and support for managing Nebraska’s most precious resource.

WATER SCIENCE:
STREAM AND AQUIFER DEPLETION

JESSE BRADLEY, P.G., NATURAL RESOURCES PROGRAMS DIRECTOR
Nebraska Department of Natural Resources
Overview

Stream and Aquifer Depletion

- The effects of well location on stream depletion
- Review of well depletion zones
- Wells in the Republican Basin through time
- Stream depletion
- Aquifer depletion
WELL LOCATION AND STREAM DEPLETION
Terminology:

Cone of Depression/Hydraulic Gradient

- As a well begins to pump water from an aquifer:
  - Groundwater levels around the well decline, creating a cone of depression in the water levels around the well
  - A hydraulic gradient is now present between the normal water table and the aquifer around the well

- The hydraulic gradient established within the cone of depression forces water to move from the aquifer into the well
### Effects of Well Location on the Rate of Stream Depletion

<table>
<thead>
<tr>
<th></th>
<th>Well A</th>
<th>Well B</th>
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<tbody>
<tr>
<td><strong>Proximity to stream</strong></td>
<td>Farther</td>
<td>Closer</td>
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<tr>
<td><strong>When cone of depression reaches stream</strong></td>
<td>Later</td>
<td>Sooner</td>
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<tr>
<td><strong>Length of time groundwater storage is a source of water to the well</strong></td>
<td>Longer</td>
<td>Shorter</td>
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<tr>
<td><strong>Streamflow depletion becomes primary source of water</strong></td>
<td>Later</td>
<td>Sooner</td>
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</tbody>
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![Diagram showing the effects of well location on stream depletion](image-url)
Questions?
REVIEW OF
WELL DEPLETION ZONES
Republican River Basin Generalized Well Depletion Zones

Zone Percents by NRD (RR Basin only)

- Upper Republican
- Middle Republican
- Lower Republican
- Tri-basin

Percent of NRD Area w/in the RR Basin

- Groundwater Zone
- Transitional Zone
- Stream Zone

Created by NDNR, alz
Updated December 1, 2015, emj
Digitized at a scale of 1:750,000.

Nebraska Department of Natural Resources
Questions?
WELLS IN THE REPUBLICAN BASIN THROUGH TIME
1940 Republican River Model Area Wells
1955 Republican River Model Area Wells
1970 Republican River Model Area Wells
1985 Republican River Model Area Wells

2000 Republican River Model Area Wells
2015 Republican River Model Area Wells
Questions?
STREAM DEPLETION
Stream Depletions by Well Depletion Zone

Stream Depletion (acre-feet)

Year

1900 1920 1940 1960 1980 2000 2020

Stream Zone  Transitional Zone  Groundwater Zone

Nebraska
Department of Natural Resources
Impacts above Reservoirs Serving Frenchman Cambridge Irrigation District

Impacts 1950-1964 compared to 2000-2012

- Runoff Reduction
- Nebraska Stream Zone
- Nebraska Transitional Zone
- Nebraska Groundwater Zone, net*
- Kansas Pumping
- Colorado Pumping

*Net = Pumping impact minus imported water
Impacts to
Frenchman Creek Subbasin

Impacts, 1950-1964 compared to 2000-2012

<table>
<thead>
<tr>
<th></th>
<th>Runoff Reduction</th>
<th>Nebraska Stream Zone</th>
<th>Nebraska Transitional Zone</th>
<th>Nebraska Groundwater Zone, net*</th>
<th>Kansas Pumping</th>
<th>Colorado Pumping</th>
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<tbody>
<tr>
<td>Stream Depletion (acre-feet)</td>
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*Net = Pumping impact minus imported water
Impacts to Mainstem, Swanson to Harlan

Impacts, 1950-1964 compared to 2000-2012

- Runoff Reduction
- Nebraska Stream Zone
- Nebraska Transitional Zone
- Nebraska Groundwater Zone, net
- Kansas Pumping
- Colorado Pumping

*Net = Pumping impact minus imported water
Above Harlan County Lake
Total Impacts above Harlan County Lake

Impacts, 1950-1964 compared to 2000-2012

- Runoff Reduction
- Nebraska Stream Zone
- Nebraska Transitional Zone
- Nebraska Groundwater Zone, net*
- Kansas Pumping
- Colorado Pumping

*Net = Pumping impact minus imported water
Total Impacts above Harlan County Lake

Impacts, 1950-1964 compared to 2000-2012

Stream Depletion (acre-feet)

<table>
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<tr>
<th>Runoff Reduction</th>
<th>URN RD</th>
<th>MRN RD</th>
<th>LRN RD</th>
<th>TBN RD/Other, Net*</th>
<th>Kansas Pumping</th>
<th>Colorado Pumping</th>
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*Net = Pumping impact minus imported water
Questions?
AQUIFER DEPLETION
Aquifer Volume by Subbasin

Decade

Total above Harlan County Lake
Frenchman-Cambridge Irrigation District Subbasins
Frenchman Creek Subbasin
Swanson to Harlan Area

Aquifer Volume (acre-feet)
Percent Change Since 1917
by Subbasin

Frenchman-Cambridge Irrigation District Subbasins
Frenchman Creek Subbasin
Swanson to Harlan Area
Percent Change Since 1917 by Subbasin

- Total above Harlan County Lake
- Frenchman-Cambridge Irrigation District Subbasins
- Frenchman Creek Subbasin
- Swanson to Harlan Area

Percent change in aquifer volume since 1917

1910s 1920s 1930s 1940s 1950s 1960s 1970s 1980s 1990s 2000s 2010s

Decade
Projection* of Storage Reduction by Depletion Zone

*Trends are projected 1000 years (power function) based 1970–2015 data
Questions?
THANK YOU

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