Hydrologic Benefits from Prairie and Wetland Restorations: Glacial Ridge NWR

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ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Glacial Ridge area

Red Lake Falls
Red Lake River
75
32
Crookston
2
RED LAKE COUNTY
POLK COUNTY
GLACIAL RIDGE NATIONAL WILDLIFE REFUGE
102
9
2
National WPA
Private WRP
Restored areas
State SNA
State WMA
32
N
Sand Hill River
Fertile
0 1.25 2.5 5 7.5 10 Miles

USGS

Restoration Benefits at Glacial Ridge NWR

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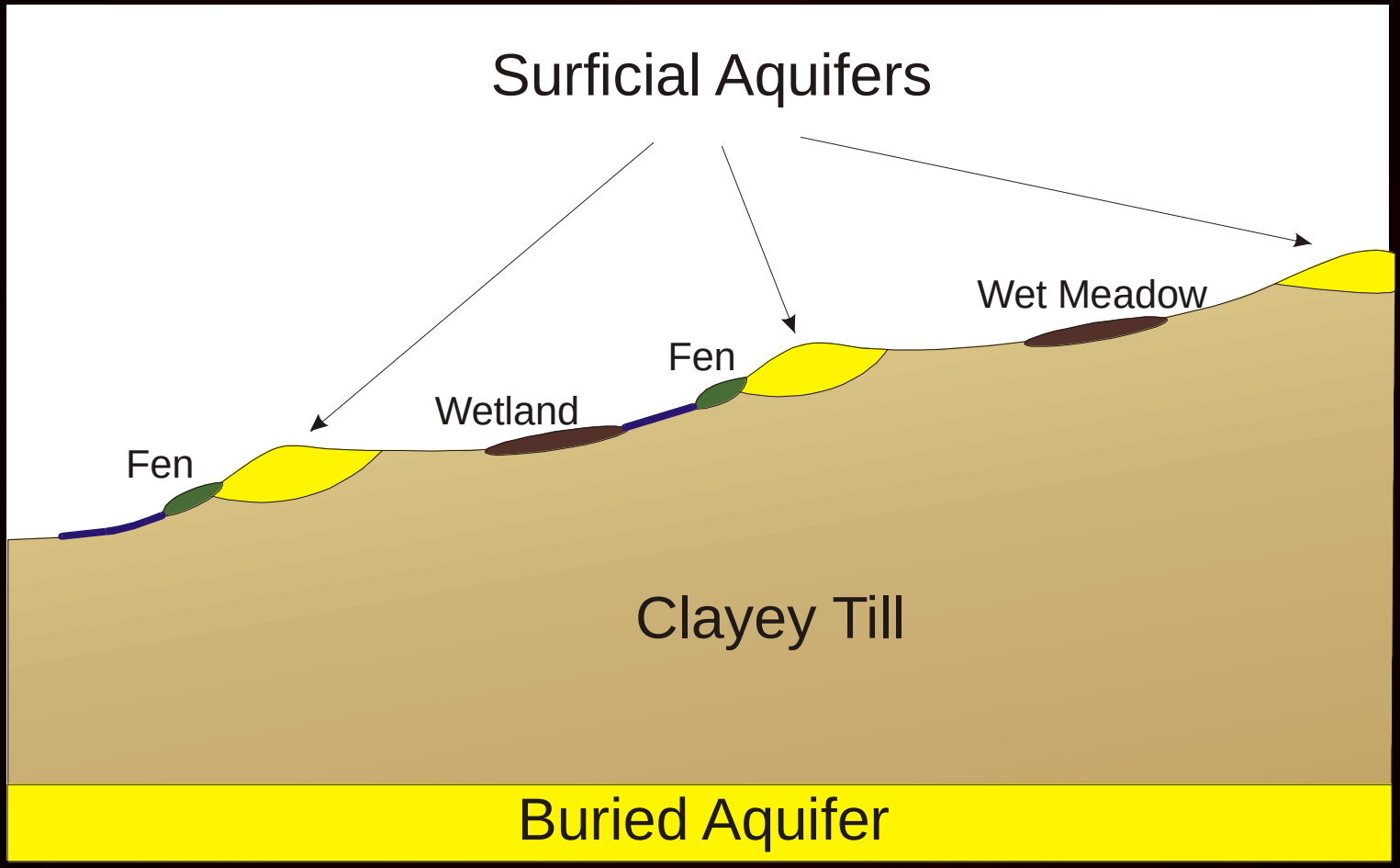
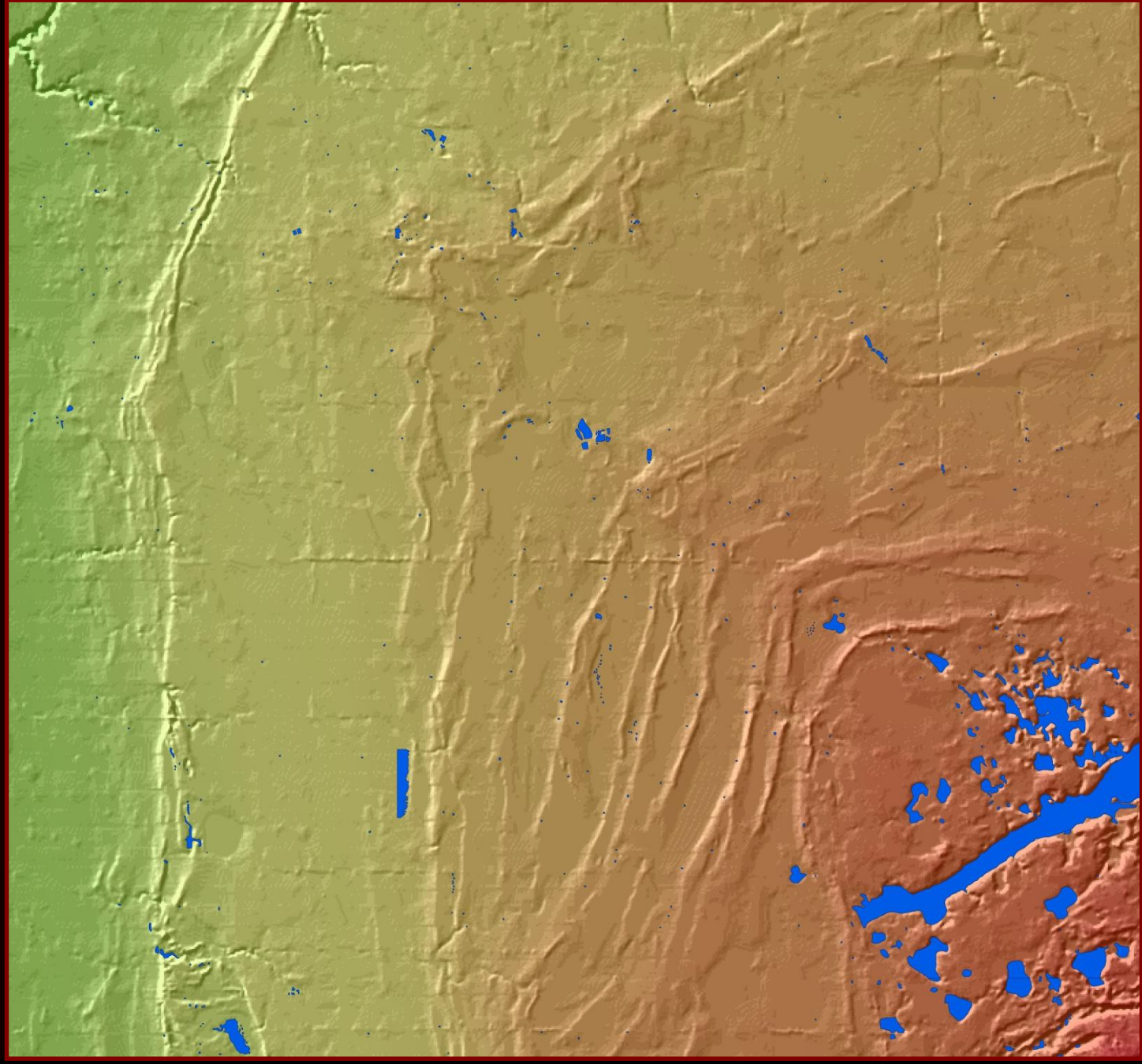
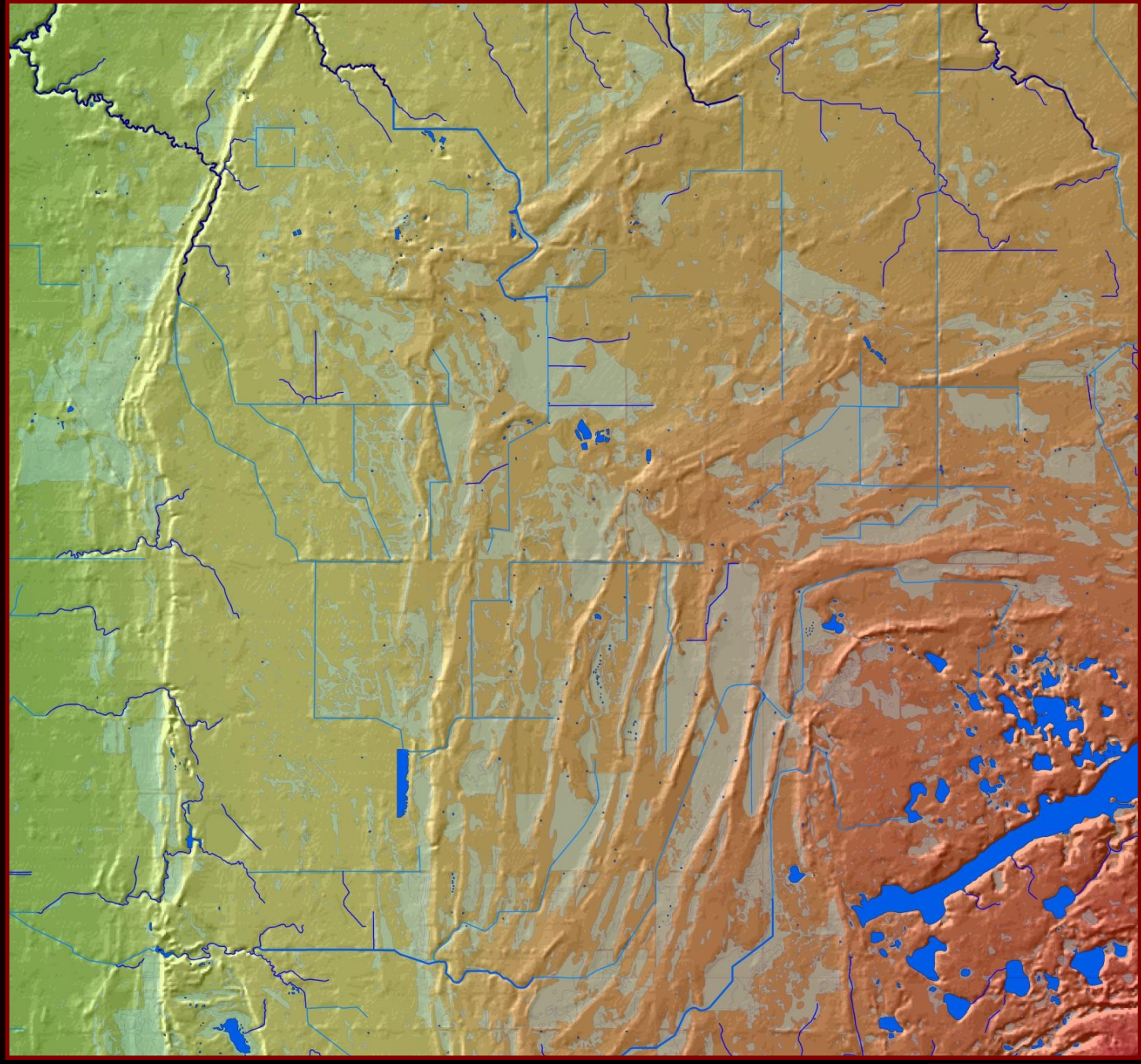
Looking North



Glacial Ridge Beach Ridges

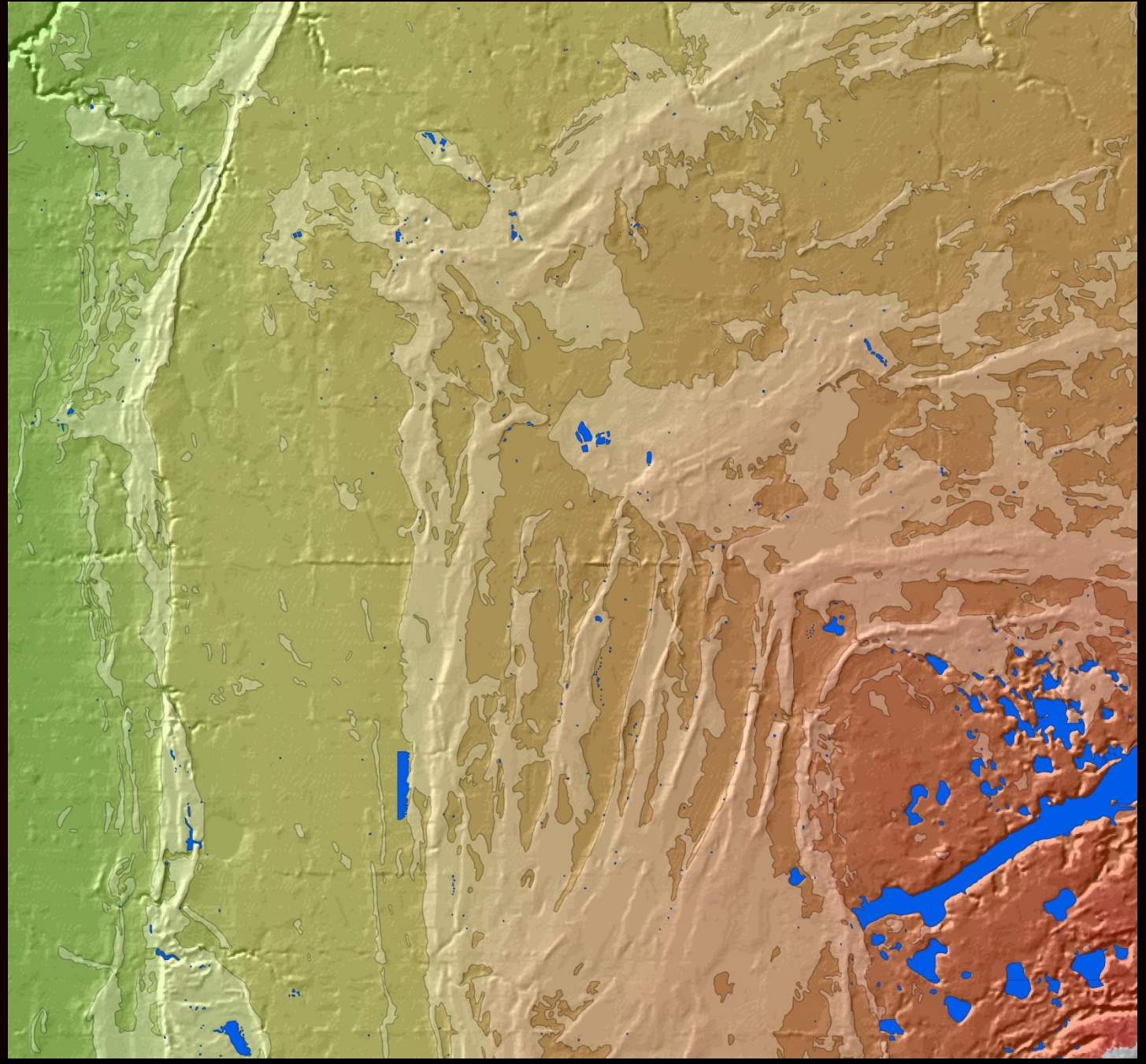


Wetland basins, streams and ditches, 2002



USGS

Surficial aquifers



Big Question 1:

How much will ditch flows decrease and water quality improve if the wetlands and prairies are restored?

Water Improvements?

A lot:

- Flow down ditches ⇩
- Storm peaks ⇩
- Water quality ⇧

And quickly.

Big Question 2:

Where else in Minnesota can these improvements be expected?

Where are the improvements?

Places with lots of:

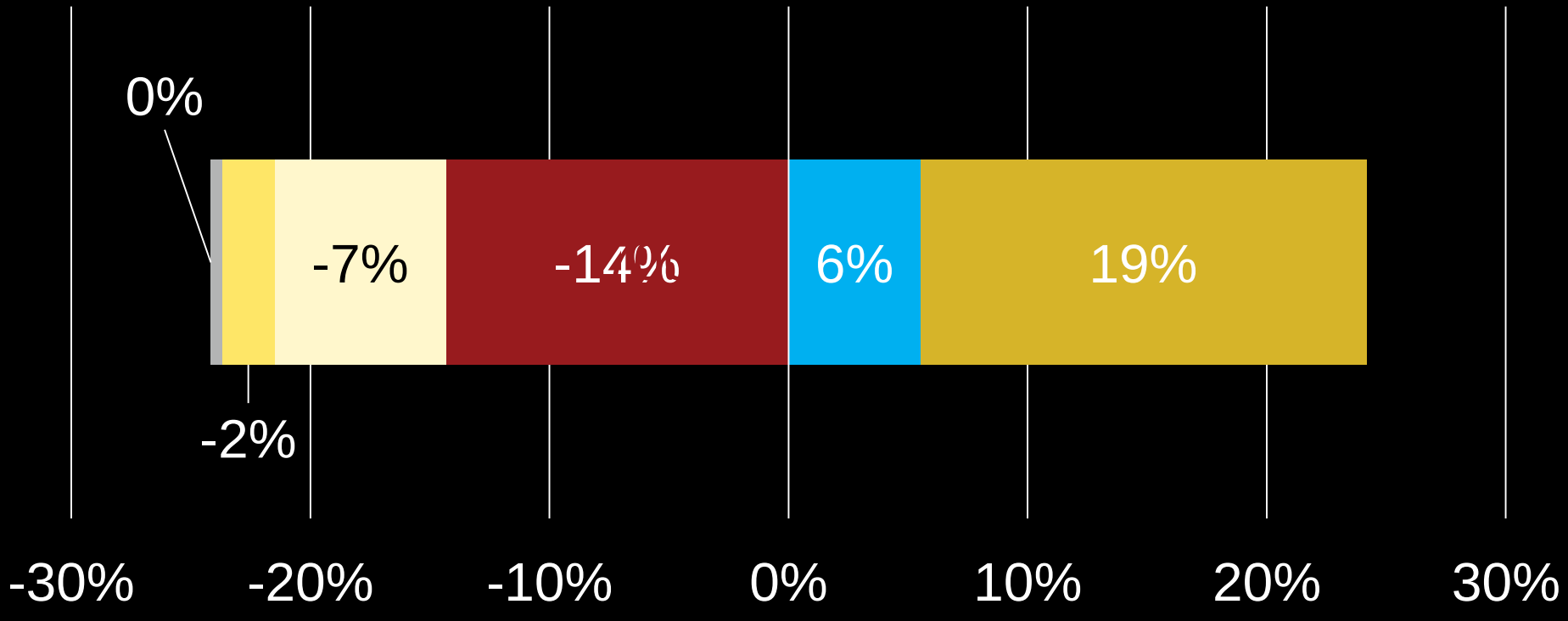
- Drained wetlands
- Surficial aquifers

(map later)

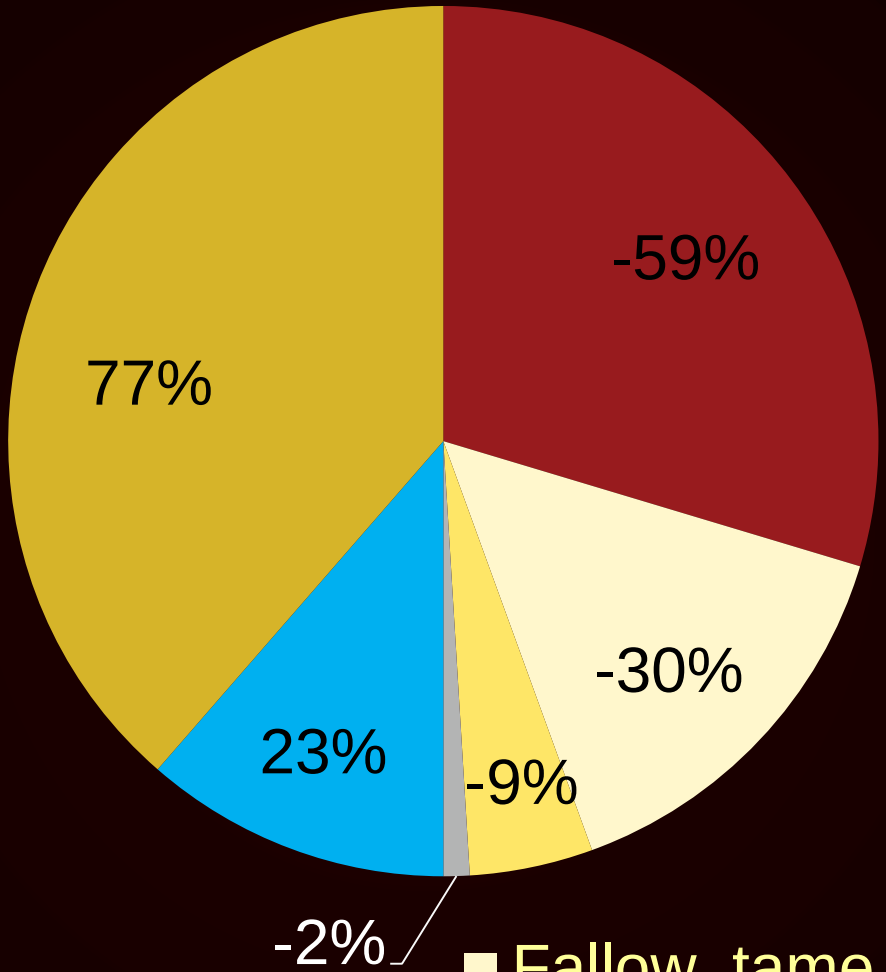
What was changed?

- Ditches restored to swales
- Drained wetlands plugged
- Cropland and pasture to prairie

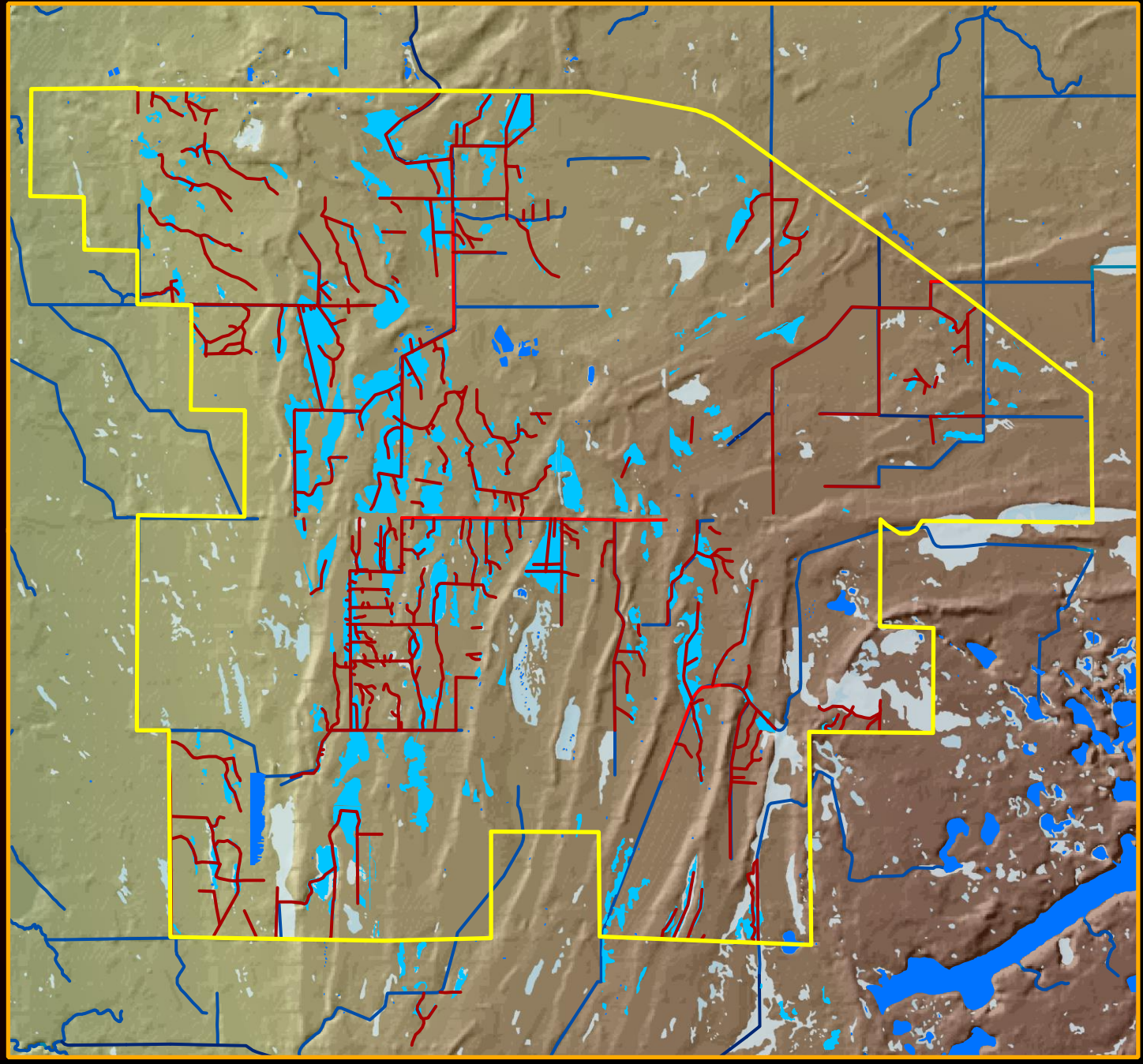
Percent change (2002–2015)



Percent of the change



Restored wetlands and abandoned ditches, 2011



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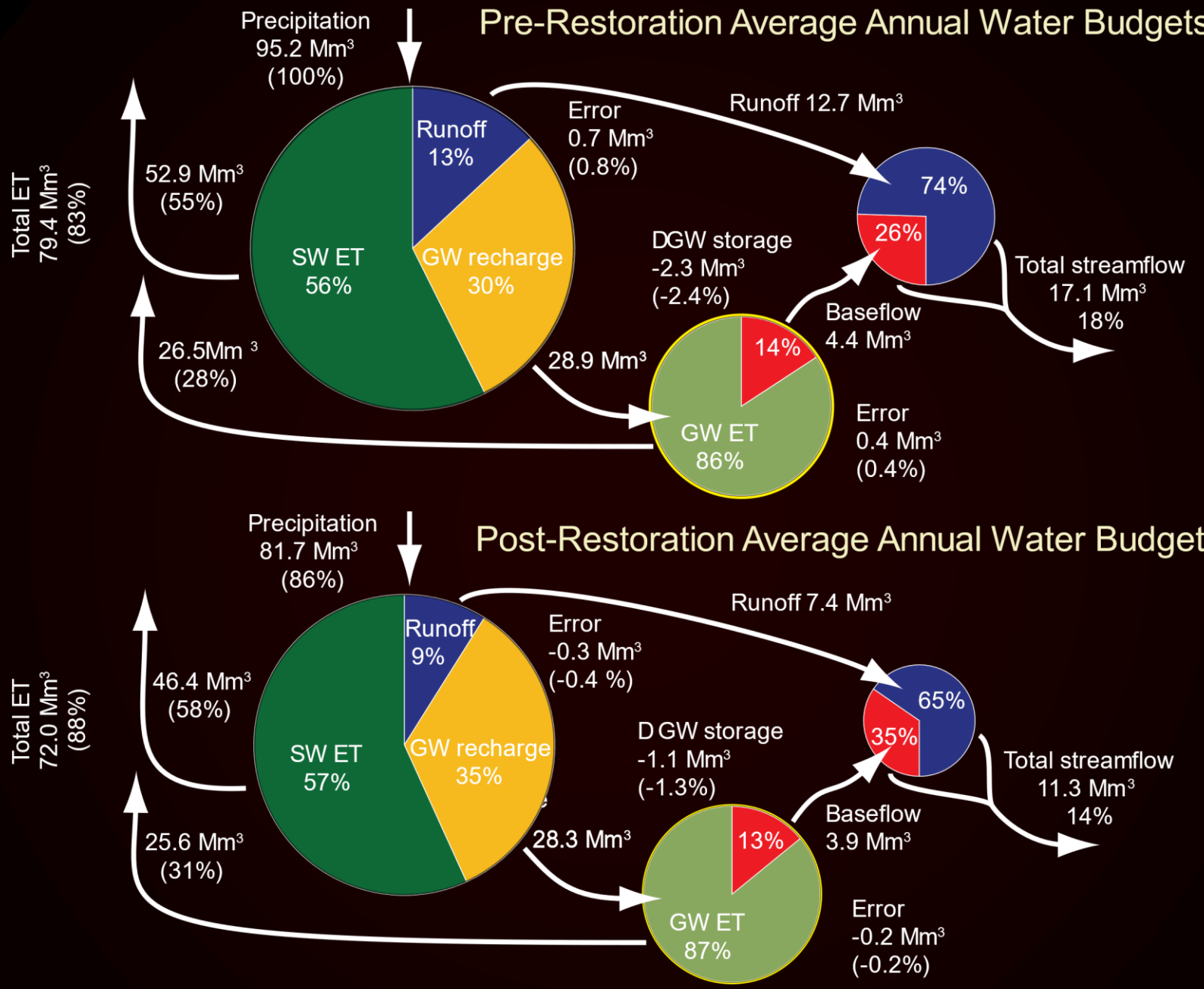
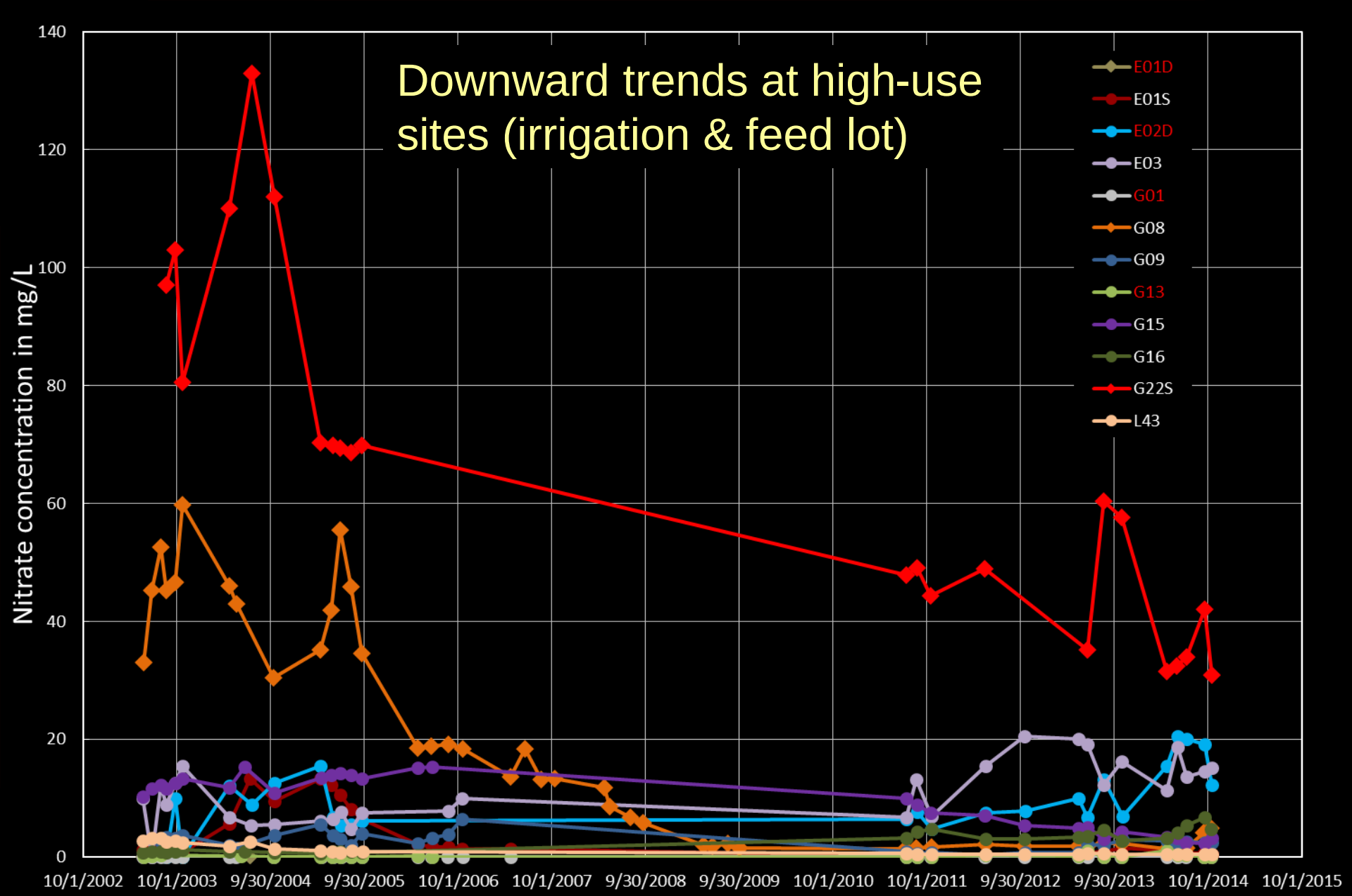
Restorations

- Total NWR area: 36,217 acres
- Wetlands restored: 2,977 acres
- Ditches abandoned: 50.1 miles
- Prairies seeded: 19,198 acres
- NWR owned: 25,658 acres (71%)
- Private WRP: 3,655 acres (10%)
- State WPA & SNA: 3,839 acres (11%)
- National WPA: 115 acres
- Total in natural land: 33,267 acres (92 %)

Techniques:

- Water balance
  - Water in and water out
- Water-quality samples
  - Surface water, groundwater, wetlands
  - Basic chemistry, nutrients, herbicides
- Storm-hydrograph curve-matching
  - How fast do ditches rise?


Pre-Restoration Average Annual Water Budgets
Precipitation
95.2 Mm³
(100%)
Runoff
13%
SW ET
56%
GW recharge
30%
Total ET
79.4 Mm³
(83%)
52.9 Mm³
(55%)
26.5Mm ³
(28%)
Error
0.7 Mm³
(0.8%)
Runoff 12.7 Mm³
74%
26%
DGW storage
-2.3 Mm³
(-2.4%)
Baseflow
4.4 Mm³
Total streamflow
17.1 Mm³
18%
28.9 Mm³
14%
GW ET
86%
Error
0.4 Mm³
(0.4%)
Post-Restoration Average Annual Water Budgets
Precipitation
81.7 Mm³
(86%)
Runoff
9%
SW ET
57%
GW recharge
35%
Total ET
72.0 Mm³
(88%)
46.4 Mm³
(58%)
25.6 Mm³
(31%)
Error
-0.3 Mm³
(-0.4 %)
Runoff 7.4 Mm³
65%
35%
D GW storage
-1.1 Mm³
(-1.3%)
Baseflow
3.9 Mm³
Total streamflow
11.3 Mm³
14%
28.3 Mm³
13%
GW ET
87%
Error
-0.2 Mm³
(-0.2%)


Downward trends at high-use sites (irrigation & feed lot)
Nitrate concentration in mg/L
140
120
100
80
60
40
20
0
10/1/2002
10/1/2003
9/30/2004
9/30/2005
10/1/2006
10/1/2007
9/30/2008
9/30/2009
10/1/2010
10/1/2011
9/30/2012
9/30/2013
10/1/2014
10/1/2015
E01D
E01S
E02D
E03
G01
G08
G09
G13
G15
G16
G22S
L43

What changed?

Land-use changes:

- +19% prairie
- + 6% wetlands
- -14% cropland
- -63% decrease in ditch density

Water-flow changes:

- -23% ditch flow
- -33% runoff
- +15% recharge
- + 6% ET

What changed?

Water quality:

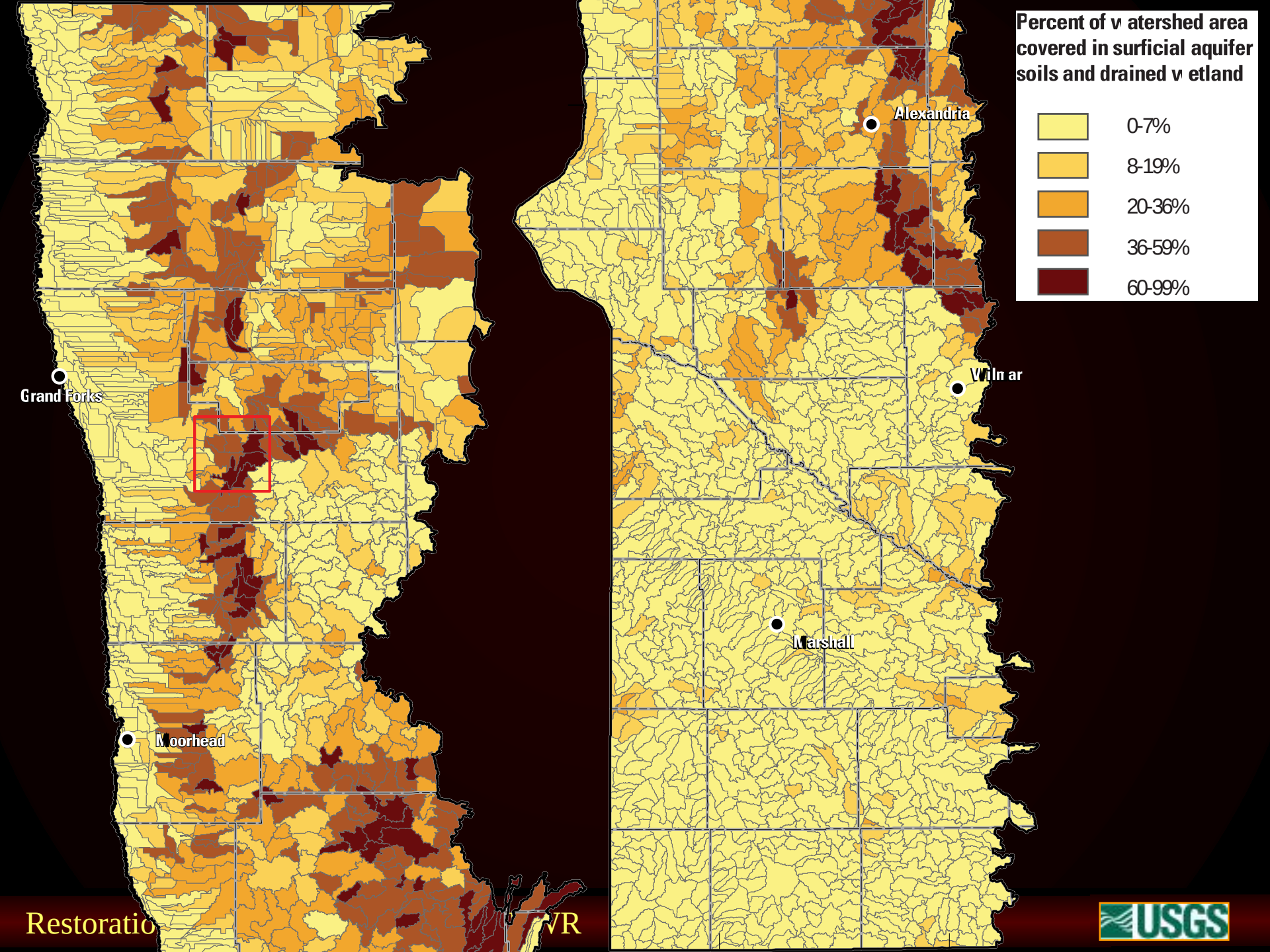
- GW nitrate: -79%
- GW ammonia: -79%
- Ditch nitrate: -53%
- Ditch ammonia: -35%
- GW nitrate >MCL: -38% (33% to 21%)

Storm flow:

- Lower peaks
- Longer tails

Were did things get better most?

- *Over surficial aquifers*
- *In areas with drained wetlands*


Percent of watershed area covered in surficial aquifer soils and drained wetland
0-7%
8-19%
20-36%
36-59%
60-99%
Alexandria
Grand Forks
Wilmar
Marshall
Moorhead
Restoratio
VR
USGS

Main Benefits of Restoration

- 24% of the land area was restored
- **Less flooding**
  - Flow down ditches decreased 23%
  - Storm peaks in ditch flow were lower GW recharge increased 15%
- **Cleaner water**
  - Nitrate in GW decreased by 79% within a few years

Where is restoration likely to work?

- In areas with surficial aquifers
- In areas with drained wetlands
- (see map)

Tim Cowdery—Glacial Ridge

Prerestoration Report
https://pubs.er.usgs.gov/publication/sir20075200

Mercury Report
https://pubs.er.usgs.gov/publication/sir20135068

Final Postresotration Report
https://pubs.er.usgs.gov/publication/sir20195041

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