SPNRD Stakeholder Meeting #2 Minutes

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|---|---|
| Project: | Stakeholder Advisory Committee Meeting to Jointly Develop 2nd Increment Integrated Management Plan (IMP) with South Platte NRD and Nebraska Department of Natural Resources |
| Subject: | Stakeholder Meeting #2 |
| Date: | Wednesday, August 15, 2018, from 2:00 p.m. - 4:00 p.m. |
| Location: | Western Nebraska Community College<br>371 College Drive, Sidney, NE |

**Attachments to Minutes:**
Attachment A- Affidavit of Publication of Notice of Meeting
Attachment B- Agenda
Attachment C- Copy of attendance sheet
Attachment D- Copies of all presentations
Attachment E- Municipal statute changes handout
Attachment F- Additional Handouts

1. **Welcome**
2. **This is an Open Meeting**
   a. Stephanie White, Facilitator, HDR, opened the meeting at 2:02 p.m. MDT by stating a copy of the open meetings act was in the room and notice of the meeting was published in the Sidney Sun Telegraph (Attachment A).
   b. Stephanie White went over the agenda (Attachment B), and safety procedures.
   c. Bill Halligan, Chairman of the South Platte Natural Resources District (SPNRD) Board of Directors and a member of the Natural Resources Commission, welcomed the group by indicating this is the second of four meetings to develop the second increment Integrated Management Plan (IMP).
3. **Administration**
   a. Beth Eckles, NeDNR, gave a June meeting recap.
   b. Stephanie White, reviewed roles and responsibilities for NeDNR, NRDs, Stakeholders and Joint NeDNR and NRD roles for both the Basin-Wide Plan (BWP) and the IMP.
   c. Copies of presentations were handed out and are attached to these minutes (Attachment D)
4. **Possible distinctions between Lodgepole Creek, South Platte River Basin, and the North Platte River Basin.**
   a. Rod Horn, General Manager, SPNRD, reviewed the post '97 depletions offset in the first increment for each of the three areas highlighted.
      i. Number of groundwater irrigated acres in the Overappropriated, Fully Appropriated and District-Wide areas.
      ii. Regulatory and non-regulatory actions taken by SPNRD to meet their goals of the first increment.
      iii. Allocations and other regulatory groundwater management actions have been included in the District's Rules and Regulations, but are outside of the IMP.

iv. Basin-Wide planning group is looking at maintaining progress made toward the post '97 depletion levels, and there are further future depletions to be offset by all five Upper Platte River Basin NRDs, with the division of the volume for individual NRDs to be determined.
v. Three levels of management options were presented to consider for the second increment of the SPNRD IMP.
vi. Stakeholder Group to consider if the three areas should be managed separately.

b. **Stakeholder Questions / Comments:**
   i. In the Basin-Wide Plan the next ten years the depletions will total around 3500 acre-feet (af). Somehow the NRDs are going to have to parcel out the depletions between them. Stephanie offered to pull up a graphic to illustrate this new volume of depletions.
   ii. There was a moratorium in the entire Upper Platte Basin, but there are replacement wells that have been constructed that are not considered new wells. A variance process is another way to drill a new well, with an offset provided. A moratorium went into effect for the Upper Platte Basin NRDs when the NeDNR declared the basin fully or overappropriated, in September of 2004. Replacement wells that have been constructed are not considered new wells. Each NRD's rules are specific to that NRD but most operate on an annual basis. So, you would have 12 months to drill that well or your permit would no longer be valid.
   iii. For the most part the goals of the IMP have been met, but we need to work to become fully appropriated, and we're not there.

**5. Robust Review Results.**

a. Stephanie encouraged the group to think about management of the three areas during the Robust Review results.

b. Jennifer Schellpeper, NeDNR presented the robust review results. (Attachment D)
   i. The robust review is called for in the current IMP's monitoring section. The purpose is to assess progress made towards meeting the goals and objectives of the first increment IMP, as well as to provide second increment discussion.
   ii. Importance of the Western Water Use Model (WWUM)
      1. Model assumptions:
         a. period of record modeled being 1953 to 2013;
         b. metered well pumping data used and repeated into the future;
         c. 1997 is used as a starting point because statute states that is the level of development, and also the Nebraska New Depletion Plan;
         d. Modeled change runs to know historical, today and into the future levels;
         e. Comingled acres are constant so that results are more straightforward;
         f. Model results cover the entire SPNRD;
         g. Crop types are used to calculate consumptive use;
         h. Pumping data was used in comparison with baseline of 1997.
   iii. Jennifer summarized the results as being positive.

c. When looking forward to 2029, the excess flow diversions help keep the situation positive. Jennifer pointed out that the depletions are hovering at zero or positive values across the South Platte River. Lodgepole Creek shows 6,000 acre-feet of accretions- as a result of allocations and the reductions in acres irrigated. Over 50 years the accretions remain in the 4,000 to 5,000 acre-feet range. The progress made in the first increment must be maintained in the 2nd and consecutive increments.

d. Thad gave a brief description of how the allocation estimates were calculated for the three areas within SPNRD.
e. There is a need to discuss the definition of a fully appropriated condition. The basin-wide group has yet to define it.

**6.** Stakeholder Questions / Comments

a. The dip in acres could be from several factors, such as acre retirements, metered data indicating fallow for a particular year and Thad looked at many years of aerial photographs to determine the number of acres irrigated before meters were in place. Acres were certified, but the wells that didn't get flow meters went into temporary deferment. There are less acres being irrigated in the SPNRD than there were in 1997. And there were many wells no longer pumping and discontinued use, as no longer needed when going to a pivot. So, a lot of quarters had two irrigation wells, now have one. Within the District, we have eliminated a lot of irrigation since 1997.
b. Excess flows in the model does not have a repeated cycle. This reflects actual events of diversion when they occur. In the future if events occur again then that will be shown.
c. The best pits are further away, mile or half mile, from the canal due to the canal saturating the ground adjacent to it, so less water will soak in closer to the canal, however the old infrastructure to get the water to those pits presents a challenge.
d. Because we don't know when excess flow events are going to happen they cannot be repeated in the model. We have the meter data of what has happened through a cycle and that is the best data to predict future cycles. We have done excess flow availability studies, and the frequency is more random, so it makes it harder to predict when they occur. We are working on a study for that. Also, a recharge event occurred in 2016, but is not shown on this since the current analysis period ends in 2013. Because the variability of the recharge events, it is best not to repeat in the model and use only the actual events. This is in contrast to the pumping data, of which we have every year's data, and can see wet and dry periods to use for an average climate cycle. A recharge event may or may not happen in the second 10-year increment, so we are taking a conservative approach. This means that management actions planned as if we do not have these recharge events, because they cannot be counted on to occur. Also, the South Platte River has had recharge events in 2011, 2013 and 2016, and the North Platte River has only had an event in 2011.
    i. All of these graphs are based on 2013 for the last year. So further allocations are repeated, so as long as the weather repeats similar to 2009-2013, the results will be similar. Unless the weather or the pumping were to be different. All we're doing here is comparing the difference between the 97 pumping against what was actually pumped. So, a difference would show up as a positive gain if pumping is reduced.
    ii. The accretions in LPC are all within the SPNRD area.

e. The current IMPs have triggers in them, if the NRD isn't meeting the triggers, you must put in regulatory controls, which are spelled out in the IMP. We have talked about having the same triggers to include in the second increment. If they have a set of controls to be required. There is an independent board (IWRB) that would be the decision maker if DNR and the NRD can't agree on an IMP. If that NRD doesn't do what they said they were going to do, that stakeholder group would be a real issue, to not follow the law.

f. Fines are at the NRD level where an NRD could fine a producer for not following the rules. So that is different than if the NRD chooses not to implement the controls.

**7.** Rod Horn presented ideas that are just examples, not all inclusive, the NRD could vote to just maintain. The basin-wide group has not landed at a number yet on how to fairly distribute the 3,500 af for 2019 to 2029. The goal of the plan is get back to a balance of water supplies and uses. It's focused on hydrologically connected water, so that's why we talk about depletions to the stream. Aiming for a balance for those uses that is economically viable. When are we at that balance? Long term conditions may change, supplies or demands may change, so we adapt our management according to the conditions to maintain the balance. How to maintain the economic and social viability and what does that mean to the SPNRD can be written into the plan as an option.

**8.** Jennifer Schellpeper noted that the IMP must be consistent with the Basin-wide plan. So, if the BWP would allow for that option, then the IMP can. But there is a requirement to get back to fully appropriated in the Basin-Wide Plan, so drought mitigation is very important, and economic viability is very important.

**9.** Stephanie White noted a theme of increasing collaboration upstream. She suggested that she can bring language to consider to the next meeting, as it resists risk but doesn't make it go away. Conjunctive management is what to do when there is water. This won't answer if we need to manage the three areas separately.

**10. Second Increment Discussion.**

a. **Municipal statute change-** SPNRD provided a handout (Attachment E) addressing the changes in the statute regarding municipal offsets. Although on the agenda, time didn't allow for viewing the presentation and was briefly discussed.

b. **Conjunctive Management**- although on the agenda, time didn't allow for viewing and discussion during the meeting. Jennifer instructed the group to review the conjunctive management slides (included in Attachment D) and bring questions and comments to be discussed in the next meeting.

c. Stephanie requested the group to prioritize topics to discuss at future meetings.

**11. Public Comment.** None.

**12. Meeting adjourned:** 4:05 p.m.

**13. Next Meeting:** November 14, 2018.

# PROOF OF PUBLICATION

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COUNTY OF DEUEL } SS.

Amount $ 11.78

Date Paid ....................

I, Michael D. Talbott, hereby certify that I am publisher of The Chappell Register, a legal weekly newspaper, of general circulation, published in said Deuel County and State of Nebraska; and further certify that the notice, of which the one attached is a true copy, was published in the regular and entire issue of each number of the said The Chappell Register

for 1 consecutive issues, the first publication being

on the 9th day of Aug 2018

and the last publication being on the .................... day of

.................... 20..........

[signature]

SUBSCRIBED in my presence and sworn to before me this

9th day of Aug 2018

GENERAL NOTARY-State of Nebraska
LINDA M WALMSLEY
My Comm. Exp. July 2, 2019

Linda M Walmsley
NOTARY PUBLIC

**PUBLIC NOTICE**

The South Platte NRD and the Nebraska Department of Natural Resources (NeDNR) will hold a Stakeholders Advisory Committee meeting on Wednesday, August 15, 2018, beginning at 2:00 PM (Mountain Time) at Western Nebraska Community College, 371 College Drive, Sidney, Nebraska. The purpose of the meeting is to discuss and develop goals and objectives to support the second increment of the jointly developed integrated management plan. The public is welcome to attend this stakeholder meeting; there will be opportunity for public comment toward the end of the meeting. Individuals with disabilities may request auxiliary aids and services necessary for participation by contacting Beth Eckles at the Nebraska Department of Natural Resources, telephone 402-471-0661 or by email at beth.eckles@nebraska.gov, before 5 pm Central Time, Thursday, August 9, 2018.

32L

**LEGAL #** L18- 497

L18-497
The South Platte NRD and the Nebraska Department of Natural Resources (NeDNR) will hold a Stakeholders Advisory Committee meeting on Wednesday, August 15, 2018, beginning at 2:00 PM (Mountain Time) at Western Nebraska Community College, 371 College Drive, Sidney, Nebraska. The purpose of the meeting is to discuss and develop goals and objectives to support the second increment of the jointly developed integrated management plan. The public is welcome to attend this stakeholder meeting; there will be opportunity for public comment toward the end of the meeting. Individuals with disabilities may request auxiliary aids and services necessary for participation by contacting Beth Eckles at the Nebraska Department of Natural Resources, telephone 402-471-0661 or by email at beth.eckles@nebraska.gov, before 5 pm Central Time, Thursday, August 9, 2018.
[Published in the Sidney Sun-Telegraph on August 8, 2018]

# AFFIDAVIT OF PUBLICATION

The undersigned, being duly sworn deposes and says that he is a Principal Clerk of the SIDNEY SUN-TELEGRAPH, a bi-weekly newspaper of general circulation in Cheyenne County, State of Nebraska, and that a notice entitled:

Stakeholder's Advisory Meeting

a true copy of which is hereto attached and made a part hereof, was published in said newspaper 1 consecutive week(s) the first publication having been made the

8 day of August 2018

and the last publication having been made the

8 day of August 2018

that said newspaper has been published bi-weekly in the English language at the City of Sidney, within said county and state for more than fifty-two consecutive weeks, immediately prior to the first date of publication above, and twice every week successively since that day, and during all said times has had and now has a bona fide circulation of more than 300 copies weekly and during all said time has been and now is printed in whole or in part in an office maintained by the Publishers at the said place of publication.

Dana Revell

*************************************************************

Subscribed in my presence and sworn to before me this 8 day of August 2018

Jennifer D Alexander

Notary Public

My commission expires 11-1-20

(SEAL)

GENERAL NOTARY - State of Nebraska
JENNIFER D. ALEXANDER
My Comm. Exp. November 1, 2020

Attachment A - Affidavit of Publication of Notice of Meeting

**MEETING NOTICE**

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#9108 Aug. 9, 2018

# AFFIDAVIT OF PRINTER

STATE OF NEBRASKA

}SS.

COUNTY OF KIMBALL

I, Nichole L O'Brien being duly sworn and under oath, say that I am an employee of Western Nebraska Observer, Company (a corporation), publishers of Western Nebraska Observer, an English Language weekly newspaper published in Kimball, Nebraska, with general circulation in both Kimball and Banner Counties, among others. I certify that said newspaper is a legal newspaper under the statutes of Nebraska, has a bona fide weekly circulation of at least 300, has been published at least 52 weeks prior to publication of this notice, that it holds a second class postage permit; and that to my personal knowledge, the attached clipping was printed in the regular and entire issue of the Western Nebraska Observer for one (1) week(s), beginning with the issue dated:

August 9, 2018

and ending with the issue dated:

August 9, 2018

Nichole L O'Brien

Signed

Printer's Fees:

$12.09

Subscribed and sworn to before me this:

10th day of August, 2018

GENERAL NOTARY - State of Nebraska
CHRISTINE D. BERGER
My Comm. Exp. March 16, 2021

Christine D Berger

Notary Public

# Agenda

Project: 2nd Increment Stakeholder Process for South Platte NRD Integrated Management Plan (IMP)

Subject: Stakeholder Meeting #2

Date: Wednesday, August 15, 2018 from 2:00 p.m. – 4:00 p.m.

Location: Western Nebraska Community College

**Topics:**

1. Welcome
2. Administration
    a. June meeting recap
    b. Necessary information to be a successful stakeholder
3. IMP Distinctions of Management Areas
4. Robust Review Results
5. 2nd Increment Discussion
    a. Municipal Statute – 2026 Offsets
    b. Conjunctive Management
6. Public Comment

**Next Meeting: November 14, 2018**

## IMP Stakeholder Meeting June 20, 2018

| Present | Name | Email | Best Contact Phone Number | Corrections |
|---|---|---|---|---|
| X | Bill Halligan | bill.halligan@pwcbank.com | 308-235-5900 | |
| X | Jim Johnson | jim.johnsonne@outlook.com | 308-241-1742 | |
| X | Tim Maas | maasfam@vistabeam.com | 308-249-0103 | |
| X | Phil Grabowski | grabow65@ymail.com | 308-249-6460 | |
| X | Chris Meyer | meyerc673@hotmail.com | 308-250-1745 | |
| X | Kathy Narjes | rodekohr@hotmail.com | 308-874-4371 | |
| X | Larry Rutt | llrutt78@vistabeam.com | 308-874-4107 | |
| X | Alan Adamson | a_dch@hotmail.com | 308-235-9400 | |
| X | Carson Sisk | KimballWater@kimballne.org | 308-241-1636 | |
| | John Perry | jpperry@embarqmail.com | 308-235-5035 | |
| X | Rick Dickinson | bvfd@daltontel.net | 308-235-7093 | |
| | Rol Rushman | RolRushman@Daltontel.net | 308-249-1384 | |
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| X | Randy Horst | | 308-250-2431 | |
| | Mike Behrends | behrends30@hotmail.com | 308-874-4300 | |
| X | Bernie Fehringer | bfehringer@icloud.com | 308-249-3116 | |
| | Nathan Knobbe | nathank@dinklagefeedyards.com | 308-249-5404 | |
| | Ed Sadler | esadler@cityofsidney.org | 308-254-4444 | |
| X | Randy Faessler | tfaess@yahoo.com | 308-249-5534 | |
| X | Dave Weiderspon | wbvet@yahoo.com | 308-254-2704 | |
| X | Kevin Derry | derrykb@embarqmail.com | 308-874-4240 | |

Attachment C - Copy of Attendance Sheet

| | | | | |
|---|---|---|---|---|
| X | Jared Derry | jared.derry32@gmail.com | 308-874-4477 | |
| X | Mark McGreer | mark.mc.greer@plantpioneer.com | 308-289-0252 | |
| | Don Kraus | dkraus@cnppid.com | 308-995-8601 | |
| X | Jeff Shafer | jtshafe@nppd.com | 402-362-7360 | |
| | Tim McCoy | tim.mccoy@nebraska.gov | 402-471-5539 | |
| | Al Hanson | al.hanson@nebraska.gov | 308-763-2940 | |
| X | John Flint | john.flint@nebraska.gov | 308-641-7273 | |
| X | Kaitlyn Steinwart | kaitlyn.steinwart@nebraska.gov | 308-765-9293 | |
| X | Kristin Dickinson | kristin.dickinson@ne.usda.gov | 308-249-2766 | |
| | Steve Sibray | ssibray@unlnotes.unl.edu | 308-632-1382 | |
| X | Thad Kuntz | thad@adaptiveresourcesinc.com | 308-633-2890 | |
| X | Rod Horn | rlhorn@spnrd.org | 308-254-2377 | |
| X | Ryan Reisdorff | rreisdorff@spnrd.org | 308-254-2377 | |
| X | Travis Glanz | tglanz@spnrd.org | 308-254-2377 | |
| X | Melissa Mosier | melissa.mosier@nebraska.gov | 402-471-3948 | |
| X | Beth Eckles | beth.eckles@nebraska.gov | 402-471-0661 | |
| X | Jennifer Schellpeper | jennifer.schellpeper@nebraska.gov | 402-471-2899 | |
| | Mike Drain | mdrain@cnppid.com | 308-995-8601 | |
| | Randy Zach | rrzach@nppd.com | | |
| | Devin Brundage | dbrundage@cnppid.com | 308-529-1621 | |
| X | Jeff Buettner | jbuettner@cnppid.com | 308-995-3559 | |
| X | Shea Winkler | Shea.winkler@nebraska.gov | | |
| | | | | |

# SPNRD IMP

## Meeting 2

Kimball Cheyenne Deuel
SOUTH PLATTE
NATURAL RESOURCES DISTRICT

NEBRASKA
DEPT. OF NATURAL RESOURCES

# TODAY'S AGENDA

- Welcome
- Administration
  - June meeting recap
  - Necessary information to be a successful stakeholder
- IMP Distinctions of Management Areas
- Robust Review Results
- 2nd Increment Discussion
  - Municipal Statute – 2026 Offsets
  - Conjunctive Management
- Public Comment

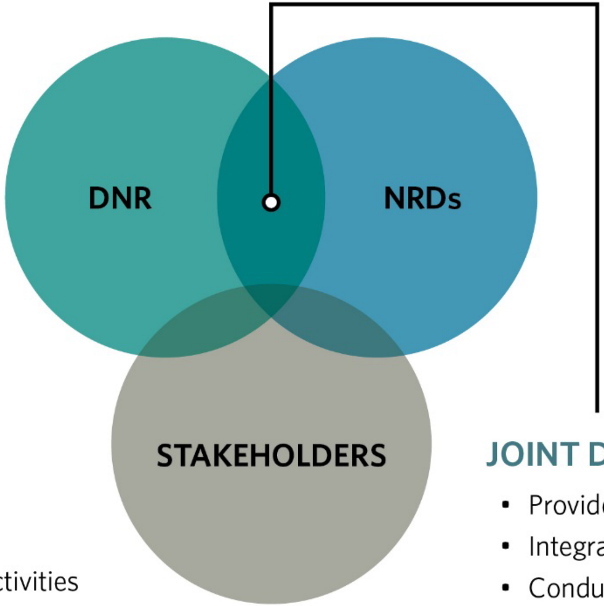
# WELCOME

- Open Meeting Notice
- Safety & Logistics

# Basin-Wide Plan Roles & Responsibilities

**DNR'S INDIVIDUAL ROLES:**

- Review, approve, and formally adopt the plan




**NRD'S INDIVIDUAL ROLES:**

- Review, approve, and formally adopt the plan

**STAKEHOLDER ROLES:**

- Provide input into the development of goals and objectives of the basin-wide plan
- Provide input on planning implementation activities
- Work toward consensus on the basin-wide plan

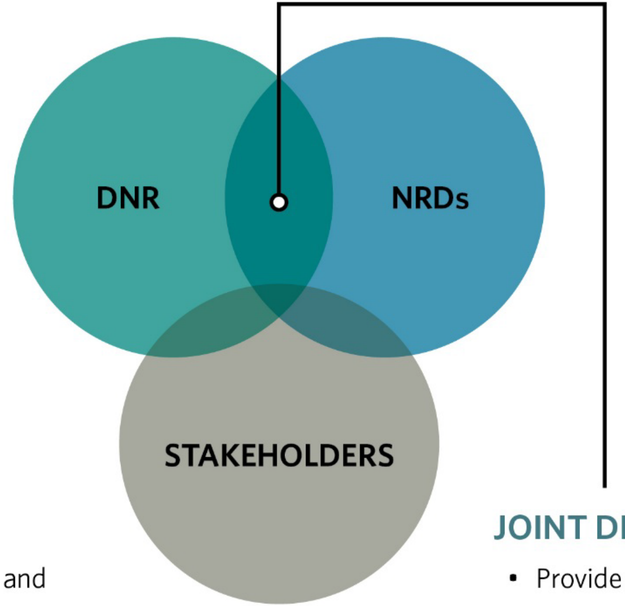
**JOINT DNR/NRD ROLES:**

- Provide a process for stakeholder engagement
- Integrate stakeholder input into the basin-wide plan
- Conduct public hearings on plan prior to adoption
- Provide a means for ongoing public input into the planning process

# NRD IMPS Roles & Responsibilities

## DNR'S INDIVIDUAL ROLES:

- Review, approve, and formally adopt the plan
- Implement and enforce any new **surface water** controls
- Provide reports on new water use and permitting activities to the NRD(s)
- Implement specific **surface water** monitoring or data collection activities outlined in the IMP




## NRD'S INDIVIDUAL ROLES:

- Review, approve, and formally adopt the plan
- Implement and enforce any new **groundwater** controls
- Provide reports on new water use and permitting activities to the DNR
- Implement specific **groundwater** monitoring or data collection activities outlined in the IMP

## STAKEHOLDER ROLES:

- Provide input into the development of goals and objectives of the plan
- Provide input on planning implementation activities
- Work toward consensus on the plan

## JOINT DNR/NRD ROLES:

- Provide a process for stakeholder engagement
- Integrate stakeholder input into the plan
- Conduct public hearings on the IMP prior to adoption
- Provide a means for ongoing public input into the planning process
- Coordinate on plan implementation activities

# ADMINISTRATION

## June meeting recap
## Necessary information to be a successful stakeholder

# IMP DISTINCTION BETWEEN MANAGEMENT AREAS

# Integrated Management Plan (IMP)

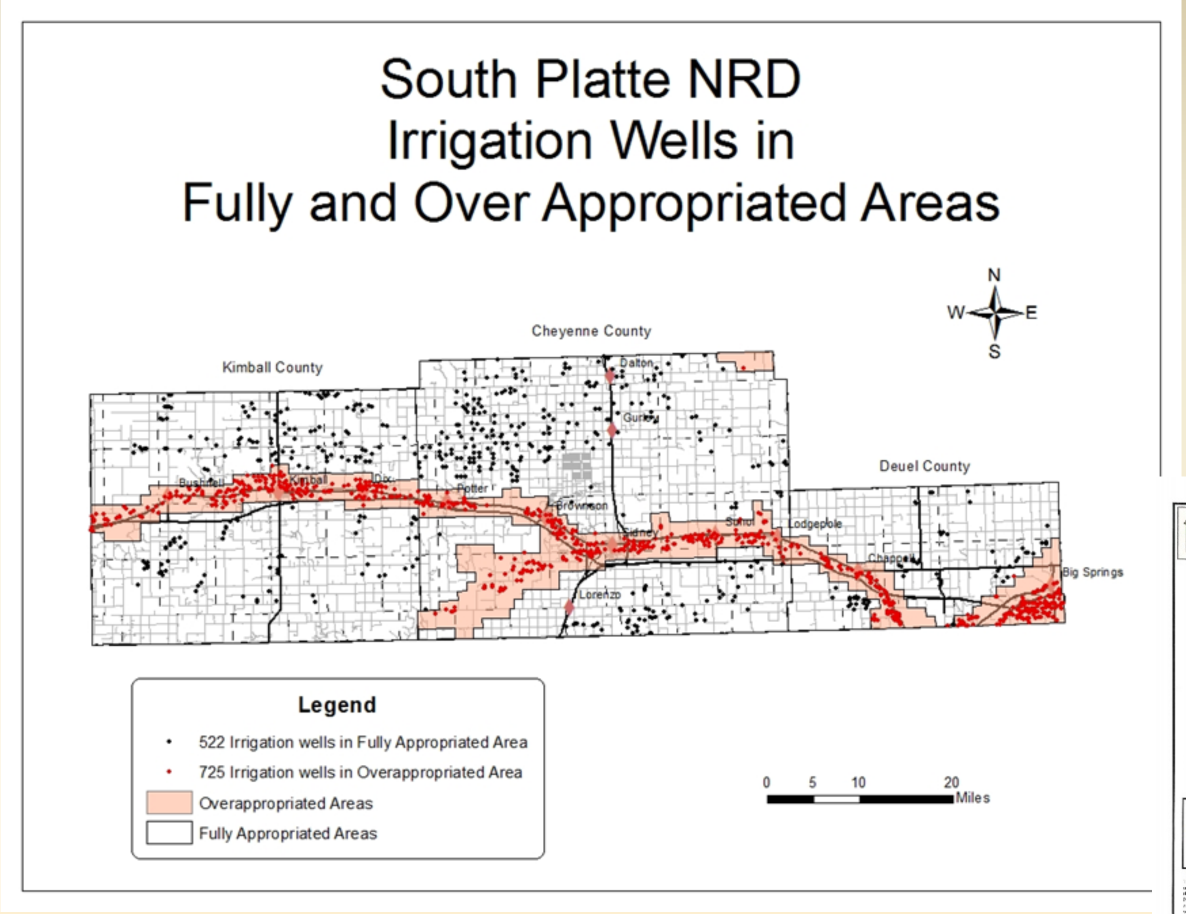
## Distinctions between Fully Appropriated, Overappropriated and Districtwide Ground Water Management Areas

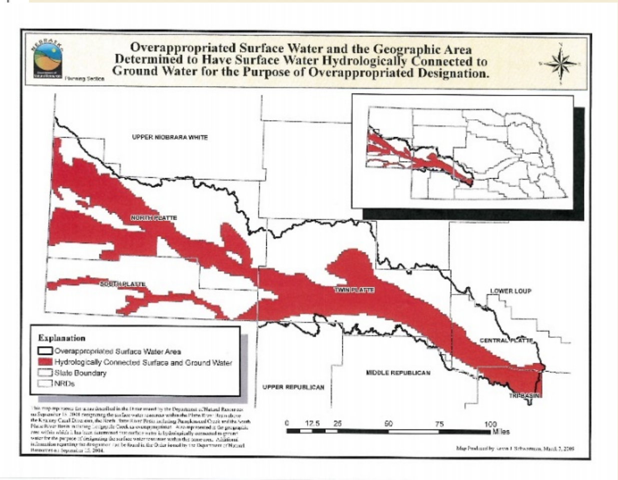
SPNRD IMP Stakeholders Group - 2nd Increment Meeting

August 15, 2018
WNCC - Sidney Campus, Nebraska

# SPNRD Upper Platte River Basin IMP Requirements

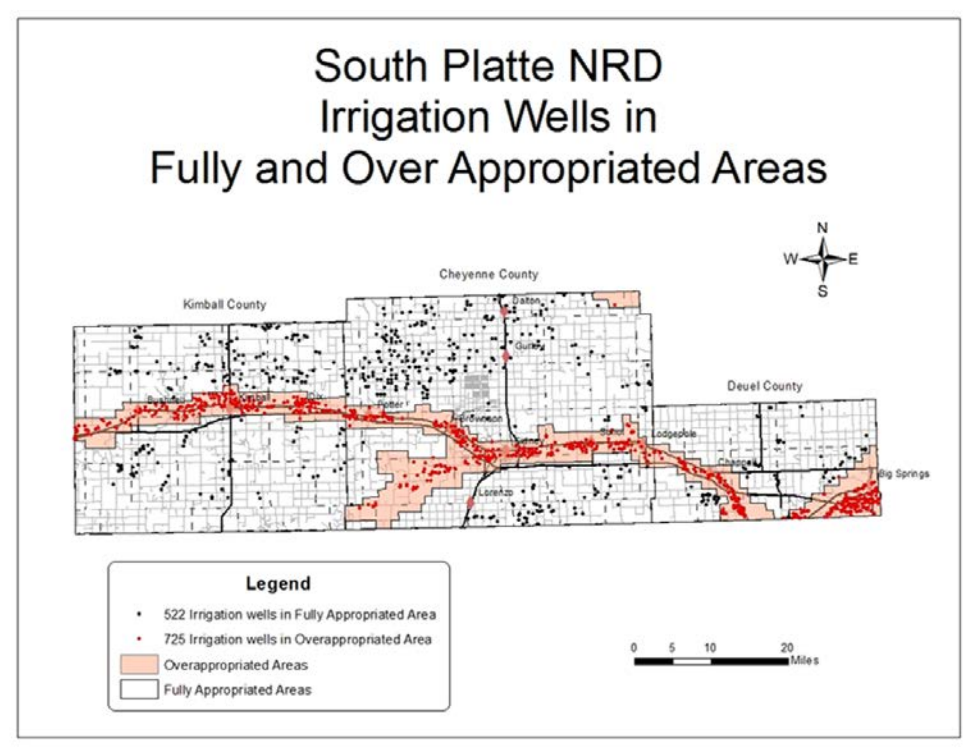
- SPNRD includes both Fully Appropriated and Overappropriated Areas
- Maintains consistency with the Upper Platte River Basin-Wide Plan
- SPNRD IMP streamflow depletion reduction requirements to return to Post 1997 levels of depletions within the first ten (10) year increment:
  - **Lodgepole Creek - 150 Acre-Feet/Year** by 2019
  - **North Platte River - 150 Acre-Feet/Year** by 2019
  - **South Platte River - 400 Acre-Feet/Year** by 2019
  - **Total** offset requirement = **700 Acre-Feet/Year** by 2019
- Our Post-1997 Results are very Positive!


South Platte NRD
Irrigation Wells in
Fully and Over Appropriated Areas
N
W
E
S
Cheyenne County
Kimball County
Deuel County
Dalton
Gurley
Bushnell
Kimball
Dix
Potter
Brownson
Sidney
Sunol
Lodgepole
Chappell
Big Springs
Lorenzo
Legend
522 Irrigation wells in Fully Appropriated Area
725 Irrigation wells in Overappropriated Area
Overappropriated Areas
Fully Appropriated Areas
0 5 10 20
Miles


Overappropriated Surface Water and the Geographic Area
Determined to Have Surface Water Hydrologically Connected to
Ground Water for the Purpose of Overappropriated Designation.
Planning Section
UPPER NIOBRARA WHITE
NORTH PLATTE
SOUTH PLATTE
TWIN PLATTE
LOWER LOUP
CENTRAL PLATTE
MIDDLE REPUBLICAN
UPPER REPUBLICAN
TRI-BASIN
Explanation
Overappropriated Surface Water Area
Hydrologically Connected Surface and Ground Water
State Boundary
NRDs
0 12.5 25 50 75 100
Miles

# *Number of Irrigated Acres in Overappropriated and Fully Appropriated Areas

1. Overappropriated Areas
   a. LPC - 41,580 acres
   b. SPR - 9,950 acres
   c. Total = 51,530 acres
2. Fully Appropriated Areas including the NPR Area
   a. Total = 80,512 acres
3. Districtwide - Total = 132,042 Irrigated Acres




* Source: SPNRD 2017 Water Usage Report, Compiled by Travis Glanz, March 23, 2018

# $1^{st}$ Increment - IMP Implementation Activities

## SPNRD Non-Regulatory Actions

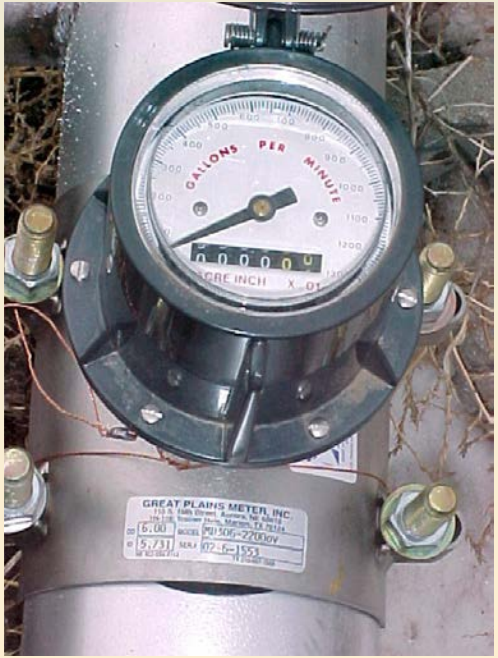
- Western Water Use Management Modeling (WWUMM) and Analyses for Agriculture, Municipal and Commercial/Industrial Water Usage Accounting
- Permanently and Temporarily Retiring/Decertifying Irrigated Acres
- Water Banking and Water Marketing Development Activities
- Oliver Reservoir Streamflow Enhancement Project
- South Platte River Augmentation/Recharge Projects
- Studies and Research
- Advisory Committees
- Information and Education

## SPNRD Regulatory Actions

- Moratorium on Permits for Large Capacity Wells (50 gpm or greater) and on New or Expanded Uses

# Outside the IMP - SPNRD Districtwide Ground Water Management Area Rules and Regulations

- SPNRD Regulatory Actions
  - Certification of Irrigated Acres
  - Installation of Flow Meters on all Irrigation Wells/Systems
  - Incorporated Allocations, Transfers and Pooling Procedures



# Path Forward

- Discussion concerning 2nd Increment IMP Goals, Objectives and Controls. Will need to be consistent with Basin-Wide Plan Goals.
- Provide and discuss updated estimates of Post-1997 depletion targets (Robust Review Results)
  - What are the SPNRD's options to meet its obligations?
    - Should the options be the same or different among LPC, SPR and NPR Areas?
      - Maintain Post-1997 depletion levels and add additional amounts
      - Maintain Post-1997 depletion levels and include drought mitigation plan and/or conjunctive management plan components
      - Maintain Post-1997 depletion levels and include compensation for lost hydropower generation
    - Should the LPC, SPR and NPR Areas have different controls
- Incrementally achieve and sustain a fully appropriated condition

# ROBUST REVIEW RESULTS

South Platte Natural Resources District

Nebraska Dept. of Natural Resources

# 2ND INCREMENT TOPICS

## Municipal Statute – 2026 Offsets
## Conjunctive Management

# 2ND INCREMENT TOPICS

## MUNICIPAL STATUTE – 2026

## OFFSETS

# PROPOSED MUNICIPAL / INDUSTRIAL CHANGES - FOR 2ND INCREMENT IMP

- 2 Parts to IMP Municipal and Industrial Changes
  - 1st part will cover 2019-2025
  - 2nd part will cover 2026 and after
- 2019-2025 IMP language will be revised to be similar to other Upper Platte Basin NRDs IMP language
  - The current language in the SPNRD IMP is very detailed and can be greatly simplified
  - Even though the language will be simplified, the reporting and tracking of municipal/industrial usage will not change
  - The simplified language could provide more flexible opportunities for offsetting water consumed over the municipal or industrial baseline

# PROPOSED MUNICIPAL/INDUSTRIAL CHANGES FOR 2ND INCREMENT IMP

- Summary of current statute language
  - Neb. Stat. § 46-740 states that an IMP, rule, or order cannot limit the use of groundwater by a municipality or non-municipal commercial/industrial use within a designated fully or over appropriated area until January 1, 2026.
  - Prior to 2026 the NRD was responsible for offsetting any new or expanded consumptive use up to 25 million gallons/year

# CHANGE #1

- Accounting Year
  - Currently:  August 1st to July 31st
  - 2026:  January 1st to December 31st
    - May be able to change sooner

- Reason:
  - Easier time frame to track
  - Matches irrigation season
    - Making transfers and offsets easier

# CHANGE #2

- Municipal Baselines Updated
  - Currently:  Single highest use year (pumped minus discharge) from 2001-2006 based on the August 1 – July 31 timeframe
  - 2026:  Single highest use year (pumped minus discharge) from 2021-2025 plus 10% based on calendar year timeframe
- Reasons:
  - Original baselines were sometimes determined with estimated data.  Now more accurate data exists.
  - Reflects changes that have occurred since the original baselines were set.  Examples:  increase/decrease in population; wastewater treatment plant (discharge) has been changed to full retention lagoons
  - Time frame is easier to manage

# CHANGE #3

- Industrial Baselines Updated
  - Currently:  Single highest use year (pumped minus discharge) from 2001-2006 based on the August 1 – July 31 timeframe.  Had to have pumping in all 5 years to qualify for a baseline.
  - 2026:  Single highest use year (pumped minus discharge) from 2002-2025 based on calendar year and also a long term average annual use will be calculates to determine the baseline
- Reasons:
  - The SPNRD has a variety of industries.  Some are traditional industries that have pumping each year, others are more closely related to the oil or sand/gravel industries and pumping is more sporadic.  By evaluating a longer timeframe we will not be punishing industries that are not currently using water, and we can also account for the more traditional industries that are experiencing growth or decline in water use.

# CHANGE #4

- Any new Municipality or Industry that does not have an established baseline as of 2026 will be responsible for offsetting all new water use.
  - Currently:  NRD is responsible for providing up to 25 million gallons offset for offsetting new consumptive uses.
  - 2026:  Municipal or Industrial user will be responsible for offsetting all new consumptive uses.
- Reasons:
  - Several existing industrial wells and a few municipal wells do not have a baseline established currently, if those wells become active in the future they will need to obtain their own offsets.

# CHANGE #5

- Offsets for new or expanded Municipal or Commercial/Industrial growth with an existing baseline
  - Currently: NRD is responsible for offsetting new or expanded consumptive water use if the baseline is exceeded up to 25 million gallons per year.  Municipality or Industry is responsible for offsetting new or expanded consumptive water use if the baseline is exceeded by greater than 25 million gallons per year.
    - Example: Baseline is 10 million gallons; user pumps between 10 million and 35 million gallons the NRD has to offset; user pumps greater than 35 million gallons they have to offset.
  - 2026:  Municipality or Industry is responsible for offsetting any new or expanded water use over the baseline. Will have to have an approved NRD offset in place within one year of the overage.
    - Example: Baseline is 10 million gallons; user pumps any amount over 10 million gallons they have to offset
- Reasons:
  - Fairness between all users.  Irrigators are responsible for all offsets if their allocation is exceeded, now it will be the same for municipalities and industries.

# CHANGE #6

- If a Municipality grows into irrigated acres then the reduced amount of consumptive use will accrue to the NRD's water bank to be used in whole or in part to offset future increased consumptive use of the municipality, or be used by the District to reach a fully appropriated status.
    - Current:  same as above except the last part… "or be used by the District to reach a fully appropriated status".
- Reason:
    - Municipalities have grown into irrigated acres but have not expanded in population or commercial/industrial growth, so the NRD is proposing to use those acres to reach a fully appropriated status rather than have them sitting in a water bank.

# CHANGE #7

- Reporting and Tracking of Municipal Water Use

- No real change will occur, but the language is just simplified from how it exists in the current plan.

- Reason:
  - Just makes the reporting of municipal water use easier for everyone to understand.
  - Helps clean up confusion about high capacity wells owned by a municipality that are used for things like irrigating golf courses/cemeteries, or industrial wells owned by a municipality that are not pumped into their potable water systems.

# SUMMARY OF MAJOR CHANGES

- Accounting time frame changes to calendar year
- Most baselines will be changing
- All Municipalities and Industries will be handled the same without regard to the NNDP 28%/40-year area.
- NRD will not be responsible for offsetting uses over the updated baseline amount.  User will have to have a plan in place to offset all uses over the baseline within one calendar year.
- Municipal baselines have no mention of per capita use, permanent population, or governmental uses.
- Remove the requirement for municipal water conservation plans after 2026.

# 2ND INCREMENT TOPICS

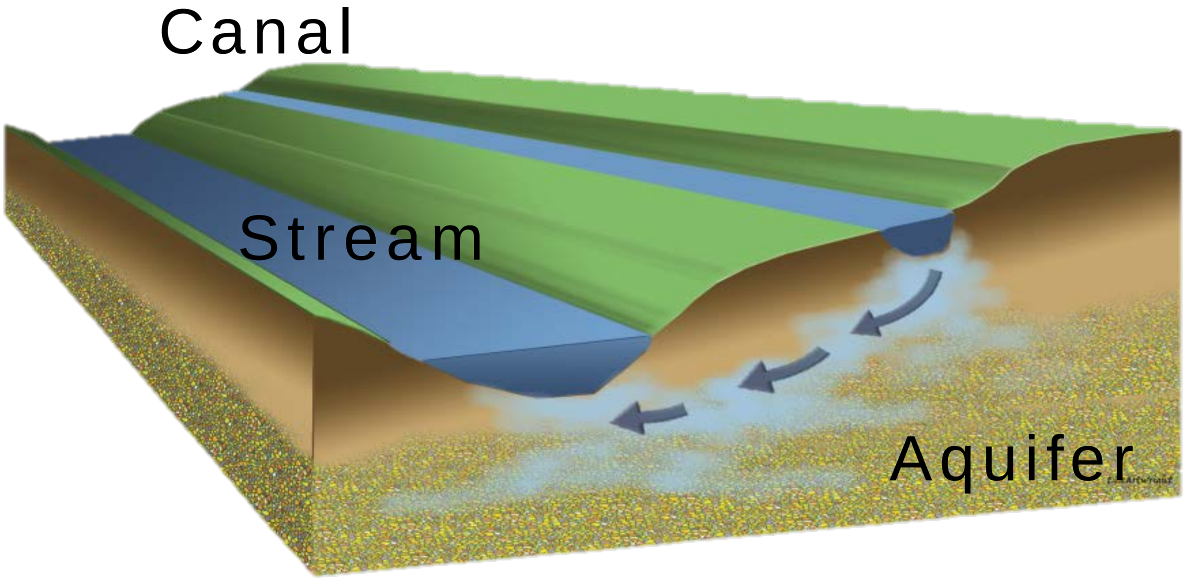
# CONJUNCTIVE MANAGEMENT

IN THE UPPER PLATTE RIVER BASIN

# UNDERLYING CONCEPTS OF CONJUNCTIVE WATER MANAGEMENT

(CWM)

- Surface and groundwater resources are interconnected
- Decisions to improve the management of one cannot be made properly without considering the other



Conjunctive Water Management is an *adaptive process* that utilizes the *connection* between surface water and groundwater to *maximize water use*, while *minimizing impacts* to streamflow and groundwater levels in an effort to increase the overall water supply of a region and improve the reliability of that supply.

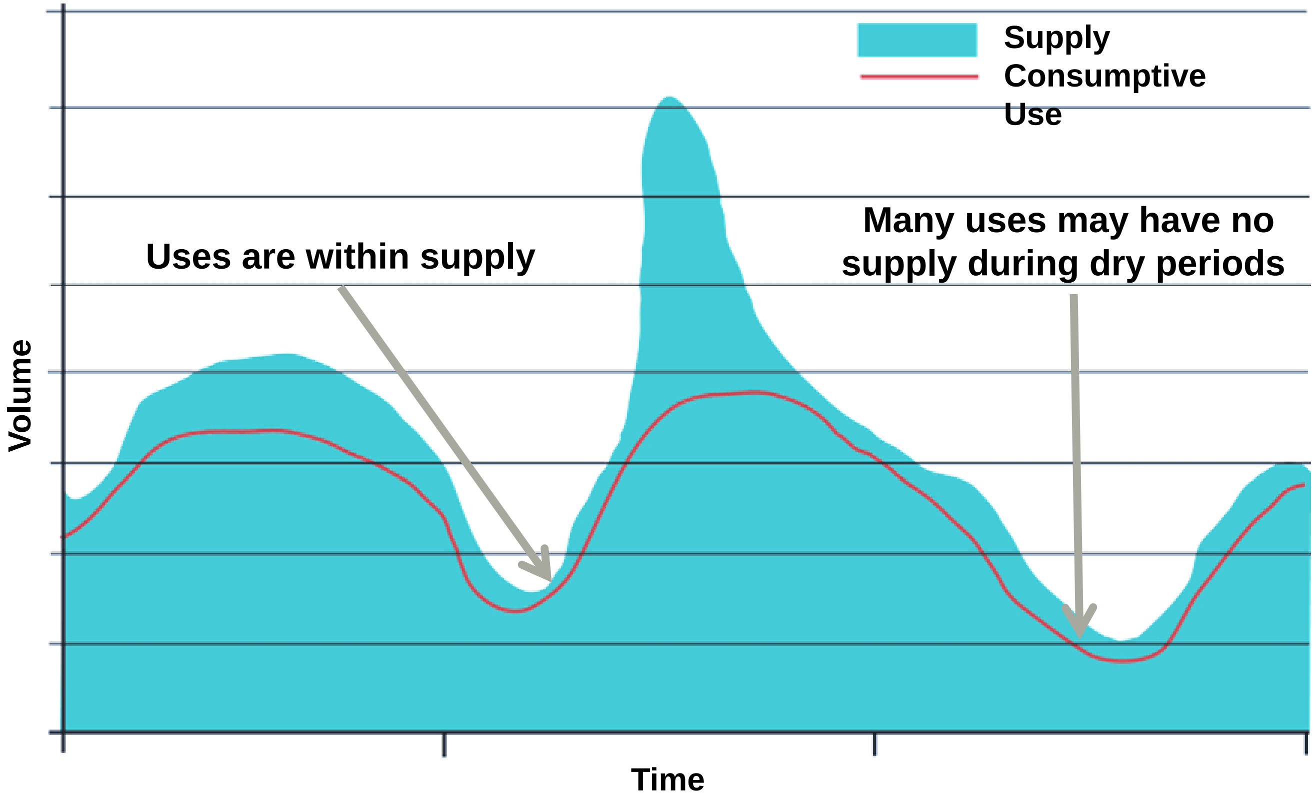
# HOW IS CWM ACCOMPLISHED?

- Typically, by:
  - Using or storing additional surface water when it is plentiful
  - Relying more heavily on groundwater during dry periods

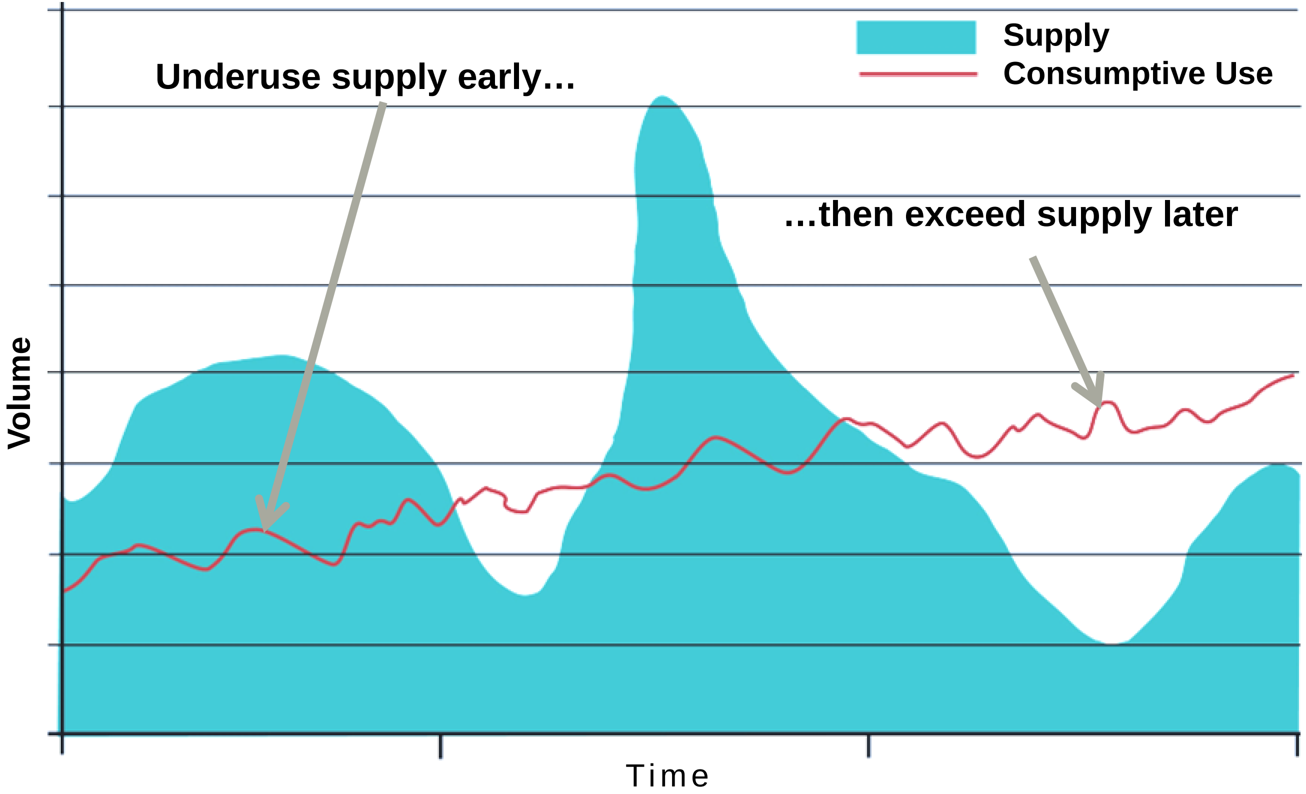
- Can change the timing and location of water for more efficient use

# SCENARIO 1:

## USING SURFACE WATER ONLY

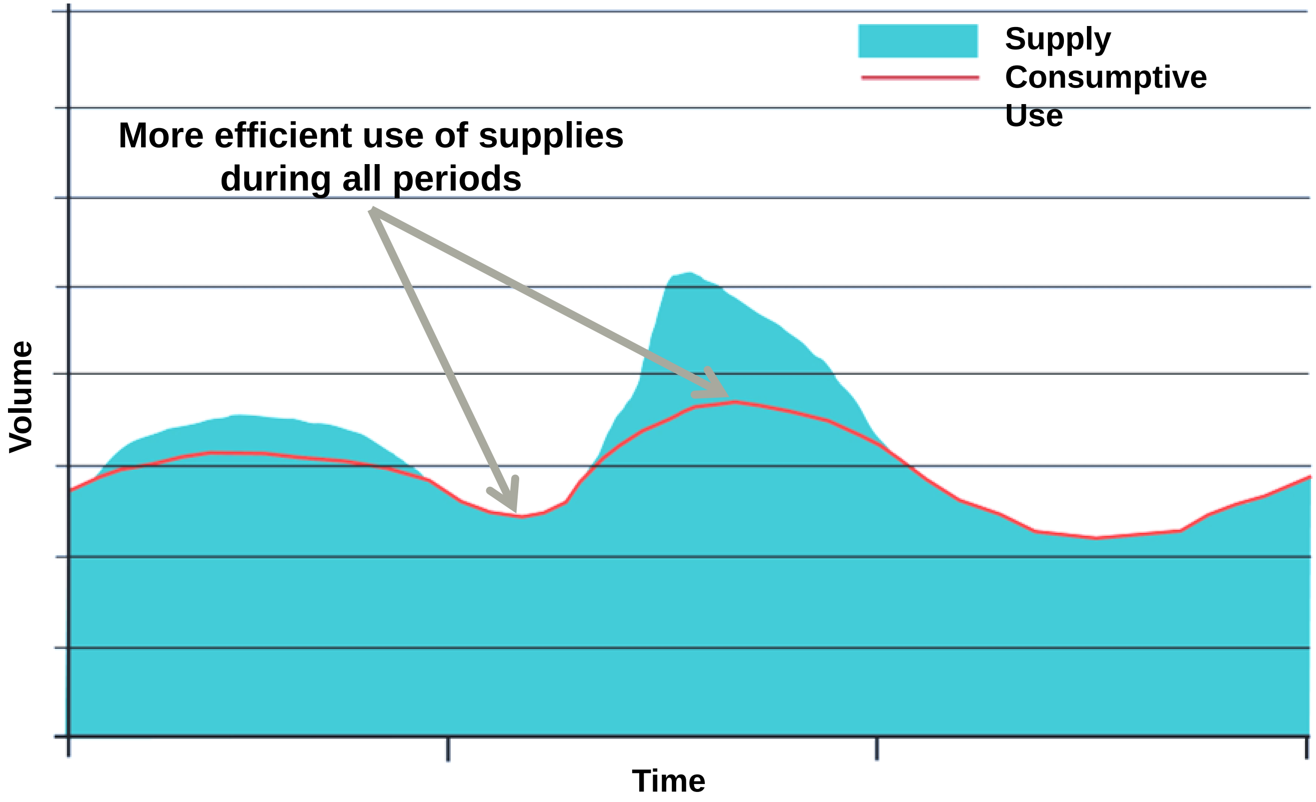


# SCENARIO 2:
## USING GROUNDWATER ONLY



# SCENARIO 3:

## MANAGING SUPPLIES THROUGH CWM

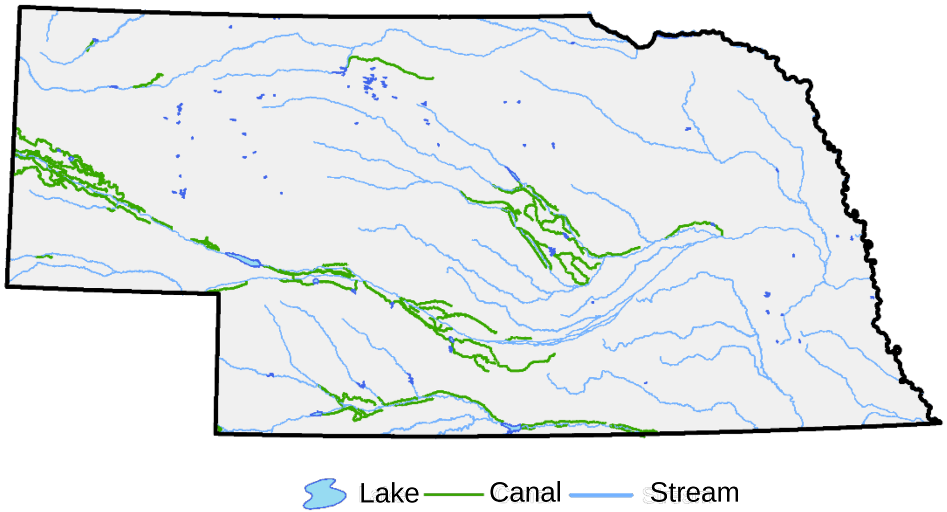


# COMPONENTS OF CWM

- Surface water diversion and groundwater pumping
- Aquifer recharge
- Management of the timing of return flows
- Program for monitoring and evaluation

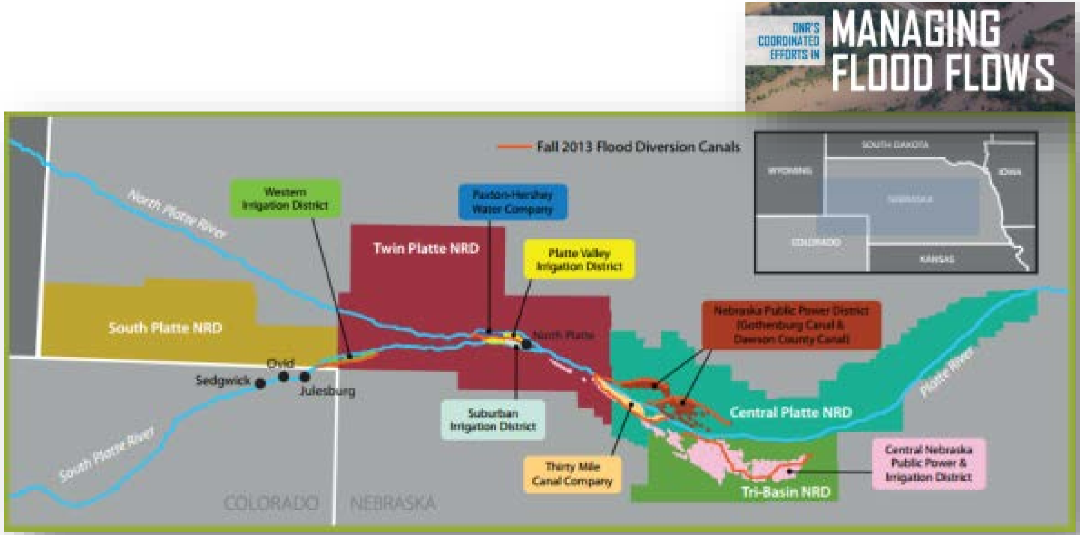
# BENEFITS OF CWM

- Maximize available water supplies
- Leverage existing infrastructure
- Use existing planning framework
- Minimize the need for regulatory actions
- Customize to local opportunities or needs
- Maintain viability of existing uses



# EXAMPLES OF CWM PROJECTS

- Augmentation projects such as N-CORPE
- Western canal conjunctive management study
- Water leasing arrangements
- CPNRD transfers and canal refurbishment
- Capturing excess flows using existing canal infrastructure (in partnership with irrigation districts)



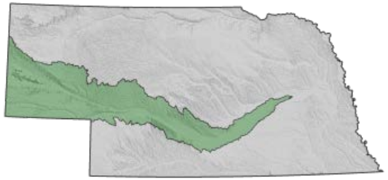
# APPLYING CONJUNCTIVE MANAGEMENT

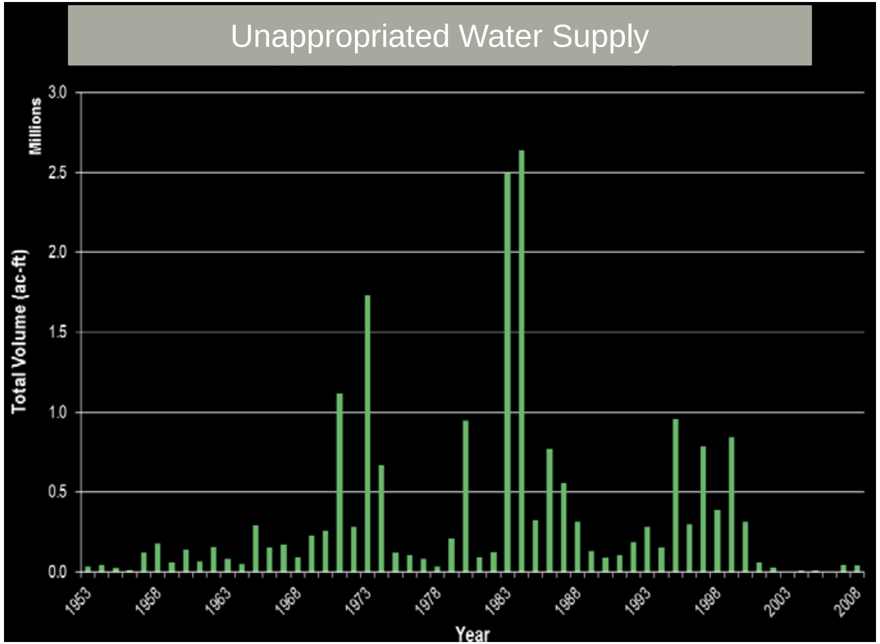
## IN THE UPPER PLATTE RIVER BASIN

First Increment CWM Activities

# UPPER PLATTE RIVER WATER SUPPLIES

- Receives average of 1 million ac-ft from snowmelt in Wyoming each year (North Platte Decree)
- More variable inflows in South Platte from Colorado
- Water is generally fully allocated, particularly above Elm Creek (overappropriated)
- Streamflows required to be shared under Endangered Species Act (Federal)
- Unappropriated water does occur during some very wet years, during shorter intervals, and outside of the irrigation season





# 2011 PILOT PROJECT

- High flows in spring prior to irrigation season
- NeDNR coordinated with NRDs, Irrigation Districts/Canal Companies to divert excesses
- Acquisition of permits
- Contracts
- Monitor

# 2011 PILOT PROJECT

- 23 Canals and 5 NRDs
  - Diversion Total 142,000 acre-ft
  - Recharge Total 64,000 acre-ft
  - 2011-2019 Returns 15,000 acre-ft
  - SPNRD Diversion Total 5,127 acre-ft
  - SPNRD Recharge Total 2,104 acre-ft

# 2013 FLOOD FLOWS

Friday, September 20, 2013 | Saturday, September 21, 2013

South Platte River Highway 83 Bridge, North Platte, NE

South Platte River Buffalo Bill Road Bridge, North Platte, NE

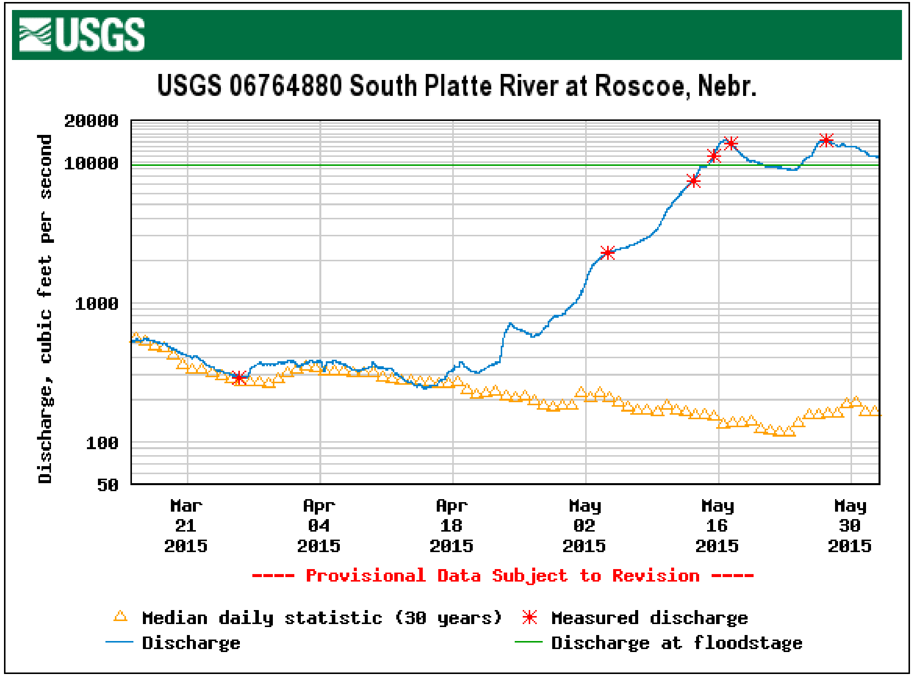
# 2013 FLOOD FLOWS

- 9 Canals and 4 NRDs
  - Diversion Total 44,000 ac-ft
  - Recharge Total 27,000 ac-ft
  - 2011-2019 Returns 5,600 ac-ft
  - SPNRD Diversion Total 1,443 acre-ft
  - SPNRD Recharge Total 516 acre-ft

# 2015 FLOOD FLOWS

- Wet conditions during above average spring snowmelt
- Canals filled early
- Stored excess in lakes, reservoirs

30-Mile Canal Headworks,
June 2015



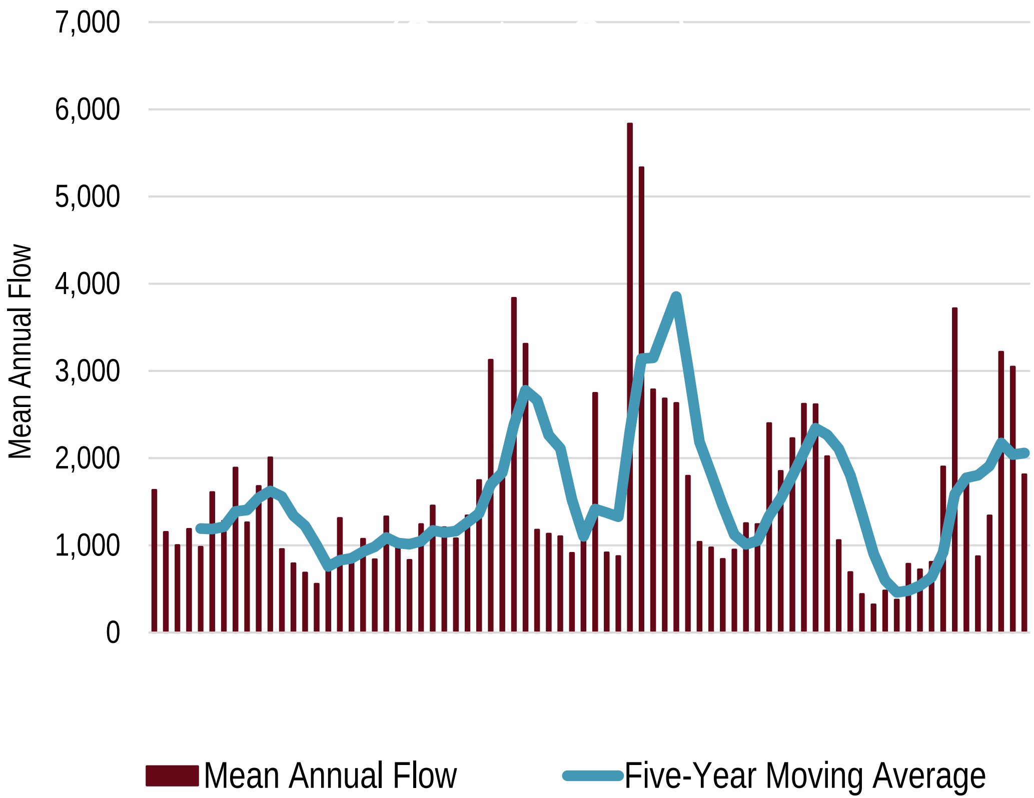
# 2015 FLOOD FLOWS

- 7 Canals and 4 NRDs
  - Diversion Total 17,700 ac-ft
  - Recharge Estimate 7,600 ac-ft
  - SPNRD Diversion Total 2,172 ac-ft
  - SPNRD Recharge Total 673 ac-ft

# SUMMARY OF FLOOD FLOW DIVERSIONS

## First Increment

- Over 200 Kaf of flood flows diverted since 2011
- Resulting recharge in excess of 100 Kaf
- Accretions will benefit Platte River flows for many years into the future
- Process in place for future successes
- Reduces the need for additional regulations
- Creates greater resiliency in future periods



# CWM FUTURE ACTIVITIES

- Expand implementation of CWM projects
- Enhance adaptation strategies based on management goals
- Support continued investment in maintaining and enhancing infrastructure
- Ensure that sound science and monitoring are available to support management decisions

Cozad Canal, Gothenberg, NE

# NEXT STEPS

SOUTH PLATTE
NATURAL RESOURCES DISTRICT

NEBRASKA
DEPT. OF NATURAL RESOURCES

# MEETING DATES

- November 14, 2018
- January 16, 2019

# PUBLIC COMMENT

Thank you

# Robust Review Analysis

## SPNRD Results

SPNRD IMP Stakeholder Meeting #2

August 15, 2018

# Robust Review Goals

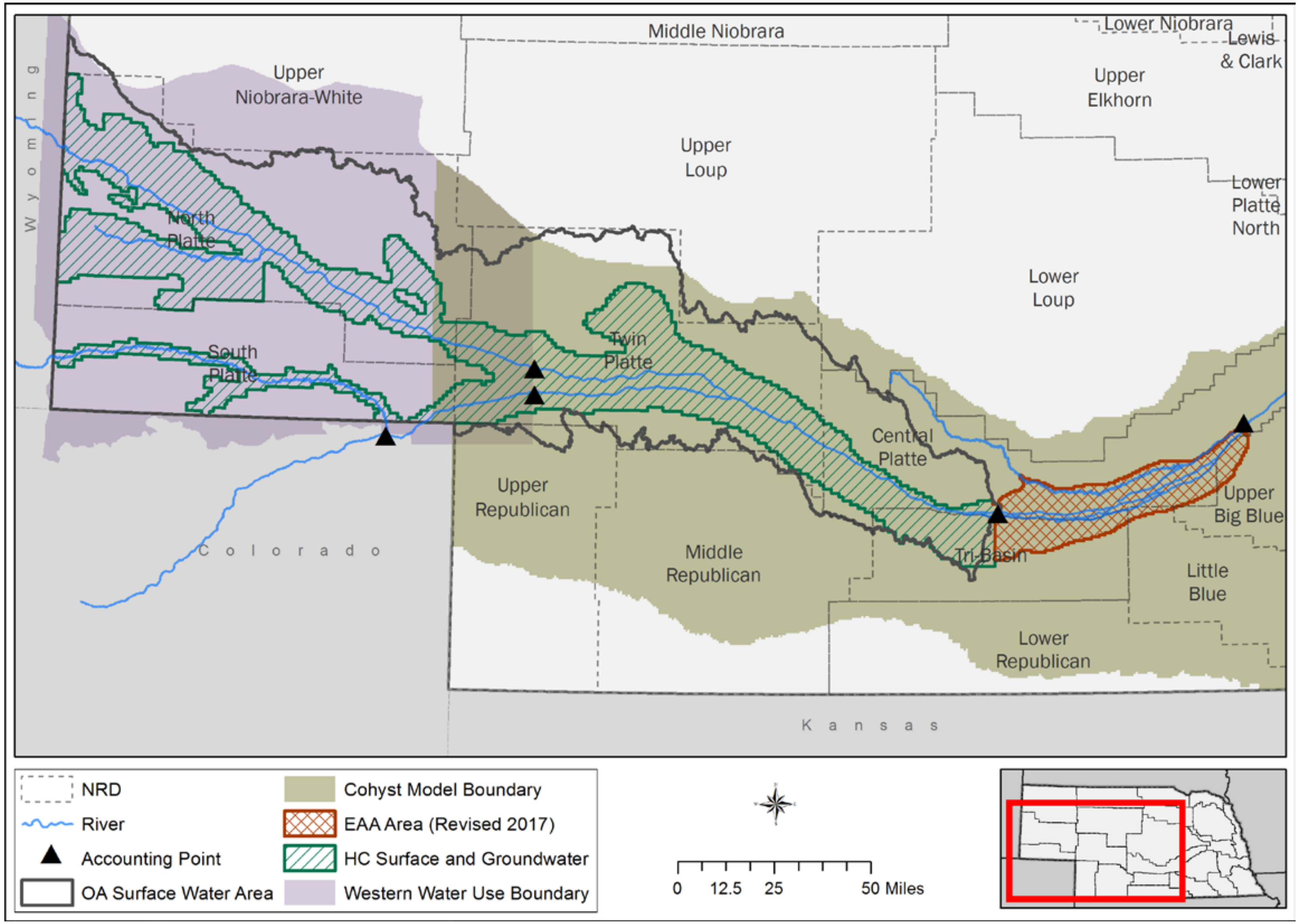
- **Complete monitoring activities outlined in the current IMP**
- **Assess progress on first increment goals and objectives**
- **Provide for more informed discussion of second increment objectives with the SPNRD IMP stakeholders**

# Robust Review Model Simulation Setup

## WWUMM Area Assumptions

- Used historical calibrated version of the groundwater and watershed models (Run 028/LU004/NIR set 2 for GW only lands)
- Model is simulated from 1953 – 2063
- Irrigation pumping repeats 2009-2013 in the baseline simulation and 1997 acres and crop types in the “1997” simulation with 2009-2013 weather repeated into the future
- Municipal and Industrial baseline simulation estimates use through time to 2013 and “1997” simulation is held constant
- Surface water and commingled acres remain constant in the baseline and 1997 simulations to cancel out commingled effects
- Results are summarized for three areas: 1) North Platte River; 2) South Platte River; and 3) Lodgepole Creek

# Model Areas



Middle Niobrara
Lower Niobrara
Lewis & Clark
Upper Niobrara-White
Upper Elkhorn
Upper Loup
Lower Platte North
Wyoming
North Platte
Lower Loup
Twin Platte
South Platte
Central Platte
Upper Republican
Upper Big Blue
Colorado
Middle Republican
Tri-Basin
Little Blue
Lower Republican
Kansas
NRD
River
Accounting Point
OA Surface Water Area
Cohyst Model Boundary
EAA Area (Revised 2017)
HC Surface and Groundwater
Western Water Use Boundary
0
12.5
25
50 Miles

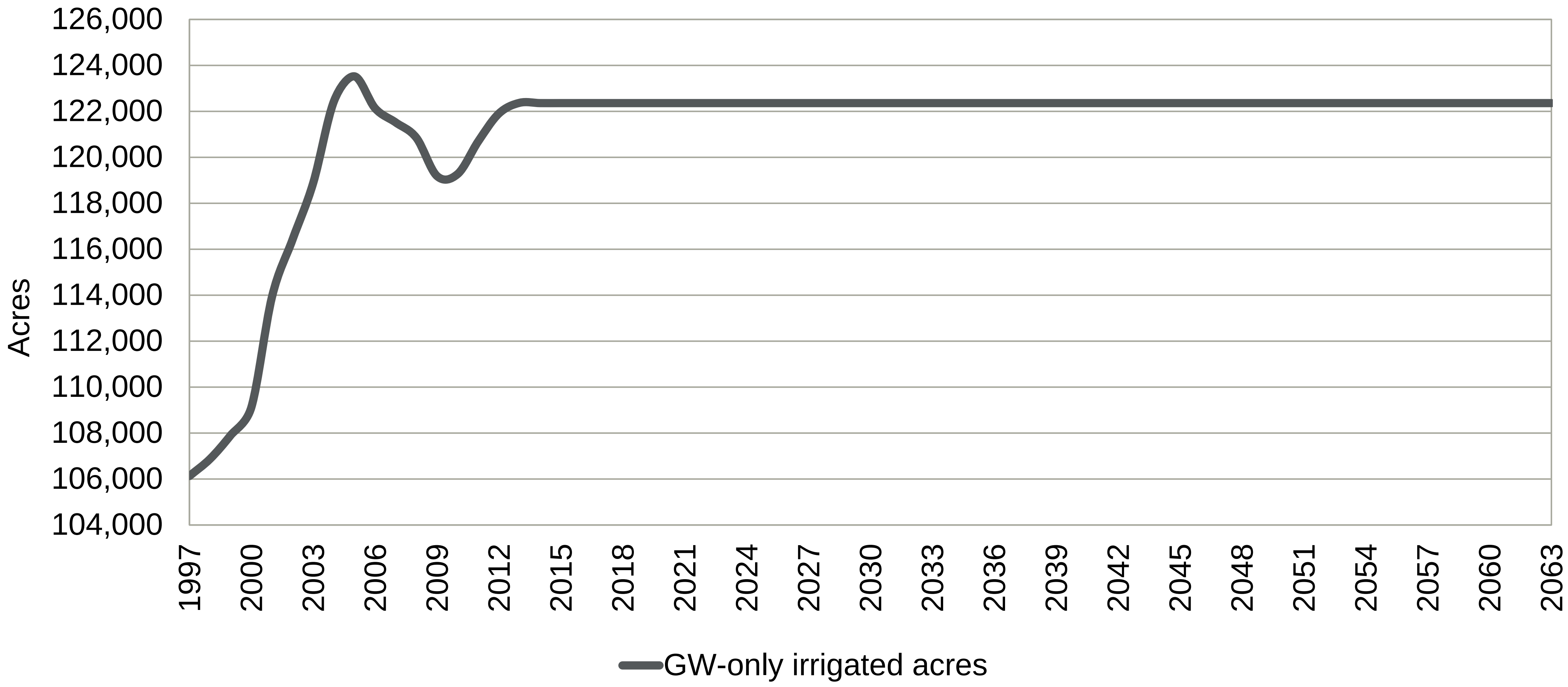
# SPNRD Inputs
## (Change in acres)

Change in groundwater-only irrigated acres 1997-2013

| SPNRD | Total change (1997 to 2013) |
|---|---|
| District-Wide | 16,200 acres |
| OA | -1,200 acres |

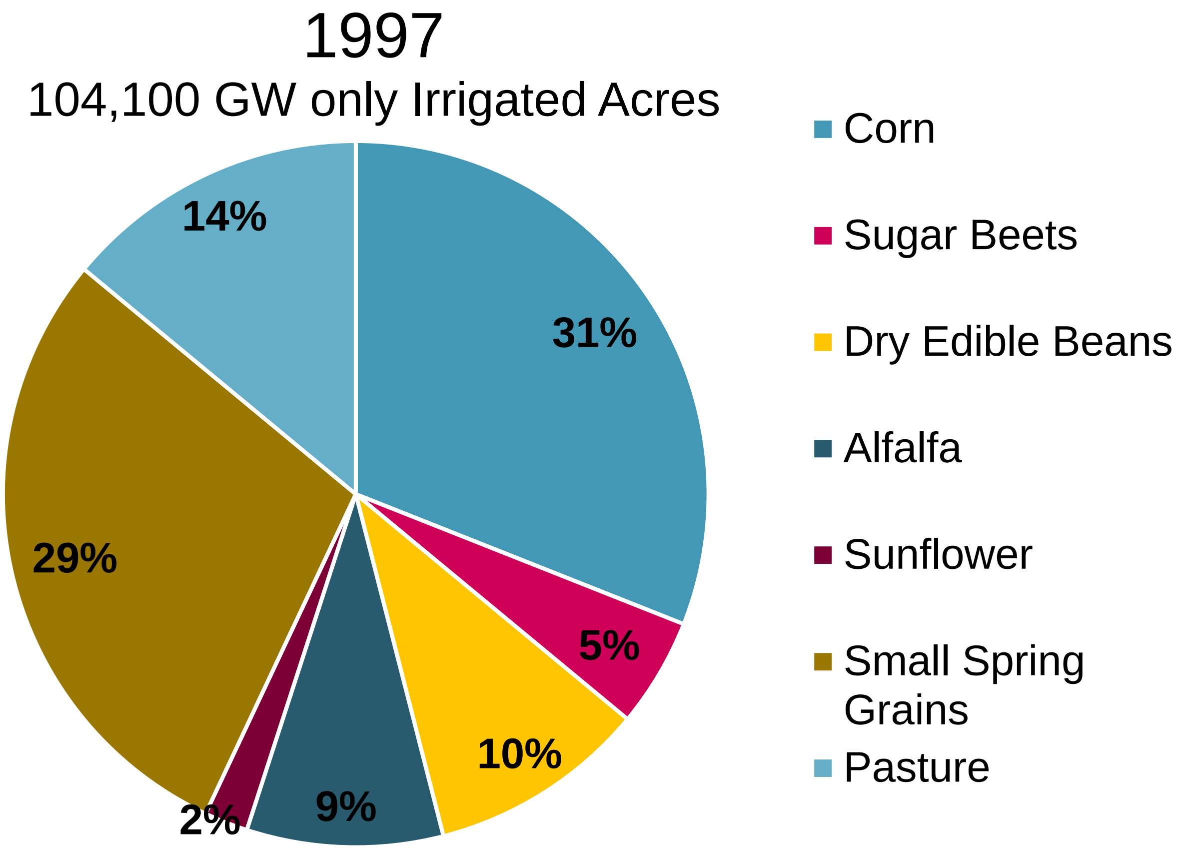
# SPNRD Inputs

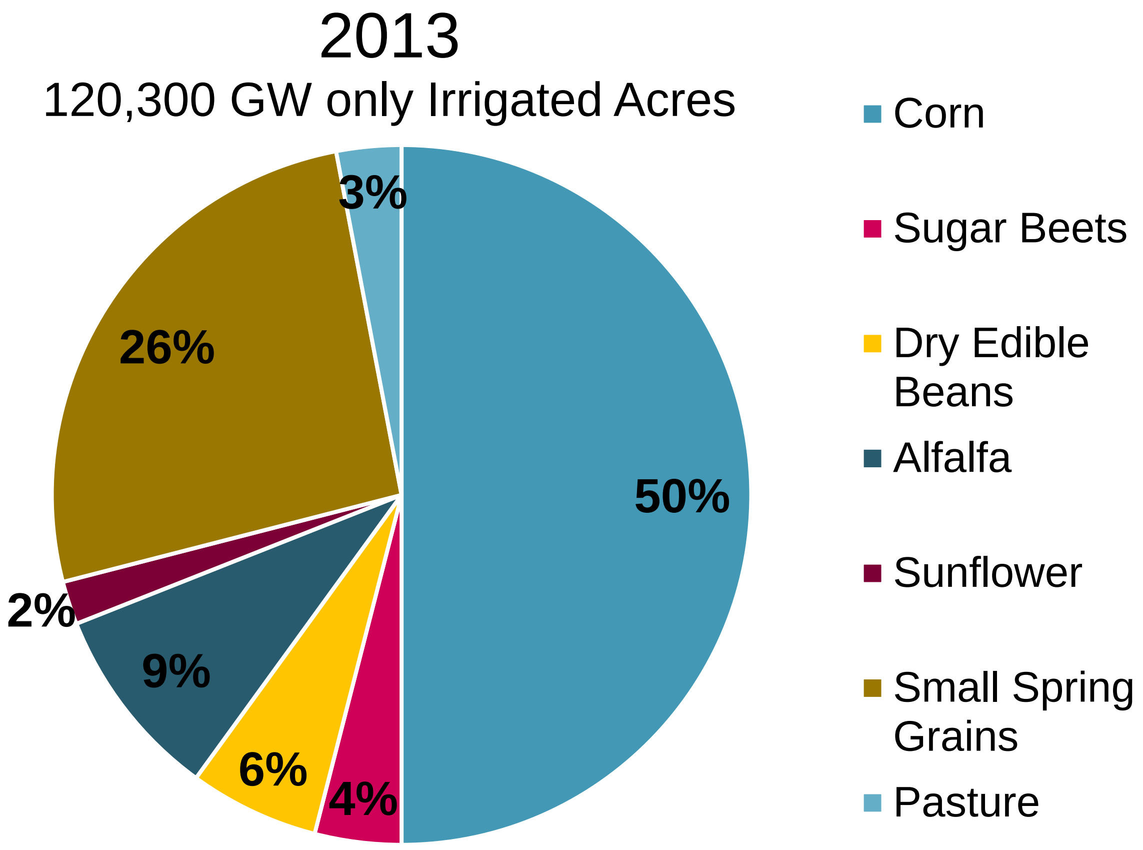
Groundwater-only irrigated acres from 1997, District-wide



# SPNRD Inputs
## (Changes in crop type, District-wide)

Change in groundwater-only irrigated acre crop types 1997-2013

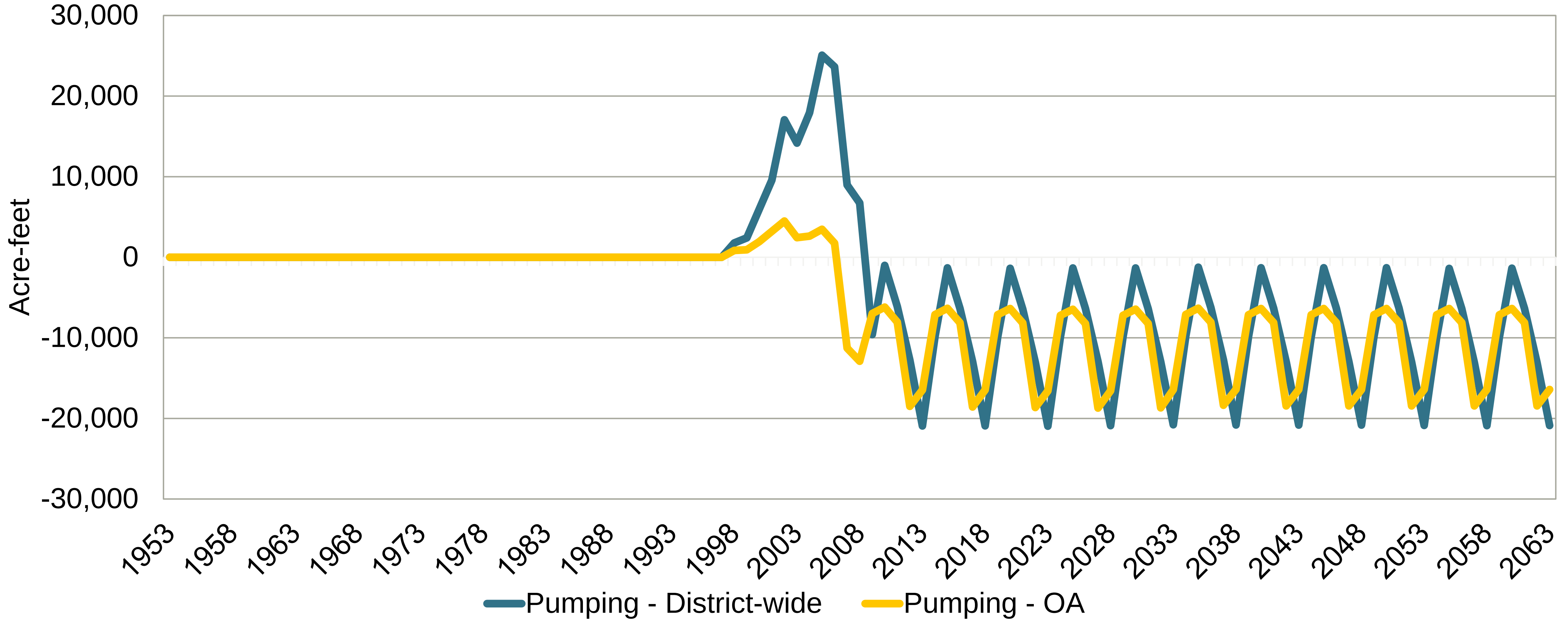


# SPNRD Inputs

## <u>Changes</u> to Post-1997 Pumping, District-Wide and OA

Groundwater-only irrigation pumping AND municipal/industrial pumping

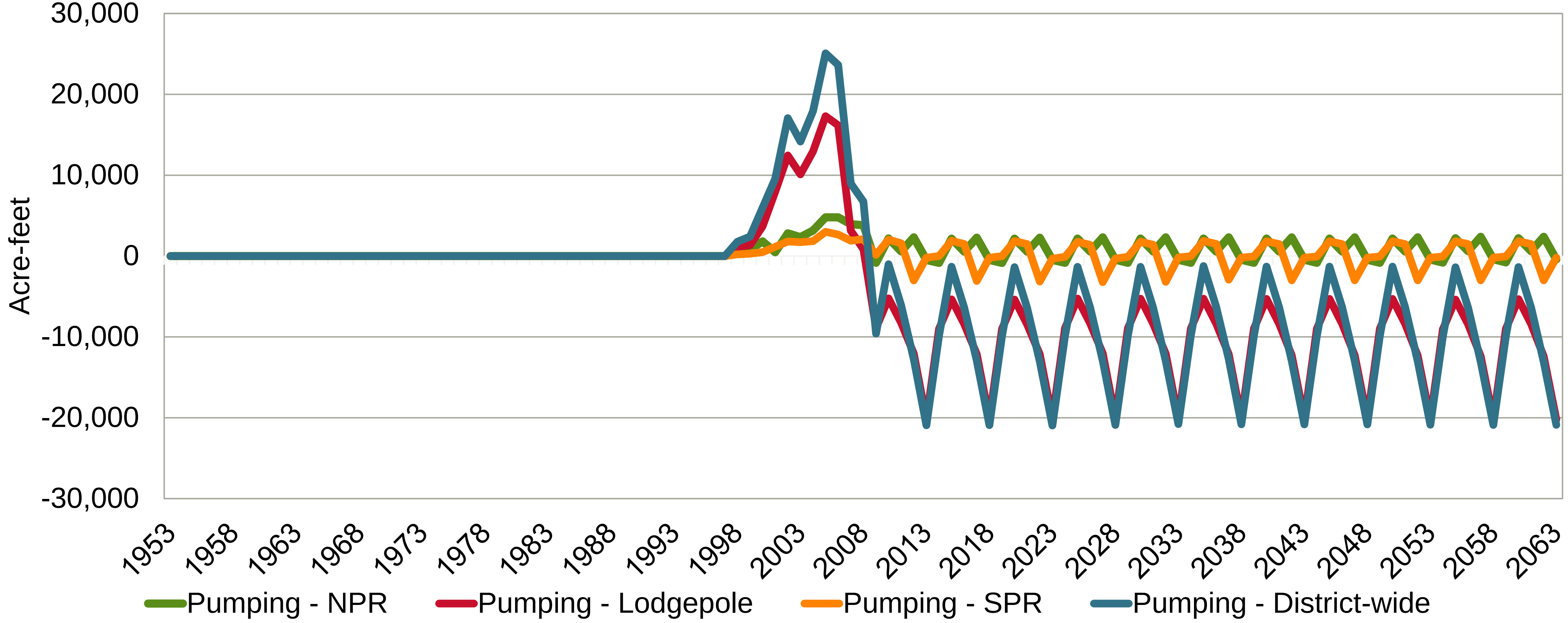


# SPNRD Inputs

**Current Estimates of Industrial and Municipal Pumping**
Industrial average annual volume 2% greater (≈18 AF) compared to 1997.
Municipal average annual volume 3% lower (≈80 AF) compared to 1997
1997 = 1,024 AF industrial 2,967 AF municipal
2013 = 1,136 AF industrial 2,441 AF municipal

## <u>Changes</u> to Post-1997 Pumping, District-Wide

Groundwater-only irrigation pumping (16,200 acres) AND municipal/industrial pumping



# SPNRD Inputs
## (Groundwater Recharge)

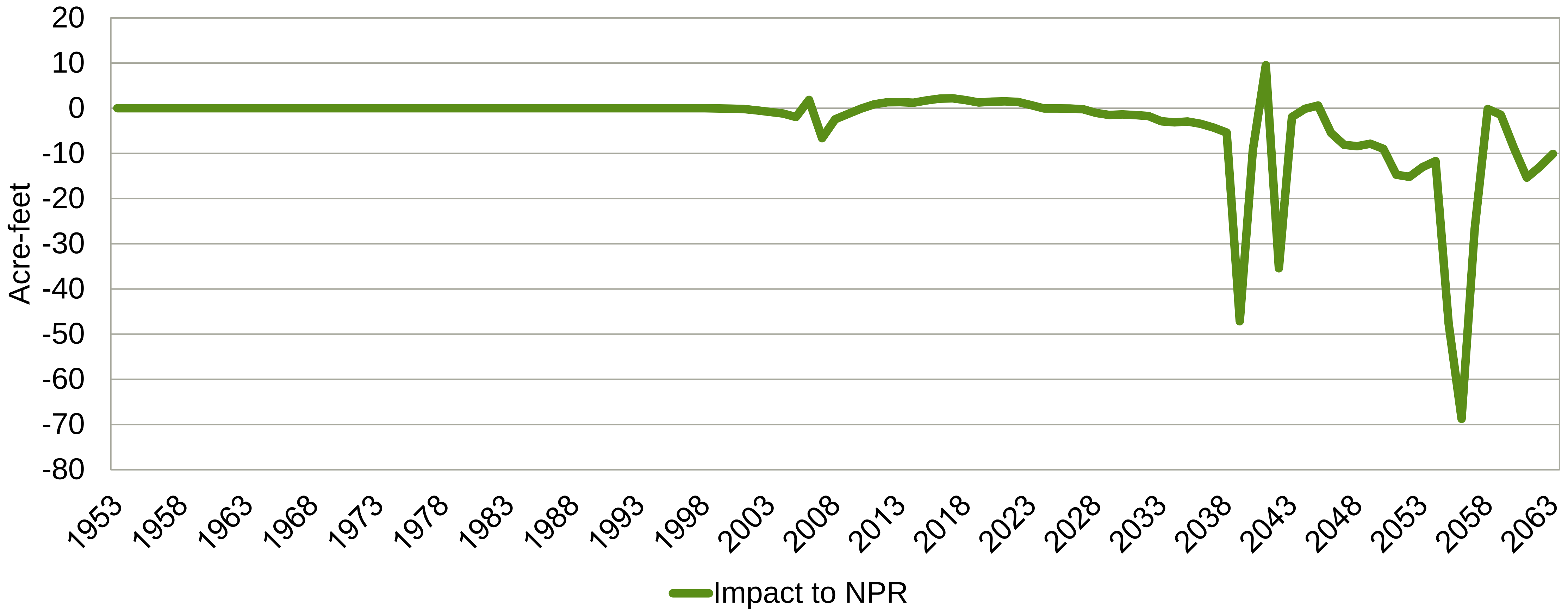
Excess Flows Diverted and Recharged into Western Canal

| SPNRD | Acre-Feet of Excess Flow | |
|---|---|---|
| | Diversion | Recharge |
| **2011** | **5,127** | **2,104** |
| **2013** | **1,443** | **516** |

*This project is shared 30/70 between the SPNRD and TPNRD, this data represents 30% of the diversion and recharge

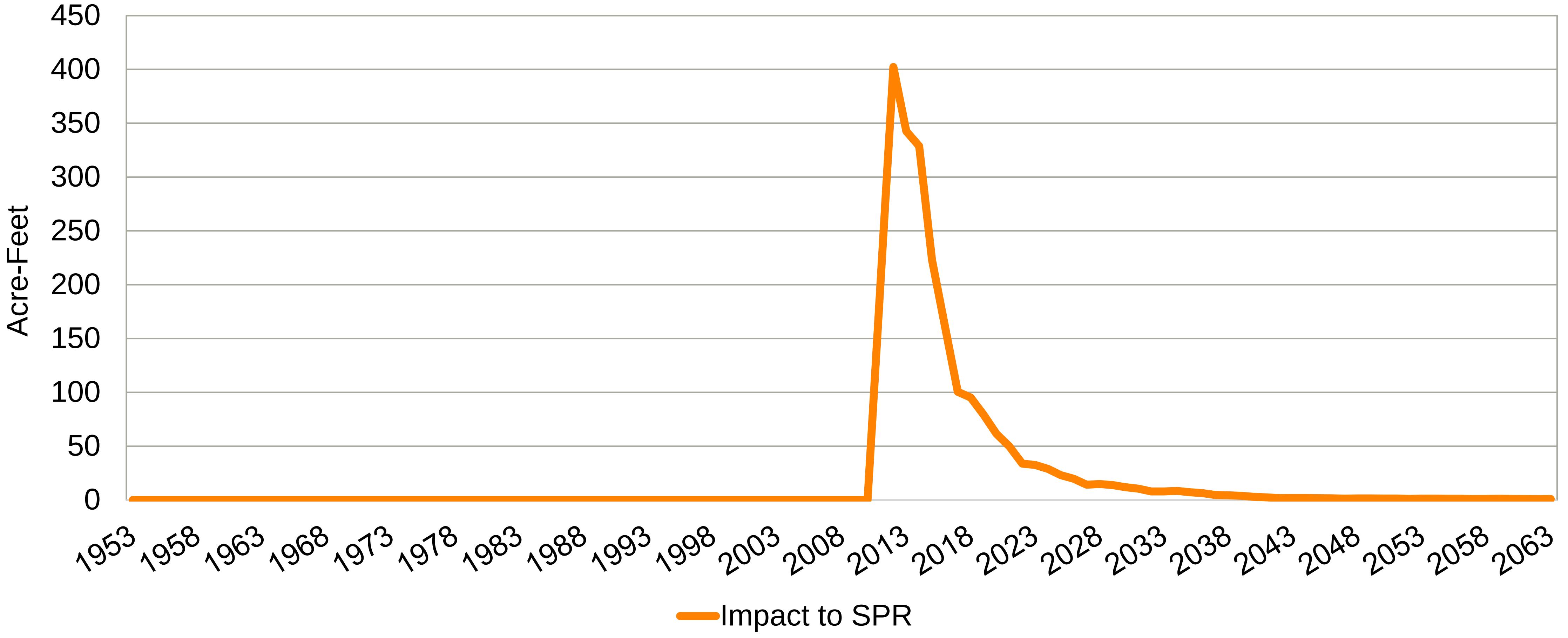
# SPNRD Results

Impact to North Platte River in SPNRD, from the Post-1997 **<u>Changes</u>**



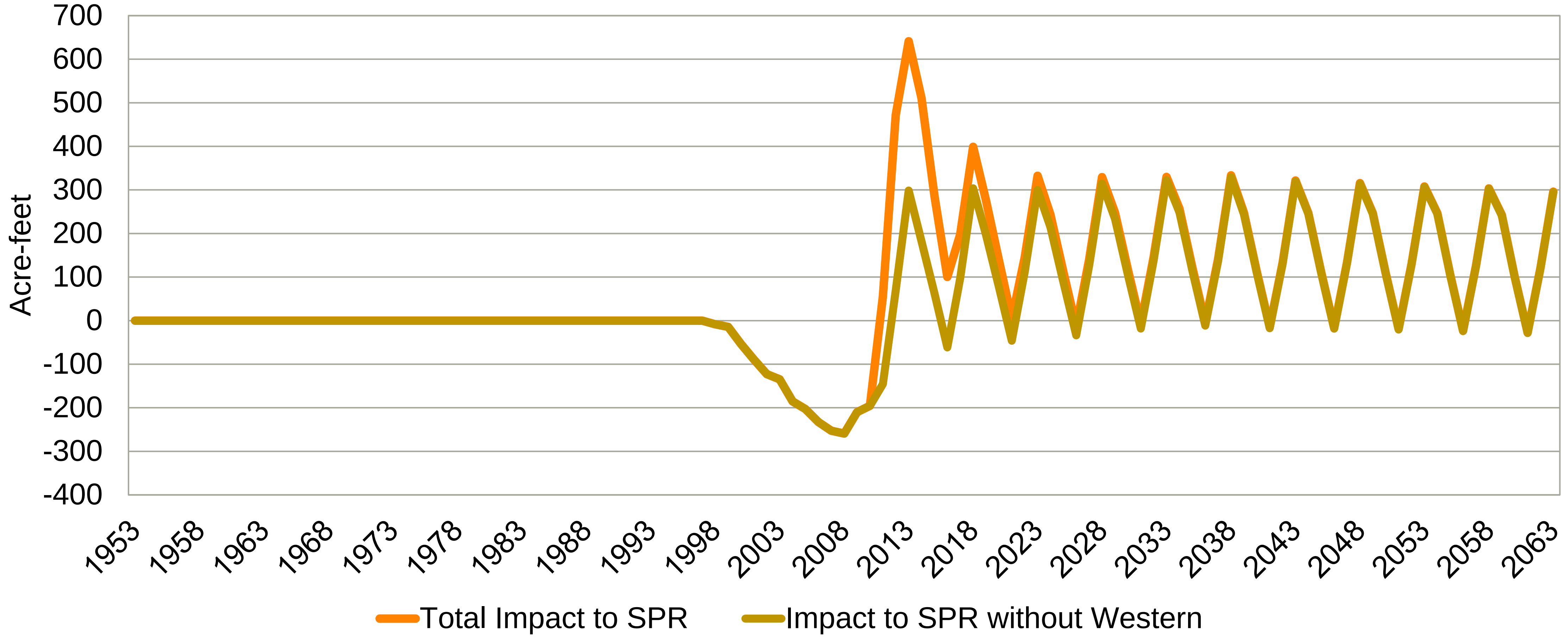
# SPNRD Results

Impact to South Platte River in SPNRD from Western Canal Recharge



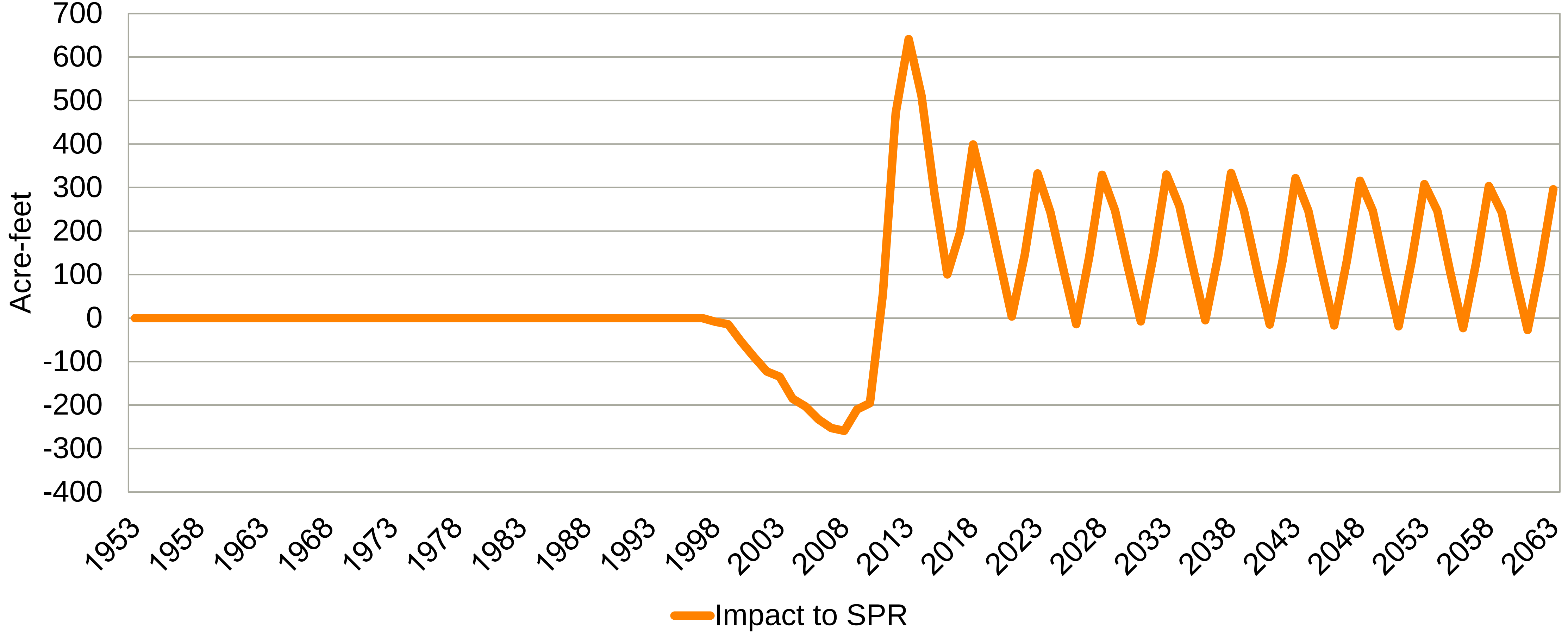
# SPNRD Results

Total Impact from Post-1997 **Changes**, to the South Platte River in SPNRD (with Recharge) Compared to Impact from Pumping Changes



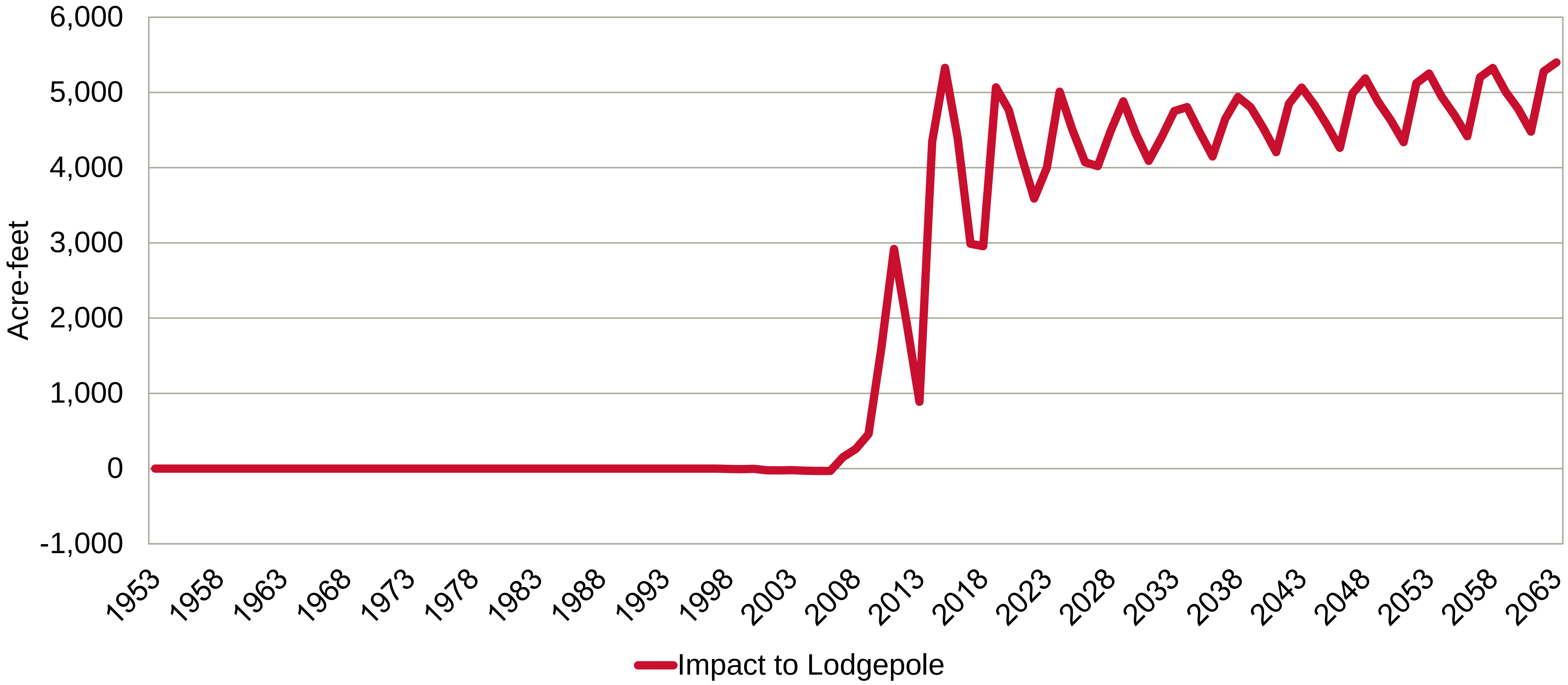
# SPNRD Results

Impact to South Platte River in SPNRD, from Post-1997 **Changes** and Western Canal Recharge Events



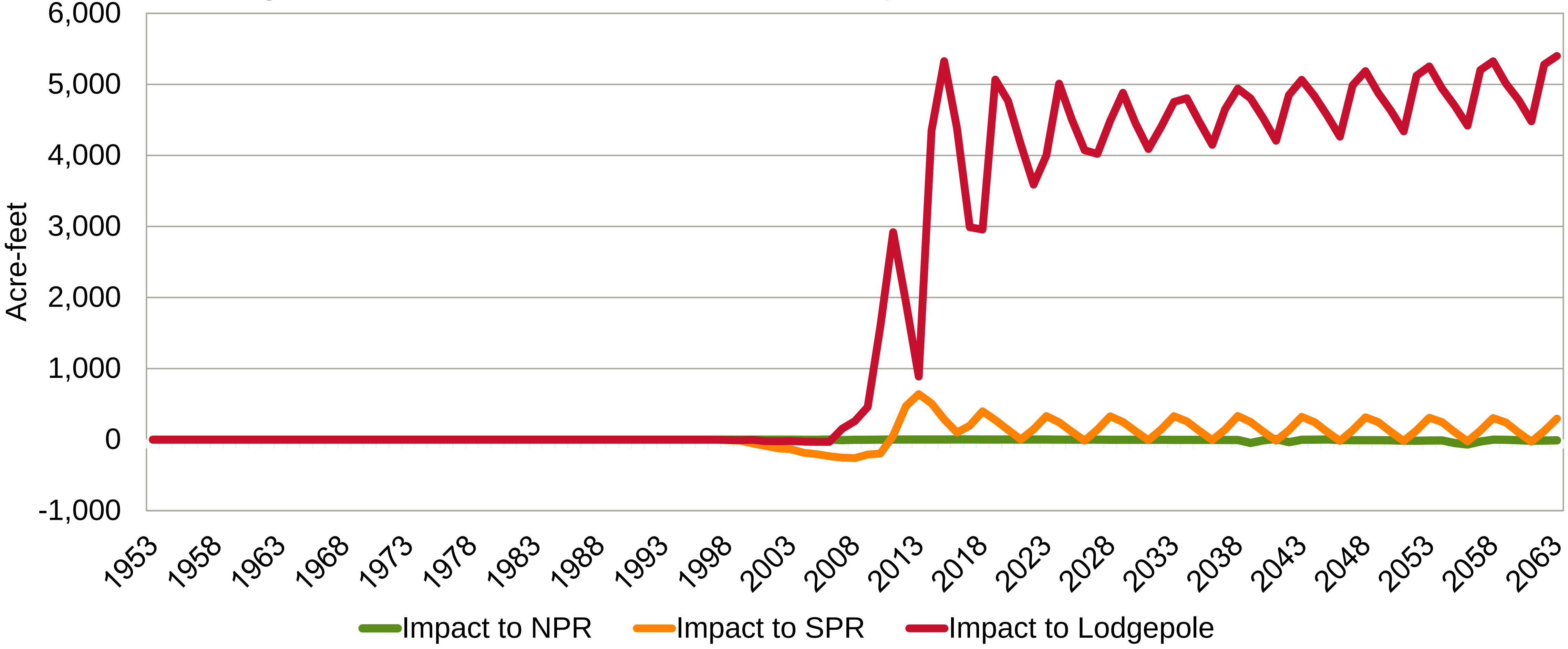
# SPNRD Results

Impact to Lodgepole Creek in SPNRD from Post-1997 **Changes**



# SPNRD Results

Impact to  North Platte River, South Platte River, and Lodgepole Creek in SPNRD from Post-1997 **Changes** and Western Canal Recharge Events



# SPNRD Results

Post-1997 estimates

| | Year | 2019 | 2029 | 50-year |
|---|---|---|---|---|
| North Platte River | Current IMP | -13 | | -150 |
| | Updated Estimate | 0 | 0 | -10 |
| South Platte River | Current IMP | -149.1 | | -400 |
| | Updated Estimate | 280 | 250 | 300 |
| Lodgepole Creek | Current IMP | -63.9 | | -150 |
| | Updated Estimate | 5,070 | 4,880 | 5,400 |

- All values in acre-feet/year

# Robust Review Analysis

Was a requirement of the first increment
Must be maintained in the second increment
Deals with Post-1997 Changes and Management Actions
It is the first step toward reaching a fully appropriated condition

NEBRASKA

DEPT. OF NATURAL RESOURCES

301 Centennial Mall South, 4th Floor

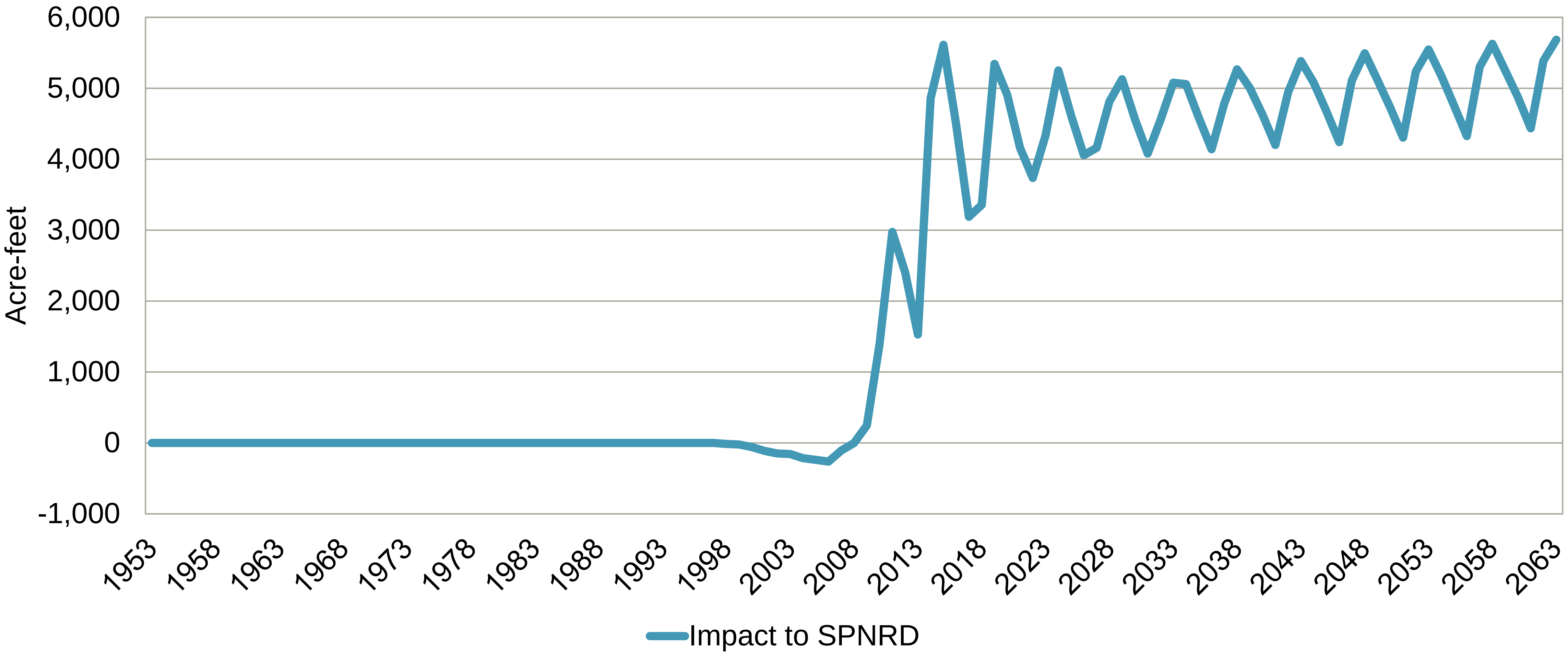
PO Box 94676

Lincoln, NE 68509-4676

402-471-2366

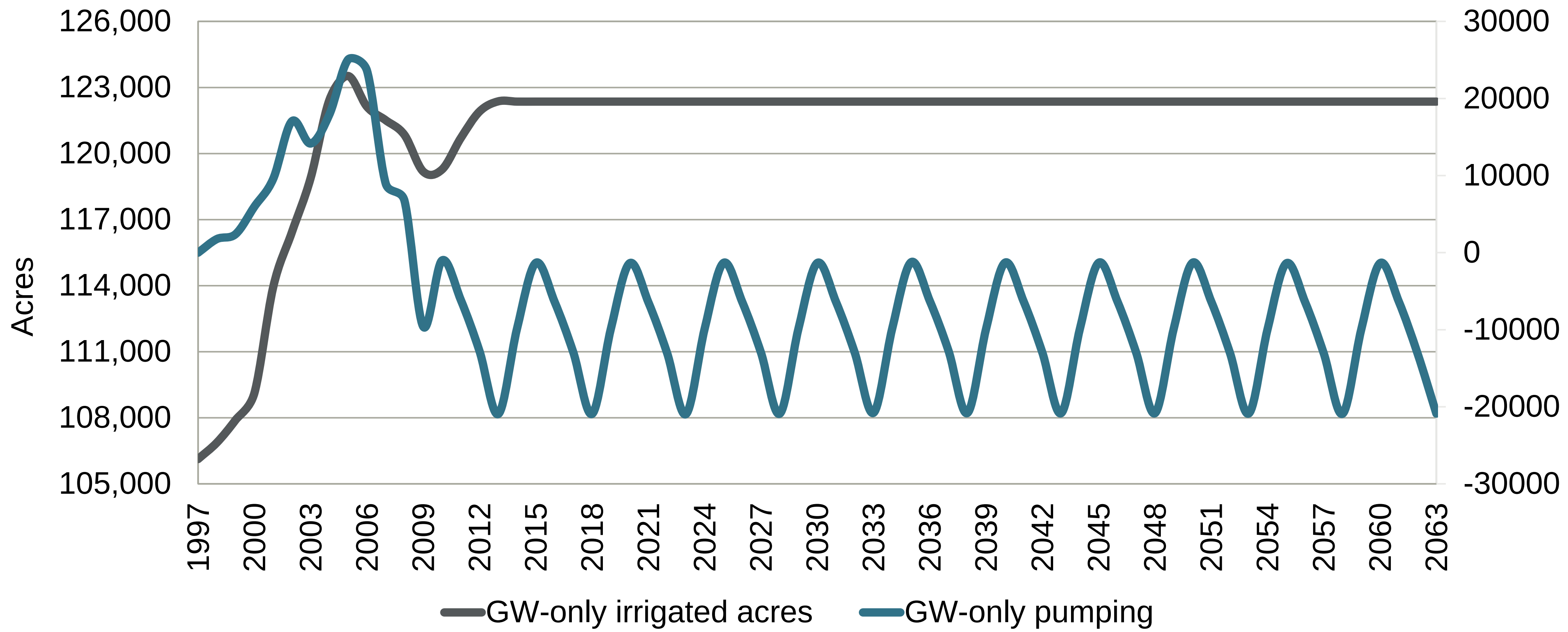
# SPNRD Results

Impact to  SPNRD

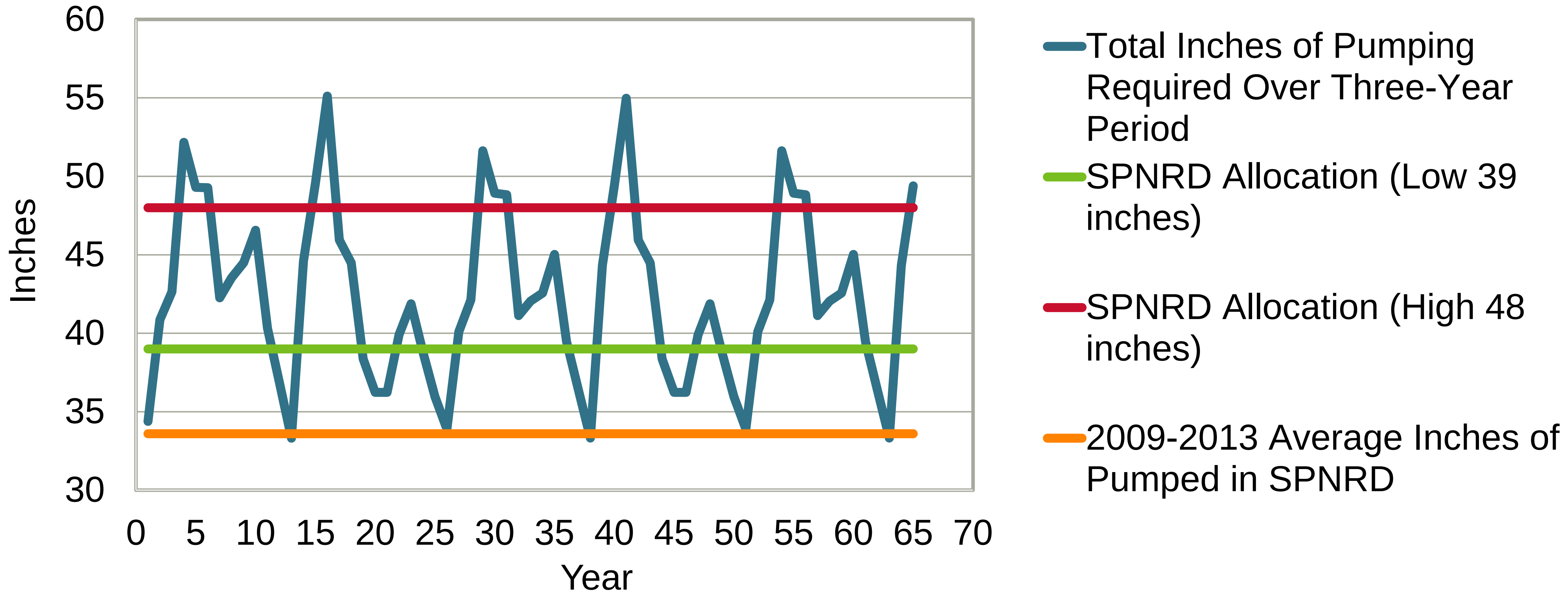


# SPNRD Inputs

Change in groundwater-only irrigated acres and groundwater pumping for groundwater-only irrigated acres, municipal & industrial uses, from 1997, District-wide



# Estimated Inches Necessary to Meet Full Crop Demand



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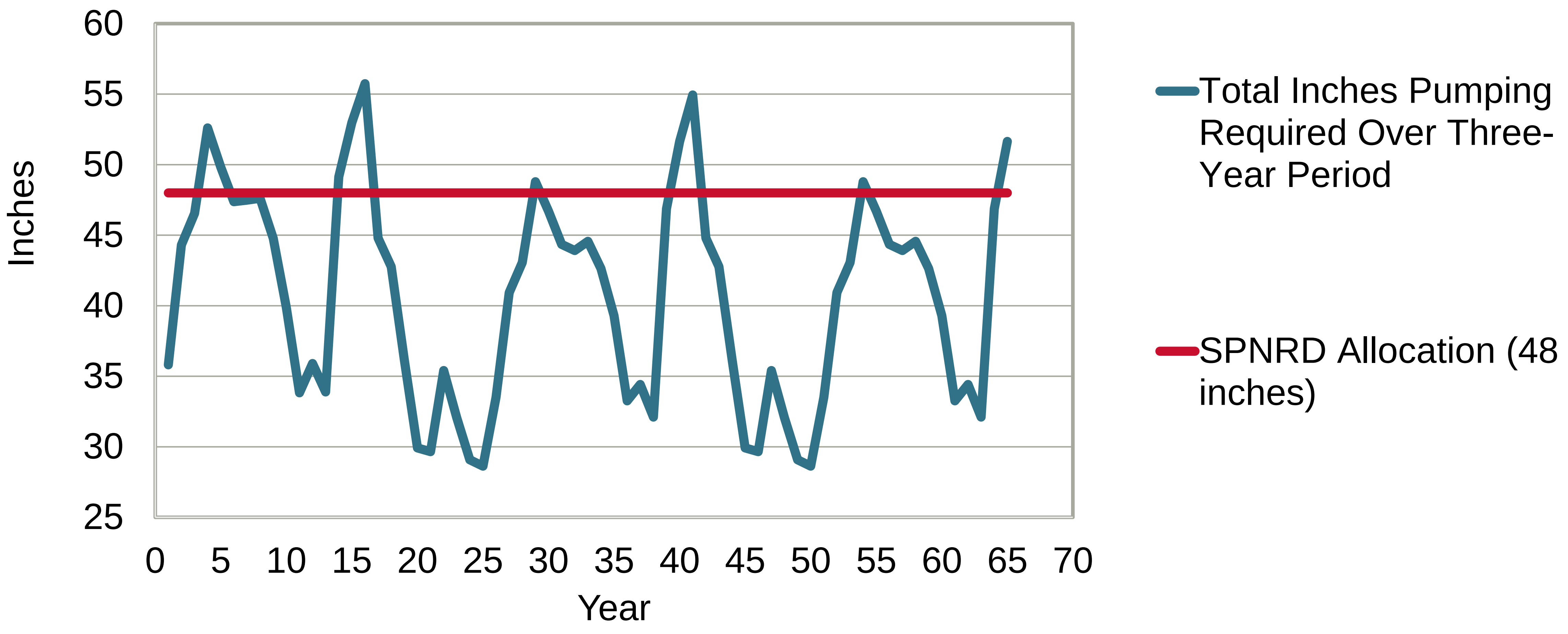
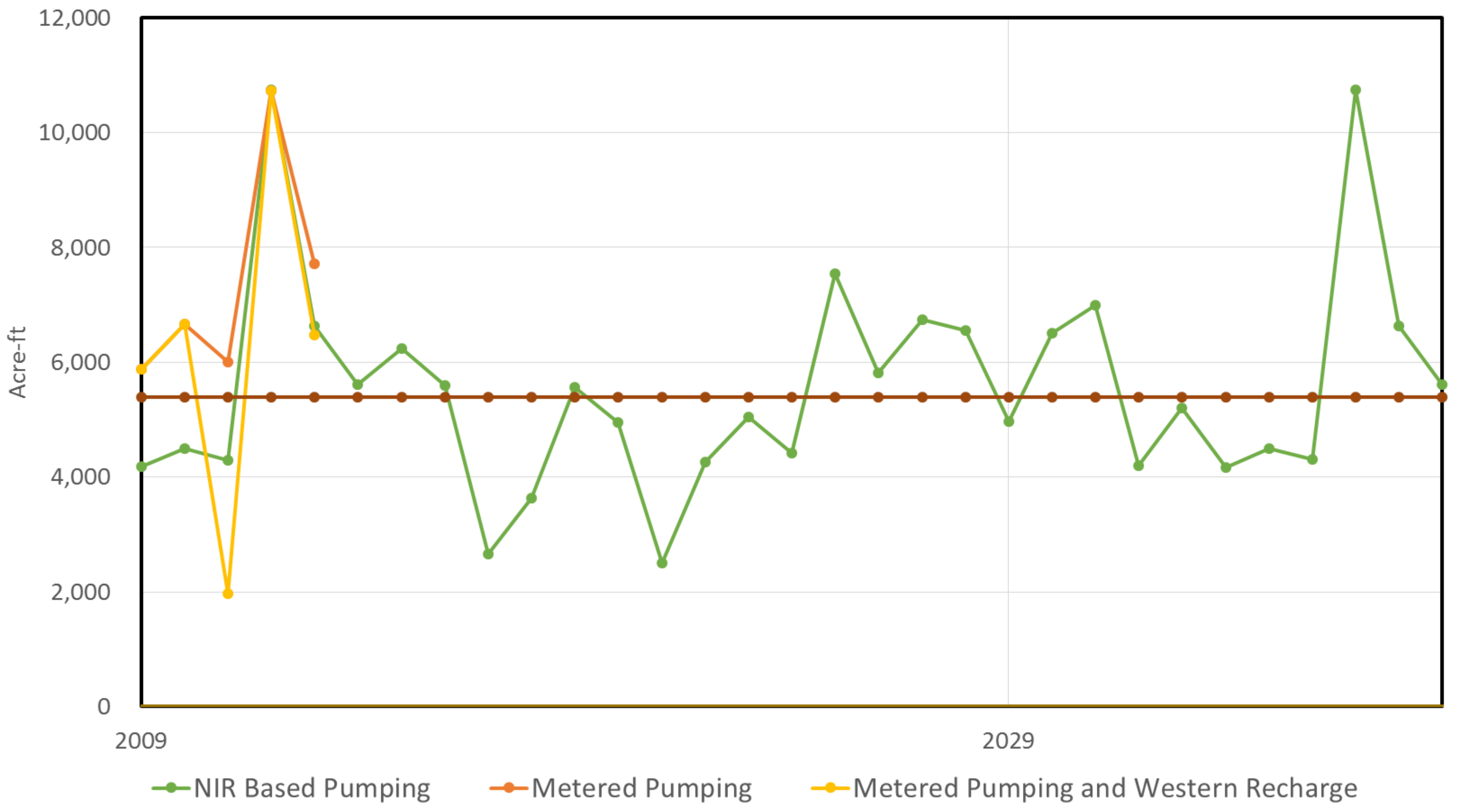


# Estimated Inches Necessary to Meet Full Crop Demand

- 25-year average NIR pumping requirement translates to 12.5” per year in the South Platte River OA Area or 37.5” over three-year allocation period
- 2009-2013 NIR pumping requirements averaged 15.5” per year
- 2009-2013 metered pumping average 15” or ~1000 ac-ft less for the 5-year period with most of the reduction occurring in 2012

# SPNRD Allocation Analysis

## (1997 Allowable Pumping Levels and 2009-2013 Metered Pumping)




- For the 2009-2013 period:
  - 6,100 ac-ft/year average for 1997 level of development
  - 7,400 ac-ft/year average of 2009-2013 metered pumping
  - 6,350 ac-ft/year average based on metered pumping and western recharge
  - ~ 250 ac-ft/year deficit during the 2009-2013 period

Date: Wednesday, August 15, 2018, from 2:00 p.m. - 4:00 p.m.

Location: Western Nebraska Community College
371 College Drive, Sidney, NE

**Attachments to Minutes:**

Attachment A- Affidavit of Publication of Notice of Meeting
Attachment B- Agenda
Attachment C- Copy of attendance sheet
Attachment D- Copies of all presentations
Attachment E- Municipal statute changes handout
Attachment F- Additional Handouts

1. **Welcome**

# Proposed Municipal/Industrial Changes for 2nd Increment IMP

- 2 Parts to IMP Municipal and Industrial Changes
  - 1st part will cover 2019-2025
  - 2nd part will cover 2026 and after
- 2019-2025 IMP language will be revised to be similar to other Upper Platte Basin NRDs IMP language
  - The current language in the SPNRD IMP is very detailed and can be greatly simplified
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  - Prior to 2026 the NRD was responsible for offsetting any new or expanded use up to 25 million gallons/year

## Slide 1

**SJ1** remove HOW
Schellpeper, Jennifer, 8/8/2018

## Slide 2

**SJ2** I believe statute say this is consumptive use. Should verify
Schellpeper, Jennifer, 8/8/2018

## Change #1

- Accounting Year
  - Currently: August 1st to July 31st
  - 2026: January 1st to December 31st
    - May be able to change sooner
- Reason:
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- Any new Municipality or Industry that does not have an established baseline as of 2026 will be responsible for offsetting all new water use.
  - Currently: NRD is responsible for providing a 25 million gallon offset for new uses.
  - 2026: Municipal or Industrial user will be responsible for offsetting all new uses.
- Reasons:
  - Several existing industrial wells and a few municipal wells do not have a baseline established currently, if those wells become active in the future they will need to obtain their own offsets.

## Slide 5

**SJ3** typo YEAR
Schellpeper, Jennifer, 8/8/2018

**SJ4** may want to describe two limits, average annual over a 25 year period and peak annual use
Schellpeper, Jennifer, 8/8/2018

## Slide 6

**SJ5** providing UP TO;
Schellpeper, Jennifer, 8/8/2018

**SJ6** again -  I believe statute descirbes this as consumptive use
Schellpeper, Jennifer, 8/8/2018

# Change #5

- Offsets for new or expanded Municipal or Commercial/Industrial growth
  - Currently: NRD is responsible for offsetting new or expanded water use above the SJ7 baseline of 25 million gallons or less per year. Municipality or Industry is responsible for offsetting new or expanded water use above the baseline of greater than 25 million gallons per year.
  - 2026: Municipality or Industry is responsible for offsetting any new or expanded water use over the baseline. Will have to have an approved NRD offset in place within one year of the overage.
- Reasons:
  - Fairness between all users. Irrigators are responsible for all offsets if their allocation is exceeded, now it will be the same for municipalities and industries.

# Change #6

- If a Municipality grows into irrigated acres then the reduced amount of consumptive use will accrue to the NRD's water bank to be used in whole or in part to offset future increased consumptive use of the municipality, or be used by the District to reach a fully appropriated status.
  - Current: same as above except the last part… "or be used by the District to reach a fully appropriated status".
- Reason:
  - Municipalities have grown into irrigated acres but have not expanded in population or commercial/industrial growth, so the NRD is proposing to use those acres to reach a fully appropriated status rather than have them sitting in a water bank.

**Slide 7**

**SJ7** BELOW
Schellpeper, Jennifer, 8/8/2018

## Change #7

- Reporting and Tracking of Municipal Water Use
- No real change will occur, but the language is just simplified from how it exists in the current plan.
- Reason:
  - Just makes the reporting of municipal water use easier for everyone to understand.
  - Helps clean up confusion about high capacity wells owned by a municipality that are used for things like irrigating golf courses/cemeteries, or industrial wells owned by a municipality that are not pumped into their potable water systems.

## Summary of Major Changes

- 1) Accounting time frame changes to calendar year
- 2) Most baselines will be changing
- 3) All Municipalities and Industries will be handled the same without regard to the NNDP 28%/40-year area.
- 4) NRD will not be responsible for offsetting uses over the updated baseline amount. User will have to have a plan in place to offset all uses over the baseline within one calendar year.
- 5) Municipal baselines have no mention of per capita use, permanent population, or governmental uses.
- 6) Remove the requirement for municipal water conservation plans after 2026.

# MANAGEMENT

## ERA OF WATER PLANNING AND POLICY DEVELOPMENT

**1981**
Legislature authorizes a State Water Planning and Review process.

**1984**
Legislature authorizes instream flow appropriations to protect recreation, fish and wildlife.

Legislature requires Natural Resources Districts to prepare local groundwater management plans.

**1986**
Legislature passes bills to implement groundwater quality protections, including expanding water quality authorities.

**1991**
Legislature requires Natural Resources Districts to expand their management plans to include protection of groundwater quality.

**1993**
Legislature enacts laws governing the use of pesticides.

**1996**
Legislature establishes integrated management of groundwater and surface water.

## ERA OF COLLABORATIVE WATER PLANNING PROCESS IMPLEMENTATION

**2000**
Natural Resources Commission is merged with Department of Water Resources to create the present Department of Natural Resources.

**2004**
Legislature directs NRD/DNR collaboration of Integrated Water Management Plans to address surface water and groundwater as a single resource.

**2010**
Legislature allows voluntary Integrated Water Management Plans.

**2014**
First voluntary Integrated Water Management Plans adopted.

**GROUNDWATER**
Does not run off and is not taken up by plants, but soaks down into an aquifer.

## INTERSTATE WATERS

Nebraska participates in six interstate water compacts, agreements, or court decrees, approved by participating state legislatures and Congress, or decreed by the United States Supreme Court. These compacts allocate water among states and often impact state water planning efforts. They are primarily administered by DNR with varying degrees of coordination and support from other state agencies and NRDs.

## FEDERAL INVOLVEMENT

Nebraska's administration of water is affected by federal regulations and impacted by the involvement of federal agencies. Three of the most significant regulations are:

- The Clean Water Act (1972) is the principal law governing pollution of the nation's surface waters (includes water standards, enforcement, and expanded federal jurisdiction, but maintains state responsibility for day-to-day implementation of the law).
- The Endangered Species Act (1973) provides for the conservation of threatened and endangered plants and animals and their habitats.
- The Safe Drinking Water Act (1974) regulates the public drinking water supply.

## SUPPORTING ROLES

Many state and federal agencies, and the NRDs, make funding available through a variety of programs. Two additional state bodies have roles that support, but do not specifically manage or regulate water:

**University of Nebraska-Lincoln Conservation and Survey Division**
- Collects, manages, and distributes groundwater data.
- Provides information and assistance regarding groundwater supplies and contamination.
- Conducts scientific studies involving water.

**Natural Resources Commission**
- State commission charged with helping to conserve, protect, and use the water and related land resources of the state through the oversight of seven state aid programs.

## CONTACT US

The Nebraska Department of Natural Resources is proud to support Nebraska's water users and work on behalf of the citizens. Please feel free to contact us at any time.

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Revised 04/2015

# WATER MANAGEMENT IN NEBRASKA

Managing Water the Nebraska Way

# HISTORY OF WATER

## ERA OF INDEPENDENT MANAGEMENT OF GROUNDWATER AND SURFACE WATERS

**1895**
Surface water rights are assigned according to doctrine of prior appropriation (first in time, first in right).

**1920**
Nebraska constitution is amended to recognize the public interest in the use of water.

**1933**
Correlative use (shared use) doctrine is adopted for groundwater established through Nebraska Supreme Court ruling.

**1943**
Nebraska enters into Republican River Compact with Kansas and Colorado. Today, this is just one of six decrees (allocating water across multiple states).

**1967**
Legislature directs state Soil and Water Conservation Commission to prepare a State Water Plan.

**1968-71**
First portions of the State Water Plan are published.

**1971**
Legislature passes Nebraska Environmental Protection Act and creates the Nebraska Department of Environmental Control (now Environmental Quality).

**1972**
Legislature creates Natural Resources Districts as multipurpose, locally elected management bodies.

**1975**
Legislature directs primary responsibility for regulating groundwater to Natural Resources Districts.

Legislature prohibits state agencies from taking actions that jeopardize endangered species or their critical habitat.

**1976**
Legislature passes standards complementary to the National Safe Drinking Water Act.

**1978**
At request of Legislature, Natural Resources Commission and other state agencies issue a policy statement and workplan which recommends replacing the State Water Plan with a State Water Planning and Review process.

**SURFACE WATER**
Comprises all rivers and streams, lakes and reservoirs, or any other water that is on the Earth's surface.

**Water management in Nebraska, like in many other states, involves a complex system of rules and management authorities. The responsibilities for water management tend to be determined by type of management (quantity or quality) and type of water (surface or ground), resulting in four quadrants of responsibility (below).**

Water has defined Nebraska, from its naming (derived from the Otoe-Missouria and Omaha tribes' names for the Platte River meaning *flat water*), to its modern dependence on water for irrigation, power, recreation, fish and wildlife, and domestic use.

Over the years, Nebraska has developed a variety of administrative structures and processes to manage water uses and supplies. During its first century, Nebraska relied on a largely centralized approach to surface water management, and a separate locally based approach for groundwater management. In the 1970s, after a decade of attempting to develop "a blueprint for total development of the state's water that would serve for generations," Nebraska's water managers realized that "published plans frequently become outdated rapidly, and some serve only to collect dust after a short time."* Rather, they envisioned water planning as a "continuous process that would provide flexible guides for future decisions" and suggested elimination of "a State Water Plan and [to instead] concentrate on the Process." What followed was a series of policy and water right studies that evaluated numerous water issues including surface water rights, groundwater management, water use efficiency, instream flows, and the integrated management of surface water and groundwater. Subsequently, many of the recommendations from these studies were implemented.

In 1981 the Legislature assigned the Nebraska Department of Natural Resources overall coordination and other specific roles in water management and regulation. State agencies and local Natural Resource Districts were assigned other specific responsibilities for water management and regulation. In 2004, the Legislature established a collaborative state and local process that, for the first time, recognized the inter-connectivity of groundwater and surface water. Nebraska's structure has become a decentralized process that integrates groundwater and surface water management and regulatory processes locally and statewide.

# WATER MANAGEMENT AND REGULATORY ROLES

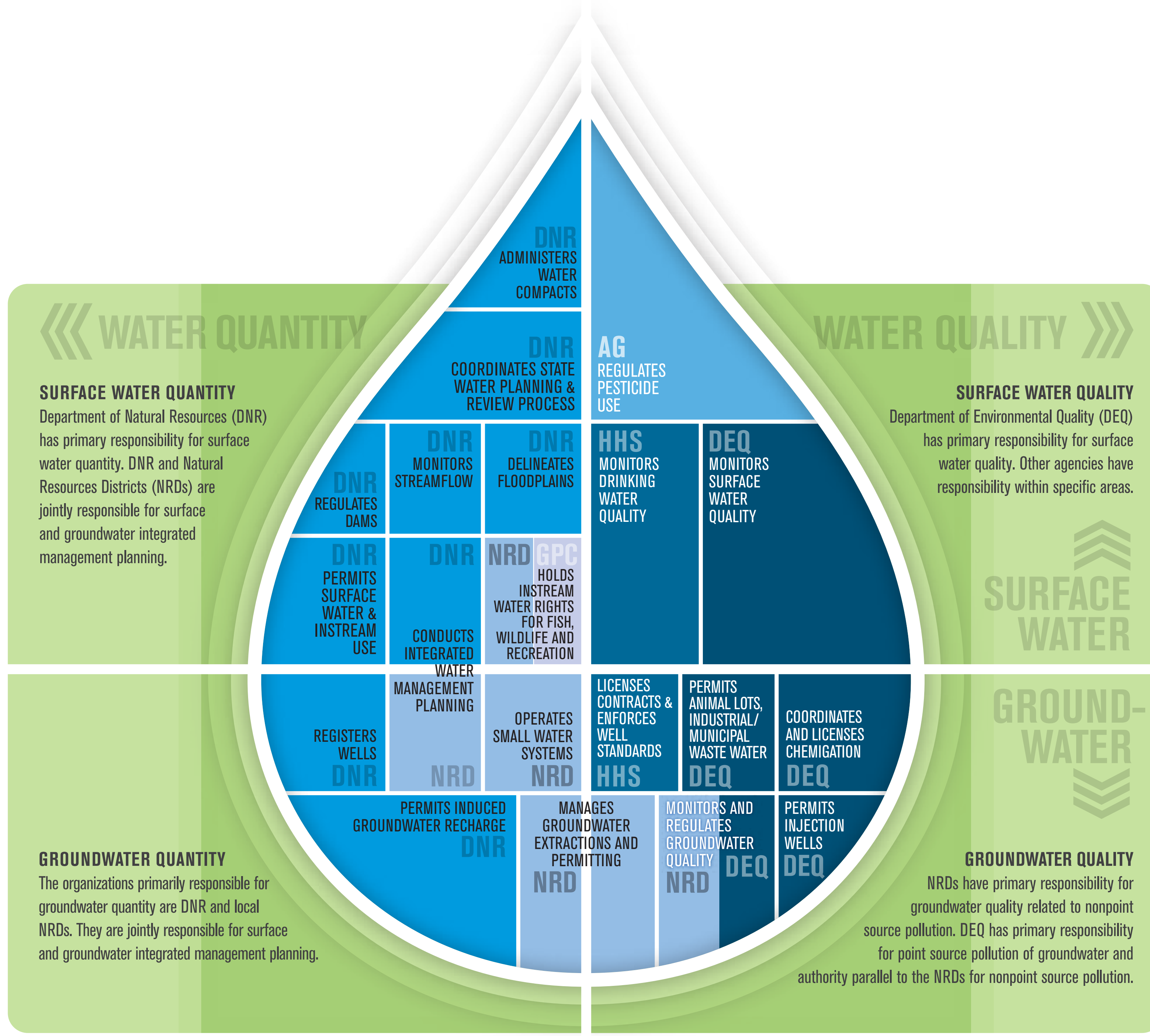
*Natural Resources Commission Report to the Legislature and Governor, 1978

## DNR Department of Natural Resources

- Responsible for permitting surface water, rights for storage, irrigation, power, manufacturing, instream flows, and other beneficial uses.
- Coordinates the annual state water planning and review process (provide policy information, provide intergovernmental coordination, maintain data, enable planning and designing of projects and undertake planning activities).
- Issues permits for surface water, instream use, water storage, induced groundwater recharge for public water suppliers, and diversions by certain groundwater irrigation wells.
- Registers wells and delineates hydrologically connected aquifers on streams and rivers.
- Regulates the construction, operation, and maintenance of dams.
- Identifies and delineates floodplains and provides related assistance and coordination.
- Administers interstate water compacts, decrees, and agreements.
- Partners with NRDs to develop and manage Integrated Water Plans.

## NRD Natural Resources Districts (23 districts cover Nebraska)

- Partners with DNR to develop Integrated Water Plans.
- Maintains district plans and implements projects to protect groundwater and surface water quality and quantity.
- Partners with other agencies to develop multi-district river basin water management plans.
- Maintains district rules and regulations to deal with groundwater contamination, shortages or user conflicts, including groundwater well permitting, allocations, flowmeters, usage reporting, well moratoriums, irrigated acre expansion, and transfers.
- Receives applications and issues permits for chemigation (fertilizers/pesticides applied to land or crops in or with water) and inspects safety equipment on chemigation systems.
- Utilizes floodplain management measures to help protect people and property from flood damage.
- May hold a surface water right for instream flows.




## AG Department of Agriculture

- Leads on issues relating to pesticides and water quality. Develops and implements state management plans for the prevention, evaluation and mitigation of occurrences of pesticides, or pesticide breakdown products, in groundwater and surface water.
- Regulates the distribution, storage, and use of all pesticides, and certifies and licenses pesticide applicators.
- Manages the Nebraska Buffer Strip Program for cropland adjacent to perennial and seasonal streams, ponds, and wetlands.

## HHS Department of Health and Human Services

- Assures drinking water quality through testing of public water systems and water wells.
- Licenses well and pump installation contractors.
- Enforces water well construction standards to protect groundwater quality.

## GPC Game and Parks Commission

- Ensures that water resource projects and programs consider and provide for fish and wildlife resources and the habitats that support them.
- May hold a surface water right for instream flows.

## DEQ Department of Environmental Quality

- Conducts surface water quality sampling in lakes, streams, and rivers.
- Conducts groundwater quality monitoring, review, and studies.
- Makes Clean Water Act impairment declarations.
- Coordinates chemigation programs and issues applicator certifications.
- Leads groundwater pollution remediation.
- Assists public water suppliers to prevent contamination.
- Issues permits for: injection wells; Concentrated Animal Feeding Operations (CAFO or AFO); and treatment and discharge of industrial and municipal wastewater and stormwater.

February 2014 No. 9

# Water Matters

Published by the Nebraska Department of Natural Resources

A guide to integrated water management in Nebraska

## Balancing Water Supplies Through Groundwater Recharge

### Part Two: A Conjunctive Management Demonstration Project

***Key concept***

*A conjunctive management demonstration project was conducted in 2011 on the Upper Platte River in order to more accurately quantify and manage the complex relationships between hydrologically connected surface water and groundwater resources. Throughout the project's planning, coordination, and implementation phases, project sponsors demonstrated the ability to divert and store excess flows in order to increase the availability and reliability of water supplies in the future, while also mitigating the negative impacts of flooding events.*

**Introduction**

Water resources in Nebraska are managed in order to best serve the interest of the state's citizens. The storage of water in the state's aquifers has been determined to be a beneficial use of water resources. Properly managing hydrologically connected water resources is essential not only to maintain the economic and physical well-being of the Nebraska's citizens, but also to ensure that these vital resources are available for use at the most opportune time and location. Given that water resources and those who depend on them are vulnerable to extremes in regard to quantity, an adept and comprehensive method of managing these resources is required.

*Water Matters*, No. 8 described the hydrologic basis and authority under which conjunctive management projects can be implemented. Techniques for conjunctively managing hydrologically connected surface and groundwater resources provide managers with a broad set of options through which the use of these resources can be optimized, while minimizing inefficiencies and other negative impacts on users and the environment. At times, the availability of water resources is frequently out of balance with user demand and the occasions at which these inconsistencies might arise can be highly variable.

**Image 1:** Photograph of a canal used during the 2011 groundwater recharge demonstration project.

*While the information presented in this article is technical in nature, it has been generalized to appeal to a broader audience. This article provides an overview of a very complex topic.*

## Utilizing Excess Flows

A stream can experience reduced flow in part due to variability in precipitation, reservoir storage, and the effects of beneficial uses of surface water and groundwater. Because of the variability of flow, the supply may not meet the demands at any given time. At other times there may be more than enough water, or excess flow, to satisfy all the beneficial uses on a given stream. It can be advantageous to store and retime excess streamflows for occasions when the water supply is insufficient to meet the demands. Implementing conjunctive management projects to utilize aquifers as extensions of available storage increases the available storage capacity. These projects potentially require less capital investment than a new surface water reservoir while still providing long-term benefits to the future water supply.

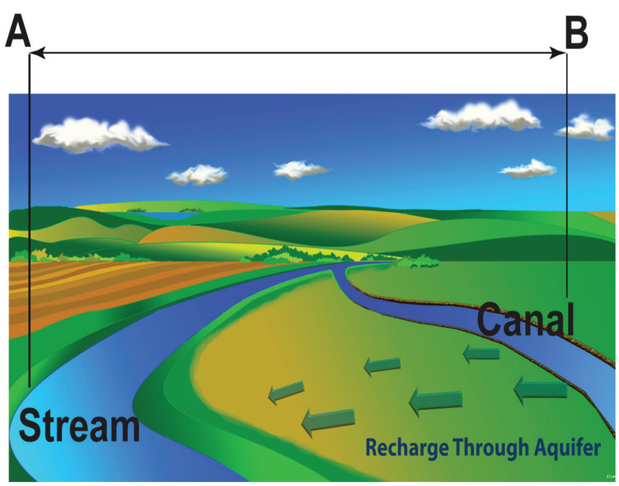



**Figure 1:** Schematic diagram illustrating the diversion of excess flow from the stream to the canal and the direction of groundwater recharge through the aquifer.

Retiming streamflows can be done using two different approaches: active or passive. The active approach includes mechanical methods such as pipes, tanks, pumps, and reservoirs for moving the water back to the stream. Mechanical methods for moving and storing water can be expensive, often requiring significant investment in infrastructure and continued operation and maintenance costs. Mechanical methods have the advantage of supplying more control over timing and amount of water; operationally, a pump can be utilized at the flip of a switch to supply water. The passive approach, such as the diversion of excess streamflows, minimizes the use of man-made structures and takes advantage of the natural hydrologic properties of near-stream aquifers. The passive approach gives the operator less control over when water is supplied to the stream than the mechanical method, but typically requires less cost.

*A single groundwater recharge event continues to influence streamflows over a period of years or decades.*

Nebraska is fortunate to have large aquifers adjacent to most of its streams that can be used for conjunctive management, serving as storage reservoirs for excess water and providing a conveyance mechanism for its return to the stream. Purposely storing water in an aquifer can be referred to as groundwater recharge, artificial recharge, or aquifer storage and recovery. These techniques have the potential to increase water storage levels in the aquifer and also increase groundwater discharge, or accretion, to streams.

Several techniques for groundwater recharge have been widely studied and implemented. In many cases, wells are used to inject and store water in a deep aquifer to be recovered later. In other situations, irrigation canals and drains can also be used to direct excess surface water flows into an aquifer. An open, unlined canal that is filled with excess streamflow can seep water into the aquifer below, and through time, that recharged water will gradually flow underground and find its way back to the stream as baseflow (see figure 1 and the cross-section of points A and B shown in figure 2). The concept that unlined canals provide water to groundwater aquifers through recharge has been well understood in Nebraska for over a century.

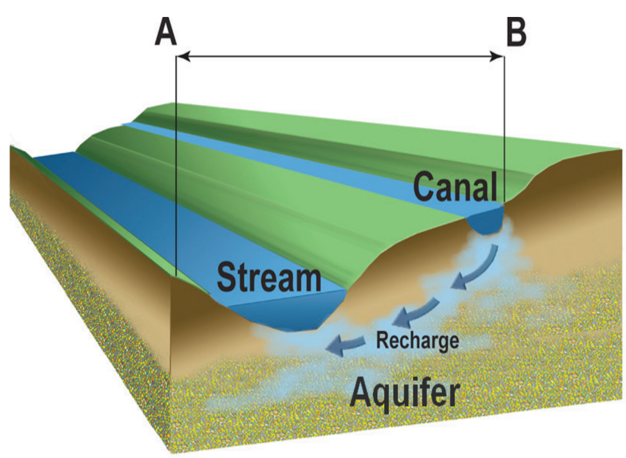



**Figure 2:** Schematic diagram illustrating the seepage of excess flow from the canal into the groundwater aquifer and subsequent return path of water to the stream.

This edition of *Water Matters* describes a cooperatively undertaken conjunctive management demonstration project that was initiated in order to determine the potential ability of the aquifer adjacent to the Upper Platte River to store excess surface water flows for later use. Numerous benefits were realized through the implementation of this project, including a quantification of the timing and rates of groundwater recharge and accretion along the Upper Platte River, as well as a demonstration of the ability of managers to use the existing hydrology and infrastructure of the region to mitigate negative impacts of flooding events. Additionally, the project provided an opportunity for the project sponsors to demonstrate their capability for coordination and implementation of timely conjunctive management action when an opportunity presents itself.

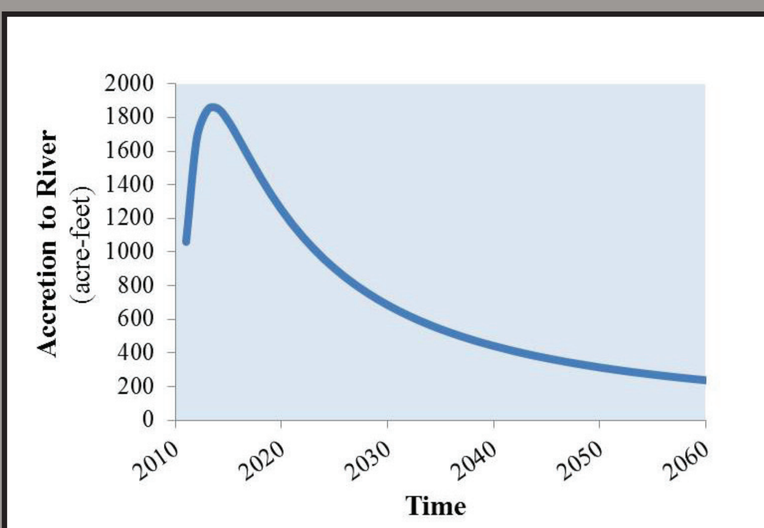
## Demonstration of the Process

In the late winter and early spring of 2011, the Bureau of Reclamation projected potential flood flows on the North Platte River. These flood flows were expected to be in excess of all demands. With this understanding, the Department of Natural Resources (Department), several natural resources districts (NRDs), and multiple irrigation districts began a demonstration project to evaluate the effects of diverting excess streamflow into existing canals. In addition to recharging groundwater and adding accretions to streamflow, another expected benefit of the project was the mitigation of the flooding predicted by the Bureau of Reclamation.

*In the late winter and early spring of 2011, the Bureau of Reclamation projected potential flood flows on the North Platte River.*

In order to carry out the project, applicable surface water appropriation permits were applied for by the irrigation districts and subsequently approved by the Department. Part of the permit application process included demonstrating that excess flows were available in the Platte River system. In 2010, a report on the availability of excess flows in the Platte River was compiled and published by the Department. The purpose of the report was not only to evaluate the historic quantity of excess flows in the Platte River, but also to assist managers in the development of a planning tool that could be used to estimate the approximate duration and frequency of those flows.

Ultimately, the results of the streamflow study showed that excess flows are available on a periodic basis and can be utilized for recharging groundwater storage. Combined with the data gathered from the groundwater recharge project and other pertinent investigations, the excess streamflow study provided valuable information to Nebraska's water managers. More details about the excess streamflow study and the full report can be found on the Department's website at: http://dnr.nebraska.gov/iwm/historic-platte-river-streamflow-excess-protected-target-flows.




| Year | Estimated Annual Accretion to River (acre-feet) |
|---|---|
| 2011 | 1,062 |
| 2020 | 1,251 |
| 2030 | 685 |
| 2040 | 442 |
| 2050 | 315 |
| 2060 | 238 |
| **10-year Cumulative Benefit** | **15,474** |
| **50-year Cumulative Benefit** | **36,168** |

**Figure 1, Table 1:** Estimated accretions to the river resulting from the 2011 recharge demonstration project.

Once the necessary permits were approved, excess flows were diverted throughout the early spring until irrigation season began, and again in the fall once irrigation season was over. The Department's Bridgeport Field Office, in conjunction with the NRDs and irrigation districts, monitored the diversions of the stream to each canal as well as many of the diversions' canal returns back to the river. Image 2 shows a dry canal before the project began and image 3 shows a canal filled with diverted water during the project. A significant accomplishment of the demonstration project was the cooperative manner in which the project sponsors worked through the required administrative procedures to obtain permits and coordinated monitoring responsibilities. Demonstrating the capability to effectively collaborate on a complex project such as this ensures that a timely response can be made in the event of a flood flow prediction.

*The demonstration project diverted 141,911 acre-feet of water. The estimated amount of water purposefully recharged into the aquifer was 64,699 acre-feet, with 36,168 acre-feet of the recharge expected to reach the river as accretions within 50 years.*

| **Diversion Canals** | |
|---|---|
| ▪ Belmont Canal | ▪ Minatare Canal |
| ▪ Castle Rock Canal | ▪ Nine Mile Canal |
| ▪ Central Canal | ▪ North Platte Canal |
| ▪ Chimney Rock Canal | ▪ Orchard-Alfalfa Canal |
| ▪ Cozad Canal | ▪ Pathfinder Canal |
| ▪ Dawson Co. Canal | ▪ Paxton-Hershey Canal |
| ▪ Enterprise Canal | ▪ Phelps County Canal |
| ▪ Farmers Canal | ▪ Suburban Canal |
| ▪ Gothenburg Canal | ▪ Thirty-Mile Canal |
| ▪ Kearney Canal | ▪ Western Canal |
| ▪ Keith-Lincoln Canal | ▪ Winters Creek Canal |
| ▪ Lisco Canal | |

**Table 2:** Canals used to divert flows during the 2011 recharge demonstration project.

The demonstration project diverted 141,911 acre-feet of water. The estimated amount of water purposefully recharged into the aquifer was 64,699 acre-feet, with 36,168 acre-feet of the recharge expected to reach the river as accretions within 50 years. The accretions to the river through time are shown in figure 1 and table 1. The general method used to estimate the recharge amount presupposed that: (1) a simple water balance equation would be used to estimate recharge as the difference between the amount of water diverted and the amount of water returned to the stream; (2) rainfall and evaporation were not considered to significantly impact the amount of water recharged; and (3) in the canals where the field office staff were not able to measure the return, a conservative estimate would be made.

In many ways, the groundwater recharge and flood mitigation demonstration project was a success. The project sponsors were able to work through the administrative requirements, implement the project in a timeframe that allowed for taking advantage of flood flows present at the time, and recharge a significant amount of water to the aquifer. A technical memo documenting the demonstration project in more detail is available on the Department's website at: http://dnr.nebraska.gov/iwm/conjunctive-management-toolbox.

**Image 2:** Photograph of a dry canal before the groundwater recharge demonstration project began.

**Image 3:** Photograph of a filled canal during the groundwater recharge demonstration project.

## Conclusions

Conjunctive management projects, such as the one described above, are designed to provide managers with information necessary to determine how hydrologically connected surface and groundwater resources can be most efficiently and effectively put to use. As was outlined in *Water Matters,* No. 8, the recharge rate of aquifers, and the response time and accretion rates between hydrologically connected aquifers and streams, vary depending on local hydrological conditions. This project provided resource managers with the opportunity to more accurately quantify the hydrologic relationship between surface water flows, groundwater recharge, storage capacity, and accretion rates along the Upper Platte River.

Given the unpredictable nature of water availability, obtaining data such as that provided by the 2011 recharge demonstration project will remain a vital component of sound conjunctive management decision-making. While this *Water Matters* focused on the groundwater recharge of excess flows, the same principles apply to other sources of recharge water as well, such as water in surface water reservoirs and existing water rights that could be transferred for groundwater recharge use. Through water management planning, conjunctive management strategies help to ensure the availability and reliability of water supplies for future use.

*Through water management planning, conjunctive management strategies help to ensure the availability and reliability of water supplies for future use.*

**Image 4:** Photograph of a canal used during the groundwater recharge demonstration project.

| **Project Partners** |
|---|
| **NRDs** |
| ▪ Central Platte NRD |
| ▪ North Platte NRD |
| ▪ South Platte NRD |
| ▪ Tri-Basin NRD |
| ▪ Twin Platte NRD |
| **Irrigation Districts** |
| ▪ Bridgeport Irrigation District |
| ▪ Castle Rock Irrigation District |
| ▪ Central Irrigation District |
| ▪ Central Nebraska Public Power and Irrigation District |
| ▪ Chimney Rock Irrigation District |
| ▪ Cozad Canal Company |
| ▪ Enterprise Irrigation District |
| ▪ Farmers Irrigation District |
| ▪ Keith-Lincoln County Irrigation District |
| ▪ Lisco Irrigation District |
| ▪ Minatare Canal Company |
| ▪ Nebraska Public Power District |
| ▪ Nine Mile Irrigation District |
| ▪ Pathfinder Irrigation District |
| ▪ Paxton-Hershey Water Company |
| ▪ Platte Valley Irrigation District |
| ▪ South Side Irrigation Company |
| ▪ Suburban Irrigation District |
| ▪ Thirty-Mile Canal Company |
| ▪ Western Irrigation District |
| ▪ Winters Creek Canal Company |

**Table 3:** NRDs and irrigation districts that participated with the Department in the 2011 recharge demonstration project.

The theoretical concepts on which this project is based are described in more detail in *Water Matters*, No. 8.

Nebraska
Department of Natural Resources

Please contact the Nebraska Department of Natural Resources with questions or concerns about this publication at (402) 471-2363.

Visit the Integrated Water Management Division's website at http://www.dnr.nebraska.gov/IWM for up-to-date information. *Water Matters* is available at this website.

February 2014 No. 8

# Water Matters

Published by the Nebraska Department of Natural Resources

A guide to integrated water management in Nebraska

## Balancing Water Supplies Through Groundwater Recharge

### Part One: A Component of the Conjunctive Management Toolbox

***Key concept***

*Hydrologic processes in many areas of the state involve a cycle in which water diverted from streams seeps through the soil into a groundwater storage system called an aquifer. Completion of this cycle involves areas of hydrologic connection where water stored in an aquifer can discharge back into a stream or river. Through integrated water management techniques, this natural process can be enhanced and controlled, making water more readily available for human use with positive streamflow impacts.*

**Introduction**

Since the turn of the century many western states, including Nebraska, have developed substantial surface water reservoir storage capacities to purposely retime streamflows. Retiming of streamflows is done by blocking a portion of a stream's flow, storing it in a reservoir, and then returning it to the stream at a later time. Reservoirs such as Lake McConaughy, Harlan County Reservoir, and Merritt Reservoir represent a few such storage facilities in Nebraska. The retiming of water supplies provided by surface water storage facilities allow for utilization of the water resources for benefits such as irrigation, power production, and recreation.

While the value of using surface water reservoirs is understood by most water users, many are unaware that water can also be purposely stored in underground reservoirs, also known as aquifers. In order to maximize water use and minimize negative impacts on streamflows and groundwater levels, conjunctive management uses the connection between surface water and groundwater aquifers to store water underground, thereby increasing the availability and reliability of the water supply in a region[1]. In other words, conjunctive management optimizes use of the whole water supply. Diverting stream water to allow it to seep into the aquifer during times of excess flow can help mitigate streamflow shortages that occur in subsequent periods. One way that excess flows can be stored in the aquifer is by diverting that water into existing canals and allowing seepage to occur via the canal bottom (figure 1). Under the authorities of an integrated management plan and the Ground Water Management and Protection Act (the Act), conjunctive management projects can be implemented that divert excess streamflows for the purpose of achieving and sustaining a balance between water uses and water supplies. To support the efforts of implementing conjunctive management projects, this edition of *Water Matters* provides a brief examination of the value of purposely storing water underground in order to increase groundwater discharge to streams and help achieve a sustainable water balance.

[1]California Department of Water Resources. (2009). Conjunctive management and groundwater. *California Water Plan Update 2009*, 1-25.

*While the information presented in this article is technical in nature, it has been generalized to appeal to a broader audience. This article provides an overview of a very complex topic.*

## Quantifying the Benefits

When excess water is diverted from the stream, a portion of it may return as runoff to the stream through surface return ditches, and a portion of it may recharge into the groundwater aquifer to return to the stream at a later point in time as baseflow. The rate at which recharged water returns to the stream as baseflow depends upon how easily the water can move through the soil and rocks of the aquifer and the distance from the canal to the stream. How fast the effects due to recharge occur throughout the aquifer is dependent upon characteristics such as the amount of connected pore space in the soil and the effective thickness of the aquifer. Many mathematical equations have been developed to estimate the quantity and timing of this returning water. One such mathematical function was described by Hunt[2] in 1999. The "Hunt Method" strives to calculate how much water will return to the stream over time, using aquifer characteristics, streambed characteristics, and distance from the stream. For a one-time diversion and recharge event (pulse), the accretion to the stream over time generally looks like the graph shown in figure 3.

Figure 3 illustrates that a single groundwater recharge event continues to influence streamflows over a period of years or decades. As an aquifer's ability to transmit water varies from location to location, and because canals lie at different distances from the stream, the response to the stream for each canal (or different sections of a single canal) will differ. Figure 4 illustrates a range of accretion rates to the stream, calculated for aquifers with varying ability to transmit water and located at varying distances from the stream. For a project with a fast response, most of the estimated accretion occurs rapidly. For moderate or slow responses, the maximum instantaneous accretion rate is lower, but persists at a higher level for much longer. Both figures 3 and 4 show that, for a single event, as water discharges to the stream the amount of accretion reaches a maximum instantaneous value at some point after the event, and then the effect gradually diminishes.

*It can be advantageous to store and retime excess streamflows for occasions when the water supply is insufficient to meet the demands. Implementing conjunctive management projects to utilize aquifers as extensions of available storage increases the available storage capacity.*

Figures 3 and 4 depict the response of the stream to a single groundwater recharge event, or pulse. Increased benefits to the system can occur if the groundwater recharge events are repeated through time.

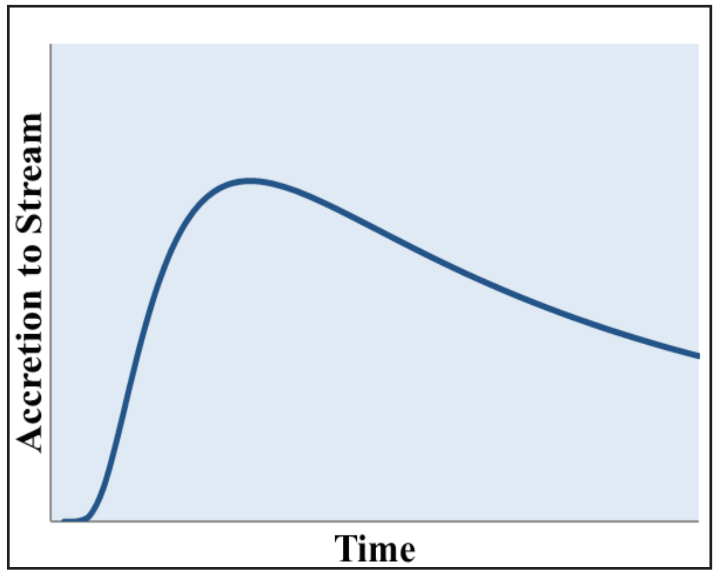



**Figure 3:** Illustration of typical accretion to streamflow from a single groundwater recharge event.

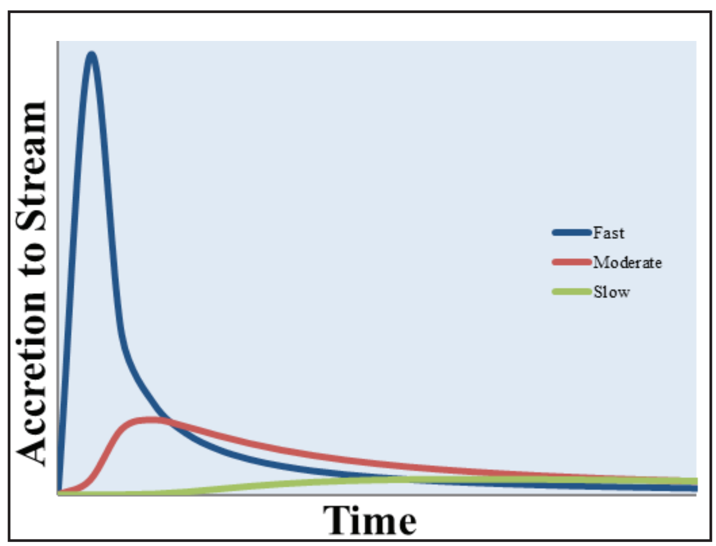



**Figure 4:** Graph illustrating fast, moderate, and slow response times and accretion rates.

[2]Hunt, B. (1999). Unsteady stream depletion from ground water pumping. *Ground Water*, *37*, 98-102.

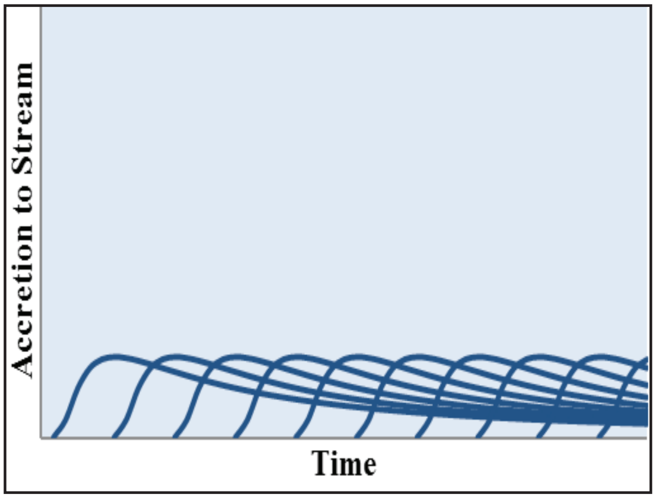



**Figure 5:** Multiple applications through time: each curve represents a single event, like that shown in figure 3. Calculating each accretion individually and plotting them on a single graph looks like a simple sequence of accretive events.

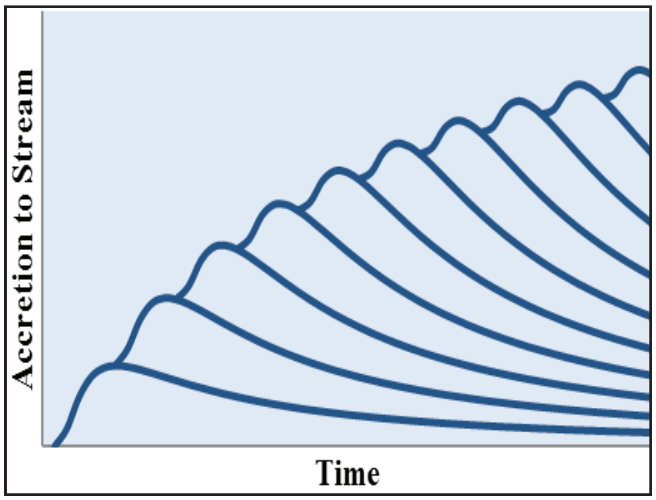



**Figure 6:** Multiple events accumulate flow: the true benefit of multiple events is not fully realized until the additive effects are shown as here, where each individual event from figure 5 is added to the previous event(s) to demonstrate the additive effect of using numerous opportunities to store excess flow in the aquifers under canals.

*The State of Nebraska has the technical and administrative tools available to design, implement, and evaluate the benefits of a groundwater recharge project.*

Figures 5 and 6 show how purposeful groundwater recharge events applied over time will create an aggregate, long-term accretion to the stream.

**Conclusions**

Conjunctive management actions aimed at developing groundwater recharge projects take advantage of excess streamflows and can retime those flows to be available to the stream in the future. If recharge events are implemented on a recurring basis, these projects have the potential to supply significant amounts of water to the stream. The State of Nebraska has the technical and administrative tools available to design, implement, and evaluate the benefits of a groundwater recharge project.

Conjunctive management strategies hold the potential to increase available storage capacity in order to mitigate flooding, protect rivers, and provide long-term benefits to future water supplies. Projects that employ methods of conjunctive management can have many positive outcomes, including minimal capital investment due to the use of existing infrastructure, and little, if any, negative effects. *Water Matters*, No. 9 describes such a project, outlining a groundwater recharge project undertaken cooperatively by the Department of Natural Resources with local natural resources districts and irrigation districts located along the Upper Platte River. Details of the project's implementation and lessons learned from the resulting data verify that conjunctive management of surface and groundwater resources can be a very adaptable and widely beneficial approach.

In *Water Matters*, No. 9, a pilot project is described in which the theoretical concepts outlined above are demonstrated in a real world setting.

Nebraska Department of Natural Resources

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June 2010 No. 4

Water Matters

Published by the Nebraska Department of Natural Resources

A guide to integrated water management in Nebraska

# Stream Depletion and Groundwater Pumping

## Part One: The Groundwater Balance

By Amy Ostdiek

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The effect of groundwater pumping on streamflows has emerged as a major water issue and the source of many conflicts in several western states. In Nebraska, some conflicts have gone before the courts, including disputes over the Republican River Compact, the North Platte Decree, and between surface water appropriators and well owners in the Pumpkin Creek Basin, a North Platte River tributary in western Nebraska.

The Nebraska Legislature has passed substantial legislation attempting to resolve some of these conflicts twice in the past 15 years. In 1996, LB 108 encoded the hydrologic connection between aquifers and streams into state law and authorized natural resources districts (NRDs) and the Department of Natural Resources (DNR) to address conflicts. In 2004, LB 962 provided for proactive, integrated management of surface water and groundwater.

Successful management of the state's water resources requires an understanding of how groundwater supplies interact with surface water supplies. This edition of *Water Matters* is intended to provide a basic explanation of the way groundwater pumping can affect surface water, a key component at the heart of integrated management. Future editions will further explore this relationship and the complex effects (including the lag effect) of groundwater use.

### Understanding the effects of groundwater use on streamflow

Though the individual relationships are varied and complex, groundwater aquifers in most of Nebraska are hydrologically connected to streams, and the two should be viewed as a single resource. The addition of water to either the aquifer or the stream will result in an overall increase to the hydrologically connected system over time. The removal of water from either the aquifer or the stream will result in a decrease over time (see figure 1).

As a general rule, the amount of water entering a system over the long term must equal the amount leaving the system, including any change in the amount stored in the system. In the shorter term, if inflows exceed outflows, the excess is stored and the water levels in the aquifer rise or the amount of water in the stream increases (or both). If the outflow is greater than the inflow to the system, water levels in the aquifer or stream decrease. If the amount of water entering the system stays relatively constant over the long term, as is typically expected, then any amount being removed (e.g., through groundwater pumping) will cause a reduction in storage or in the amount flowing out of the system.

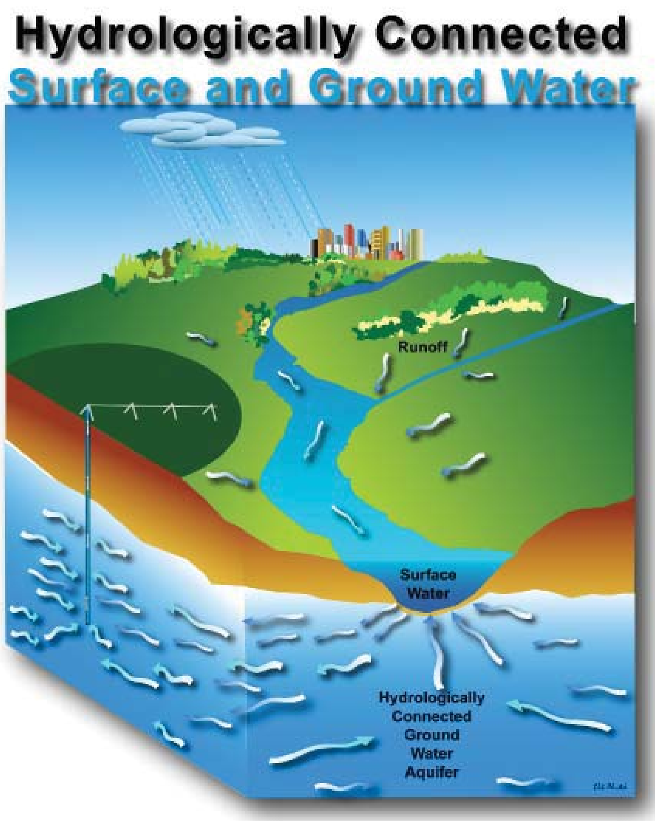


**Figure 1:** Hydrologically connected surface water and groundwater.

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### Groundwater flow and the simple sandbox analogy

Unlike surface water flow, which is readily observed and measured, groundwater flow occurs below the land surface and is difficult to measure. This makes the effects of changes in groundwater flow more abstract and difficult to understand. Groundwater velocities are generally much slower than those of surface water. Groundwater often only moves a few feet per year, compared to typical flow rates of a few feet per second in rivers and streams. This slow movement of water occurs through the pore spaces between the rocks, sands, gravels, and other sub-surface materials. These sub-surface materials that store and transmit groundwater are called aquifers.

A simple way to think of an aquifer is as a sandbox filled with sand. When water is poured into the sandbox (addition of water to the system is called recharge), it fills the empty spaces between the grains of sand, much like groundwater in an aquifer. If there is a hole in the side of the sandbox, water will flow out of it until the water level in the box drops below the elevation of the hole. The hole in this case is like a river, and the flow out of the hole will depend on how full the sandbox is with water (or how quickly the sandbox is recharged with water to replace the water flowing out). In the absence of any other factors, the relationship between the amount of water being poured into the sandbox and the amount flowing through the hole will eventually come into equilibrium (see figure 2).

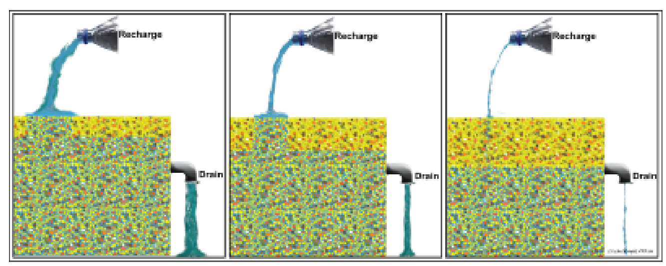


**Figure 2:** In a system with no additional factors (i.e. pumping), the amount of recharge will be equal to the change in storage plus the flow out the drain (or river)

If you dig a hole in the sand, you may see water fill in the hole (this is like many of the sandpit lakes and borrow pits along the Platte River and in other portions of the state). If you scoop water out of the hole with a cup, water will move into the hole from the surrounding sand. Scooping water out of the hole is like pumping a well. Like a well, it reduces the amount available to go out of the notch unless the amount of water being poured in (recharge) is increased (see figure 3).

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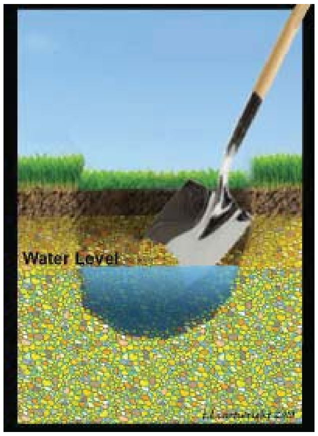


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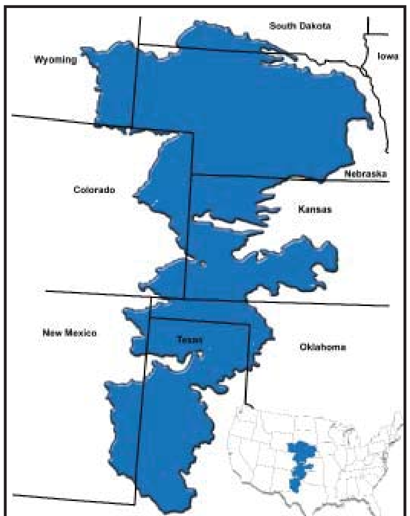
you dig in the sand box (i.e., well) to remove water relative to the drain (i.e., river) will affect how quickly flow of water out of the drain is reduced. Of course, increasing the flow into the sandbox (i.e., increased precipitation or recharge) will add water to the system, which may temporarily restore the amount of flow. However, this can't permanently mitigate the effects of the ongoing removal of water (i.e., groundwater pumping) unless the flow into the sandbox (recharge) continues to increase. Also, while the temporary increase in recharge may increase the water level in the aquifer (and consequently increase the amount of water flowing from the drain), it's important to remember that the effects of water withdrawn far away from the drain may not be fully realized at the location at which flow is being measured. Consider the complexity of a system like this as big as the High Plains Aquifer (also known as the Ogallala Aquifer), which covers roughly two-thirds of Nebraska (figure 4).

### How does groundwater pumping affect the hydrologically connected system?

In a hydrologically connected surface water/groundwater system, depletions to streamflow due to groundwater pumping can occur either by wells that intercept water that otherwise would have flowed to the stream or by causing water to move from the stream to the well (see figure 5). In Nebraska, the first case is more common, though excessive levels of development and groundwater use can lead to the latter. So, as a typical well is pumped, water is initially removed from aquifer storage and over time this translates into less water reaching the stream. If pumping continues to the point that the water level in the aquifer is lower than the water level of the stream, water would flow from the stream into the aquifer to replenish aquifer storage and supply the well.

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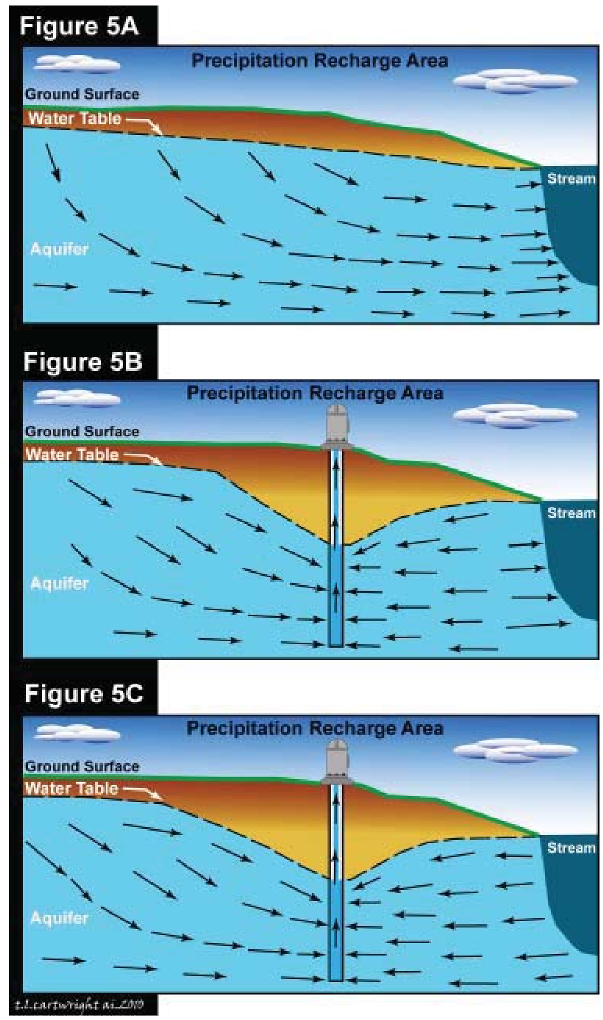


**Figure 5:** If a well starts removing water from the aquifer (5B), the well will intercept water that otherwise would have flown to the stream. As the well continues to pump, more water is removed from the system and less water reaches the stream. Eventually, if pumping continues, water will flow directly from the stream toward the well (5C).

Groundwater models (analytical and numerical) must be used to understand and predict streamflow depletions. Depletions are determined by calculating the difference between the streamflow that would have occurred if the well was not pumped and the streamflow that occurs when a well is pumped (figure 6). Many factors within a model can change the time it takes for a pumping well to affect water supply, such as the properties of the aquifer, intensity and duration of the pumping, the presence or absence of a clogging layer within the streambed, and distance to the stream. In many areas of Nebraska significant efforts have been and are being made to refine our understanding of these properties, which will help us to further understand the timing aspects of depletions. However, all pumping[1] in the hydrologically connected system must eventually result in a near 100% depletion. In other words, if one acre-foot of water is pumped, there will be one acre-foot less water in the system, even though the effect may not be realized instantaneously. The next issue of *Water Matters* will provide an in-depth discussion of the lag effect of groundwater pumping and other timing-related issues of stream depletions.

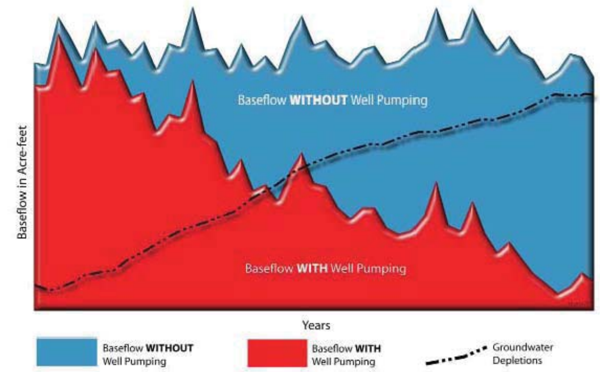


**Figure 6:** An example of how groundwater pumping may affect streamflow.

### When does streamflow depletion become a concern?

There are many factors that may determine how much streamflow depletion due to groundwater use is acceptable in a given area, such as interstate compacts or decrees and the rate of past and predicted future development. For this reason, the definition of effective management can vary greatly by area. Not only are there different restrictions in various areas across the state; stakeholders also have different priorities. Therefore, the type of management utilized must be receptive to changes in circumstances and provide for monitoring of how those circumstances may change through time. That is why the integrated management process (read more about the integrated management process in *Water Matters*, No. 1) is so critical to successful preservation of Nebraska's water resources.

Through the integrated management process, Nebraska must ensure that it is able to meet its interstate obligations. The process should also be used to respond flexibly and responsibly to the area's needs and priorities. Conceptually, and by law, an integrated management plan is always a work in progress for either maintaining a balance of the hydrologic system or regaining a balance. As the affected area changes and more data become available, an IMP must be reassessed, evolving as needed to accommodate changing circumstances, which may include hydrology, economics, water demands, and stakeholder priorities.

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A guide to integrated water management in Nebraska

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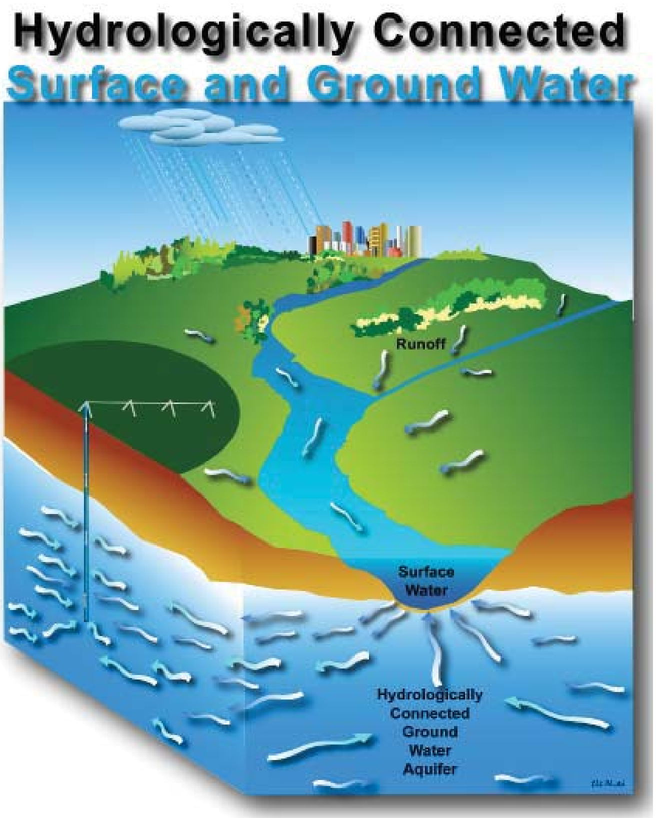


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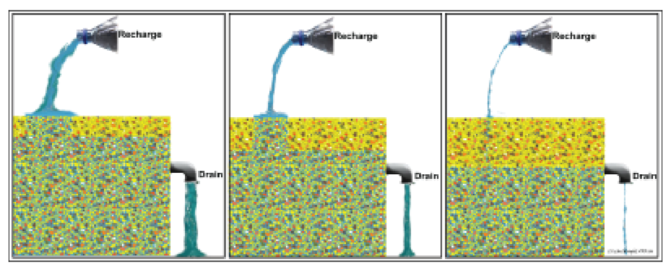


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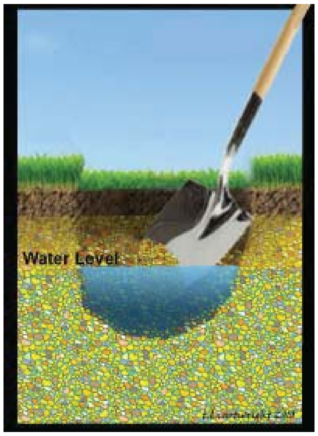


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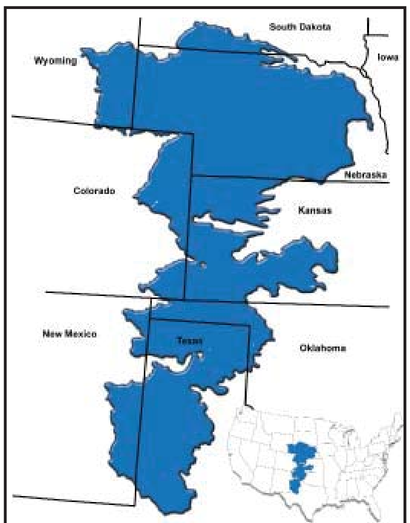


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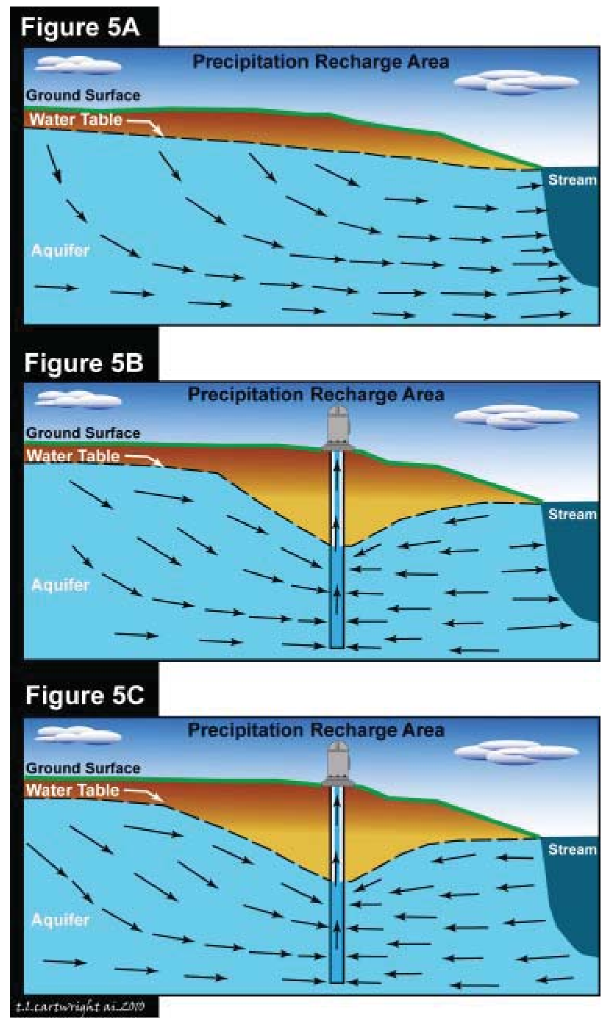


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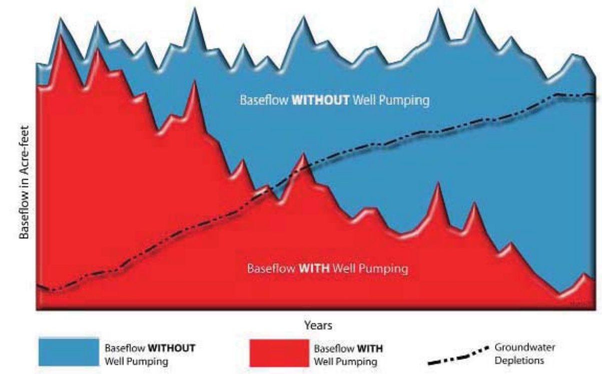


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July 2010 No. 5

# Water Matters

Published by the Nebraska Department of Natural Resources

A guide to integrated water management in Nebraska

## Stream Depletion and Groundwater Pumping

### Part Two: The Timing of Groundwater Depletions

By James Schneider, Ph.D.

While the information presented in this article is technical in nature, it has been generalized to appeal to a broader audience. This article provides an overview of a very complex topic.

**Introduction**

In most areas of Nebraska, the groundwater system is in direct hydrologic connection with the surface water system. Therefore, the consumptive use of groundwater will have some impact on the amount of groundwater discharge (baseflow) to hydrologically connected streams. Reductions in baseflow due to groundwater pumping are not instantaneous, and may take many years or decades to be fully realized. The time lag between the start of pumping and the advent of streamflow depletions is largely dependant on the distance between the well and the stream, as well as the aquifer and streambed properties.

One factor that will affect lag time is the level of hydraulic conductivity of the materials in the aquifer. Hydraulic conductivity is a measure of the ease with which water travels through aquifer materials. Wells installed near a stream and/or in high hydraulic conductivity materials will have a quicker impact on the streams. Wells installed far from a stream and/or in lower hydraulic conductivity areas can take considerably longer to impact nearby streams (see figures 1a, 1b, and 1c on page 2).

Generally speaking, any consumptive groundwater pumping[1] in a hydrologically connected stream/aquifer system will eventually result in a similar level of stream depletion. However, in a large regional aquifer system such as the High Plains Aquifer in Nebraska (sometimes referred to as the Ogallala Aquifer), this stream depletion due to groundwater pumping during a given year will likely not be realized for many years.

**The Timing of Stream Depletions**

Stream depletions cannot be directly measured. Therefore, groundwater models are widely used to simulate past and predict future impacts to streams due to groundwater use. A calibrated groundwater model can be run with and without estimated past pumping rates. The difference between the baseflow to the streams for these two scenarios is referred to as stream depletion due to groundwater use. The model can then be run forward in time using similar scenarios

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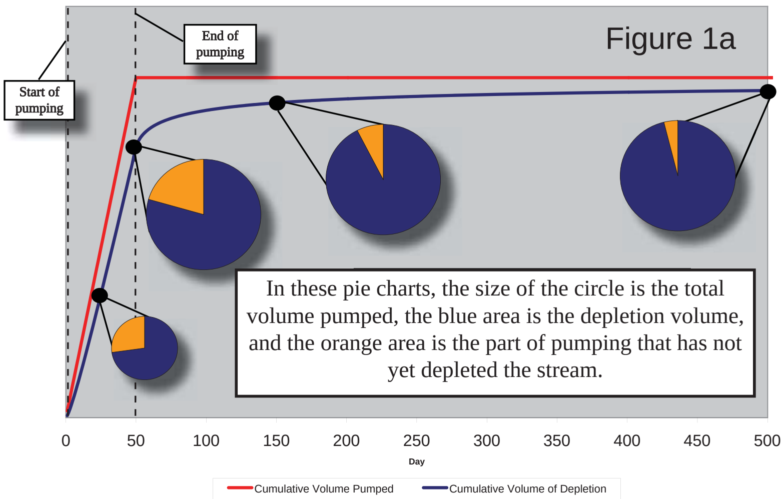
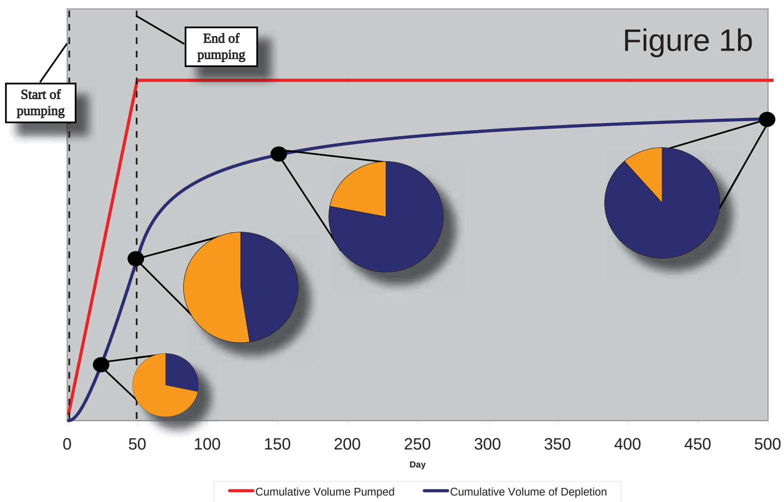


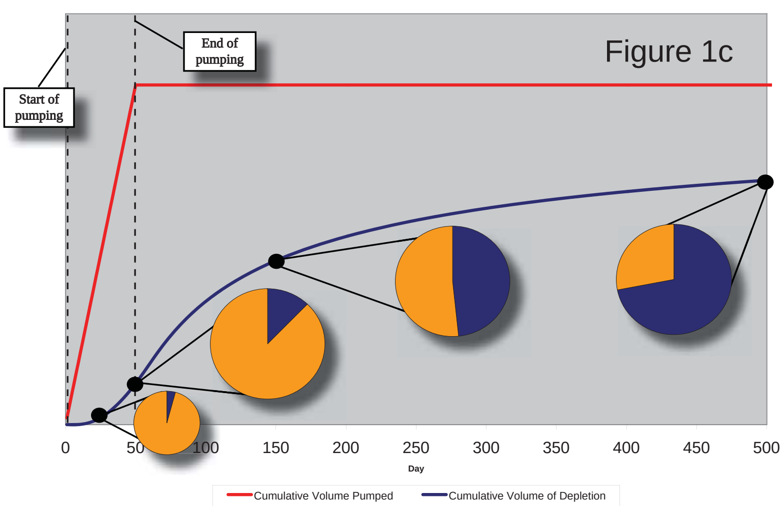
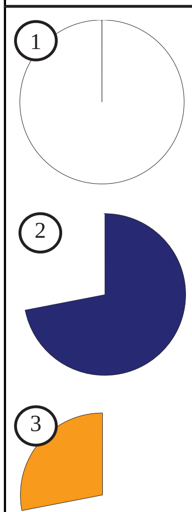




**Figure 1 (a, b, c):** Three hypothetical scenarios in which three different wells pump for 50 days. In all three of these scenarios, the wells pump the same volume of water. The red line shows the cumulative volume of groundwater that is pumped and the blue line represents the volume of depletion to streamflow. Again, in all three of these scenarios, the cumulative volume pumped is the same. However, the rates of depletion differ significantly. Even though the depletion rates differ, it is important to note that in all three scenarios, the volume of groundwater pumped and the volume of the depletion will eventually be nearly equal. This means that all pumping will eventually result in a near 100% depletion. However, the amount of time it takes for the depletion to be fully realized will differ depending on depletion rate. For example, in figure 1a, roughly 96% of the volume of groundwater pumped has depleted the stream after 500 days. In figure 1b, roughly 89% of the volume of groundwater pumped has depleted the stream after 500 days. And in figure 1c, roughly 72% of the volume of groundwater pumped has depleted the stream after 500 days. The pie charts show the volume of streamflow depletion relative to the volume of water pumped. The depletion rate (and therefore the depletion volume) will depend on many factors, such as aquifer properties and distance to the stream.

## Explanation of Pie Charts in Figures 1a, 1b, and 1c




The pie charts in figures 1a, 1b, and 1c show the amount of streamflow depletion relative to the volume of water pumped. Here, pie chart 1 represents the height of the red line, which is the entire amount pumped. Pie chart 2 represents the height of the blue line, which is only the depletion due to groundwater pumping at day 500 in figure 1c. Note that the pie chart is incomplete: there is a portion of the full pie (which represents the volume of water pumped) that is missing. Pie chart 3 is that missing piece. The orange area represents the difference between pie charts 1 and 2, which is the distance between the red and blue lines. This is portion of the groundwater pumping that has not yet been realized as a depletion.

to estimate projected stream depletions due to past, current, and/or future groundwater use.

To better understand this long-term relationship between groundwater pumping and stream depletions, it is useful to separate streamflow depletions for a given basin into two components that are best understood in terms of some reference year (any appropriate year against which future depletions are measured). Relative to this reference year, there are residual impacts to streamflow from pumping that has occurred in the past and there are the lagged impacts of current pumping levels continuing into the future. Model scenarios can be used to illustrate the relative amount of each of these factors in the projected future streamflow depletions.

## Residual Depletions

The scenario in figure 2 illustrates the residual impacts to streamflow from pumping that has occurred in the past (i.e. up to the reference year). It is important to note that in figures 1a, 1b, and 1c, *cumulative volumes* of pumping and depletion were shown. However, in the upcoming figures, pumping and *depletion rates* are shown. While cumulative volume measurements reflect the total volume of water pumped or depleted up to a given time, the rate is the volume of water pumped or depleted at one specific point in time.

The bars in figure 2 represent the amount of groundwater pumping during a given year (the rate of groundwater pumping), and the line represents the impact of this pumping on streamflow (this rate of streamflow depletion may be affected by pumping that has occurred in the past). The short term variability in the depletions curve is due to changes in year-to-year rainfall totals, which also affect the amount of streamflow. In this example, groundwater pumping has increased up to a given level through year six (the reference year in this scenario), after which all current pumping is set to zero. Despite the fact that no further pumping occurs beyond year six in this example, baseflow to the stream continues to be depleted due to continued effects of pumping that occurred during and before year six. This is referred to as the residual effect.

The residual effect has both a time component and a streamflow depletion component. The residual depletion is the streamflow depletion remaining during any given year after the reference year due to pumping that has occurred up to that reference year. The recovery time is the length of time after the reference year required for the residual depletions to approach zero.

The information on residual depletions and recovery time is compiled by running a groundwater model through this scenario. The model is run up to the reference year with groundwater use active, then it is run forward beyond the reference year with all pumping removed to quantify the recovery of baseflow to the streams. In this example, year six is the reference year, and the residual depletions approach zero sometime around year 41, for a recovery time of approximately 35 years (figure 2).

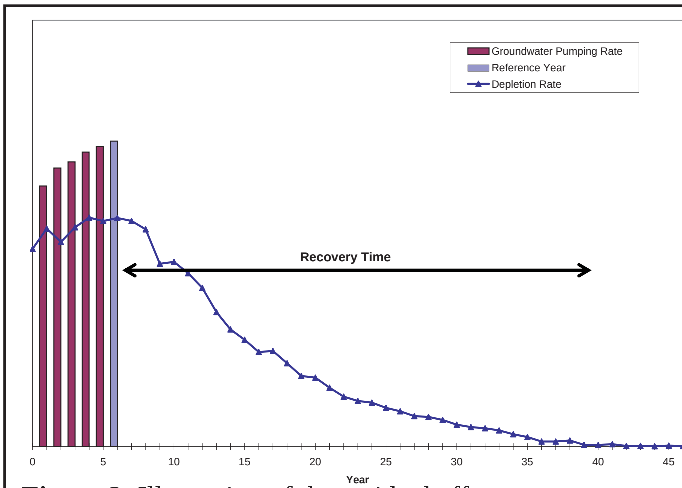



**Figure 2**: Illustration of the residual effect.

## Lagged Depletions

Figure 3 illustrates a modeling scenario demonstrating the lagged impact to streamflow due to current levels of pumping. Here, groundwater pumping has been increasing until year six (reference year), at which time a hypothetical moratorium is placed on further well development in this basin, which is modeled as constant pumping for every year after the reference year (year six). This time, however, the model is run beyond the reference year with a constant level of pumping to assess the depletions to the stream due to past and current levels of water use. As in our first scenario, we observe short-term fluctuations due to the effects of annual precipitation variability. However, streamflow depletions will continue to increase despite the constant level of pumping. This is referred to as the lag effect. The depletions curve generated in this

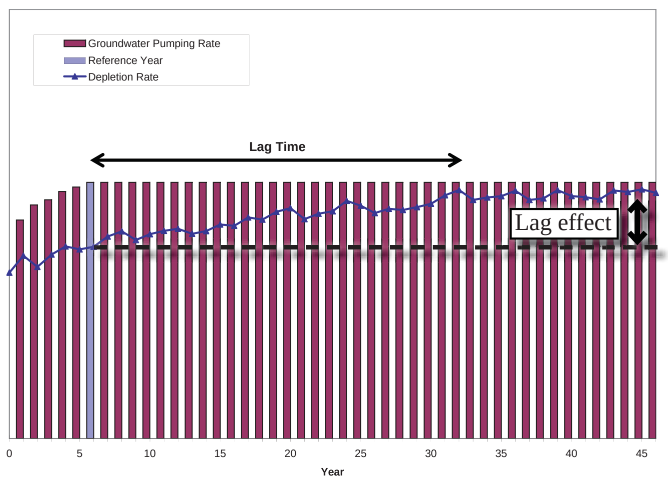


**Figure 3:** Illustration of the lag effect.

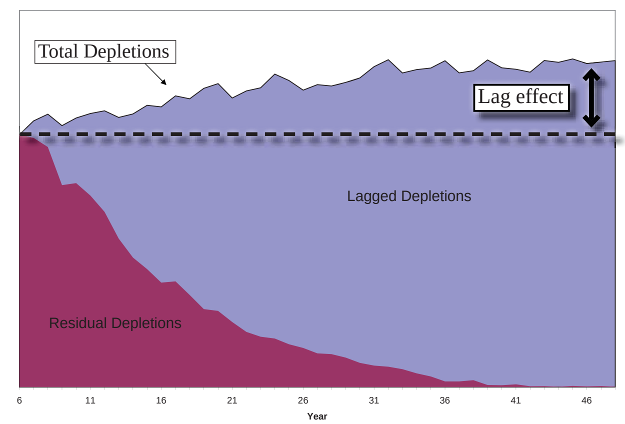


**Figure 4:** The residual and lagged components of total depletion beginning at the reference year (year 6).

scenario includes both the residual and lag depletions.

The lag effect also has a time and streamflow depletion component. The lag time is the length of time before the streamflow depletions come into equilibrium with continued groundwater pumping, and is defined in relation to a reference year. In this model scenario, the streamflow depletions appear to begin to reach equilibrium with respect to year six levels of pumping around year 36, for a lag time of approximately 30 years (figure 3). The lagged depletions for a given year are the difference between the residual depletions and the total depletions (figure 4).

## Summary

The successful management of hydrologically connected waters requires an understanding of the complex effects of groundwater pumping on stream baseflow. The timing of the components of stream depletion are most easily discussed relative to points in time (a reference year) with an eventual realization of all consumptive groundwater withdrawals as stream depletions, years to centuries in the future. Understanding the timing of these effects and the response of hydrologically connected streams to groundwater pumping is critical in long–term management and planning.

This edition of *Water Matters* will be referenced and discussed in the October 2010 DNR newsletter.

Please contact the Nebraska Department of Natural Resources with questions or concerns about this publication at (402) 471-2363.

Visit the Integrated Water Management Division's website at http://www.dnr.ne.gov/IWM for up-to-date information. *Water Matters* is available at this website.