# Appendix A

## UPPER PLATTE RIVER BASIN INSIGHT ANALYSIS

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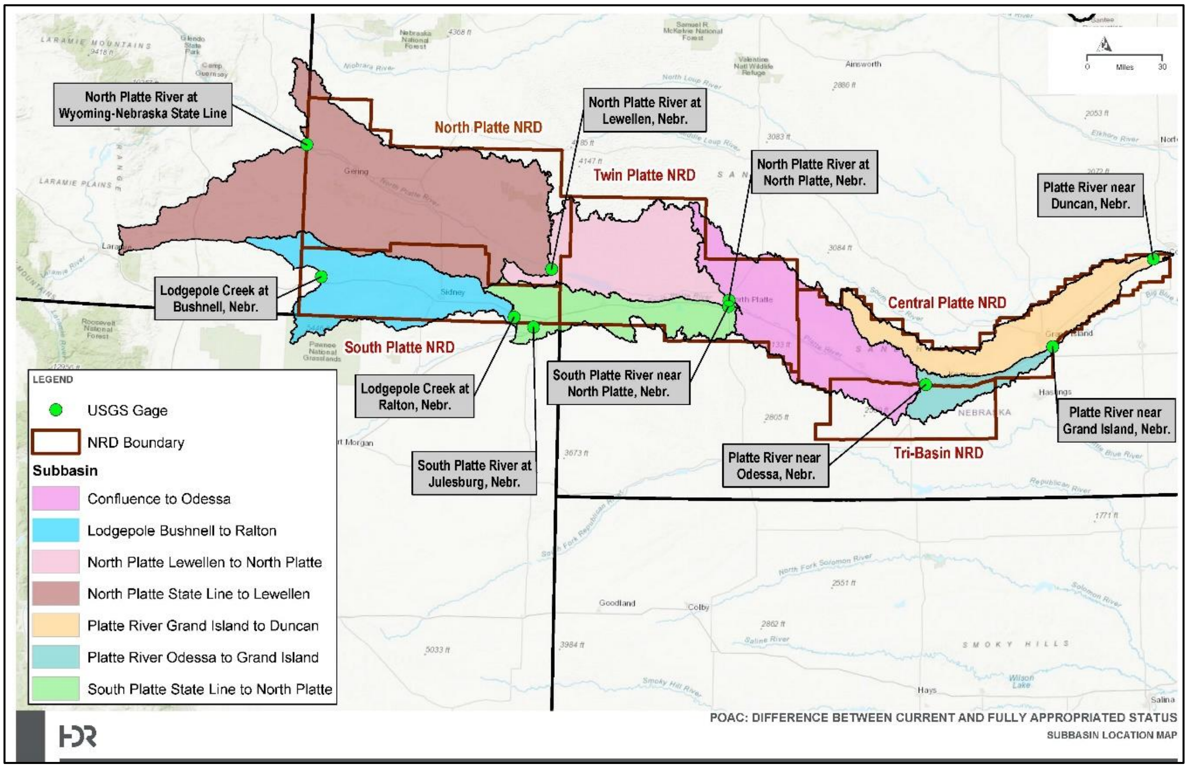
## 1.0 Introduction and Background

This report documents the application of the NeDNR INSIGHT methodology, with appropriate modifications described herein, to the Upper Platte River Basin. This effort was performed by HDR on behalf of the Platte Basin Coalition (PBC). The PBC was formed through an Interlocal Cooperation Agreement among the Nebraska Department of Natural Resources (NeDNR) and the following five Natural Resources Districts (NRDs) that encompass the Upper Platte River Basin:

- North Platte Natural Resources District (NPNRD)
- South Platte Natural Resources District (SPNRD)
- Tri-Basin Natural Resources District (TBNRD)
- Twin Platte Natural Resources District (TPNRD)
- Central Platte Natural Resources District (CPNRD)

The Upper Platte River Basin includes the North Platte River, South Platte River, and Platte River from the confluence to Duncan, as shown in Figure 1. It is noted that the Lodgepole Creek basin illustrated in Figure 1 was not explicitly included in this analysis. Lodgepole Creek flows through the southwest corner of the Nebraska Panhandle into Colorado, before joining the South Platte River upstream of the Julesburg, CO gage on the South Platte River. As such, Lodgepole Creek was not considered for the analysis of the Upper Platte River basin.

Figure 1: Subbasins in the Upper Platte River Basin Overlaid by NRD Boundaries



The HDR Team applied the NeDNR INSIGHT methodologies, with modifications as noted herein, to the Upper Platte River Basin to assist in evaluating the overall difference between the current and fully appropriated levels of development within the overappropriated portion of the Platte River Basin. The Act (*Neb. Rev. Stat.* § 46-713 (3)), defines that the overall difference between the current and fully appropriated levels of development to mean the extent to which existing uses of hydrologically connected surface water and ground water and conservation activities result in the water supply available for purposes identified in subsection (3) of section *Neb. Rev. Stat.* § 46-713 to be less than the water supply available if the river basin, subbasin, or reach had been determined to be fully appropriated in accordance with section *Neb. Rev. Stat.* § 46-714. This, in essence, suggests the overall difference between current and fully appropriated levels of development is determined through the rules and methods used by NeDNR to designate basins as fully appropriated.

The rules and methods used by NeDNR to designate a basin as fully appropriated in accordance with *Neb. Rev. Stat.* § 46-714 primarily rely on the evaluation of junior natural-flow surface water irrigation appropriations (see N.A.C. Title 457, Chapter 24 and Annual Evaluation of Availability of Hydrologically Connected Water Supplies, December 30, 2016). The rules further establish that in the event other natural-flow and storage appropriations need to be considered, NeDNR has the ability to utilize a standard of interference appropriate for the use in conducting its evaluation. Through the course of attempting to apply the rules and methods to the complexities of the Upper Platte River Basin, NeDNR and NRDs have agreed that further standards are necessary and have applied different methods (see INSIGHT, Preliminary Estimate of Historical Stream Flow Reductions in the Overappropriated Portion of the Platte River in Nebraska, 2009) to support the assessments. These alternative methods remain flexible to NeDNR and the NRDs and may be refined in subsequent evaluations.

The technical evaluations described in this report, in conjunction with other supporting data, are ultimately used to establish appropriate IMP goals and objectives. The IMPs must contain clear goals and objectives with a purpose of sustaining a balance between ***water uses*** and ***water supplies*** so that the economic viability, social and environmental health, safety, and welfare of the river basin, subbasin, or reach can be achieved and maintained for both the near term and the long term (*Neb. Rev. Stat.* § 46-715 (2)). Understanding that water uses cannot exceed water supplies (natural-flow and storage supplies), a balance will likely exist each year in the overappropriated basin. However, ***water demand*** can exceed water use when supplies are limited. Even if all water users have access to and are able to use water supplies, their total demand may not be met. It is important to review the distribution of the balance of water supply and water use among various water users to see which users might not be meeting their full demand. The distribution of water use among the different user groups in the basin and the degree to which the use meets the demand is what influences the economic viability, social and environmental health, safety, and welfare of the river basin. Therefore, establishing appropriate goals and objectives in the IMP requires careful consideration of this distribution, as well as the total water use and supply, in order to ensure that the balance recognizes the overall welfare of the basin.

The application of the NeDNR INSIGHT methodology to the Upper Platte River basin then provides information on water supplies, as well as the distribution of water use among the different user groups and the degree to which the use meets the demand.

## 2.0 INSIGHT -(Integrated Network of Scientific Information and GeoHydrologic Tools)

INSIGHT (Integrated Network of Scientific Information and GeoHydrologic Tools) is a web-based, interactive tool[1] developed by NeDNR in support of required and voluntary integrated water management planning efforts pursuant to Neb. Rev. Stat. § 46-715. INSIGHT consolidates data from several sources, including NeDNR, the United States Geological Survey (USGS), the United States Bureau of Reclamation (USBR), and local NRDs. The NeDNR uses that hydrologic data to conduct an analysis of the following items at the basin- and subbasin-level: 1) streamflow water supplies available for use, 2) the current amount of demand on these supplies, 3) the long-term demand on these water supplies due to current uses, 4) the projected long-term demand on these water supplies due to five percent growth in total use[2], and 5) the balance between these water supplies and demands. . The INSIGHT website displays the results of this analysis in various charts and graphs.

The NeDNR INSIGHT methodology examines a statistically unbiased period of record (see Section 2.1.6). The analysis evaluates basins and subbasins on both a seasonal and annual time-frame. The two sub-periods within the year are the "Peak Season" (June 1 through August 31) and the "Non-peak Season" (September 1 through May 31). If a basin's near-term demand and/or the long-term demand of hydrologically connected groundwater and surface water exceeds the basin water supplies (BWS) during either of the two sub-periods when summed over the time period utilized in the evaluation, then supplies may not be sufficient to sustain the demands over the long term.". The geographic area within which the NeDNR considers surface water and groundwater to be hydrologically connected for the purpose prescribed in *Neb. Rev. Stat.* §46-713(3) is the area within which pumping of a well for 50 years will deplete the river or a base flow tributary thereof by at least ten (10) percent of the amount pumped in that time. This area is also referred to as the 10/50 area or the hydrologically connected area.[3]

The components that make up the BWS, near-term demand and long-term demand are described in greater detail in the following sections.

## 2.1 Intrinsic Supply

The BWS is made up of four components: 1) streamflow reach-gain/ loss; 2) surface water consumptive use; 3) streamflow depletions from groundwater pumping (also referred to as groundwater depletions; and 4) required inflow (or the amount of water that is necessary to flow out of basins or subbasins upstream to a given location). Required inflow does not represent water that is required by law or permit, but rather the typical amount of water a basin or subbasin relies upon from upstream under the NeDNR INSIGHT methodology.

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[1] The INSIGHT interactive tool is available at https://nednr.nebraska.gov/INSIGHT/.

[2] The projected growth in long-term demand was not applied in the Upper Platte River basin analysis as new uses are regulated

[3] The Department determined hydrologically connected areas using the 10/50 area as established under Regulation 457 NAC 24.001.02. The analytical approach for determining the 10/50 area is described further in the INIGHT documentation.

The intrinsic supply is the same as the BWS but does not include the required inflow term. It is necessary to calculate the intrinsic supply of the subbasins before the BWS can be computed because the ratio of intrinsic supplies is used to proportion the supplies (the required inflow term) and demands (downstream demand term). Section 2.3.5 explains this proportioning in greater detail. Because of this, the required inflow term will be discussed separately in Section 2.3.6. The remainder of this section will focus on the components of the intrinsic supply.

### 2.1.1 Streamflow

The streamflow volumes represent the amount of water that originates within that particular subbasin or reach. If an upstream subbasin is present, only the streamflow reach-gain/loss is considered. USGS streamflow records and NeDNR streamflow records were used to determine the streamflow reach-gain/loss discussed. Table 1 lists the gage locations and the associated period-of-record used in this analysis.

**Table 1: Stream Gage Locations**

| Gage | Gage Number | Period-of-Record Utilized |
|---|---|---|
| South Platte River at Julesburg, Co. | 06764000 | 1988-10-01 to 2012-09-30 (USGS) |
| South Platte River at North Platte, Nebr. | 06765500 | 1988-10-01 to 1994-09-30 (USGS);<br>1994-10-1 to 2012-9-30 (NeDNR) |
| Western Canal from South Platte River | 147000 | 1988-10-01 to 2012-09-30 (NeDNR) |
| South Platte Supply Canal (Korty) from South Platte River | 06764900 | 1988-10-01 to 2012-10-01 (NeDNR) |
| South Platte River at Paxton, Nebr. | 06765000 | 1988-10-01 to 1970-04-30 |
| North Platte River at Lewellen, Nebr. | 06687500 | 1988-10-01 to 1991-09-30 (USGS);<br>1991-10-1 to 2012-9-30 (NeDNR) |
| North Platte River at North Platte, Nebr. | 06693000 | 1988-10-01 to 1994-09-30 (USGS);<br>1994-10-1 to 2012-9-30 (NeDNR) |
| North Platte River at Keystone, Nebr. | 06690500 | 1988-10-1 to 1994-09-30 (USGS);<br>1994-09-30 to 2012-9-30 (NeDNR) |
| Sutherland Power Return at South Platte River | 140000 | 1988-10-1 to 2012-9-30 (NeDNR) |
| Tri-county Diversion | 142000 | 1988-10-1 to 2012-9-30 (NeDNR) |
| Platte River near Odessa, Nebr. | 06770000 | 1988-10-01 to 1991-09-30 (USGS);<br>1991-10-1 to 2012-9-30 (NeDNR) |
| Platte River near Grand Island, Nebr. | 06770500 | 1988-10-01 to 2012-09-30 (USGS) |
| Platte River near Duncan, Nebr. | 06774000 | 1988-10-01 to 2012-09-30 (USGS) |

Additionally, to recognize that extreme flow events produce water that often cannot be utilized or stored in reservoir systems, the NeDNR INSIGHT methodology reduces the daily streamflow or reach-gain/loss values with an exceedance probability[4] of 5 percent or less to the value corresponding to the 5

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[4] The exceedance probability is the probability of occurrence for each flow level. Higher flows are exceeded less frequently and therefore have a lower exceedance probability

percent exceedance probability, as shown in Figure 2.[5] It should be noted that no cap was applied to those stream gages upstream of Lake McConaughy as it was assumed that extreme flow events could be captured in this reservoir. Table 2 below lists the daily caps for each gage location where these caps were applied

Figure 2: Example of an Exceedance Plot and the Result from Capping Streamflows at 5 percent Exceedance Flow Probability (Source: "INSIGHT Methods" 2015)

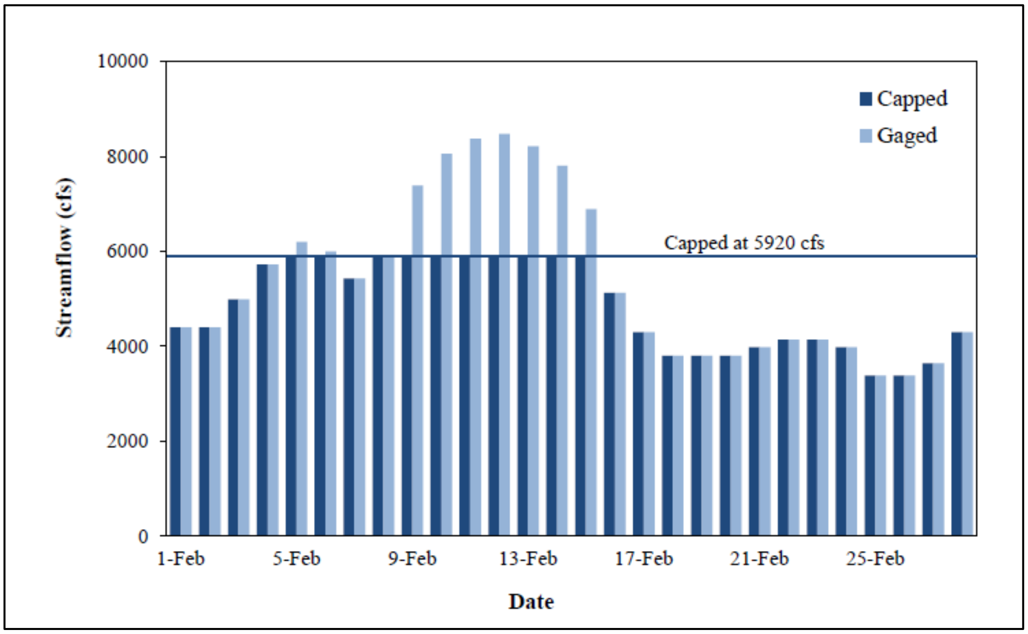

Table 2: Daily Streamflow Cap by Gage Location

| Basin | Streamflow Cap, AF |
|---|---|
| North Platte River at Lewellen | N/A[1] |
| North Platte River at North Platte | 4,198 |
| South Platte River at South Platte | 2,772 |
| North Platte River at Keystone | 4,673 |
| Platte River at Confluence | 9,583 |
| Platte River at Odessa | 9,207 |
| Platte River at Grand Island | 9,662 |
| Platte River at Duncan | 11,365 |

[1] The gages above Lake McConaughy were not capped. Unlike the extreme events below Lake McConaughy, the extreme events above Lake McConaughy could be captured and stored in the reservoir.

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[5] This analysis uses 5% to remain consistent with how NeDNRcurrently adjusts streamflow in INSIGHT. Specific values for each subbasin or basin may be incorporated into future evaluations. The streamflow gages upstream of Lake McConaughy were not capped as Lake McConaughy is large enough to capture extreme flow events.

The confluence of the North and South Platte Rivers is not gaged and was estimated as follows:

Estimated Flow at Platte River Confluence = North Platte River at North Platte gage + South Platte River at North Platte gage + Sutherland Return

The South Platte River at Paxton gage was closed in 1970. The South Platte River at Paxton gage is necessary to determine the undepleted streamflow[6] in order to limit the Sutherland hydropower demand.[7] Thus, it was necessary to calculate a synthetic South Platte River at Paxton gage as follows[8]:

South Platte River at Paxton = South Platte at Roscoe gage + Streamflow Reach-gain/Loss (Roscoe to North Platte)

In order to remove the affect the Lake McConaughy operations has on the North Platte River, Lewellen to North Platte subbasin, the streamflow reach-gain/loss for the North Platte River, Lewellen to North Platte was estimated as follows:

Estimated Streamflow Reach-Gain/Loss North Platte Subbasin = North Platte River at North Platte gage – North Platte River at Keystone + 40 cfs

The streamflow reach- gain/loss term for the South Platte River, Julesburg to North Platte was calculated as follows:

Estimated Streamflow Reach-Gain/Loss South Platte Subbasin = South Platte River at North Platte gage + Korty Diversion

The streamflow reach-gain/loss term for the Platte River, Confluence to Odessa was calculated as follows:

Estimated Streamflow Reach-Gain/Loss Odessa Subbasin = Estimated Flow Platte River at Confluence + Kearney Diversion

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[6] Undepleted streamflow is a term coined by NeDNR to describe the cap used in the NeDNR INSIGHT methodology when capping a hydropower or instream flow demand. This is calculated as the gaged streamflow plus the groundwater depletions for that subbasin.

[7] See sections 2.3.3.1 and 2.3.3.2 for further description of the undepleted streamflow and hydropower demand.

[8] RGL obtained from ftp://dnrftp.dnr.ne.gov/Pub/cohystftp/2010Report/Section12_Linked%20Doc%20List/Linked_Documents/1984-2008_Reach_Gain_Loss.xlsx.

## 2.1.2 Groundwater and Surface Water Models

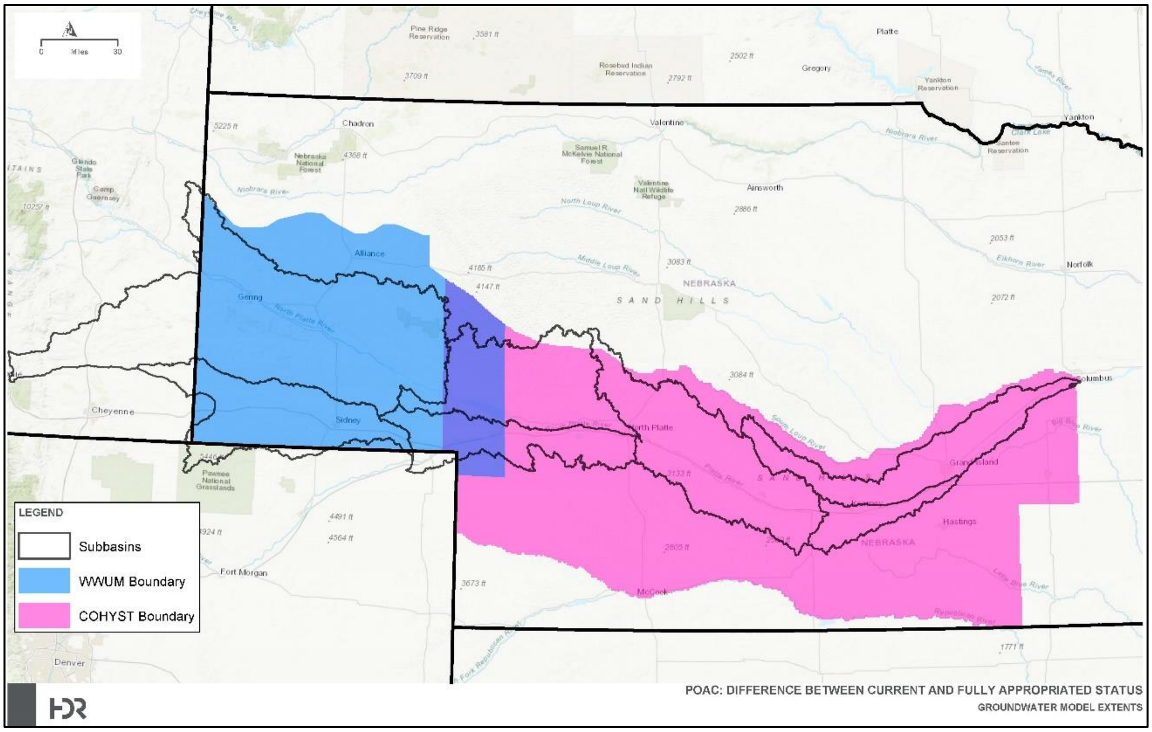
### 2.1.3.1 Western Water Use Model (WWUM)

The WWUM covers the central and southern panhandle in Western Nebraska and extends east to include Lake McConaughy and a small portion of the South Platte River. The model is an integrated tool consisting of a surface water operations model, groundwater flow model, and soil-water balance model. Groundwater depletion, groundwater consumptive use, surface water consumptive use, and seepage data from WWUM were used in this analysis.[9]

### 2.1.3.2 Cooperative Hydrology Study (COHYST)

The COHYST 2010 model covers the Platte River Basin from Lake McConaughy downstream to Chapman, Nebraska and takes into account surface water as well as groundwater. COHYST 2010 consists of three integrated modeling tools –watershed model for land, surface water model for the river (STELLA), and groundwater model for the aquifer. Groundwater depletion, groundwater consumptive use, surface water demand, and seepage data from COHYST were used in this analysis.[10]

**Figure 3: Groundwater Model Extents**



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[9] Visit https://dnr.nebraska.gov/Western-Water-Use-Conjunctive-Use-Model for more information on the Western Water Use Model.

[10] Visit https://dnr.nebraska.gov/COHYST-Conjunctive-Use-Model for more information on the COHYST Model.

### 2.1.3 Surface Water Consumptive Use (SWCU)

Surface water consumptive use is defined as water that is used directly from the stream (or other surface water body) to make full beneficial use of an existing irrigation, municipal, or industrial use, accounting for limitations on the supply available. Surface water consumptive use is transpired, evaporated, or otherwise consumed and does not return to the stream.

The NeDNR INSIGHT methodology separates the surface water consumptive use (SWCU) into four main use categories: 1) irrigation; 2) municipal; 3) industrial; and 4) evaporation from large water bodies. In the WWUM and COHYST model areas, there are currently no municipal and industrial users that rely on direct surface water sources. Therefore, under the NeDNR INSIGHT methodology, irrigation and evaporation are the only surface water consumptive uses evaluated for this analysis. SWCU irrigation demand estimates were obtained from the WWUM and COHYST models and the reservoir evaporation was calculated separately. See Section 2.1.5 for further discussion of reservoir evaporation. The remainder of this section will focus only on the SWCU for irrigation.

SWCU estimates were readily available from the models described in Section 2.1.2. The WWUM SWCU estimates were used for the North Platte River above Lewellen. The COHYST full surface water demand estimates were used for the North Platte River below Lewellen, the South Platte River subbasin, and the Platte River from the confluence to Duncan. Because COHYST reports the full surface water demand, these data were multiplied by a 0.65 to convert the full surface water demand to SWCU.[11] For purposes of this analysis (consistent with INSIGHT), the SWCU demands are assigned at their associated points of diversion. Table 3 indicates those surface water canals with surface water rights associated with this analysis.

SWCU associated with the WWUM were provided by Adaptive Resources, Inc. (ARI) with the efficiency factor already incorporated; therefore, no further adjustment to reported results was necessary. Rather than using a constant efficiency factor, the WWUM varies the efficiency factor through time based on evolution of irrigation practices and seasonally based on flow-dependent system losses. .[12]

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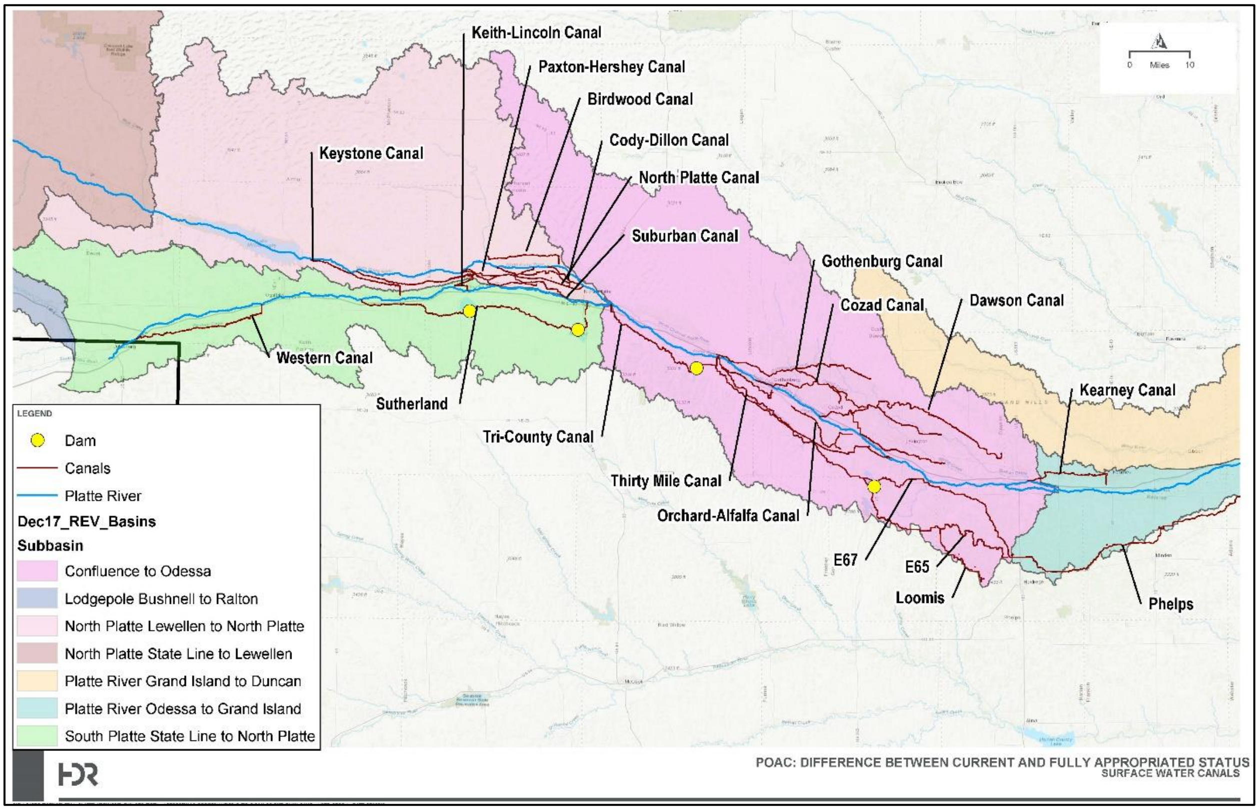
[11] Of the water applied, 65% is consumed via evaporation and transpiration by plants (Trenberth et al. 2007. Estimates of the Global Water Budget and Its Annual Cycle Using Observational and Model Data. Journal of Hydrometeorology 8:758-769). The remaining net diversion (100% - 65% = 35%) is assumed to have recharged to groundwater or field runoff.

[12] Western Water Use Management Model Historical Crop Consumptive Use Analysis, Final Report, July 2014 by Wilson Water Group

## Figure 4: STELLA Surface Water Canals



STELLA, the surface water operations model for the COHYST area, incorporates crop demands from CropSim. The approach for incorporating irrigation demands for lands served by surface water canals is documented in *Section 6.6 Operational Rules* of the COHYST documentation[13]. In general, the annual irrigation demand is distributed to constant values for four distinct periods (June 16-30, July, August, and Sept 1-10) as shown in Table 4.

## Table 3: STELLA Surface Water Canals that Serve Water Rights

| Canal | Basin Demand Assigned To: |
|---|---|
| Western | South Platte River; State Line to North Platte |
| Keith-Lincoln | North Platte River; Lewellen to North Platte |
| North Platte | |
| Paxton-Hershey | |
| Suburban | |
| Cody-Dillon | |
| Tri-County/E65/E67/Phelps | Platte River; Confluence to Odessa |
| Gothenburg | |
| 30 Mile | |
| 6 Mile | |
| Cozad | |
| Orchard-Alfalfa | |

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[13] http://cohyst.nebraska.gov/

| | |
|---|---|
| Dawson | |
| Kearney | |

**Table 4: Distribution of CropSIM Irrigation Demand in STELLA**

| Month | Percentage |
|---|---|
| June 16-30 | 7.4% |
| July | 50.0% |
| August | 35.9% |
| Sept 1-10 | 6.7% |

### 2.1.4 Groundwater Depletion (GWDP)

The depletions analysis consists of a comparison of two model runs: 1) one that represents historical pumping; and 2) another that represents the basin without pumping. The difference between these two model runs indicates the depletions to streamflow from groundwater pumping. The NeDNR INSIGHT methodology considers depletions from irrigation, municipal, and industrial groundwater withdrawals. Groundwater depletions (GWDP) are used as a component of BWS as well as to represent near-term demand of groundwater uses (see Section 2.5 for discussion on the near-term demand).

The above mentioned groundwater models as well as analytical results were used to estimate the groundwater depletions as part of this analysis. The COHYST depletion estimates were used for the South Platte River Julesburg to North Platte, North Platte Lewellen to North Platte, and Platte River confluence to Duncan reaches. The depletions estimates from the WWUM were provided by ARI for the North Platte River (Wyoming state line to the eastern boundary of the NPNRD), South Platte River (SPNRD along the South Platte River), Lodgepole Creek (Wyoming state line to Colorado state line), and Lake McConaughy (including North Platte River, Lake McConaughy, and tributaries).

### 2.1.5 Reservoir Evaporation (Res Evap)

The NeDNR INSIGHT methodology considers evaporation for reservoirs with a capacity greater than 32,000 acre-feet as a surface water consumptive use. The reservoirs included in this analysis were Sutherland Reservoir, Lake Maloney, , Elwood Reservoir, Lake McConaughy, and the Inland Lakes.

Surface area and net evaporation for these reservoirs were calculated as part of the COHYST modeling. The surface areas for the reservoirs were calculated as a function of storage volumes using the equations shown in Tables 5 and 6.

**Table 5: Lake McConaughy Surface Area Equations for STELLA Modeling**

| Volume Bounds | Surface Area Equation<br>Y = area (acres)<br>X = storage (AF) |
|---|---|
| 80 AF to 53,900 AF | $y = 0.085x + 526.27$ |
| 53,900 AF to 104,900 AF | $y = 0.047x + 2094.98$ |

| | |
|---|---|
| 104,900 AF to 205,900 AF | y = 0.028x + 4168.00 |
| 205,900 AF to 310,100 AF | y = 0.021x + 5373.07 |
| 310,100 AF to 412,400 AF | y = 0.020x + 5680.17 |
| 412,400 AF to 501,100 AF | y = 0.017x + 6965.21 |
| 501,100 AF to 704,100 AF | y = 0.014x + 8764.34 |
| 704,100 AF to 1,273,900 AF | y = 0.011x + 10221.33 |
| 1,273,900 AF to 1,773,800 AF | y = 0.012x + 10225.93 |
| 1,773,800 AF to 2,315,500 AF | y = 0.010x + 12939.88 |

Table 6: Other Reservoir Surface Area Equations for STELLA Modeling

| Reservoir | Surface Area Equation<br>Y = area (acres)<br>X = storage (AF) |
|---|---|
| Sutherland Reservoir | $y = -0.00000031x^2 + 0.054x + 1127.47$ |
| Lake Maloney | $y= -0.00000197x^2 + 0.103x + 411.54$ |
| Elwood Reservoir | $y = -0.00000023x^2 + 0.035x + 162.10$ |

These evaporative losses are estimated by accessing information on pan evaporation, surface area, and precipitation. The equation for calculation Reservoir Evaporation[14] is:

Reservoir Evaporation = [(Pan evaporation*0.7*surface area) – (precipitation*surface area)]

Following this formula, the net evaporation equations used in the STELLA Modeling are calculated using the formulas shown in Table 7.

Table 7: Reservoir Net Evaporation Equations for STELLA Modeling[15]

| Reservoir | Surface Area Equation (acre-ft/day (AFD)) |
|---|---|
| Lake McConaughy | ((Kingsley_Dam_Pan_Evap_in/12) x 0.7 x LakeMac_Surface_Area_AC)-((Kingsley_Dam_Precip_in/12) x LakeMac_Surface_Area_AC) |
| Sutherland Reservoir | ((North_Platte_Pan_Evap_in/12) x 0.7 x Suth_Res_SurfaceArea_ac)-((North_Platte_Precip_in/12) x Suth_Res_SurfaceArea_ac) + Suth_Res_heat_ind_evap_afd) |
| | STELL A uses the minimum of the equation above or 80 afd for Sutherland |
| Lake Maloney | ((North_Platte_Pan_Evap_in/12) x 0.7 x Maloney_SurfaceArea_ac)-((North_Platte_Precip_in/12) x Maloney_SurfaceArea_ac) |
| Elwood Reservoir | (((Gothenburg_Pan_Evap_in/12) x 0.7)-(Gothenburg_Precip_in/12)) x Elwood_Res_Surface_Area_ac |

National Weather Service data used in the analysis come from the University of Nebraska, High Plains Regional Climate Center (HPRCC): www.hprcc.unl.edu/index.php. The stations utilized are shown in Table 8.

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[14] The 0.7 is a multiplier to reduce pan evaporation to values more representative of a large water body (Farnsworth et al., 1982. Evaporation Atlas for the Contiguous 48 United States. NOAA Technical Report NWS 33).

[15] The Kingsley Evaporation data was obtained from the HPRCC. Per discussions with HPRCC and NeDNR, the winter month evaporation estimates are inaccurate and were capped to the average daily evaporation by month.

Table 8: HPRCC Stations

| Station | Used in Analysis | Notes |
|---|---|---|
| North Platte EXP FAR NE | Sutherland Reservoir and Lake Maloney Net Evaporation | Used in computing synthetic Gothenburg station |
| Grand Island WSO AP NE | N/A | Used in computing synthetic Gothenburg station |
| Synthetic Gothenburg Station* | Jeffrey Reservoir, Johnson Lake, and Elwood Reservoir Net Evaporation | Calculated as the average of the North Platte and Grand Island stations |
| Kingsley Dam, NE | Lake McConaughy Net Evaporation | NOAA NCDC gage post 2011 |

### 2.1.6 Period of Record

The evaluation utilizes the most recent period of record that represents naturally occurring wet/dry cycles in order to avoid bias between wet and dry periods and to accommodate non-stationarity in climate cycles. Suitability of the selected climatic period was evaluated by performing an autocovariance and Kendall Tau statistical analysis of the data. The period 1988 to 2012 was utilized for this analysis for the current analysis.

## 2.2 Demand Components

The total demand of water within a basin or subbasin is derived from seven main categories of water use:

1. Consumptive water demands for surface water uses
2. Consumptive water demands for hydrologically connected high capacity (greater than 50 gpm) groundwater well pumping
3. Net surface water loss (canal seepage losses)
4. Streamflow demands for hydropower operations
5. Streamflow demands to meet instream flow demands (accounting for all development in place at the time the appropriation was granted)
6. Downstream demands (the proportionate amount of BWS necessary to meet demands downstream of a given basin or subbasin)

Similar to required inflows, downstream demands do not represent demands that are required to be met by permit or statute, but rather water that is consistent with the NeDNR INSIGHT methodology and a way to provide more spatially refined evaluations.

**Table 9: Components of Demand by Subbasin**

| Subbasin | Groundwater Demand (GWDP or GWCU) | Surface Water Demand (SW Demand) | Net SW Loss | Non-Consumptive Use Demand (NonCU) | | |
|---|---|---|---|---|---|---|
| | | | | Instream Flow Demand | Hydropower Demand | Downstream Demand |
| North Platte River;<br>State Line to Lewellen | X | X | X | | | X |
| North Platte River;<br>Lewellen to North Platte | X | X | X | | X | X |
| South Platte River;<br>State Line to North Platte | X | X | X | | X | X |
| Platte River;<br>Confluence to Odessa | X | X | X | X | X | X |
| Platte River;<br>Odessa to Grand Island | X | | | X | | X |
| Platte River;<br>Grand Island to Duncan | X | | | X | | X |

### 2.2.1 Surface Water Demand (SWDemand)

The surface water demand term is calculated in a similar manner as the surface water consumptive use (SWCU) for the BWS. Only irrigation and evaporation were included in the surface water demand, as there are no municipal or industrial surface water demands in the basin. The only differences were that for the surface water demand calculation, the full surface water demand was accounted for (rather than the historic demand). As described in Section 2.2.3, the surface water demand is applied at the point-of-diversion.

Surface water demands were readily available from the models described in Section 2.2.2. The COHYST full surface water demand estimates were used for the North Platte River below Lewellen, the South Platte River subbasin, and the Platte River from the confluence to Duncan[16].

Surface water demands associated with the WWUM were provided by ARI for the North Platte River above Lewellen. The WWUM surface water demands exclude the acres associated with the State line canals as these demands are served by diversions upstream of the State line. There are three years (1993, 1995 and 1999) that the WWUM modeled SWCU exceeds the surface water demand (which is counterintuitive as the historical use should not exceed the full permitted use). ARI has indicated that there are 1,500 acres included in the SWCU data that are outside the 10/50 area that should be included in the surface water demand for consistency with the NeDNR INSIGHT methodology as a possible cause. ARI has indicated that additional effort would be needed to refine the splits for groundwater and surface water consumptive use on comingled acres as well as including the these 1,500 additional acres in the surface water demand term. These refinements will be accomplished in the next update of the WWUM.s.

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[16] From STELLA Model (HDR): Run 22A_13_21 (Feb 2014)

### *2.2.1.1 Redistributing the Surface Water Demand*

Because the streamflow reach- gain/loss term (described in Section 2.2.1) is calculated as the downstream streamflow reach –gain/loss less the upstream streamflow reach-gain/loss, any water stored in a reservoir is not considered in the basin water supply term. Recognizing that the purpose of storage reservoirs is to store water during the non-peak season and make those flows available during the peak season, the peak season consumptive use demand is adjusted by the non-peak season change-in-storage[17] .[18]The adjustment is calculated as follows:

Adjustment = [Consumptive Use Demands] – {the minimum of [Non-peak Season Change-in-Storage Volume] – [Peak Season Releases] or [Consumptive Use Demands]}

*Note: If the change-in-storage is less than the consumptive use demands, this formula would only reduce the consumptive use demands by the change-in-storage amount. If the change-in-storage exceeds the consumptive use demands, then it would reduce the consumptive use demands to zero.*

## 2.2.2 Groundwater Consumptive Use Demand (GWCU)

Calculation of long-term groundwater demand relied upon the same raw data that was utilized to calculate groundwater depletions (Section 2.2.4).[19] The only difference was that the long-term groundwater demands considers groundwater consumption to be the total net irrigation requirement and removes the lag-effect as if all water consumed is immediately realized in the streamflow. Groundwater depletions are the lagged impacts of groundwater pumping on the stream. The assumption is that over time, within the hydrologically connected area, all groundwater pumping that goes to consumptive use will impact streamflows 100 percent.

COHYST was used to estimate the groundwater consumptive use (GWCU) demand for the North Platte River below Lewellen, South Platte River, and Platte River confluence to Duncan reaches. The model grid was obtained from The Flatwater Group, Inc. (TFG) and clipped down to the 10/50 area. It is important to note that the water balance data provided by TFG was provided on an annual time step. Annual groundwater consumptive uses were distributed 70 percent to the non-peak season and 30 percent to the peak season. The proportioning between the seasons was intended to match the observed seasonal pattern of groundwater depletions.[20]

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[17] The non-peak season change is storage is calculated the May end-of-month volume (current year) less the August end-of-month volume (from the previous year)

[18] This adjustment is made on a year-by-year basis so that the reduction in demand does not exceed that year's change in storage.

[19] The long-term groundwater demand considers all groundwater irrigated acres (not what was historically irrigated as in the depletion term) and the full irrigation requirement.

[20] See *Water Matters: Stream Depletion and Groundwater Pumping Part One: The Groundwater Balance (No. 4, June 2010)* at https://dnr.nebraska.gov/sites/dnr.nebraska.gov/files/doc/water-planning/water-matters/WaterMatters_No4.pdf and *Stream Depletion and Groundwater Pumping Part Two: The Timing of Groundwater Depletions (No. 5, July 2010)* at https://dnr.nebraska.gov/sites/dnr.nebraska.gov/files/doc/water-planning/water-matters/WaterMatters_No5.pdf for more information.

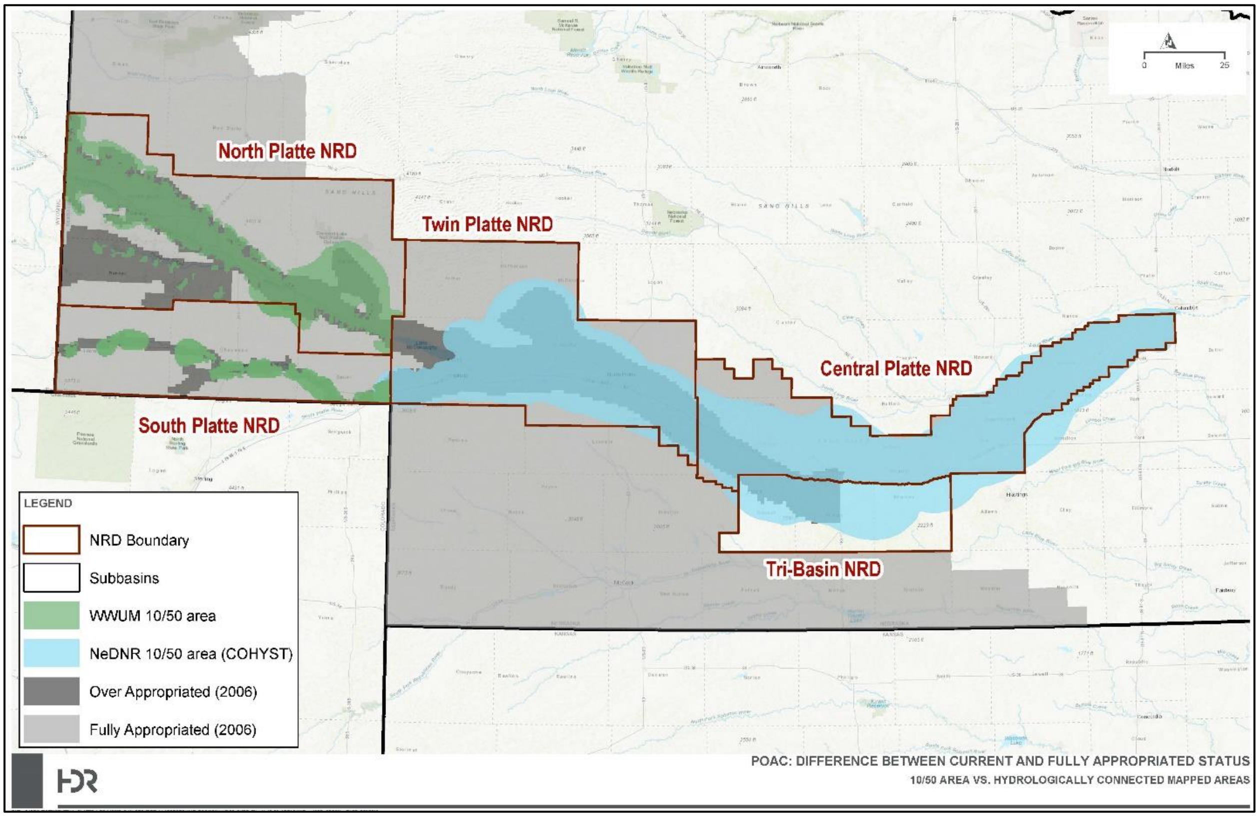
The WWUM GWCU estimates were provided by ARI for the North Platte River above Lewellen reach on a monthly time step. Monthly groundwater consumptive uses were summed on an annual basis and then distributed 70 percent to the non-peak season and 30 percent to the peak season to match the observed seasonal pattern in depletions.

It should be noted that there are occasions when the groundwater depletions exceeded the groundwater consumptive use in the Odessa to Grand Island subbasin (for select years) and State Line to Lewellen subbasin (all years). The occurrences in the Odessa to Grand Island reach appears to be a phenomenon during relatively wet years (1993, 1996, 1998, 1999, 2001, 2007 and 2008). This could be due to relatively high precipitation during the growing season, which would reduce the consumptive use demands on groundwater and surface water, but would not immediately affect groundwater depletions because of the lag effect.

In the State Line to Lewellen subbasin, groundwater depletions exceed groundwater consumptive use for every year. Similar to the surface water consumptive use demand discussion, additional effort may be necessary to refine the splits in this subbasin for groundwater and surface water consumptive use on comingled acres. In addition, depletions are estimated from the entire subbasin, where groundwater consumptive uses are limited to the 10/50 area. Further investigation of the differences and extent of groundwater irrigation use between these two limits may offer insight. These refinements could be accomplished in future analysis.

As an intermediate solution to allow completion of this study effort, the groundwater consumptive use demand was set equal to the groundwater depletions for purposes of this analysis. The effect of this is that the groundwater supply and demand terms cancel each other when comparing supplies and demands and represents a condition where the lag effect of groundwater usage has been removed and the full effect of pumping is being realized on streamflows.

Figure 5: Map of 10/50 Area in Study Area



## 2.2.4 Net Surface Water Loss (Net SW Loss)

Net surface water loss is the water lost through canal seepage after diversion from the stream, essentially the conveyance losses that occur from the point of diversion to delivery at the field turnout. While this water can be beneficial toward recharging the aquifer, the passive return of this water as baseflow does not occur within the same time period (lagged return). Therefore is represents an additional demand for water at the point of diversion to satisfy the downstream surface water demand. For this evaluation, it was assumed that the net surface water loss was the difference of the full diversion and the amount consumed for irrigation.

Canal seepage data from the STELLA model (part of the COHYST integrated model) were utilized as the net surface water loss term. The associated STELLA nodes from which seepage data was obtained are listed in Table 10.[21] Net surface water loss data for canal diversions above Lewellen were obtained from the WWUM and were provided by ARI.

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[21] From STELLA Model (HDR): 'Canal_Res_Seepage_1950_2012.xlsx'; Run 22A_13_21 (Feb 2014)

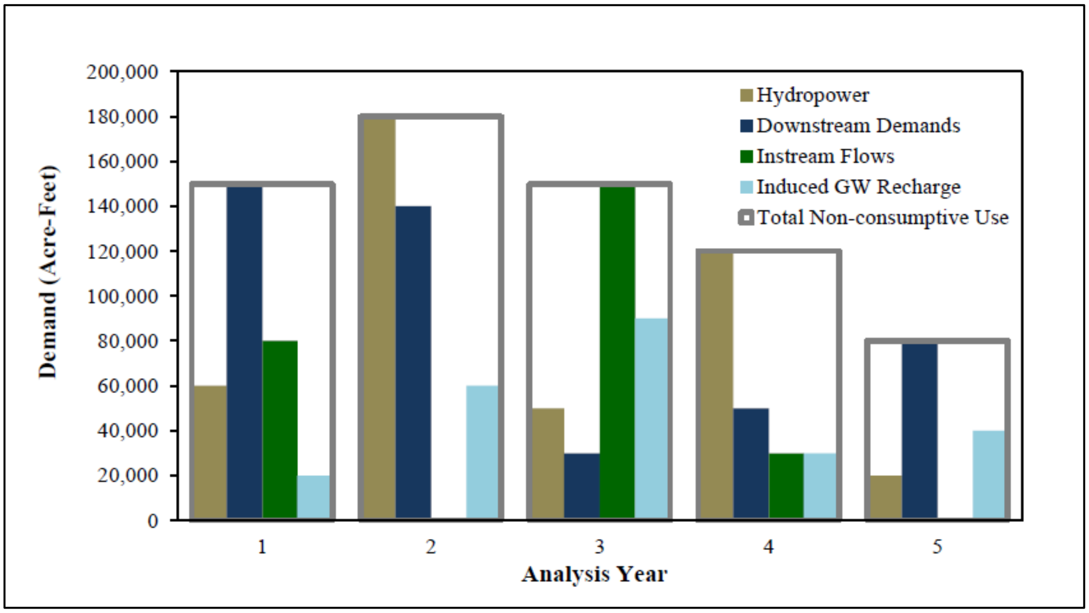
### Table 10: STELLA Seepage Nodes Used for Seepage Estimate

| STELLA Node | River Reach |
|---|---|
| Cody-Dillon | North Platte River;<br>Lewellen to North Platte |
| Keith Lincoln | |
| North Platte Canal | |
| Paxton Hershey | |
| Suburban Canal | |
| Sutherland Canal below Res | |
| Sutherland Canal | |
| Sutherland Reservoir | |
| Sutherland Return | |
| Cozad Canal below Lateral 6 | Platte River;<br>Confluence to Odessa |
| Cozad Diversion | |
| Dawson Canal below Berquist | |
| Dawson Canal below French Creek | |
| Dawson Canal below Lateral 2 | |
| Dawson Canal below Spring Creek | |
| Dawson Diversion | |
| E65 below Elwood Reservoir | |
| E65 Diversion | |
| E65 Lateral 23 7 | |
| E65 Main/Loomis | |
| E67 Diversion | |
| Gothenburg Canal below Lake Helen | |
| Gothenburg Canal below Lateral 6 | |
| Gothenburg Canal below Spring Creek | |
| Gothenburg Diversion | |
| Head gate to Jeffrey | |
| Kearney Canal below Cotton Mill Lake | |
| Kearney Canal below Turkey Creek | |
| Kearney Diversion | |
| Kearney Power Return | |
| Orchard Alfalfa | |
| Phelps below 29 8 (Junction) | |
| Phelps below E65 | |
| Phelps Diversion | |
| Tri-County below 30 Mi Siphon | |
| Below J1 | |
| Below Jeffrey Reservoir | |
| Below Jeffrey Return | |
| J2 Return | |
| 6 Mi Canal | |
| 30 Mile below Midway Lakes | |
| 30 Mile below 30 Mi Siphon | |
| 30 Mile Diversion | |
| 30 Mile below 30 Mi Siphon | |
| 30 Mile Diversion | |
| Western Canal | South Platte River;<br>State Line to North Platte |

## 2.2.3 Non-Consumptive Use Demands (NonCU)

Non-consumptive use demands (NonCU) are demands on the water supply that do not take water out of the stream or consume it therefore the water is available to meet other demands such as instream flow, induced recharge, or downstream demands for consumptive and/or non-consumptive uses. Non-consumptive use demands include hydropower demands, instream flow demands, induced groundwater recharge, and downstream demands. For non-consumptive use demands, the NeDNR INSIGHT methodology only applies the greater of the non-consumptive demands, i.e. the non-consumptive demands are not cumulative as the water is not consumed and available to meet downstream demands. For example, if hydropower demand exceeds instream flow demands or downstream demands, then the hydropower demand is applied to the basin in question, recognizing the returns will be adequate to serve the instream and downstream demands. Figure 6 shows a chart of how the maximum non-consumptive use is determined on an annual basis.

**Figure 6: Example Plot Showing Maximum Non-Consumptive Use Demand (Source: "INSIGHT Methods", 2015)**



### *2.2.3.1 Hydropower Demand*

Multiple hydropower demands exist within the Upper Platte River Basin. The Central Nebraska Public Power and Irrigation District (CNPPID) owns and operates multiple hydropower facilities in the Upper Platte River Basin. CNNPID diverts water released from Lake McConaughy and/or the South Platte River into the Tri-County Canal, directs it through Jeffrey and Johnson lakes (regulating reservoirs), three hydroelectric plants (Jeffrey, J-1, J-2), and delivers it to the irrigation system (during the irrigation season) or back to the Platte River (non-irrigation season).[22] Table 9 lists these hydropower demands by analysis subbasin.

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[22] http://www.cnppid.com/operations/hydropower/

Nebraska Public Power District (NPPD), also operates multiple hydropower facilities in the Upper Platte River Basin, in addition to the Gerald Gentleman coal-fire plant that utilizes surface water as a cooling water source. NPPD operates diversions on the South Platte River (Korty Diversion) and the North Platte River (Keystone Diversion). Flows are conveyed through their supply canal to Sutherland Reservoir (cooling water source for the Gentleman Station), then through Lake Maloney near North Platte which serves as a regulating reservoir for NPPDs North Platte hydropower facility. The hydropower returns flows to the South Platte River just above the confluence with the North Platte River and CNPPID's Tri-County diversion. NPPD also has a hydropower facility in Kearney, served by the Kearney Canal Diversion. Table 9 describes these hydropower demands by analysis subbasin.

**Table 11: Hydropower Demands by Subbasin**

| Hydropower Demand | Demand Applied: | Applied To Subbasin: |
|---|---|---|
| Kearney | Min[400 cfs or (Platte River Streamflow at Overton + ∑GWDP above Overton)] | Platte River; Odessa to Grand Island |
| J2/Jeffrey[A] | Min[2,250 cfs or (Platte River Streamflow at Confluence + ∑GWDP above Platte River Confluence)] | Platte River; Confluence to Odessa |
| Sutherland[B] | Min[1,900 cfs or (Synthetic South Platte River Streamflow at Paxton + ∑GWDP above Paxton)] | South Platte River; State Line to North Platte/ North Platte River; Lewellen to North Platte |
| McConaughy | N/A | North Platte: Lewellen to North Platte |

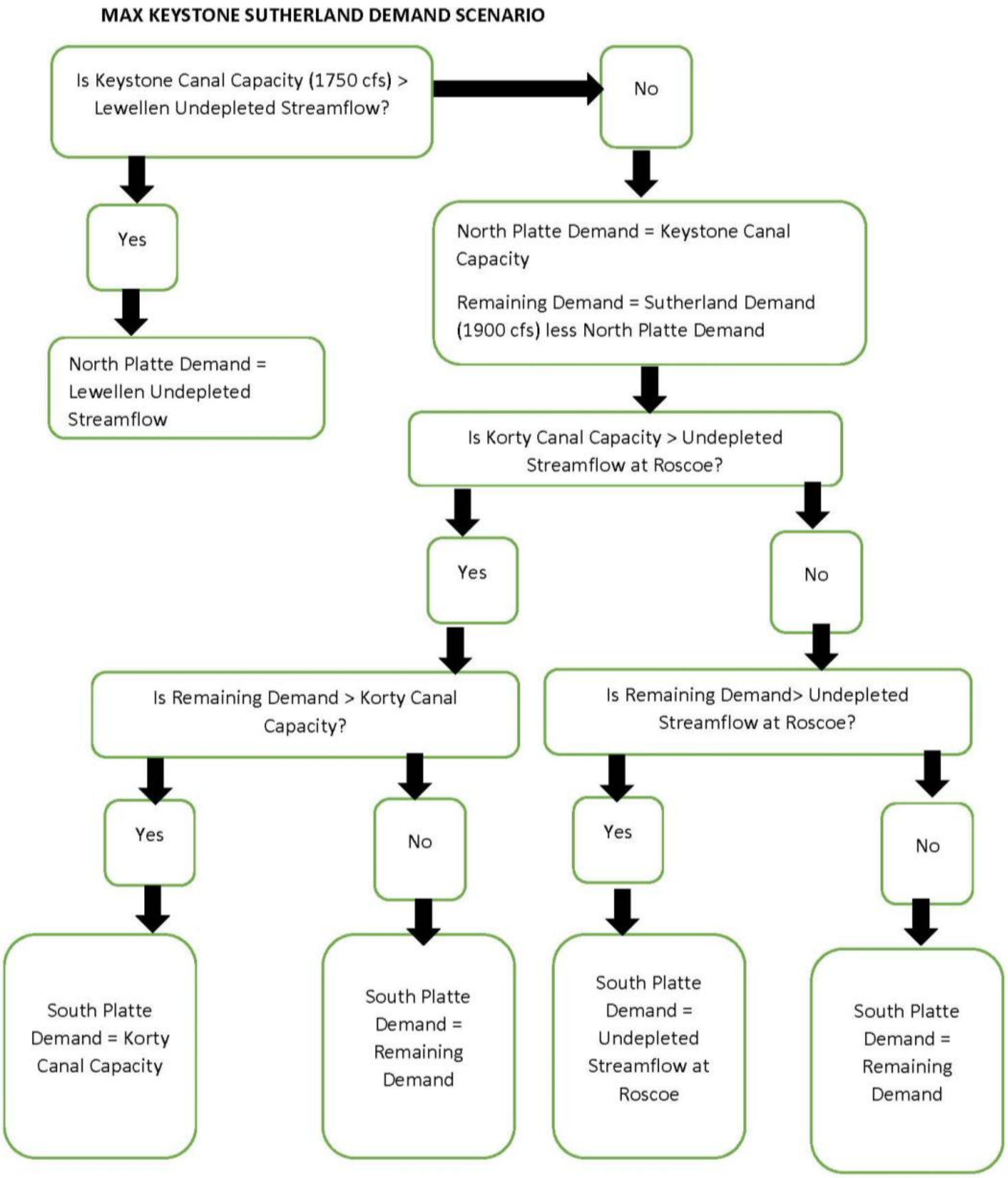
Notes:

A) The Tri-County Canal serves both surface water consumptive and non-consumptive use demands. In some cases, the surface water consumptive demands are located upstream of the non-consumptive use demands; therefore, it was necessary to consider the surface water consumptive and non-consumptive use demands separately for this canal. These demands were broken out as follow:

- Full Tri-County Demand = Minimum of [ Canal losses above Brady + Max (surface water demands or CNPPID hydropower demand) OR Undepleted streamflow at Confluence of North Platte & South Platte Rivers]
- Tri-County Non-consumptive Use Demand = Full Tri-County Demand – Tri-County SW Demand – Tri-County Canal seepage

(B) The demand associated with Sutherland is unique in that the water right exceeds canal capacity. Therefore, two demand scenarios were evaluated for purposes of this analysis. The first scenario maximizes the contribution of the Sutherland demand from the South Platte River, Julesburg to North Platte subbasin by placing the 850 cfs Korty canal capacity capped to historic undepleted flow at Roscoe and assigning the remainder to the North Platte subbasin. The second demand scenario places a 1,750 cfs demand on the North Platte Lewellen to North Platte subbasin (the capacity of the Keystone Canal) capped to the undepleted historic streamflow at Lewellen and assigning the remainder of the Sutherland demand to the South Platte Julesburg to North Platte subbasin. In actuality, the demands assigned to these two subbasins will likely be somewhere in-between these two scenarios. An example of this methodology is shown in Figure 7.

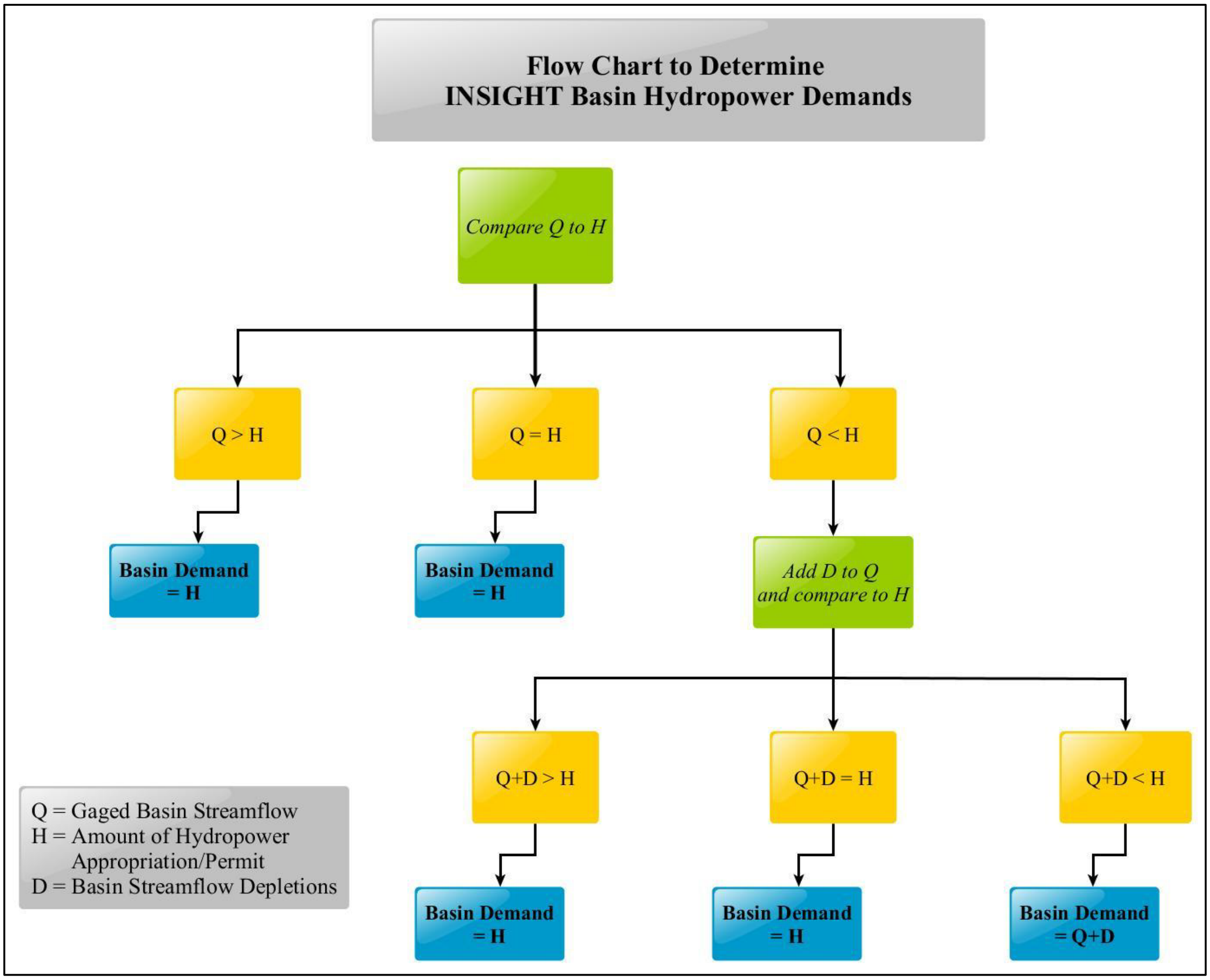
**Figure 7: Example calculation where the contribution from the North Platte subbasin (Keystone Diversion) is maximized**



(C) Lake McConaughy is operated based on downstream demands; that is the Kingsley Hydropower unit at Lake McConaughy is not explicitly represented as a demand, but generates hydropower based on releases to serve the downstream demands. The CNPPID demand is assigned to upstream basins as a downstream demand.

The NeDNR INSIGHT methodology evaluates hydropower demands at the basin level. Hydropower demands are evaluated by comparing the daily streamflow through the hydropower plant to the permitted hydropower appropriation. If streamflow is greater than or equal to the hydropower appropriation, the demand is considered to be the amount of the appropriation, as that is the maximum amount of water permitted for that use and the demand cannot legally exceed that. If streamflow is less than the appropriation, then streamflow depletions from groundwater pumping will also be considered in order to determine if undepleted streamflow would would have been available prior to impacts of groundwater uses. The depletions are added to the daily streamflow, resulting in the undepleted streamflow.  This undepleted streamflow is compared to the hydropower appropriation. If the undepleted streamflow is greater than or equal to the hydropower appropriation, the demand is considered to be the amount of the appropriation. In the case that the undepleted streamflow available is not adequate to meet the appropriation, the demand for the basin is equal to the undepleted streamflow. Figure 8 illustrates the process used to determine daily hydropower demands for each basin.

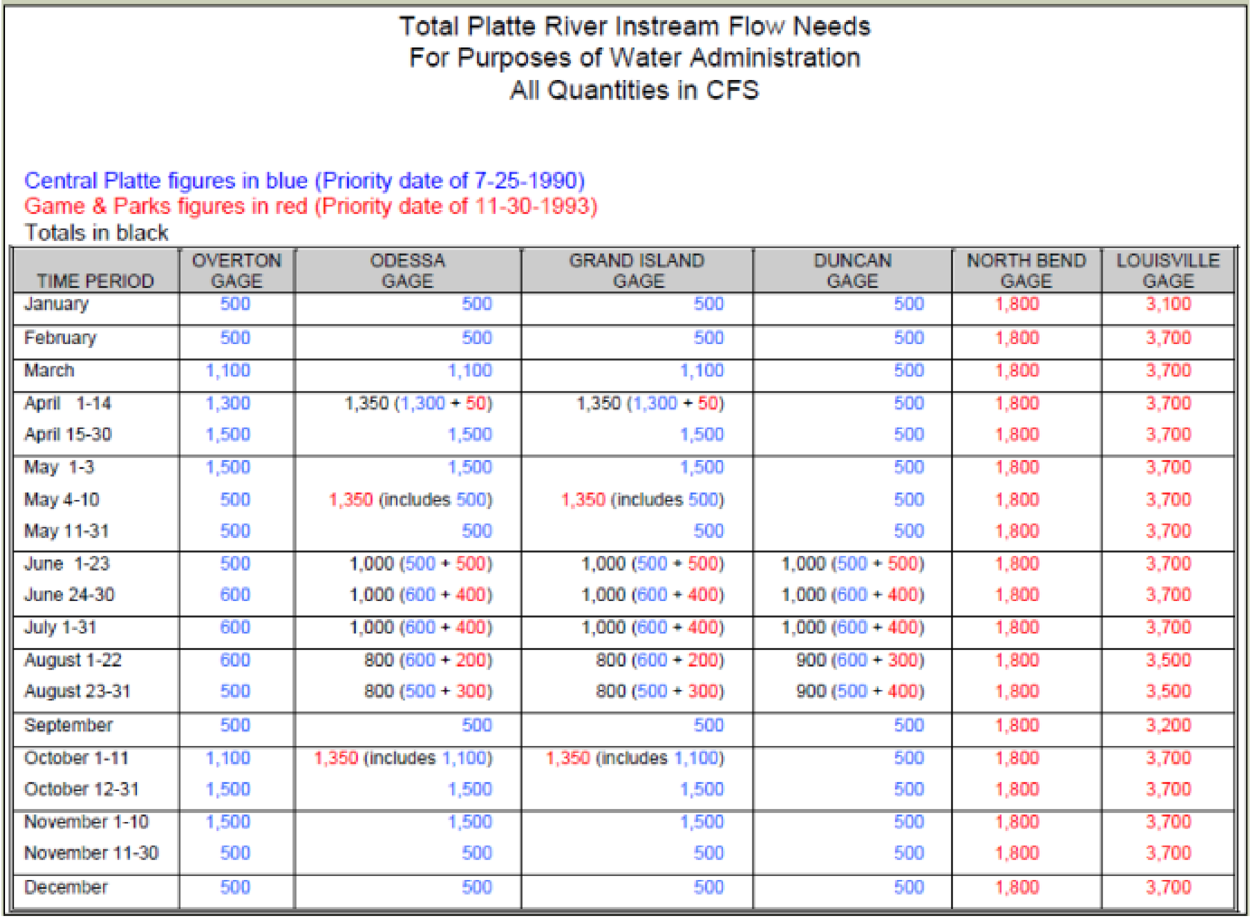
**Figure 8:  Flow Chart to Determine INSIGHT Basin Hydropower Demands (Source: "INSIGHT Methods" 2015)**



### 2.2.3.2 Instream Flow Demands

Instream flow appropriations exist in the Confluence to Odessa, Odessa to Grand Island, and Grand Island to Duncan reaches for the purpose of fish and wildlife needs. The appropriated instream flow rates are shown in Figure 9.[23] Like hydropower uses, instream flows represent a non-consumptive use demand.

Figure 12: Total Platte River Instream Flow Appropriations (Source: NeDNR)



Total Platte River Instream Flow Needs
For Purposes of Water Administration
All Quantities in CFS

Central Platte figures in blue (Priority date of 7-25-1990)
Game & Parks figures in red (Priority date of 11-30-1993)
Totals in black

| TIME PERIOD | OVERTON GAGE | ODESSA GAGE | GRAND ISLAND GAGE | DUNCAN GAGE | NORTH BEND GAGE | LOUISVILLE GAGE |
|---|---|---|---|---|---|---|
| January | 500 | 500 | 500 | 500 | 1,800 | 3,100 |
| February | 500 | 500 | 500 | 500 | 1,800 | 3,700 |
| March | 1,100 | 1,100 | 1,100 | 500 | 1,800 | 3,700 |
| April 1-14 | 1,300 | 1,350 (1,300 + 50) | 1,350 (1,300 + 50) | 500 | 1,800 | 3,700 |
| April 15-30 | 1,500 | 1,500 | 1,500 | 500 | 1,800 | 3,700 |
| May 1-3 | 1,500 | 1,500 | 1,500 | 500 | 1,800 | 3,700 |
| May 4-10 | 500 | 1,350 (includes 500) | 1,350 (includes 500) | 500 | 1,800 | 3,700 |
| May 11-31 | 500 | 500 | 500 | 500 | 1,800 | 3,700 |
| June 1-23 | 500 | 1,000 (500 + 500) | 1,000 (500 + 500) | 1,000 (500 + 500) | 1,800 | 3,700 |
| June 24-30 | 600 | 1,000 (600 + 400) | 1,000 (600 + 400) | 1,000 (600 + 400) | 1,800 | 3,700 |
| July 1-31 | 600 | 1,000 (600 + 400) | 1,000 (600 + 400) | 1,000 (600 + 400) | 1,800 | 3,700 |
| August 1-22 | 600 | 800 (600 + 200) | 800 (600 + 200) | 900 (600 + 300) | 1,800 | 3,500 |
| August 23-31 | 500 | 800 (500 + 300) | 800 (500 + 300) | 900 (500 + 400) | 1,800 | 3,500 |
| September | 500 | 500 | 500 | 500 | 1,800 | 3,200 |
| October 1-11 | 1,100 | 1,350 (includes 1,100) | 1,350 (includes 1,100) | 500 | 1,800 | 3,700 |
| October 12-31 | 1,500 | 1,500 | 1,500 | 500 | 1,800 | 3,700 |
| November 1-10 | 1,500 | 1,500 | 1,500 | 500 | 1,800 | 3,700 |
| November 11-30 | 500 | 500 | 500 | 500 | 1,800 | 3,700 |
| December | 500 | 500 | 500 | 500 | 1,800 | 3,700 |

Because the instream flow demand is a non-consumptive use demand, the NeDNR INSIGHT methodology compares the instream flow demand to the undepleted streamflow similar to the way that the hydropower demands are evaluated. Consistent with the NeDNR INSIGHT methodology, if undepleted streamflow is greater than the instream flow appropriation, the demand is capped at the instream flow appropriation because the demand cannot exceed what is legally permitted.[24] Consistent with NeDNR INSIGHT methodology, if the undepleted streamflow does not meet the instream flow appropriation, then the instream flow demand is capped to the undepleted streamflow.

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[23] *Neb. Rev. Stat. § 46-2,115(1)*

[24] Note this description only applies to the NeDNR INSIGHT methodology for evaluating demands in a river basin. This statement is not intended to reflect how surface water rights are actually administered with respect to the prior-appropriation doctrine.

Consistent with *Neb. Rev. Stat*. § 46-713(3) of the Ground Water Management and Protection Act, the NeDNR INSIGHT methodology further adjusts the instream flow demands by the level of groundwater development in place in 1993.[25] The adjustment to pre-1993 historic flows consists of reducing the observed historic flows by the consumptive use of those acres irrigated by groundwater in 1993. Conceptually, this adjustment incorporates the lag effect of groundwater irrigation in the pre-1993 period that had not yet resulted in depletions to the stream in 1993. Pre-1993 surface water development is inherently included by its ability to use water in priority.

Mathematically, the Instream Flow Demand applied in INSIGHT is as follows:

INSIGHT Instream Demand = Instream Flow Appropriation (Capped to Undepleted Flow) less 1993 Level of Groundwater Development

For this analysis, TFG applied the watershed model component of the COHYST integrated model using the period-of-analysis with 1993 land use held constant in order to estimate the impact that the 1993 level of groundwater development would have for each year (climatic cycles allowed to vary). TFG provided these consumptive use results to adjust the instream flow demands in each year at each instream flow location (Overton, Odessa, Grand Island, Duncan, North Bend, and Louisville).

### 2.2.5 Proportioning Supplies and Demands

As previously mentioned, it is necessary to calculate the intrinsic supply prior to calculating required inflows or downstream demands because the ratio of intrinsic supplies is used to proportion the supplies and demands to each subbasin. Figure 10 shows a simplified schematic for how basin proportioning in the Upper Platte River Basin would be calculated.

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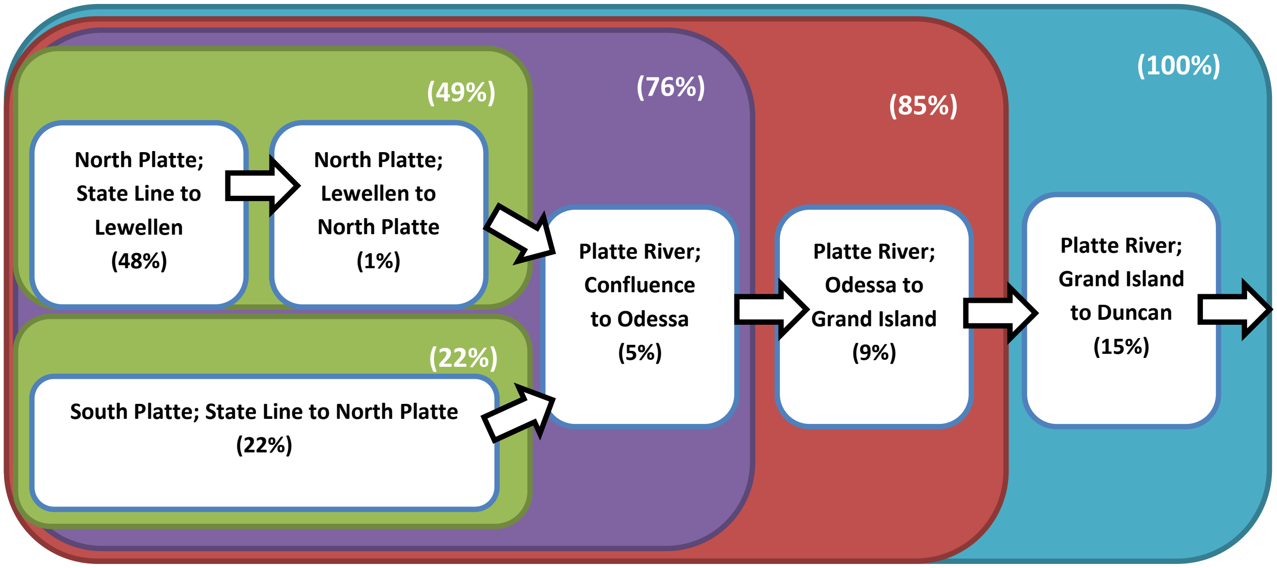
[25] The Nebraska Game and Parks Commission obtained instream flow appropriations for fish and wildlife purposes in 1993.

**Figure 10: Schematic of Upper Platte River Basin Intrinsic Basin Water Supply**

**Note:** ***Values included for example purposes only and actual results may vary.***



Several steps were necessary to determine the contributing proportion of each subbasin. The steps for calculating contributing proportions are as follows:

**Step 1:** Calculate the intrinsic supply at the furthest downstream accounting point in a basin (total intrinsic supply).

**Step 2:** Calculate the intrinsic supply at each subbasin confluence upstream.

**Step 3:** Calculate the percent contribution for each subbasin relative to the total intrinsic BWS for the basin. This represents the proportion an upper basin contributes to the basin as a whole.

### 2.2.6 Required Inflow and Downstream Demand

The required inflow term is used to recognize the historic contribution of BWS from an upstream basin. Similarly, downstream demands are used to reflect the portion of mainstem surface water demand of a downstream subbasin that has historically been satisfied by water originating in an upstream basin. This is done because water development in a lower basin was based on water supply that was historically available at the time the surface water appropriation was granted. Because an upstream basin's water supply represents only a portion of the total downstream basin's total water supply, only a portion of the downstream basin's demand is applied to an upstream basin. The proportioning discussed in Section 2.3.5 is used to carry downstream demands to upstream basins as well as calculate required inflow from upstream basins to downstream basins. These terms cancel out at the whole basin level.

Downstream demands are those mainstem surface water consumptive use demands, non-consumptive use demands, and net surface water loss demands in downstream subbasins that have historically relied on water supply from an upstream basin. Downstream groundwater demands are not assigned to upstream basins as surface water flows cannot be expected to meet downstream groundwater demands. The following are the formulas used for calculating the required inflow and downstream demands in the Upper Platte River Basin.

North Platte River, Lewellen to North Platte, Required Inflow
(% Lewellen to North Platte) x
(Odessa Subbasin: Mainstem SW Demand + Net SW Loss + Max Non-consumptive Use Demand)

Platte River, Confluence to Odessa, Required Inflow
(% Lewellen to Odessa + % North Platte to Odessa + % South Platte to Odessa) x
(Odessa Subbasin: Mainstem SW Demand + Net SW Loss + Max Non-consumptive Use Demand)

Platte River, Odessa to Grand Island, Required Inflow
(% Lewellen to Grand Island + % North Platte to Grand Island + % South Platte to Grand Island
+ % Odessa to Grand Island) x
(Grand Island Subbasin: Max Non-consumptive Use Demand)

*Note: There are no SW Demands or Net SW Loss Demands in the Grand Island Subbasin*

Platte River, Grand Island to Duncan, Required Inflow
(% Lewellen to Duncan + % North Platte to Duncan + % South Platte to Duncan
+ % Odessa to Duncan + % Grand Island to Duncan) x
(Duncan Subbasin: Max Non-consumptive Use Demand)

*Note: There are no SW Demands or Net SW Loss Demands in the Duncan Subbasin*

North Platte River, State Line to Lewellen, Downstream Demand
% Lewellen to North Platte x (North Platte Subbasin: Mainstem SW Demand + Net SW Loss) +
% Lewellen to Odessa x (Odessa Subbasin: Mainstem SW Demand + Net SW Loss) +
% Lewellen to Lower Platte x (Lower Platte Subbasin: Mainstem SW Demand + Net SW Loss) +

MAX {% Lewellen to North Platte x North Platte Subbasin: Max Non-consumptive Use Demand,
% Lewellen to Odessa x Odessa Subbasin: Max Non-consumptive Use Demand,
% Lewellen to Grand Island x Grand Island Subbasin: Max Non-consumptive Use Demand,
% Lewellen to Duncan x Duncan Subbasin: Max Non-consumptive Use Demand,
% Lewellen to Lower Platte x Lower Platte Subbasin: Max Non-consumptive Use Demand}

*Note: There are no SW Demands or Net SW Loss Demands in the Grand Island or Duncan Subbasins*

### North Platte River, Lewellen to North Platte, Downstream Demand

% North Platte to Odessa x (Odessa Subbasin: Mainstem SW Demand + Net SW Loss) +
% North Platte to Lower Platte x (Lower Platte Subbasin: Mainstem SW Demand + Net SW Loss) +

MAX {% North Platte to Odessa x Odessa Subbasin: Max Non-consumptive Use Demand,
% North Platte to Grand Island x Grand Island Subbasin: Max Non-consumptive Use Demand,
% North Platte to Duncan x Duncan Subbasin: Max Non-consumptive Use Demand,
% North Platte to Lower Platte x Lower Platte Subbasin: Max Non-consumptive Use Demand}

*Note: There are no SW Demands or Net SW Loss Demands in the Grand Island or Duncan Subbasins*

### Platte River, Confluence to Odessa, Downstream Demand

% Odessa to Lower Platte x (Lower Platte Subbasin: Mainstem SW Demand + Net SW)

MAX {% Odessa to Grand Island x Grand Island Subbasin: Max Non-consumptive Use Demand,
% Odessa to Duncan x Duncan Subbasin: Max Non-consumptive Use Demand,
% Odessa to Lower Platte x Lower Platte Subbasin: Max Non-consumptive Use Demand}

*Note: There are no SW Demands or Net SW Loss Demands in the Grand Island or Duncan Subbasins*

### Platte River, Odessa to Grand Island, Downstream Demand

% Grand Island to Lower Platte x (Lower Platte Subbasin: Mainstem SW Demand + Net SW Loss) +

MAX {% Grand Island to Duncan x Duncan Subbasin: Max Non-consumptive Use Demand,
% Grand Island to Lower Platte x Lower Platte Subbasin: Max Non-consumptive Use Demand}

*Note: There are no SW Demands or Net SW Loss Demands in the Grand Island or Duncan Subbasins*

### Platte River, Grand Island to Duncan, Downstream Demand

% Duncan to Lower Platte x (Lower Platte Subbasin: Mainstem SW Demand + Net SW Loss + Max Non-consumptive Use Demand)

South Platte River, State Line to North Platte, Downstream Demand
% South Platte to Odessa x (Odessa Subbasin: Mainstem SW Demand + Net SW Loss) +
% South Platte to Lower Platte x (Lower Platte Subbasin: Mainstem SW Demand + Net SW Loss) +

MAX {% North Platte to Odessa x Odessa Subbasin: Max Non-consumptive Use Demand,
% North Platte to Grand Island x Grand Island Subbasin: Max Non-consumptive Use Demand,
% North Platte to Duncan x Duncan Subbasin: Max Non-consumptive Use Demand,
% North Platte to Lower Platte x Lower Platte Subbasin: Max Non-consumptive Use Demand}

*Note: There are no SW Demands or Net SW Loss Demands in the Grand Island or Duncan Subbasins*

## 2.3 Basin Water Supply

As discussed in Section 2.2, the BWS is made up of four components: 1) streamflow reach-gain/loss; 2) surface water consumptive use; 3) groundwater depletions; and 4) required inflow, which is the amount of water that is necessary to flow out of basins or subbasins upstream to a given location. Required inflow does not represent water that is required by law or permit, but rather the typical amount of water a basin or subbasin relies upon from upstream under the NeDNR INSIGHT methodology.

The intrinsic supply (Section 2.2) is the same as the BWS only less the required inflow term (intrinsic supply = streamflow reach-gain/loss + surface water consumptive use + groundwater depletions). It was necessary to calculate the intrinsic supply first because the ratio of intrinsic supplies is used to calculate the required inflow and downstream demand terms, as discussed in Section 2.3.6. With all terms calculated, the BWS can now be calculated. The formula for BWS is as follows:

BWS = Streamflow reach-gain/Loss + SWCU + GWDP + Required Inflow

Table 13: Components of BWS by Subbasin

| Subbasin | Streamflow/ Reach-Gain/Loss | Surface water Consumptive Use (SWCU & Res Evap) | Groundwater Depletions (GWDP) | Required Inflow |
|---|---|---|---|---|
| North Platte River; State Line to Lewellen | X | X | X | |
| North Platte River; Lewellen to North Platte | X | X | X | X |
| South Platte River; State Line to North Platte | X | X | X | |
| Platte River; Confluence to Odessa | X | X | X | X |
| Platte River; Odessa to Grand Island | X | | X | X |
| Platte River; Grand Island to Duncan | X | | X | X |

## 2.4 Near-Term Demand & Near-Term Balance

The NeDNR INSIGHT methodology used the BWS concept in conjunction with Total Demand (TD) to determine the balance of water supply and water use. The BWS recreates, at any defined timestep, the amount of streamflow water supply available for use, while the TD, at any defined timestep, recreates the total demand on streamflow water supplies, including those demands that may not always be met. The comparison of these two values is the basis for determining the balance of supplies and uses.

As previously discussed in Section 2.0, the NeDNR INSIGHT methodology evaluates the basin on both a seasonal and annual time frame. The two sub-periods within the year are the "Peak Season" (June 1 through August 31) and the "Non-peak Season" (September 1 through May 31). If a basin's near-term demand and/or the long-term demand of hydrologically connected groundwater and surface water exceeds the basin water supplies (BWS) during either of the two sub-periods when summed over the time period utilized in the INSIGHT evaluation, then supplies may not be sufficient to sustain the demands over the long term.

The difference between the near-term and long-term demands is that the near-term demand calculation considers the groundwater depletion (current effect of wells on the stream) while the long-term calculation considers the groundwater consumption (full impact of wells on a hydrologically connected stream). The formula for the near-term demand is as follows:

Near-term Demand = GWDP + SW Demand + Net SW Loss + Max Non-Consumptive Use Demand

*Note: The max non-consumptive use demand includes the downstream demands*

With the near-term demand calculated, the near-term balance is calculated using the following formula:

Near-term Balance = BWS – Near-term Demand

## 2.5 Long-Term Demand & Long-Term Balance

The difference between the near-term and long-term demands is that the near-term demand calculation considers the groundwater depletion (current effect of wells on the stream) while the long-term calculation considers the groundwater consumption (full impact of wells on a hydrologically connected stream). The formula for the long-term demand is as follows:

Long-term Demand = GWCU + SW Demand + Net SW Loss + Max Non-Consumptive Use Demand

*Note: The max non-consumptive use demand includes the downstream demands*

With the long-term demand calculated, the long-term balance is calculated using the following formula:

Long-term Balance = BWS – Long-term Demand

## 3.0 Results

This section presents the results of the basin accounting for the Upper Platte River Basin following the NeDNR INSIGHT Methodology. It should be noted that this NeDNR INSIGHT Methodology considers demands in their entirety (all surface and groundwater acres irrigated at full net irrigation requirement). The intent of this methodology is not to imply that all water demands would, could, or should be satisfied; rather its intent is to understand demands of the total surface water appropriations and groundwater permitted acres existing within the basin. Additionally, the reader should note that while the non-consumptive uses (hydropower and instream flow) are capped based on historically available flow, surface water uses, downstream demands, and required inflow are not. Future studies by the PBC and NeDNR could consider investigating surface water and groundwater demands in greater detail to better define an appropriate level of supplies and demands in the Upper Platte Basin. The data gathered and presented as part of this analysis serves as a starting point for any future investigation.

Figure 11 shows the 1988-2012 25-year average calculated supplies in the Upper Platte River Basin. Note that the supply only changes by Sutherland demand scenario (described in Section 2.3.3.1) for the Lewellen to North Platte subbasin. This is because the required inflow term for the Lewellen to North Platte subbasin changes based on which Sutherland demand (described in Section 2.3.3.1) is applied to the subbasin. Both the Lewellen to North Platte subbasin as well as Confluence to Odessa subbasin supplies are largely driven by the required inflow term which is based upon upstream subbasin contributions to the large CNPPID demand. The Odessa to Grand Island supply is driven by the required inflow term which is based upon upstream subbasin contributions to the Grand Island instream flow demand.

## Figure 11: Annual Supply Plot for the Upper Platte River Basin

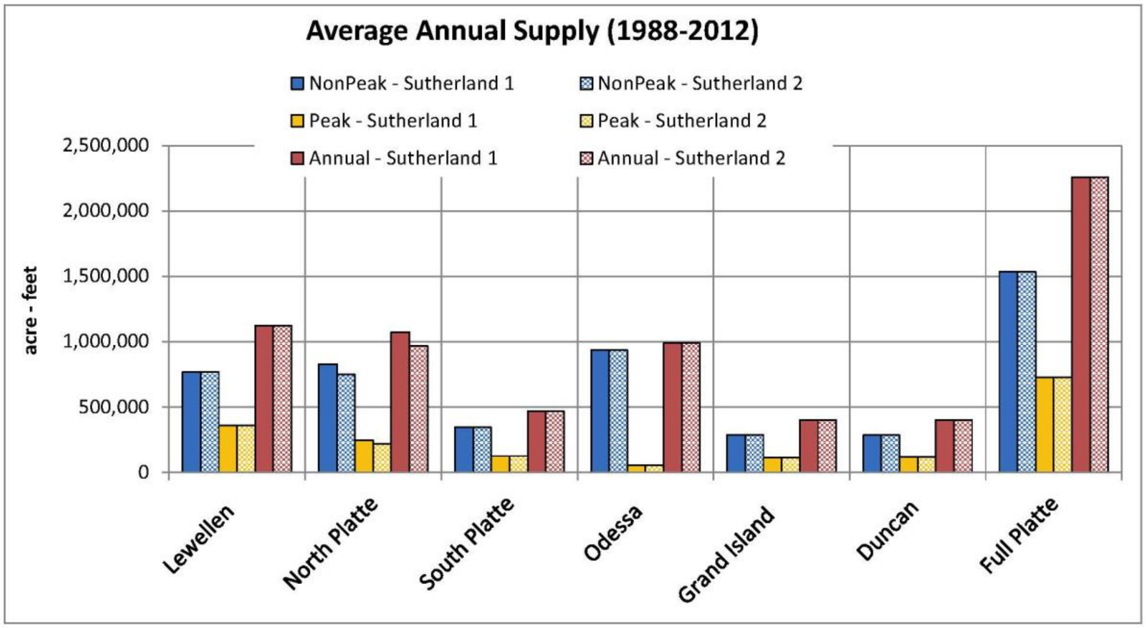


Figure 12 shows the 1988-2012 25-year average calculated near-term demands in the Upper Platte River Basin. Note that the demand only changes by Sutherland demand scenario (described in Section 2.3.3.1).

## Figure 12: Annual Near-term Demand Plot for the Upper Platte River Basin

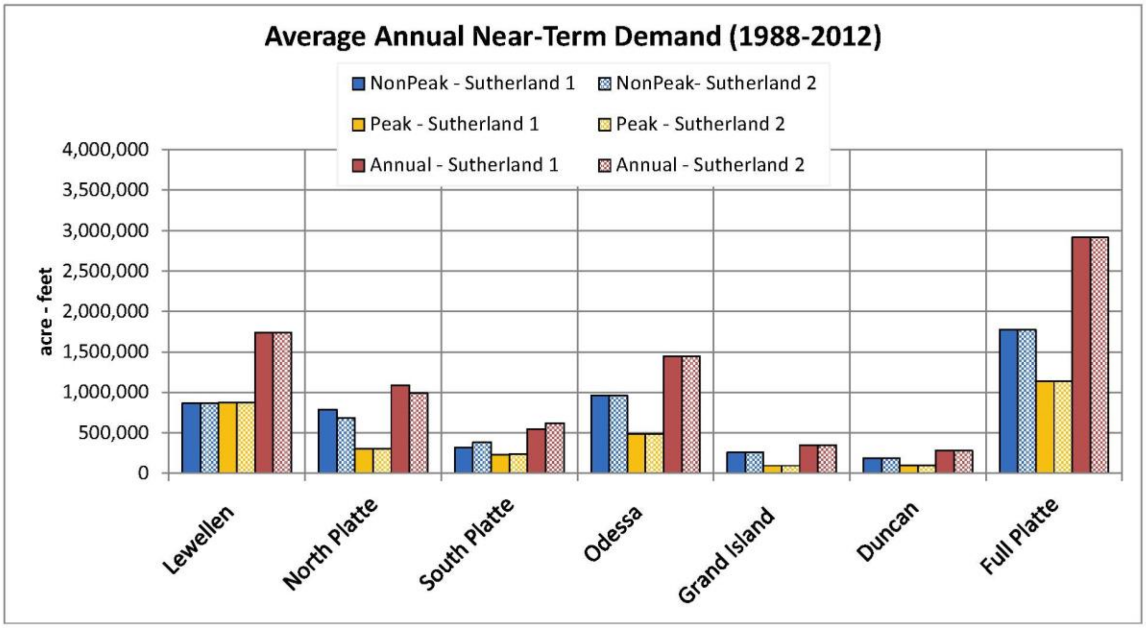
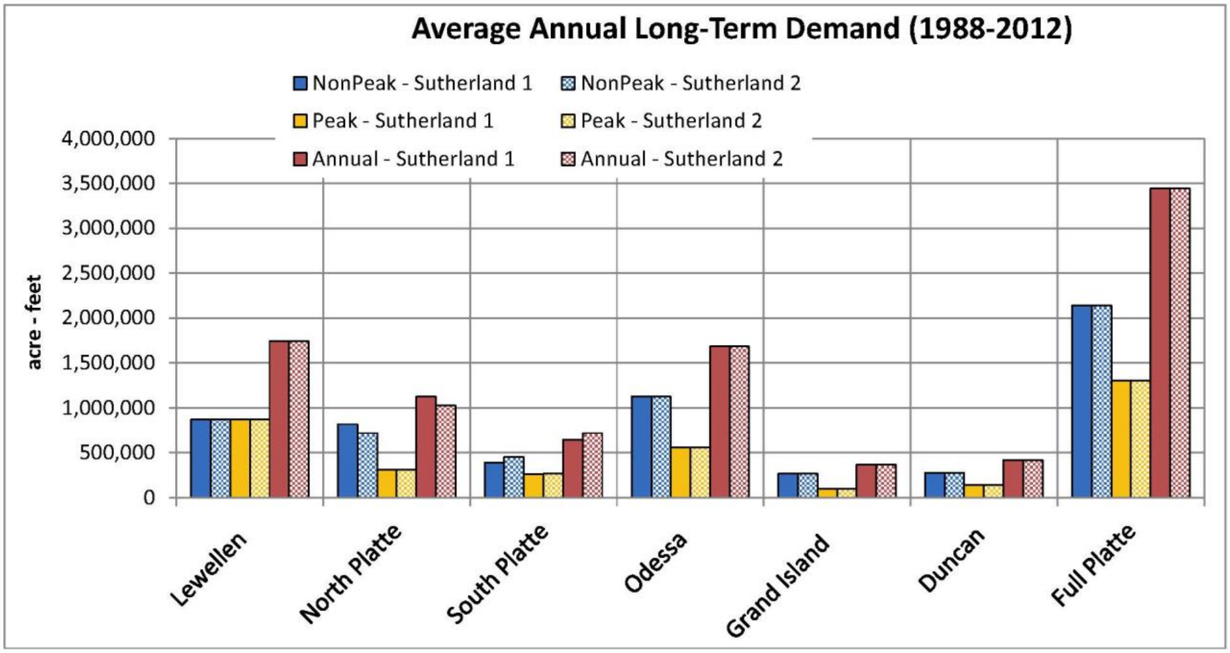


Figure 13 shows the 1988-2012 25-year average calculated long-term demands in the Upper Platte River Basin. Note that the demand only changes by Sutherland demand scenario (described in Section 2.3.3.1). The breakdown of supply and demand terms are described in further detail in the Nature and Extent of Use Section (Section 4.0).

**Figure 13: Annual Long-term Demand Plot for the Upper Platte River Basin**



With the supplies and demands calculated, the excess supplies were calculated as described in Section 2.5 and Section 2.6. Figure 14 shows the 1988-2012 25-year average calculated annual excess supply for the Upper Platte River Basin based on near-term demand while Figure 15 shows the 1988-2012 25-year average calculated annual excess supply for the Upper Platte River Basin based on long-term demand. Tables 13 and 14 corresponds to the annual excess supply numbers shown in Figures 14 and 15.

**Figure 14: Annual Excess Supply (based on Near-term demand) for the Upper Platte River Basin**

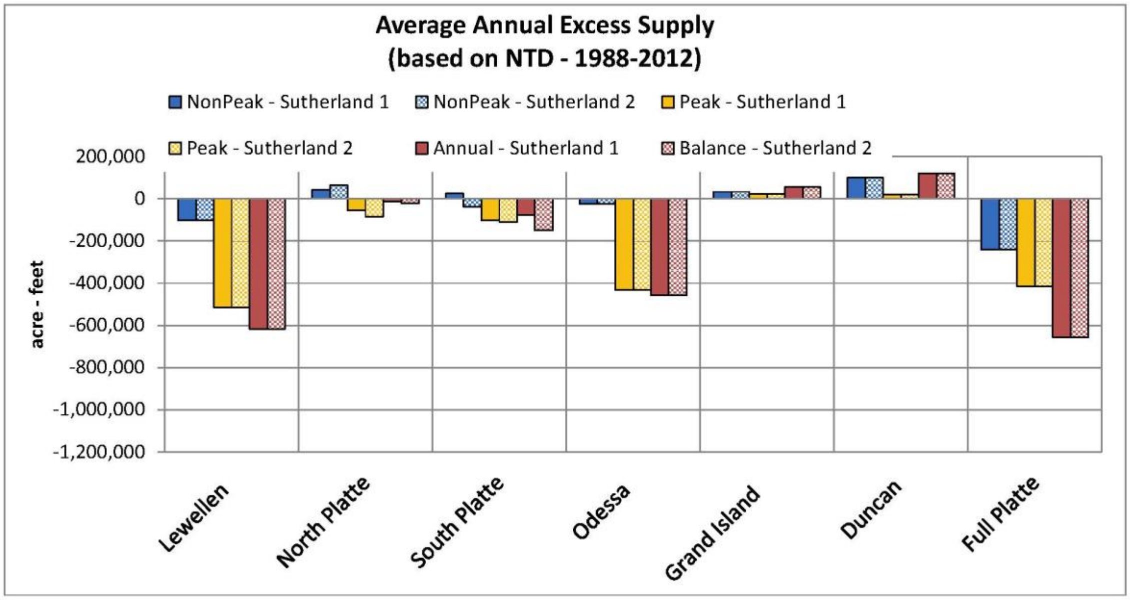


Figure 15: Annual Excess Supply (based on Long-term demand) for the Upper Platte River Basin

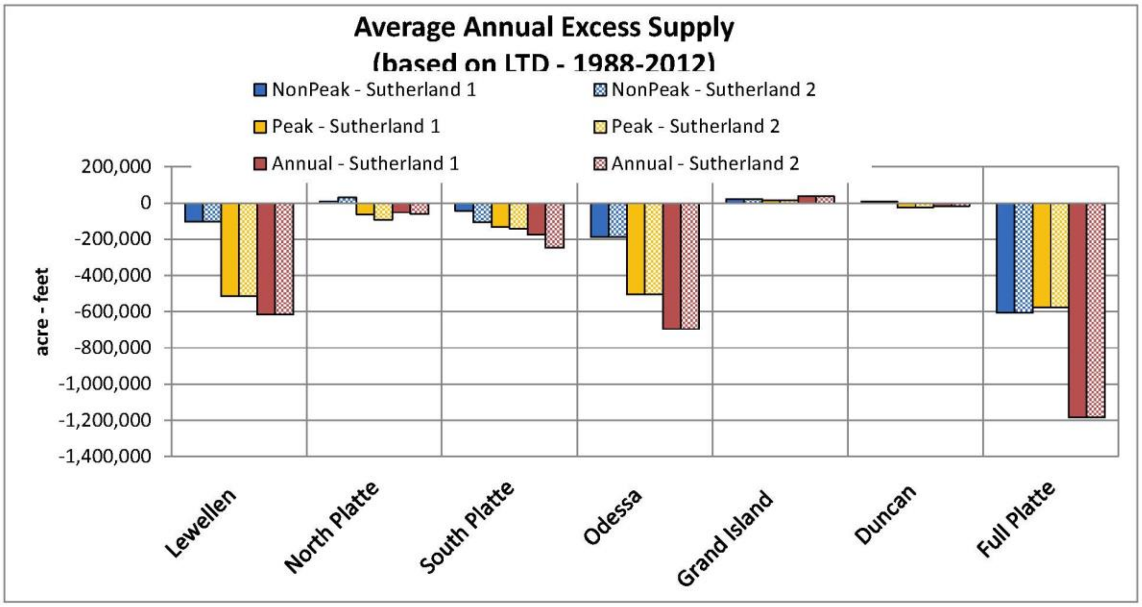


**Table 14: Annual Excess Supply (based on Near-term demand) by Subbasin (AF)**

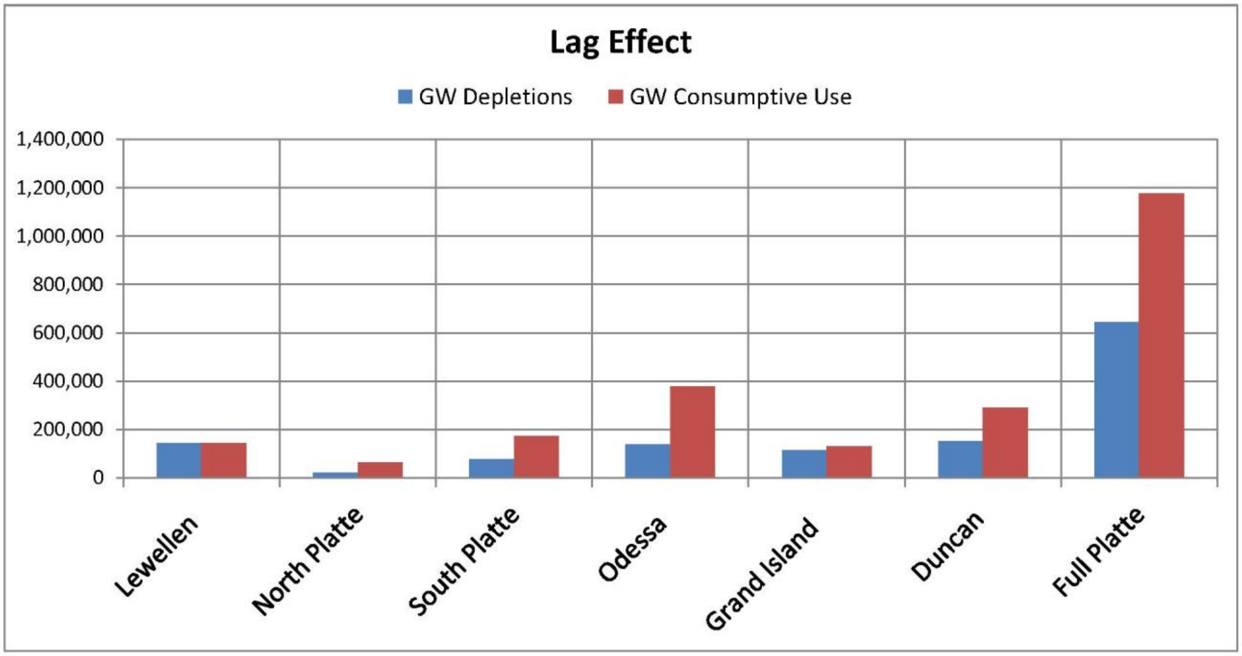
| Subbasin | Sutherland Demand Scenario 1 | | | Sutherland Demand Scenario 2 | | |
|---|---|---|---|---|---|---|
| | Non-peak | Peak | Annual | Non-peak | Peak | Annual |
| North Platte River, State Line to Lewellen | (102,302) | (514,616) | (616,918) | (102,302) | (514,616) | (616,918) |
| North Platte River, Lewellen to North Platte | 41,935 | (55,126) | (13,190) | 62,754 | (85,106) | (22,353) |
| South Platte River, State Line to North Platte | 24,346 | (102,400) | (78,053) | (38,366) | (112,142) | (150,508) |
| Platte River, Confluence to Odessa | (25,527) | (431,938) | (457,464) | (25,527) | (431,938) | (457,464) |
| Platte River, Odessa to Grand Island | 32,445 | 21,670 | 54,114 | 32,445 | 21,670 | 54,114 |
| Platte River, Grand Island to Duncan | 99,396 | 20,802 | 120,198 | 99,396 | 20,802 | 120,198 |
| Full Upper Platte River Basin | (241,025) | (415,308) | (656,333) | (241,025) | (415,308) | (656,333) |

**Table 15: Annual Excess Supply (based on Long-term demand) by Subbasin (AF)**

| Subbasin | Sutherland Demand Scenario 1 | | | Sutherland Demand Scenario 2 | | |
|---|---|---|---|---|---|---|
| | Non-peak | Peak | Annual | Non-peak | Peak | Annual |
| North Platte River, State Line to Lewellen | (102,302) | (514,616) | (616,918) | (102,302) | (514,616) | (618,918) |
| North Platte River, Lewellen to North Platte | 9,722 | (62,169) | (52,477) | 30,540 | (95,150) | (61,610) |
| South Platte River, State Line to North Platte | (43,719) | (131,974) | (175,693) | (106,432) | (141,716) | (248,148) |
| Platte River, Confluence to Odessa | (189,530) | (506,073) | (695,602) | (189,530) | (506,073) | (695,602) |
| Platte River, Odessa to Grand Island | 21,896 | 15,244 | 37,140 | 21,896 | 15,244 | 37,140 |
| Platte River, Grand Island to Duncan | 7,795 | (24,173) | (16,378) | 7,795 | (24,173) | (16,378) |
| Full Upper Platte River Basin | (607,457) | (577,462) | (1,184,919) | (607,457) | (577,462) | (1,184,919) |

As described in Section 2.5 and Section 2.6, the difference between near-term and long-term demand is in the groundwater demand term. The near-term demand uses the groundwater depletions while the long-term demand uses the full groundwater consumptive use and does not account for the lag-effects for the wells located within the hydrologically connected area. Figure 16 shows a comparison of the 25-year average groundwater depletions versus the 25-year average groundwater consumptive use.

Figure 16: Upper Platte River Basin, Lag Effect (based on 25-year averages)

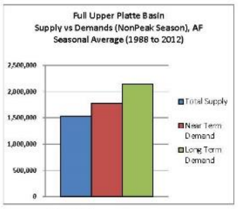


Because the only difference between near-term and long-term demands is the groundwater term, it holds that the only difference between the near-term excess supply and long-term excess supply is also the groundwater term. Therefore, the magnitude of difference between near-term and long-term demands (shown in Figure 16) is the same as the magnitude of difference between the near-term and long-term excess supplies.

## 4.0 Nature and Extent of Use

The nature and extent of use are displayed in pie charts and provide information on the general distribution of water demands for a given basin. These pie charts provide information on the relative magnitude of each demand within a subbasin and easily identifies the driver of demands in a subbasin. This is another powerful informational tool as it can help target management or conservation efforts toward the demands where the biggest impact can be made. The pie charts also include a piece showing the excess supply. If the pie piece associated with the excess supply is gold in color, then the excess supply is a positive number and supplies exceed demands in the subbasin. If the pie piece associated with excess supply is black-hatched in color, then the excess supply is a negative number and the demands exceed the supply. Figures 17 through 23 show the nature and extent of use in each subbasin in the Upper Platte River Basin.

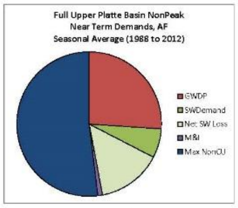
## Figure 17: Nature and Extent of Use: Full Upper Platte Basin


Full Upper Platte Basin
Supply vs Demands (NonPeak Season), AF
Seasonal Average (1988 to 2012)

Supply, AF

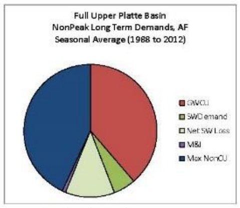
| | |
|---|---|
| Streamflow (Gain) | 981,120 |
| GWDP | 462,645 |
| SWCU | 90,271 |
| Total Supply | 1,534,036 |

| | |
|---|---|
| Total Supply | 1,534,036 |
| Near Term | 1,775,061 |
| Long Term | 2,141,493 |


Full Upper Platte Basin NonPeak
Near Term Demands, AF
Seasonal Average (1988 to 2012)

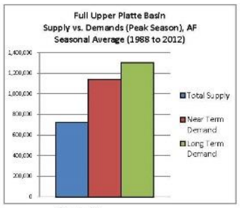
Near Term Demand, AF

| | |
|---|---|
| GWDP | 462,645 |
| SWDemand | 115,791 |
| Net SW Loss | 256,399 |
| M&I | 18,579 |
| Max NonCU | 921,647 |
| Excess Supply | (241,025) |
| Total Near Term Demand | 1,775,061 |


Full Upper Platte Basin
NonPeak Long Term Demands, AF
Seasonal Average (1988 to 2012)

Long Term Demand, AF

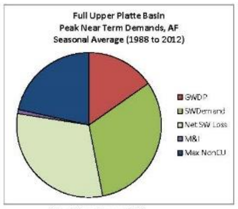
| | |
|---|---|
| GWCU | 829,077 |
| SWDemand | 115,791 |
| Net SW Loss | 256,399 |
| M&I | 18,579 |
| Max NonCU | 921,647 |
| Excess Supply | (607,457) |
| Total Long Term Demand | 2,141,493 |


Full Upper Platte Basin
Supply vs. Demands (Peak Season), AF
Seasonal Average (1988 to 2012)

Supply, AF

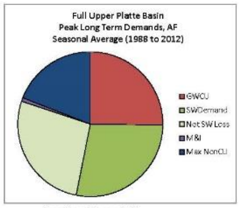
| | |
|---|---|
| Streamflow (Gain) | 305,186 |
| GWDP | 187,527 |
| SWCU | 231,647 |
| Total Supply | 724,359 |

| | |
|---|---|
| Total Supply | 724,359 |
| Near Term | 1,139,667 |
| Long Term | 1,301,821 |


Full Upper Platte Basin
Peak Near Term Demands, AF
Seasonal Average (1988 to 2012)

Near Term Demand, AF

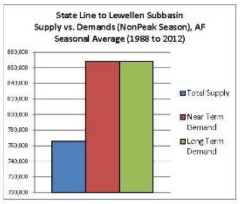
| | |
|---|---|
| GWDP | 187,527 |
| SWDemand | 389,304 |
| Net SW Loss | 375,817 |
| M&I | 11,080 |
| Max NonCU | 264,887 |
| Excess Supply | (415,308) |
| MAC Storage Offset | (88,948) |
| Total Near Term Demand | 1,139,667 |

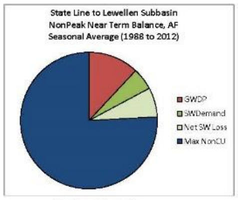

Full Upper Platte Basin
Peak Long Term Demands, AF
Seasonal Average (1988 to 2012)

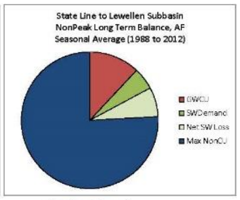
Long Term Demand, AF

| | |
|---|---|
| GWCU | 349,681 |
| SWDemand | 389,304 |
| Net SW Loss | 375,817 |
| M&I | 11,080 |
| Max NonCU | 264,887 |
| Excess Supply | (577,462) |
| MAC Storage Offset | (88,948) |
| Total Long Term Demand | 1,301,821 |

## Figure 18: Nature and Extent of Use: North Platte River, State Line to Lewellen Subbasin







**Supply, AF**

| | |
|---|---|
| Streamflow (Gain) | 637,306 |
| GWDP | 103,772 |
| SWCU | 24,612 |
| Total Supply | 765,689 |

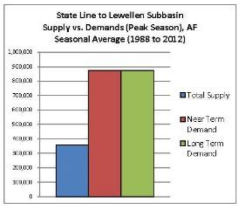
**Near Term Demand; Sutherland Scenario 1, AF**

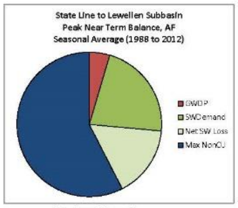
| | |
|---|---|
| GWDP | 103,772 |
| SWDemand | 45,258 |
| Net SW Loss | 60,561 |
| Max NonCU | 658,401 |
| Excess Supply | (102,302) |
| Total Near Term Demand | 867,991 |

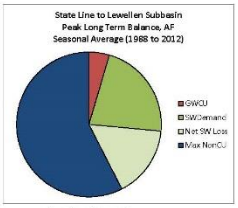
**Long Term Demand; Sutherland Scenario 1, AF**

| | |
|---|---|
| GWCU | 103,772 |
| SWDemand | 45,258 |
| Net SW Loss | 60,561 |
| Max NonCU | 658,401 |
| Excess Supply | (102,302) |
| Total Long Term Demand | 867,991 |

| | |
|---|---|
| Total Supply | 765,689 |
| Near Term | 867,991 |
| Long Term | 867,991 |







**Supply, AF**

| | |
|---|---|
| Streamflow (Gain) | 219,544 |
| GWDP | 39,794 |
| SWCU | 99,315 |
| Total Supply | 358,653 |

**Near Term Demand; Sutherland Scenario 1, AF**

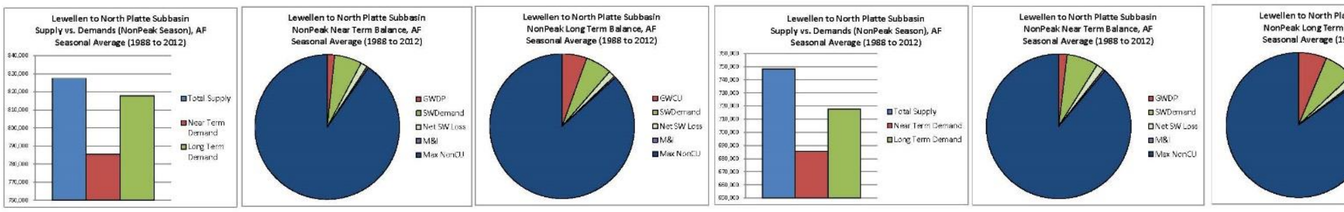
| | |
|---|---|
| GWDP | 39,794 |
| SWDemand | 191,258 |
| Net SW Loss | 139,854 |
| Max NonCU | 502,363 |
| Excess Supply | (514,616) |
| Total Near Term Demand | 873,269 |

**Long Term Demand; Sutherland Scenario 1, AF**

| | |
|---|---|
| GWCU | 39,794 |
| SWDemand | 191,258 |
| Net SW Loss | 139,854 |
| Max NonCU | 502,363 |
| Excess Supply | (514,616) |
| Total Long Term Demand | 873,269 |

| | |
|---|---|
| Total Supply | 358,653 |
| Near Term | 873,269 |
| Long Term | 873,269 |

## Figure 19: Nature and Extent of Use: North Platte River, Lewellen to North Platte Subbasin



**Supply;
Sutherland Scenario 1, AF**

| | |
|---|---|
| Streamflow (Gain) | 187,484 |
| GWDP | 12,912 |
| SWCU | 47,169 |
| Req. Inflow | 579,910 |
| Total Supply | 827,476 |

| | |
|---|---|
| Total Supply | 827,476 |
| Near Term | 785,541 |
| Long Term | 817,754 |

**Near Term Demand;
Sutherland Scenario 1, AF**

| | |
|---|---|
| GWDP | 12,912 |
| SWDemand | 48,049 |
| Net SW Loss | 11,870 |
| M&I | 3,074 |
| Max NonCU | 709,635 |
| Excess Supply | 41,935 |
| Total Near Term Demand | 785,541 |

**Long Term Demand;
Sutherland Scenario 1, AF**

| | |
|---|---|
| GWCU | 45,126 |
| SWDemand | 48,049 |
| Net SW Loss | 11,870 |
| M&I | 3,074 |
| Max NonCU | 709,635 |
| Excess Supply | 9,722 |
| Total Long Term Demand | 817,754 |

**Supply;
Sutherland Scenario 2, AF**

| | |
|---|---|
| Streamflow (Gain) | 187,484 |
| GWDP | 12,912 |
| SWCU | 47,169 |
| Req. Inflow | 500,778 |
| Total Supply | 748,344 |

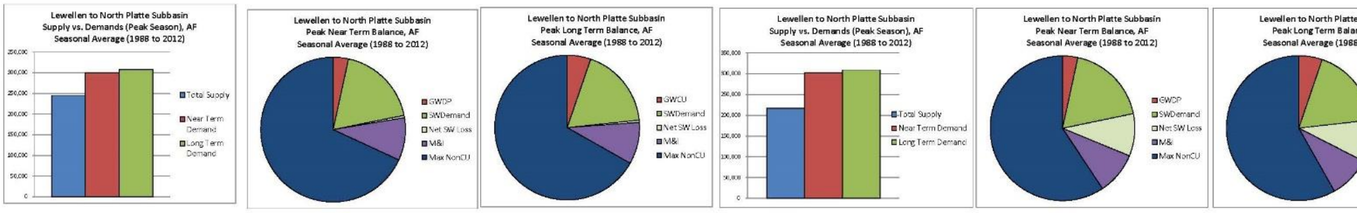
| | |
|---|---|
| Total Supply | 748,344 |
| Near Term Demand | 685,591 |
| Long Term Demand | 717,804 |

**Near Term Demand;
Sutherland Scenario 2, AF**

| | |
|---|---|
| GWDP | 12,912 |
| SWDemand | 48,049 |
| Net SW Loss | 11,870 |
| M&I | 3,074 |
| Max NonCU | 609,685 |
| Excess Supply | 62,754 |
| Total Near Term Demand | 685,591 |

**Long Term Demand;
Sutherland Scenario 2**

| | |
|---|---|
| GWCU | |
| SWDemand | |
| Net SW Loss | |
| M&I | |
| Max NonCU | |
| Excess Supply | |
| Total Long Term Demand | |



**Supply;
Sutherland Scenario 1, AF**

| | |
|---|---|
| Streamflow (Gain) | (11,421) |
| GWDP | 12,343 |
| SWCU | 54,253 |
| Req. Inflow | 190,122 |
| Total Supply | 245,298 |

| | |
|---|---|
| Total Supply | 245,298 |
| Near Term | 300,423 |
| Long Term Demand | 307,467 |

**Near Term Demand;
Sutherland Scenario 1, AF**

| | |
|---|---|
| GWDP | 12,343 |
| SWDemand | 66,507 |
| Net SW Loss | 1,852 |
| M&I | 34,366 |
| Max NonCU | 245,856 |
| Excess Supply | (55,126) |
| MAC Storage Offset | (60,502) |
| Total Near Term Demand | 300,423 |

**Long Term Demand;
Sutherland Scenario 1, AF**

| | |
|---|---|
| GWCU | 19,387 |
| SWDemand | 66,507 |
| Net SW Loss | 1,852 |
| M&I | 34,366 |
| Max NonCU | 245,856 |
| Excess Supply | (62,169) |
| MAC Storage Offset | (60,502) |
| Total Long Term Demand | 307,467 |

**Supply;
Sutherland Scenario 2, AF**

| | |
|---|---|
| Streamflow (Gain) | (11,421) |
| GWDP | 12,343 |
| SWCU | 54,253 |
| Req. Inflow | 162,013 |
| Total Supply | 217,189 |

| | |
|---|---|
| Total Supply | 217,189 |
| Near Term Demand | 302,295 |
| Long Term Demand | 309,339 |

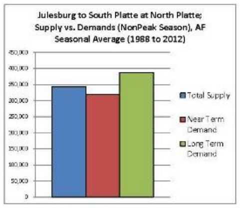
**Near Term Demand;
Sutherland Scenario 2, AF**

| | |
|---|---|
| GWDP | 12,343 |
| SWDemand | 66,507 |
| Net SW Loss | 34,366 |
| M&I | 34,366 |
| Max NonCU | 215,213 |
| Excess Supply | (85,106) |
| MAC Storage Offset | (60,502) |
| Total Near Term Demand | 302,295 |

**Long Term Demand;
Sutherland Scenario 2**

| | |
|---|---|
| GWCU | |
| SWDemand | |
| Net SW Loss | |
| M&I | |
| Max NonCU | |
| Excess Supply | |
| MAC Storage Offset | |
| Total Long Term Demand | |

## Figure 20: Nature and Extent of Use: South Platte River, State Line to North Platte Subbasin

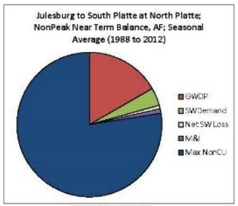


**Supply, AF**

| | |
|---|---|
| Streamflow (Gain) | 277,681 |
| GWDP | 53,189 |
| SWCU | 12,665 |
| Total Supply | 343,535 |

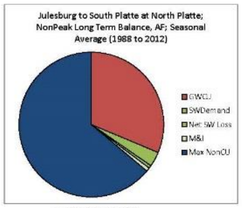
**Sutherland Scenario 1, AF**

| | |
|---|---|
| Total Supply | 343,535 |
| Near Term | 319,189 |
| Long Term | 387,255 |



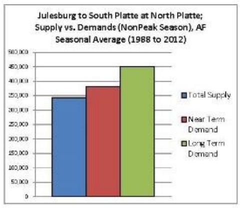
**Near Term Demand; Sutherland Scenario 1, AF**

| | |
|---|---|
| GWDP | 53,189 |
| SWDemand | 12,810 |
| Net SW Loss | 2,492 |
| M&I | 3,221 |
| Max NonCU | 247,476 |
| Excess Supply | 24,346 |
| Total Near Term Demand | 319,189 |



**Long Term Demand; Sutherland Scenario 1, AF**

| | |
|---|---|
| GWCU | 121,255 |
| SWDemand | 12,810 |
| Net SW Loss | 2,492 |
| M&I | 3,221 |
| Max NonCU | 247,476 |
| Excess Supply | (43,719) |
| Total Long Term Demand | 387,255 |

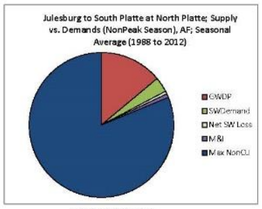


**Supply, AF**

| | |
|---|---|
| Streamflow (Gain) | 277,681 |
| GWDP | 53,189 |
| SWCU | 12,665 |
| Total Supply | 343,535 |

**Sutherland Scenario 2, AF**

| | |
|---|---|
| Total Supply | 343,535 |
| Near Term Demand | 381,901 |
| Long Term Demand | 449,967 |

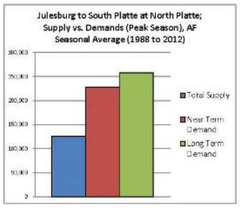


**Near Term Demand; Sutherland Scenario 2, AF**

| | |
|---|---|
| GWDP | 53,189 |
| SWDemand | 12,810 |
| Net SW Loss | 2,492 |
| M&I | 3,221 |
| Max NonCU | 310,189 |
| Excess Supply | (38,366) |
| Total Near Term Demand | 381,901 |

**Long Term Dema Scen**

| | |
|---|---|
| GWCU | |
| SWDemand | |
| Net SW Loss | |
| M&I | |
| Max NonCU | |
| Excess Supply | |
| Total Long Term D | |

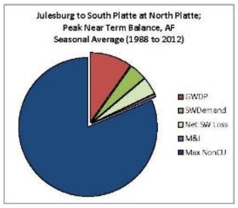


**Supply, AF**

| | |
|---|---|
| Streamflow (Gain) | 96,326 |
| GWDP | 22,392 |
| SWCU | 7,306 |
| Total Supply | 126,024 |

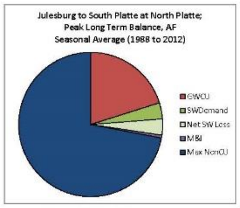
**Sutherland Scenario 1, AF**

| | |
|---|---|
| Total Supply | 126,024 |
| Near Term | 228,424 |
| Long Term | 257,998 |



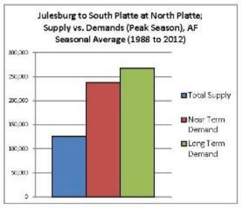
**Near Term Demand; Sutherland Scenario 1, AF**

| | |
|---|---|
| GWDP | 22,392 |
| SWDemand | 9,327 |
| Net SW Loss | 9,290 |
| M&I | 1,666 |
| Max NonCU | 185,748 |
| Excess Supply | (102,400) |
| Total Near Term Demand | 228,424 |



**Long Term Demand; Sutherland Scenario 1, AF**

| | |
|---|---|
| GWCU | 51,966 |
| SWDemand | 9,327 |
| Net SW Loss | 9,290 |
| M&I | 1,666 |
| Max NonCU | 185,748 |
| Excess Supply | (131,974) |
| Total Long Term Demand | 257,998 |

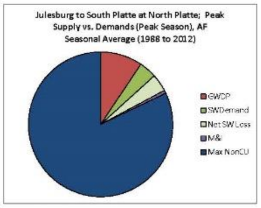


**Supply, AF**

| | |
|---|---|
| Streamflow (Gain) | 96,326 |
| GWDP | 22,392 |
| SWCU | 7,306 |
| Total Supply | 126,024 |

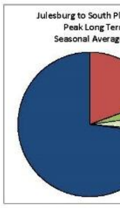
**Sutherland Scenario 2, AF**

| | |
|---|---|
| Total Supply | 126,024 |
| Demand | 238,166 |
| Long Term Demand | 267,740 |



**Near Term Demand; Sutherland Scenario 2, AF**

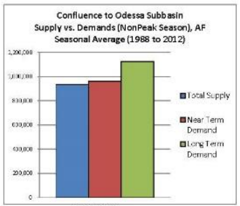
| | |
|---|---|
| GWDP | 22,392 |
| SWDemand | 9,327 |
| Net SW Loss | 9,290 |
| M&I | 1,666 |
| Max NonCU | 195,490 |
| Excess Supply | (112,142) |
| Total Near Term Demand | 238,166 |



**Long Term Demand Sutherland Scenario 2**

| | |
|---|---|
| GWCU | |
| SWDemand | |
| Net SW Loss | |
| M&I | |
| Max NonCU | |
| Excess Supply | |
| Total Long Term Demand | |

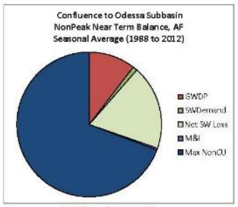
## Figure 21: Nature and Extent of Use: Platte River, Confluence to Odessa Subbasin



Supply, AF

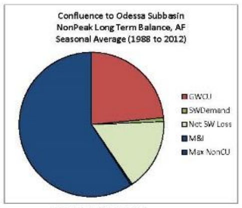
| | |
|---|---|
| Streamflow (Gain) | 64,579 |
| GWDP | 100,128 |
| SWCU | 5,825 |
| Req. Inflow | 764,521 |
| Total Supply | 935,053 |

| | |
|---|---|
| Total Supply | 935,053 |
| Near Term | 960,580 |
| Long Term | 1,124,583 |



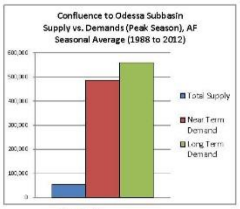
Near Term Demand, AF

| | |
|---|---|
| GWDP | 100,128 |
| SWDemand | 9,673 |
| Net SW Loss | 181,476 |
| M&I | 3,812 |
| Max NonCU | 665,491 |
| Excess Supply | (25,527) |
| Total Near Term Demand | 960,580 |



Long Term Demand, AF

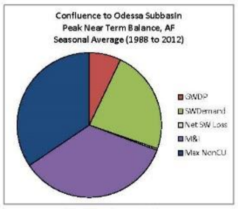
| | |
|---|---|
| GWCU | 264,131 |
| SWDemand | 9,673 |
| Net SW Loss | 181,476 |
| M&I | 3,812 |
| Max NonCU | 665,491 |
| Excess Supply | (189,530) |
| Total Long Term Demand | 1,124,583 |



Supply, AF

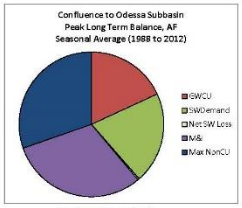
| | |
|---|---|
| Streamflow (Gain) | (239,089) |
| GWDP | 39,064 |
| SWCU | 74,137 |
| Req. Inflow | 179,559 |
| Total Supply | 53,672 |

| | |
|---|---|
| Total Supply | 53,672 |
| Near Term | 485,609 |
| Long Term | 559,744 |



Near Term Demand, AF

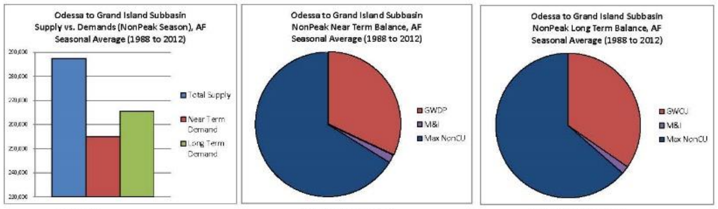
| | |
|---|---|
| GWDP | 39,064 |
| SWDemand | 127,732 |
| Net SW Loss | 2,088 |
| M&I | 192,306 |
| Max NonCU | 189,594 |
| Excess Supply | (431,938) |
| Mac Offset | (65,175) |
| Total Near Term Demand | 485,609 |



Long Term Demand, AF

| | |
|---|---|
| GWCU | 113,199 |
| SWDemand | 127,732 |
| Net SW Loss | 2,088 |
| M&I | 192,306 |
| Max NonCU | 189,594 |
| Excess Supply | (506,073) |
| Mac Offset | (65,175) |
| Total Long Term Demand | 559,744 |

## Figure 22: Nature and Extent of Use: Platte River, Odessa to Grand Island Subbasin



**Supply, AF**

| | |
|---|---|
| Streamflow (Gain) | 51,795 |
| GWDP | 81,583 |
| SWCU | 0 |
| Req. Inflow | 154,073 |
| Total Supply | 287,451 |

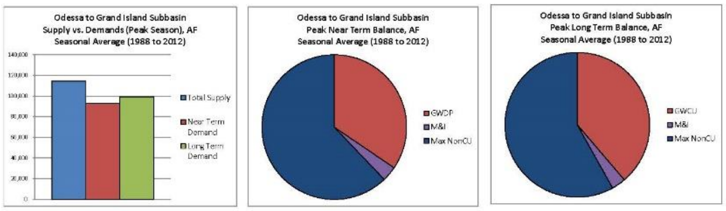
| | |
|---|---|
| Total Supply | 287,451 |
| Near Term | 255,007 |
| Long Term | 265,555 |

**Near Term Demand, AF**

| | |
|---|---|
| GWDP | 81,583 |
| SWDemand | 0 |
| M&I | 4,667 |
| Max NonCU | 168,757 |
| Excess Supply | 32,445 |
| Total Near Term Demand | 255,007 |

**Long Term Demand, AF**

| | |
|---|---|
| GWCU | 92,132 |
| SWDemand | 0 |
| M&I | 4,667 |
| Max NonCU | 168,757 |
| Excess Supply | 21,896 |
| Total Long Term Demand | 265,555 |



**Supply, AF**

| | |
|---|---|
| Streamflow (Gain) | 43,136 |
| GWDP | 32,053 |
| SWCU | 0 |
| Req. Inflow | 39,347 |
| Total Supply | 114,535 |

| | |
|---|---|
| Total Supply | 114,535 |
| Near Term | 92,866 |
| Long Term | 99,292 |

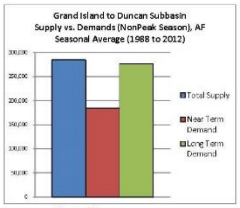
**Near Term Demand, AF**

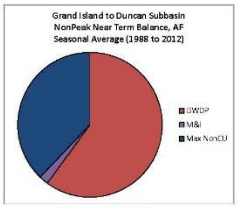
| | |
|---|---|
| GWDP | 32,053 |
| SWDemand | 0 |
| M&I | 3,117 |
| Max NonCU | 57,696 |
| Excess Supply | 21,670 |
| Total Near Term Demand | 92,866 |

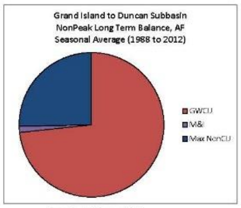
**Long Term Demand, AF**

| | |
|---|---|
| GWCU | 38,478 |
| SWDemand | 0 |
| M&I | 3,117 |
| Max NonCU | 57,696 |
| Excess Supply | 15,244 |
| Total Long Term Demand | 99,292 |

## Figure 23: Nature and Extent of Use: Platte River, Grand Island to Duncan Subbasin


Grand Island to Duncan Subbasin
Supply vs. Demands (NonPeak Season), AF
Seasonal Average (1988 to 2012)


Grand Island to Duncan Subbasin
NonPeak Near Term Balance, AF
Seasonal Average (1988 to 2012)


Grand Island to Duncan Subbasin
NonPeak Long Term Balance, AF
Seasonal Average (1988 to 2012)

**Supply, AF**

| | |
|---|---|
| Streamflow (Gain) | 169,076 |
| GWDP | 111,061 |
| SWCU | 0 |
| Req. Inflow | 4,160 |
| Total Supply | 284,296 |

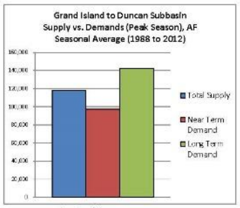
| | |
|---|---|
| Total Supply | 284,296 |
| Near Term | 184,900 |
| Long Term | 276,501 |

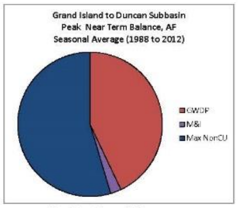
**Near Term Demand, AF**

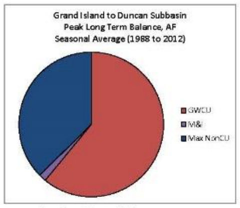
| | |
|---|---|
| GWDP | 111,061 |
| SWDemand | 0 |
| M&I | 3,806 |
| Max NonCU | 70,033 |
| Excess Supply | 99,396 |
| Total Near Term Demand | 184,900 |

**Long Term Demand, AF**

| | |
|---|---|
| GWCU | 202,662 |
| SWDemand | 0 |
| M&I | 3,806 |
| Max NonCU | 70,033 |
| Excess Supply | 7,795 |
| Total Long Term Demand | 276,501 |


Grand Island to Duncan Subbasin
Supply vs. Demands (Peak Season), AF
Seasonal Average (1988 to 2012)


Grand Island to Duncan Subbasin
Peak Near Term Balance, AF
Seasonal Average (1988 to 2012)


Grand Island to Duncan Subbasin
Peak Long Term Balance, AF
Seasonal Average (1988 to 2012)

**Supply, AF**

| | |
|---|---|
| Streamflow (Gain) | 62,912 |
| GWDP | 41,880 |
| SWCU | 0 |
| Req. Inflow | 13,479 |
| Total Supply | 118,271 |

| | |
|---|---|
| Total Supply | 118,271 |
| Near Term | 97,469 |
| Long Term | 142,444 |

**Near Term Demand, AF**

| | |
|---|---|
| GWDP | 41,880 |
| M&I | 2,357 |
| Max NonCU | 53,232 |
| Excess Supply | 20,802 |
| Total Near Term Demand | 97,469 |

**Long Term Demand, AF**

| | |
|---|---|
| GWCU | 86,855 |
| M&I | 2,357 |
| Max NonCU | 53,232 |
| Excess Supply | (24,173) |
| Total Long Term Demand | 142,444 |