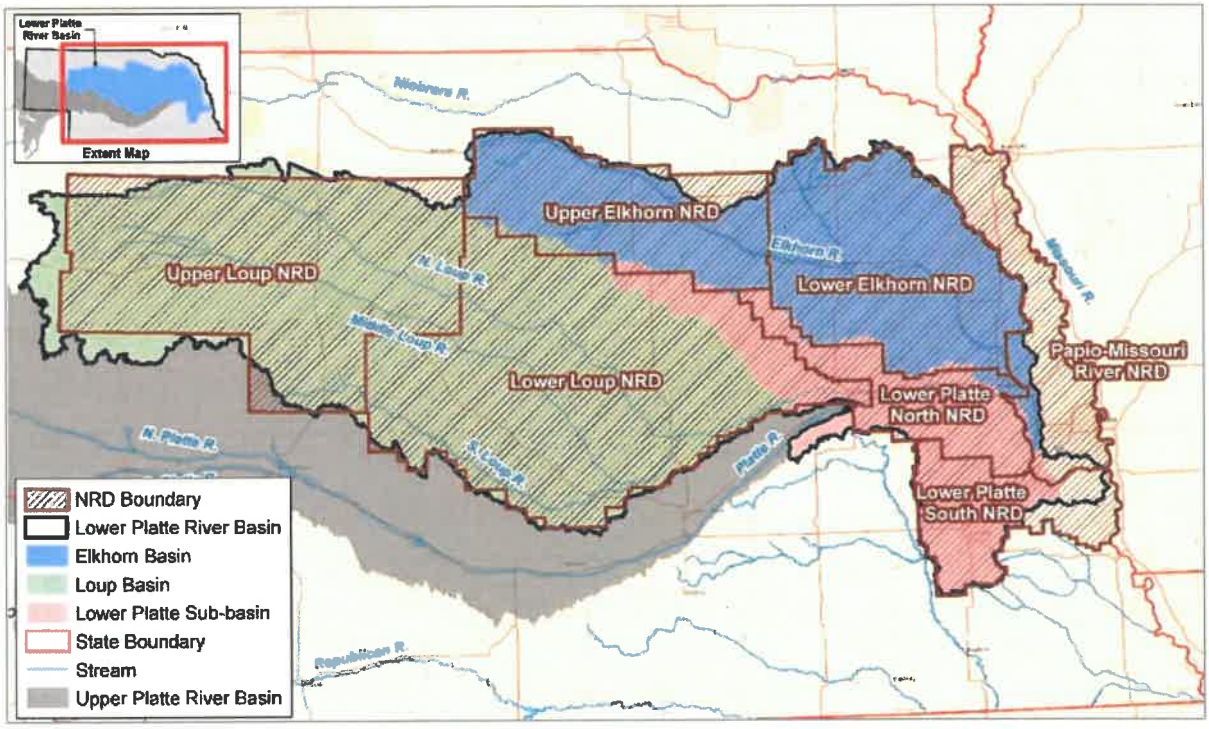
Lower Platte River Drought Contingency Plan – DRAFT

Executive Summary

Beginning in 2016, the Lower Platte South Natural Resources District (NRD), Papio-Missouri River NRD, Lower Platte North NRD, Metropolitan Utilities District (MUD), Lincoln Water System (LWS), and Nebraska Department of Natural Resources (NeDNR), collectively referred to as the Lower Platte River Consortium (Consortium), embarked on an effort to develop a drought contingency plan for the Lower Platte River Basin in Nebraska.

The drought-driven risks are diverse and alternatives for resolving them were developed through this planning effort. The Lower Platte River and its tributaries serve approximately 80 percent of Nebraska's population, thousands of businesses and industries, includes more than 2 million irrigated acres, and provides streamflows for threatened and endangered species. The six water management agencies that comprise the Consortium worked together to develop regional solutions to improve the water supply reliability and drought resiliency of the Lower Platte River.

Figure E-1: Map of Lower Platte River Basin



1.0 Drought Contingency Plan Background

In 2017, the Lower Platte River Basin Coalition, which includes the seven NRDs[1] in the Loup, Elkhorn, and Lower Platte River Basins, and NeDNR, adopted the *Lower Platte River Coalition Basin Water Management Plan*. The plan sets criteria for managing new water development in the Lower Platte River (basin), and goals and objectives that work to protect the existing domestic, agricultural, and industrial water uses in the basin. This planning effort for the *Lower Platte River Drought Contingency Plan* (LPRDCP) followed the development of the *Lower Platte River Coalition Basin Water Management Plan*

[1] This includes the three NRD members of the Consortium (Lower Platte North NRD, Lower Platte South NRD, and Papio-Missouri River NRD).

to further address water supply shortages during drought periods, when peak demands overlap periods of low streamflows.

The primary focus of the LPRDCP is to refine the Consortium's collective understanding of drought vulnerabilities, while developing more robust monitoring and forecasting tools coupled with timely triggers, new mitigation strategies, and responsive actions to create a sound, operational framework and to improve critical water supply of the area through drought periods.

Management and Technical staff from each of the six Consortium members collaborated in the development of this LPRDCP. The Consortium represents a range of stakeholder interests. The Consortium solicited stakeholder input throughout the development of the LPRDCP through written comments, two stakeholder workshops, and two public open houses.

2.0 Lower Platte River Basin

Basin Water Demands

The water demands and water uses in the Lower Platte River are diverse; they include municipal, domestic, and agricultural uses, instream flows, and hydropower. The water utilities for the municipalities of Omaha and Lincoln, Nebraska, serve the two primary metropolitan areas in Nebraska, constituting approximately 60 percent of Nebraska's population. Both municipalities hold induced recharge permits (that is, permits that require streamflows adjacent to their well fields) and municipal groundwater transfer permits (that is, permits where groundwater is transferred from the water well site for use in another location). The Nebraska Game and Parks Commission holds instream flow appropriations for much of the Platte River and specifically in the areas of municipal well field operations. The Loup Public Power District holds a hydropower appropriation for off-channel hydroelectric power generation. In addition, thousands of individual water rights are held to support irrigation from both surface water and hydrologically connected groundwater sources.

Basin Water Supplies

Water supplies of the Lower Platte River are driven by snowmelt, rainfall runoff, and aquifer baseflow contributions. Supplies can be highly variable, with annual flows ranging from 2 million acre-feet per year to more than 10 million acre-feet per year.

During low flow years, the Upper Platte River becomes disconnected from the Lower Platte River with flows at Duncan, Nebraska, representing a negligible portion of flows observed in the Lower Platte River. During these times, most of the flow in the Lower Platte River originates from the groundwater-fed Loup River, Elkhorn River, and Platte River tributaries downstream from Duncan. The water supplies of the Loup River and Elkhorn River sub-basins tend to be more reliable because of significant baseflow contributions. During drought periods, these water supplies reliant on baseflow contributions are stressed in support of irrigated agricultural production (primarily corn and soybeans).

While annual water supplies in the Lower Platte River generally tend to be supportive of most water uses, peak demands in the summer months can create water shortages, typically in July and August. These shortages are further exacerbated by drought periods when summer flows become most critical in supporting water demands.

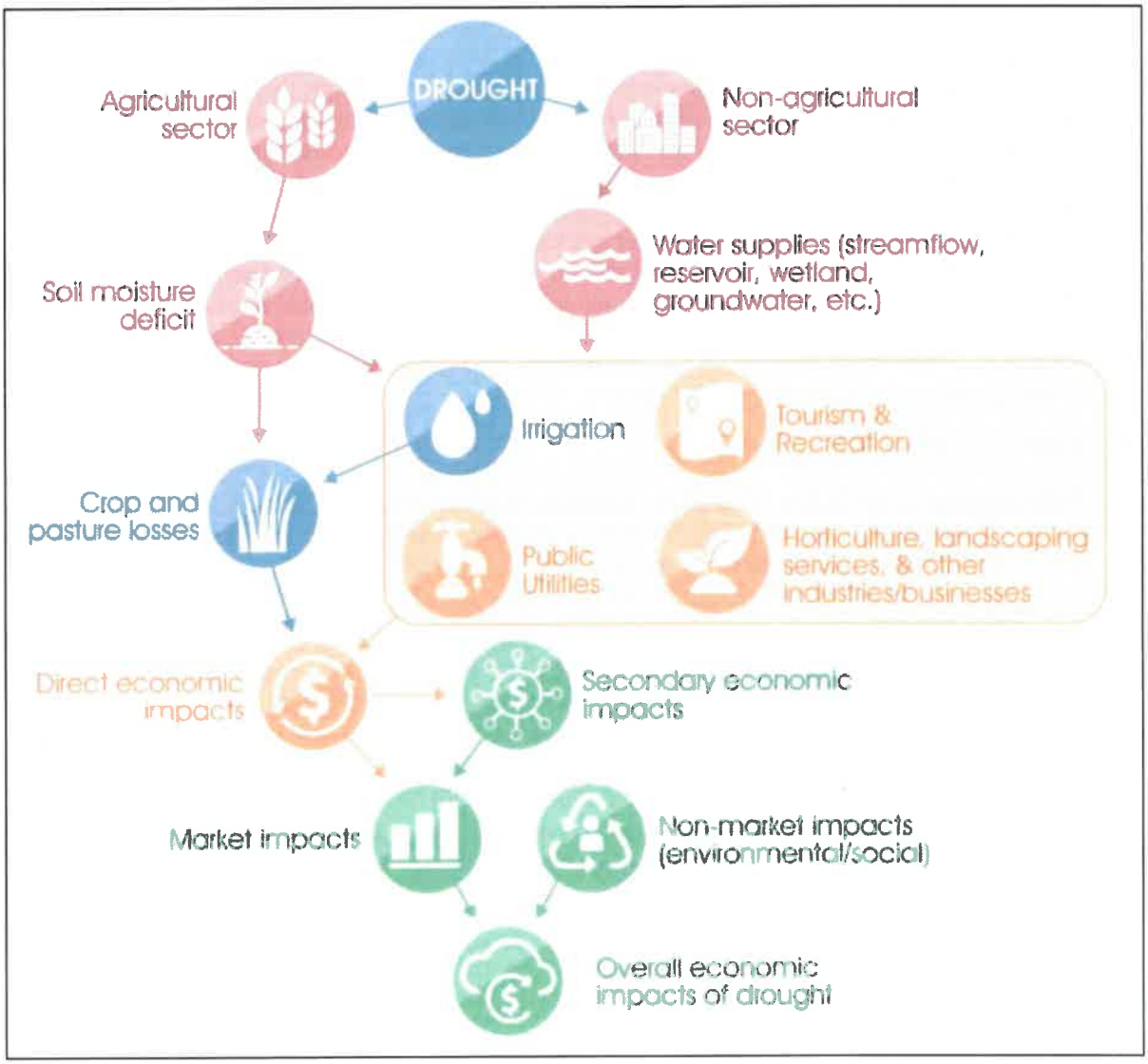
3.0 Vulnerability Assessment

"[V]ulnerability to drought is the product of numerous interrelated factors such as population growth and shifts, urbanization, demographic characteristics, water use trends, social behavior, and environmental

susceptibilities…. The degree to which a population is vulnerable hinges on the ability to anticipate, to deal with, resist, and recover from the drought" (Commission on Water Resource Management 2003).

The effects from drought can be classified as direct and indirect. Direct effects include physical destruction of property, crops, natural resources, as well as public health and safety. Indirect effects are consequences of that destruction, such as temporary unemployment and business interruption (National Academy of Sciences 1999). "The most vulnerable portions of the state in terms of economic impact are cropland, pasture land for animals, recreational areas, and businesses that depend on agricultural industries for the bulk of their business. However, all areas of the state can be impacted by drought events" (Nebraska Emergency Management Agency [NEMA] 2014). Figure E-2 summarizes sectors that are affected by drought (both agriculture and non-agriculture).

Figure E-2: An Overview of Drought Economic Effects



Source: Adapted from Ding, Hayes, and Widhalm 2010

Public water systems along the Lower Platte River are largely dependent on aquifers hydrologically connected to the river and its tributaries, and dependent on streamflow for recharge. Omaha and Lincoln, Nebraska's two largest municipalities, rely heavily on water supplies in the Lower Platte River to support well field operations adjacent to the river. MUD's water system receives roughly half of its capacity from the Lower Platte River and the other half is received from the Missouri River. The capacity of Lincoln Water Systems' Ashland Wellfield is directly dependent on flows in the Lower Platte River adjacent to the wellfield. The vulnerability of public water supply during drought is amplified in the Lower Platte River Basin due to the lack of redundant water sources. With the exception of MUD, public water systems along the Lower Platte River rely solely on the aquifers hydrologically connected to the Platte River and reliant on its flows for recharge. A 2012 report by the University of Florida listed Lincoln as the third most at-risk city in the nation for water shortage due to its reliance on the Platte River as its sole source of water supply (University of Florida 2013).

The Lower Platte River provides habitat for numerous species, including federally listed threatened and endangered species, that is dependent on sustained flows. In addition, this reach of the river provides recreational amenities for the eastern portion of the state, including the primary population centers.

4.0 Drought Monitoring

Hydroclimatic indices assess drought severity and are essential for tracking and anticipating droughts as well as providing historical reference. Indices provide useful triggers to help direct decision-makers toward proactive risk management. For this increment of the LPRDCP, the Palmer Drought Severity Index (PDSI) will be utilized in combination with streamflow observations for drought determination in the Lower Platte River Basin. The PDSI reflects recent precipitation and the soil moisture balance. Zero or near zero PDSI values indicate normal conditions, a negative PDSI value indicates below normal, or drought conditions; and a positive value represents above normal, or wetter periods.

Three categories of drought have been identified for the LPRDCP. These levels of drought remain consistent with the National Drought Monitor definitions of drought. These categories and corresponding PDSI and streamflow thresholds are presented in Table E-1.

The following lists the levels of drought and their corresponding definition:

- A Level 0, "Abnormally Dry"[2] indicates an area may be experiencing "short-term dryness slowing planting, growth of crops or pastures" indicating the onset of drought or may be coming out of drought and experiencing lingering effects of drought.
- A Level 1, "Moderate Drought" involves "some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; and voluntary water-use restrictions requested."
- A Level 2, "Severe Drought" means that "crop or pasture losses likely; water shortages common; and water restrictions imposed."
- A Level 3, "Extreme Drought" involves "major crop/pasture losses" and "widespread water shortages or restrictions."

[2] An "Abnormally Dry" classification by the National Drought Monitor corresponds to a PDSI "mild drought" classification.

Table E-1: Drought Triggers

Category	PDSI	Platte River Streamflow at Ashland
Mild Drought	-1.0 to -1.99	--
Moderate Drought	-2.0 to -2.99	3,000-1,500 cfs
Severe Drought	-3.0 to -3.99	1,500-500 cfs
Extreme Drought	-4.0 and below	Less than 500 cfs

Notes: PDSI = Palmer Drought Severity Index

Analysis of historic PDSI values from the last 116 years reveal that mild, moderate, severe, and extreme droughts have historically occurred in the Lower Platte River Basin once every three, six, nine, and fourteen years, respectively.

It should be noted that no groundwater trigger is included in Table E-1. Each of the Consortium NRD members has some form of drought monitoring and triggers for response actions in defined areas of their District. The intent of the LPRDCP is not to replace each members' groundwater monitoring and management plans; rather to supplement these plans. These individual plans are discussed in detail in Appendix A.

Understanding the behavior of the Platte River at Ashland as flows recede is important to the ability of the Consortium to forecast and properly time the implementation of response actions. Using the LPRDCP Platte River at Ashland Recession Tool allows the user to enter the current observed flow in the Platte River at Ashland and predict the flow decay behavior for the next 30 days, assuming no further inputs to the system (precipitation runoff or upstream storage releases). The resulting recession curve can be used to estimate the days until a critical threshold is reached. The development of the LPRDCP Platte River at Ashland Recession Tool is discussed in detail in Appendix E. Figure E-3 is a schematic of the functional utility of the LPRDCP Platte River at Ashland Recession Tool in drought forecasting and response.

Figure E-3: Lower Platte River Drought Contingency Plan Platte River at Ashland Recession Tool

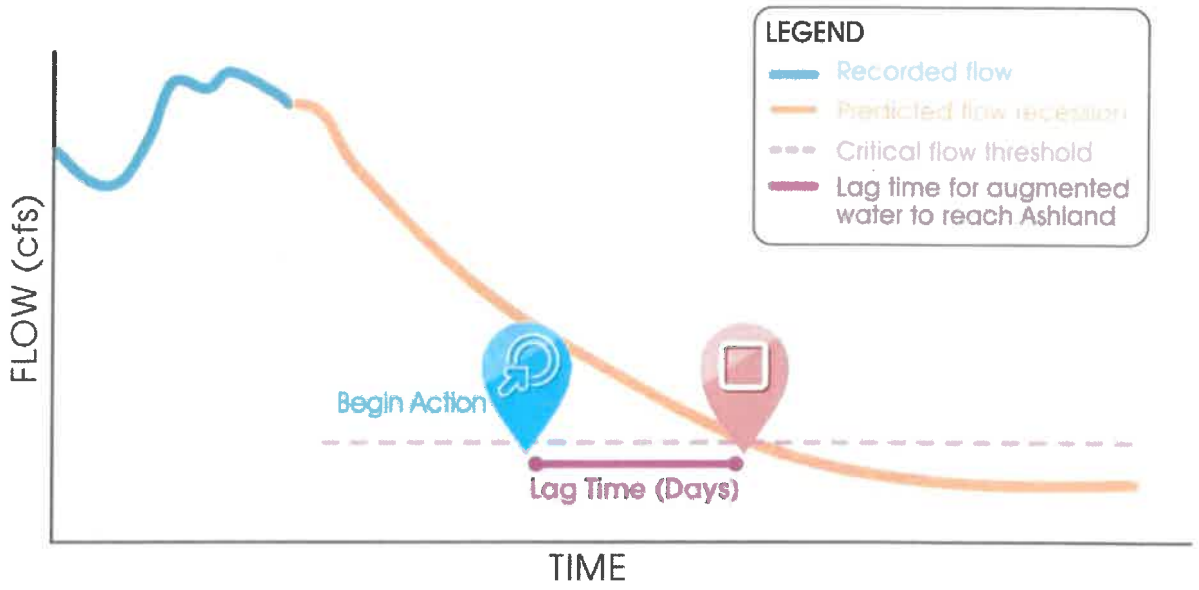
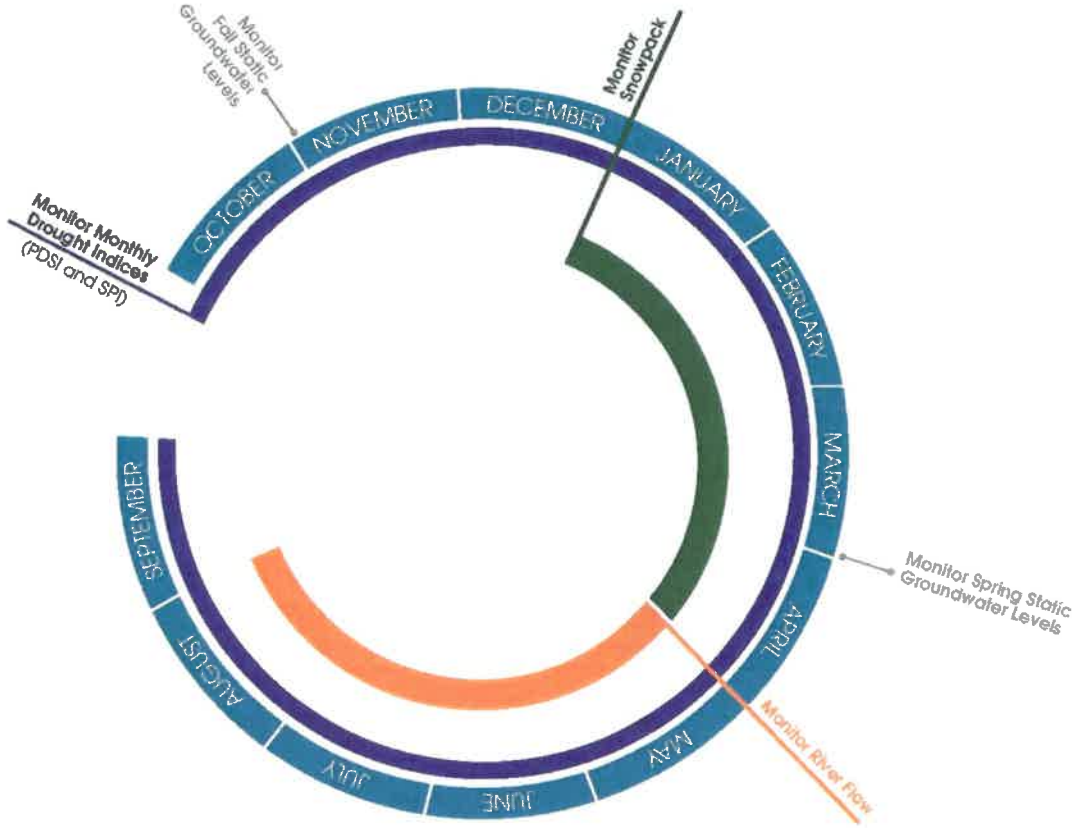


Figure E-4: Drought Monitoring Continuum



The recommended timeline for drought monitoring is displayed in Figure E-4 Figure 42. Hydroclimate indices SPI and PDSI should be monitored year round. Groundwater levels are monitored by NRDs in the spring and fall of each year in accordance with their individual groundwater management plans. Snowpack volumes should be monitored from the beginning of the calendar year through the runoff season. Streamflows should be monitored starting in late spring through the summer when water use for irrigation, cooling, and lawn watering is at its peak.

5.0 Drought Management

Drought Mitigation Measures

Drought mitigation measures are actions, programs, and strategies implemented during non-drought periods to address potential risks and effects and to reduce the need for response actions; implementation of drought mitigation measures improves long-term resilience and reliability of the regional water supply.

Eight mitigation measures were evaluated in the LPRDCP that could increase regional water supply reliability. These include the following and are summarized in Table E-2.

- Installing an alluvial well field adjacent to the Missouri River and pumping water to a tributary of the Elkhorn River for availability on demand.
- Purchasing storage in the existing Sherman Reservoir and releasing water on demand.
- A new surface water storage reservoir on Skull Creek near Linwood for releasing water on demand.
- A new surface water storage reservoir on Bell Creek east of Winslow for releasing water on demand.
- Capture of Middle Loup River water in the non-irrigation season and diversion into the Middle Loup Canal system for intentional recharge and baseflow augmentation.
- Installing a wellfield to tap into groundwater aquifers with limited connection to streamflow that can be pumped to the river to augment flows.
- Pumping from alluvial sandpits directly to the river to augment flows.
- A dry-year-lease agreement with farmers irrigating lands adjacent to the main channel of the Platte River from the alluvial aquifer.

Conceptual design of infrastructure requirements and anticipated operational characteristics were defined for each mitigation measure. In addition, the estimated project yield to the Lower Platte River at the Ashland gage was determined. For projects upstream in the basin, a routing tool was used to estimate the losses that occur during conveyance to the Ashland gage. This routing tool utilizes historic reach loss data during low flow periods to estimate conveyance losses (see Appendix D). As part of this planning effort, continuous recording monitoring wells paired with stage recorders were installed to foster a better understanding of losses in the Lower Platte River under varying hydrologic conditions.

For comparison of alternative costs and benefits, a 20-year period was evaluated to reflect the relative reliability of water from the mitigation action, i.e. for some mitigation actions water will not be available every year. A 15-day operation period, targeting the typical late-July/early-August critical low flow period in the Lower Platte River was assumed for project operations. For developing cost/AF estimates included in Table E-2, costs were estimated over a 20-year period without using a discount rate or otherwise accounting for the time value of money. Benefits were based on acre-foot of water estimated to be delivered at the Ashland gage during the 15-day target period over the 20-yr period. Assumptions for each mitigation action are described in Section 5.0 and Appendix C.

Of the eight mitigation measures (and combinations thereof) evaluated, 3 measures were estimated to cost less than $1,000 per acre-foot of water delivered to the lower Platte River. Three mitigation measures cost more than $1,000 per acre-foot but less than $2,000 per acre-foot. The dry-year lease option cost was estimated at more than 30 times greater than most of the other measures, at $62,000/acre-foot.

When evaluating the summary provided in Table E-2, additional considerations beyond the cost/benefit metrics include:

- The canal recharge and dry year lease projects are passive mitigation measures whose benefits (passive baseflow returns) accrue throughout the year. Active management to target the 15-day period is not an option for these two alternatives. Therefore, the cost-benefit analysis in Table E-2 does not capture the tangible benefits provided by augmenting streamflows year round, benefits that do add drought resiliency to the overall system.
- The canal recharge, dry year lease, Sherman Reservoir storage agreement, and sandpit pumping (Lake Clagus) measures all require cooperation and agreements with existing facilities/producers. Negotiations will dictate the ultimate operational and financial characteristics of the agreements. Estimates of agreement costs herein are best estimates based on similar agreements in the state, and factors such as cost differential between irrigated and dryland rental rates.
- Of all the mitigation measures evaluated, the alluvial wellfield adjacent to the Missouri River is the only measure that imports water from another source. While the cost may be more for this

alternative, the benefit of adding an additional water source – relatively immune to drought stresses and independent of the Platte River basin - must be considered.

Table E-2: Evaluation of Potential Mitigation Measures

Alternative	Volume Added at Source (AF)	Time Period of Added Flow	Where Added	Volume Increase at Ashland (AF)	Cost Estimate (assuming 20-year agreement)	Cost per Acre-Foot added at Ashland
Alluvial Sandpit (Lake Clagus)	14,850	15 days	North Bend Gage & Ashland Gage	14,850	$5,980,000	$403
Sherman Release (400 cfs at St Paul)	47,520	15 days	St. Paul Gage	15,720	$9,628,000	$612
Skull Creek Res. Rel. (100 cfs at Linwood)	59,400	15 days	North Bend Gage	46,300	$32,630,000	$705
Sherman Release (250 cfs at St. Paul)	29,700	15 days	St. Paul Gage	9,800	$6,955,000	$710
Augmentation Wellfield	59,400	15 days	TBD	59,400	$81,008,040	$1,364
Import Missouri River Water	59,400	15 days	Waterloo Gage	46,300	$76,572,840	$1,654
Bell Creek Res. Rel. (100 cfs at Waterloo)	59,400	15 days	Waterloo Gage	46,300	$81,520,000	$1,761
Bell Creek Reservoir + Missouri River Import Water	59,400	15 days	Waterloo Gage	46,300	$158,092,840	$3,415
Middle Loup Canal Recharge (Historic Loup Canal Operations)	7,525	15 days	Arcadia	2,525	$16,360,000	$6,478
Middle Loup Canal Recharge (Full Hydropower Right downstream)	2,034	15 days	Arcadia	634	$5,225,000	$8,238
GW Dry Year Lease	4,000	15 days	North Bend Gage and Ashland Gage	4,000	$248,500,800	$62,125

Notes: AF = acre-feet; cfs = cubic feet per second.

Drought Response Actions

Drought response actions are near-term actions triggered during specific stages of drought to manage the limited supply and to decrease the severity of immediate effects of drought periods on the regional water supply. In this first increment of the LPRDCP, potential mitigation measures (Table E-2) have been evaluated, but preferred measures have not been determined or constructed; therefore, the primary drought response action available to the Consortium at this time is communication and outreach.

Consistent and coordinated messaging to basin water users (municipal, industrial, domestic, irrigation, etc.), as well as the general public, raises awareness of the current water supply conditions, allows water users to proactively alter their demand and usage based on limited water supplies, and defines expectations of forecasted conditions and potential actions in response to the drought.

6.0 Operational and Administrative Framework

Future Lower Platte River Drought Contingency Plan Updates

The LPRDCP and associated planning is meant to be part of an adaptive process that is routinely updated to reflect the needs of the basin. The Consortium will hold meetings each year and will evaluate the need for updating the LPRDCP every 5 years. The following list provides information related to the anticipated frequency of Consortium actions and steps taken in regard to updating the LPRDCP.

- On an annual basis, the Consortium will gather information and make any necessary updates to the Vulnerability Assessment.
- On an annual basis, the Consortium will review any changes in the Vulnerability Assessment, determine the need for new and revised actions, update the status of existing actions, and add new actions (as needed).
- Every 5 years, the Consortium will assess the need for and prepare an updated LPRDCP (as needed).

It should be noted that the Consortium may identify planning and technical efforts outside those anticipated that need to be undertaken based on changed conditions or a potential need.

Continued Communication and Outreach

The Consortium will consider the only drought response action available to it at this time, which is communication and outreach. The following list provides information related to communication and outreach.

- The Consortium will keep the project website updated and will send emails to keep interested stakeholders informed of meetings, new materials, and other information related to the LPRDCP and its implementation.
- Each individual agency in the Consortium will be responsible for informing its constituents, customers, and the public of any actions initiated and related progress and results.
- Coordination and information sharing with other ongoing efforts will be mutually beneficial (Missouri Basin Plan, Nebraska Emergency Management Agency, etc.). It is anticipated this coordination and information sharing with other ongoing efforts and agencies will occur on an as-needed basis.