NEBRASKA NATURAL RESOURCES COMMISSION

Water Sustainability Fund

Application for Funding

Section A.

ADMINISTRATIVE

PROJECT NAME: **Understanding Arsenic Trends in the Lower Platte River and the Surface Water Contribution to the City of Lincoln Water System Groundwater Wells for use in Future Water Supply Needs.**

SPONSOR'S *City of Lincoln Transportation and Utilities Department*

Sponsor Business Name: Lincoln Water System (LWS)

Sponsor Contact's Name: Steve R. Owen

Sponsor Contact's Address: 2021 N 27th St, Lincoln, NE 68503

Sponsor Contact's Phone: 402-441-5925

Sponsor Contact's Email: sowen@lincoln.ne.gov

1. **Funding** amount requested from the Water Sustainability Fund:

   Grant amount requested. $ 145,000

   - If requesting less than 60% cost share, what %? Click here to enter text.

   If a loan is requested amount requested. $ 0.00

   - How many years repayment period? NA
   - Supply a complete year-by-year repayment schedule. NA

2. **Neb. Rev. Stat. § 2-1507 (2)**

   Are you applying for a **combined sewer overflow project**? YES☐ NO☒

   If yes:

- Do you have a Long Term Control Plan that is currently approved by the Nebraska Department of Environmental Quality? YES☐ NO☐
- Attach a copy to your application. Click here to enter text.
- What is the population served by your project? Click here to enter text.
- Provide a demonstration of need. Click here to enter text.
- **Do not complete the remainder of the application.**

3. **Permits Required/Obtained** Attach a copy of each that has been obtained. For those needed, but not yet obtained (box **"NO"** checked), 1.) State when you will apply for the permit, 2.) When you anticipate receiving the permit, and 3.) Your estimated cost to obtain the permit.

(N/A = Not applicable/not asking for cost share to obtain)
(Yes = See attached)
(No = Might need, don't have & are asking for 60% cost share to obtain)

G&P - T&E consultation (required)	N/A☒ Obtained: YES☐ NO☐
DNR Surface Water Right	N/A☒ Obtained: YES☐ NO☐
USACE (e.g., 404/other Permit)	N/A☒ Obtained: YES☐ NO☐
FEMA (CLOMR)	N/A☒ Obtained: YES☐ NO☐
Local Zoning/Construction	N/A☒ Obtained: YES☐ NO☐
Cultural Resources Evaluation	N/A☒ Obtained: YES☐ NO☐
Other (provide explanation below)	N/A☒ Obtained: YES☐ NO☐

Click here to enter text.

4. **Partnerships**

List each Partner / Co-sponsor, attach documentation of agreement:
Lincoln Water System (LWS) and U.S. Geological Survey (USGS) Documentation of agreement is provided through letters of financial support from each partner, 30 years of past cooperation between the partners, and an example of the partners federal fiscal year 2021 agreement for yearly data collection and current studies.

Identify the roles and responsibilities of each Partner / Co-sponsor involved in the proposed project regardless of whether each is an additional funding source.

The Lincoln Water System (LWS) will provide guidance and system knowledge during the research project. The LWS will be a primary user of the study results. The US Geological Survey (USGS) will be responsible for collecting and analyzing the water quality samples. The USGS will manage, interpret, and publish the collected data and research results.

5. **Other Sources of Funding**

Identify the costs of the entire project, what costs each other source of funding will be applied to, and whether each of these other sources of funding is confirmed. If not, please identify those entities and list the date when confirmation is expected. Explain how you will implement the project if these sources are not obtained.

Funding Source	Federal Fiscal Year 2022	Federal Fiscal Year 2023	Federal Fiscal Year 2024	Totals
Water Sustainability Fund	$60,000	$44,000	$41,000	$145,000
USGS Cooperative Matching Funds	$33,000	$43,000	$32,000	$108,000
Lincoln Transportation and Utilities	$30,000	$35,000	$32,000	$97,000

The total cost of the project is $350,000. The USGS through its Cooperative Matching Funds will provide $108,000 in Federal funding. The remaining project costs ($242,000), the Water Sustainability Fund will cover 60% ($145,000) and the Lincoln Transportation and Utilities Department will cover 40% ($97,000). The Lincoln Transportation and Utilities Department and USGS funds are confirmed. If funding is not received from the WSF this research work may proceed with the other funding sources but with an extended timeline to reduce yearly costs. This situation would not be ideal because the City of Lincoln needs this initial data and analysis complete to determine the next steps needed to ensure continued safe drinking water supplies. Letters of financial support for this project from the USGS and the Lincoln Transportation and Utilities Department are provided with this grant application.

6. **Overview**

In 1,000 words *or less*, provide a brief description of your project including the nature/purpose of the project and its objectives. Do not exceed one page!

The U.S. Geological Survey (USGS) and the City of Lincoln Water Systems (LWS) plan to conduct a study to assess arsenic concentrations in the Platte River and to assess the amount of surface water contributing to horizontal collector wells and vertical wells used by the LWS to provide clean, safe drinking water to approximately 300,000 Nebraskans. The primary intent of this project is to support arsenic management in the drinking water supply of LWS. Specifically, the study will assist the LWS in understanding arsenic concentrations in the surface water of the Platte River and the contribution of the surface water to the horizontal collector wells so future decisions can be made on the best alternative for mitigating arsenic levels at, or below, 80% of EPA's Maximum Contaminate Lever (MCL). The capital and O&M cost of arsenic removal is highly dependent on removal efficiency so knowing more information about the source of arsenic and its contribution to levels in raw water supply is key to developing a cost-effective mitigation system. The preliminary design goal of a mitigation system is to supply potable water at 60% of the MCL by using a removal technology to be determined during project development. A firm understanding of the influence of arsenic concentrations of the Platte River and its major tributaries on groundwater quality will help LWS to determine the most logical, cost-effective approach to delivering safe, quality drinking water. Arsenic is a regulated constituent under the Safe Drinking Water Act with a maximum contaminant level (MCL) of 10 parts per billion (ppb) in public drinking water. Arsenic became a constituent of higher priority in 2002 when the federal drinking water limit was lowered from 50 ppb to 10 ppb. Previous arsenic monitoring has focused on monitoring wells in and around the LWS wellfield. Arsenic concentrations in the LWS's source water fluctuates seasonally, spatially, and by well location and type (U.S. Geological Survey, 2021) with some data showing higher arsenic concentrations when more source water is supplied from the horizontal collector wells. Although current monitoring has been informative, it has not conclusively identified the factors contributing to the arsenic levels in the LWS source water supply. While LWS has consistently maintained arsenic levels below the MCL, additional horizontal collector wells are planned in the future development of the wellfield which will make maintaining the target concentration below 80% of the MCL more difficult. The proposed study will examine existing surface-water and groundwater quality data and include additional surface-water and groundwater sampling to supplement existing data sets. Specific project tasks include: 1) Determine the concentrations of arsenic in the Platte River, major tributaries, and Platte River alluvial aquifer. 2) Characterize and assess long-term trends in arsenic concentrations of the Platte River. 3) Examine groundwater/surface-water interaction and contribution to LWS wells in relation to arsenic. The alternative to completing this project is to continue operations even as arsenic concentrations approach 80% of the MCL as additional water supply is provided through horizontal collector wells. Not fully understanding the sources of arsenic in groundwater and surface water and the processes of mobilization and transport that can lead to increased concentrations near the Lincoln Water System wellfield (fig. 1) will make design and implementation of future arsenic treatment systems less cost effective as the LWS continues to provide Lincoln's approximately 300,000 customers with a safe, reliable source of drinking water. This research along with past monitoring will continue to improve understanding of arsenic in the Platte River alluvial aquifer system which will be beneficial to other water managers and municipalities that also have a part in water management in the lower Platte River system. The results of the study will be published as an online USGS Scientific Investigations Report. Availability of an online report helps disseminate the results of the investigations to a broad audience and enables water managers and users to gain access to this information in a timely manner. All products will adhere to the USGS Fundamental Science Practices including peer review and to all other USGS standards for scientific integrity and quality.

7. **Project Tasks and Timeline**

Identify what activities will be conducted to complete the project, and the anticipated completion date.

Activity	Federal Year 2022				Federal Year 2023				Federal Year 2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Platte River at Ashland sampling		X	X	X	X	X	X	X	X			
Sampling Platte River at Leshara and Elkhorn at Waterloo		X	X	X	X	X	X	X	X			
Statistical trend analysis SW		X	X	X	X	X			X			
Examine GW/SW relationships			X	X	X	X	X	X	X			
Report writing and production			X	X	X	X	X	X	X	X	X	X

Click here to enter text.

8. **IMP**

Do you have an **Integrated Management Plan** in place, or have you initiated one? YES☐ NO☐ Sponsor is not an NRD☒

Section B.

DNR DIRECTOR'S FINDINGS

Prove Engineering & Technical Feasibility

(Applicant must demonstrate compliance with Title 261, CH 2 - 004)

- Does your project include physical construction (defined as moving dirt, directing water, physically constructing something, or installing equipment)?
  YES☐ NO☒

  If you answered "YES" you must answer all questions in section 1.A.
  If you answer "NO" you must answer all questions in section 1.B.

  If "YES", it is considered mostly structural, so answer the following:

1.A.1 Insert a feasibility report to comply with Title 261, Chapter 2, including engineering and technical data; Click here to enter text.

1.A.2 Describe the plan of development (004.01 A); Click here to enter text.

1.A.3 Include a description of all field investigations made to substantiate the feasibility report (004.01 B); Click here to enter text.

1.A.4 Provide maps, drawings, charts, tables, etc., used as a basis for the feasibility report (004.01 C); Click here to enter text.

1.A.5 Describe any necessary water and/or land rights including pertinent water supply and water quality information (004.01 D); Click here to enter text.

1.A.6 Discuss each component of the final plan (004.01 E); Click here to enter text.

1.A.7 When applicable include the geologic investigation required for the project (004.01 E 1); Click here to enter text.

1.A.8 When applicable include the hydrologic data investigation required for the project (004.01 E 2); Click here to enter text.

1.A.9 When applicable include the criteria for final design including, but not limited to, soil mechanics, hydraulic, hydrologic, structural, embankments and foundation criteria (004.01 E 3). Click here to enter text.

If "NO", it is considered mostly non-structural, so answer the following:

1.B.1 Insert data necessary to establish technical feasibility (004.02);

As part of its mission, the USGS is tasked with monitoring the quality of water in the Nation's rivers and aquifers. The USGS has detailed procedures for collecting both surface water and groundwater quality samples (U.S. Geological Survey, variously dated), field and lab safety protocols, data management processes, and quality control and quality assurance practices. The USGS Nebraska Water Science Center has worked cooperatively with the Lincoln Water System (LWS) to collect water quality samples in groundwater and surface water for nearly 30 years to characterize current conditions, determine the occurrence of volatile organic, inorganic, and explosive compounds, and assess the possible effects of development in the watershed on water quality. For the proposed project, the USGS and the LWS wish to conduct a study to assess the major surface water contributions of arsenic in the Platte River and the Platte River alluvial aquifer in Eastern Nebraska. Concentrations of arsenic in LWS source water from production wells have approached 80 percent of the U.S. Environmental Protection Agency Maximum Contaminate Level of 10 parts per billion (ppb). In eastern Nebraska, arsenic concentrations in filtered surface water samples collected from 1965 to 2021 from the Platte and Elkhorn Rivers have ranged from non-detect to 40 µg/L in the 1970s in 90 samples to 1.4 to 16.1 µg/L from 2010 to current (2021) in 430 samples. In filtered groundwater samples from the Platte River alluvial aquifer, arsenic concentrations ranged from non-detect to 9 µg/L in the 1970s in three samples, from 1 to 10 µg/L in the 1990's in 114 samples, and from 0.08 to 45 µg/L from 2010 to current (2021) in 298 samples, (U.S. Geological Survey, 2021). The City of Lincoln utilizes both vertical and horizontal collector wells as their production wells. Future buildout of the Ashland wellfields calls for at least two additional large collector wells, which makes the characterization of arsenic an important undertaking for future mitigation and maintaining levels below the MCL. Previous studies have estimated that 52 to 97 percent of the yield from these horizontal collector wells is derived from surface water (Steele and Verstraeten, 1999), indicating that water quality from these wells can be substantially influenced by surface water. The proposed study will examine existing surface-water and groundwater quality data and include additional surface-water sampling to supplement existing data sets. Additional information gained from this study will allow the LWS to determine the most cost-effective approach to mitigate arsenic in the source water supply to deliver safe and reliable drinking water to its approximately 300,000 customers.

1.B.2 Discuss the plan of development (004.02 A);

The USGS and the LWS plan to conduct a study to assess arsenic in the Platte River and to assess the amount of surface water contributing to horizontal collector wells and vertical wells used by the LWS. The proposed study will examine existing surface-water and groundwater quality data and include additional surface-water and groundwater sampling to supplement existing data sets. Specific project tasks and subtasks include: 1) Determine the concentrations of arsenic in the Platte River, its major tributaries, and Platte River

alluvial aquifer. 1a) Continue to collect 14 yearly (12 monthly + 2 runoff) surface-water samples for arsenic, major ion, nutrient, and other trace elements in the Platte River at Ashland (USGS site 06801000, fig. 1), including comparative arsenic analysis completed by LWS to assess possible differences in analytical methods. 1b) Synoptic sampling upstream of Ashland, NE to account for incomplete mixing of Platte River and Elkhorn River sources. Given the inherent variability expected between the two rivers, 10 sets of paired synoptic samples would be able to detect a systematic difference of 1 µg/L or more. This proposal would leverage the arsenic sampling that is already occurring in the Elkhorn River at Waterloo (USGS site 06800500, fig. 1) as part of the USGS National Water Quality Network. Therefore, 10 sets of arsenic samples would be collected from the Platte River at Leshara (USGS site 06796500, fig. 1) on the same days as the Elkhorn sampling. 2) Characterize and assess long-term trends in arsenic concentrations of the Platte River. 2a) Examine apparent statistical trends in arsenic concentrations in surface-water from the Platte River at Louisville (USGS site 068055000, fig. 1) and Elkhorn River at Waterloo with respect to streamflow, seasonality, and decadal trends using data that have already been collected as part of the USGS National Water Quality Network. These statistical trends would be explored using a statistical model, such as the Weighted Regressions on Time, Discharge, and Season (WRTDS) model (Hirsch and others, 2010) or the Load Estimator (LOADEST) model (Runkel and others, 2004). 3) Examine groundwater/surface-water interaction and relation to arsenic. 3a) Determine the relative contributions of surface water and groundwater to horizontal collector wells and selected vertical production wells by collecting up to 20 samples from recently installed and existing horizontal collector wells and vertical wells. Samples would be collected in the summer and analyzed for stable isotopes for relative groundwater contributions and arsenic. 3b) Determine if the range in relative contributions of groundwater and surface water in the northern horizontal collector wells determined by Steele and Verstraeten (1999) have changed over time possibly due to high flow events in 2011 and 2019 that may have altered the Platte River channel geometry.

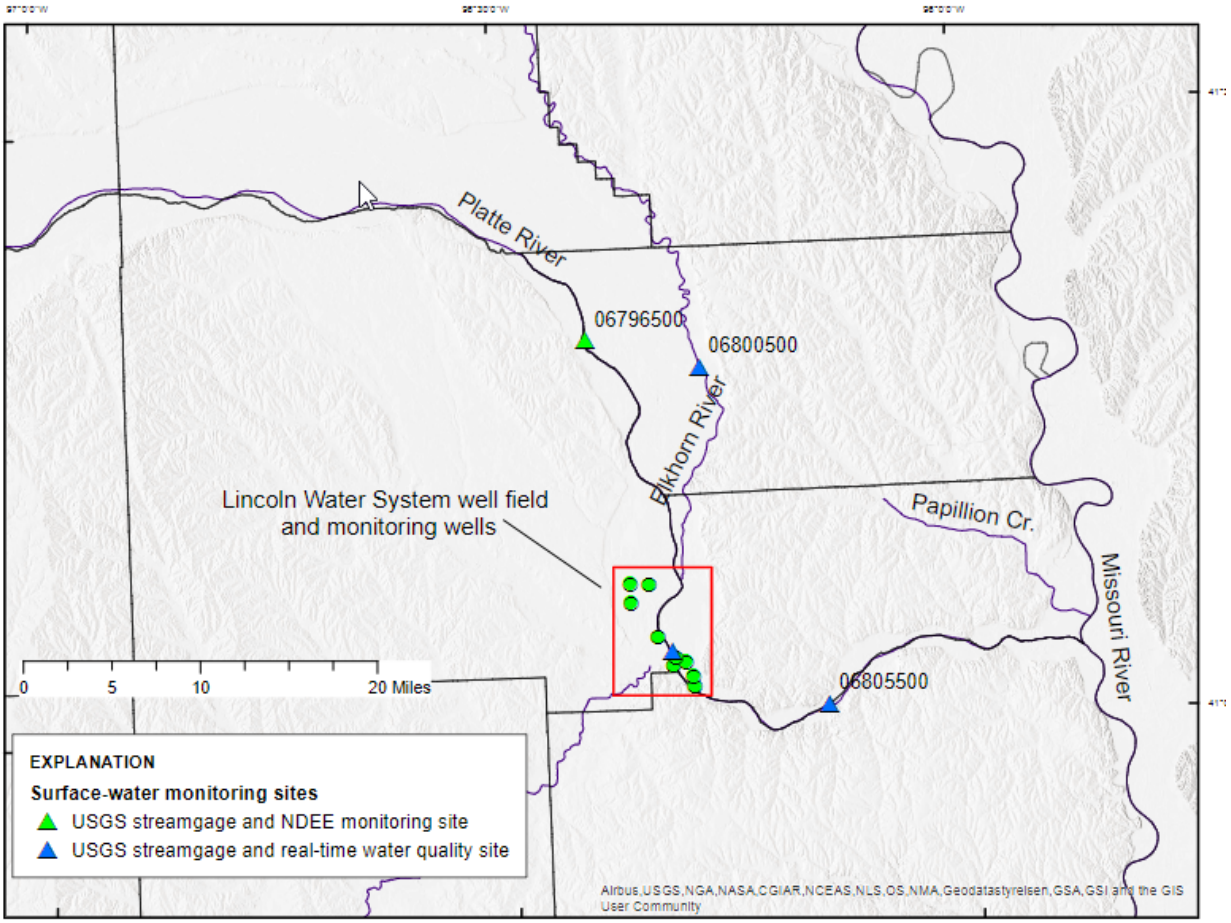

Figure 1. Location of the Lincoln Water System (LWS) well field near Ashland, Nebraska, LWS monitoring wells, and Nebraska Department of Energy and Environment (NDEE) and U.S. Geological Survey (USGS) streamgages and monitoring sites

1.B.3 Describe field or research investigations utilized to substantiate the project conception (004.02 B); The Platte River alluvial aquifer is a major source of water for the largest city in Nebraska—Omaha and the only source of water for the second largest city in Nebraska—Lincoln. Concentrations of arsenic in LWS's individual production wells have at times exceeded 80 percent of the U.S. Environmental Protection Agency Maximum Contaminant Level (MCL) of 10 parts per billion (ppb, verbal communication with the City of Lincoln). In eastern Nebraska, arsenic concentrations in filtered surface water samples collected from 1965 to 2021 from the Platte and Elkhorn Rivers have ranged from non-detect to 40 µg/L in the 1970s in 90 samples to 1.4 to 16.1 µg/L from 2010 to current (2021) in 430 samples. In filtered groundwater samples from the Platte River alluvial aquifer, arsenic concentrations ranged from non-detect to 9 µg/L in the 1970s in three samples, from 1 to 10 µg/L in the 1990's in 114 samples, and from 0.08 to 45 µg/L from 2010 to current (2021) in 298 samples, (U.S. Geological Survey, 2021). The City of Lincoln utilizes vertical and horizontal collector wells as their production wells. Previous studies have estimated that 52 to 97 percent

of the yield from these horizontal collector wells is derived from surface water (Steele and Verstraeten, 1999), indicating that groundwater quality from these wells can be substantially influenced by surface water. The vertical wells generally lie to the west of the Platte River whereas the horizontal collector wells are located on the island within the river or on land on the eastern side of the channel. The lateral screen projections from the collector wells in some locations extend outward to underneath the existing river channel. Recent LWS monitoring has suggested that the horizontal collector wells are typically higher in arsenic than the vertical wells. The explanation for this difference is undetermined but might be from differences in the groundwater quality on the east side of the river or the large percentage of surface water contribution in these horizontal collector wells or a combination of both (fig. 2). The LWS includes two separate water treatment facilities- one treating groundwater (vertical wells) and one treating groundwater under the influence of surface water (horizontal collector wells). Understanding the cause of higher arsenic in the horizontal collector wells is critical information as both treatment facilities are required to meet the MCL independent of the other. In other words, blending finished water between the two treatment facilities is currently not an option. LWS's 2020 Water Facilities Master Plan recommends the addition of arsenic treatment as early as 2025 with an estimated cost of $45 million. Actual capital and O&M costs associated with arsenic treatment will be highly dependent on accurate assumptions of expected source water arsenic concentrations. In addition, future buildout of the Ashland wellfields calls for at least two additional large collector wells to meet future water demands. Because of the near ubiquity of arsenic in eastern Nebraska (Ayotte and others, 2017), an incorrectly sited well may still produce high arsenic groundwater. Given the expense of possible long-term solutions, a thorough understanding of the contributions, trends, and influences of naturally occurring arsenic in groundwater and surface sources is needed to understand the processes and controls that affect aquifer geochemistry and arsenic mobility in the Platte River alluvial aquifer. A firm understanding of the influence of arsenic concentrations of the Platte River and its major tributaries on groundwater quality will allow LWS to determine the most logical, cost-effective approach to delivering safe, quality, drinking water to its approximately 300,000 users. The Lincoln Water System's 2020 Facilities Master Plan identifies the need for a better understanding of the presence of arsenic in the Platte River system as a precursor to the evaluation of arsenic treatment and mitigation options.

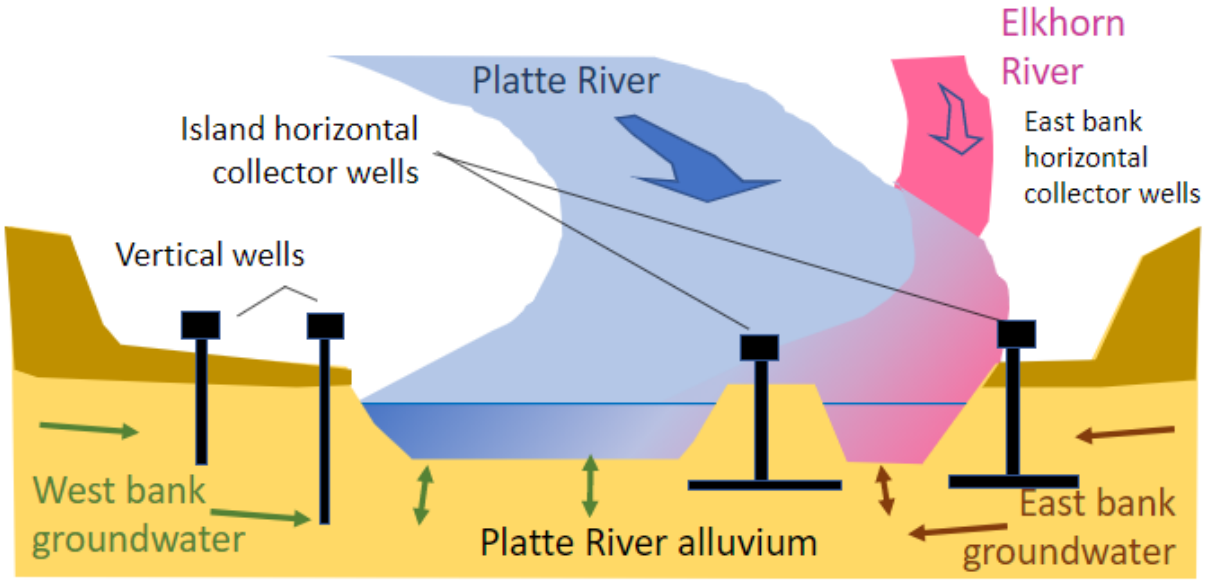

Figure 2. Schematic showing the hydrologic components in the vicinity of the Lincoln Water System's well field, including incomplete mixing of water in the Platte and Elkhorn Rivers, arrows indicating between the aquifer and the river, and the location of the vertical and horizontal collector wells (Figure is not to scale).

1.B.4 Describe any necessary water and/or land rights (004.02 C); No new water rights are required for this project and all land rights for sampling are secured through the project partners or project sponsors.

1.B.5 Discuss the anticipated effects, if any, of the project upon the development and/or operation of existing or envisioned structural measures including a brief description of any such measure (004.02 D). The proposed project seeks to provide the LWS with information that will allow them to move forward with cost-effective solutions to maintain arsenic concentrations in drinking water below the MCL. The information gained through this research on the sources and timing of arsenic in the Platte River hydrogeology system (fig. 1) is a necessary first step as outlined in the Lincoln Water System's 2020 Facilities Master Plan Update to provide data and information needed to determine future treatment and mitigation strategy to maintain arsenic concentrations below the U.S. EPA maximum contaminant level (MCL). Arsenic removal cost is highly dependent on the desired level of treatment and a zero concentration goal is considered cost prohibitive. A more realistic treatment goal is between 6 ppb and 8 ppb. A better understanding of how seasonal arsenic concentrations observed in surface water (Platte River) is key to properly evaluating the type of treatment process and mitigation steps required and the associated O&M costs. This becomes crucial as the LWS completes the development of its wellfield areas that are directly

influenced by surface water quality and intended to provide water supply capacity through 2045.

Prove Economic Feasibility

(Applicant must demonstrate compliance with Title 261, CH 2 - 005)

- Provide evidence that there are no known means of accomplishing the same purpose or purposes more economically, by describing the next best alternative. Alternative of not completing this research project, might lead to LWS making decisions on future arsenic treatment that is not the most cost effective because of lack of understanding on how arsenic concentration in the surface water and groundwater system is functioning. Partnering with USGS offers the more efficient option for conducting this project considering their experience and expertise in groundwater and surface water quality research and ensures quality data collection, analysis, and publishing methods are used.

- Document all sources and report all **costs** and **benefit data** using current data, (commodity prices, recreation benefit prices, and wildlife prices as prescribed by the Director) using both dollar values and other units of measurement when appropriate (environmental, social, cultural, data improvement, etc.). The period of analysis for economic feasibility studies is the project life, up to fifty (50) years; *or*, with prior approval of the Director up to one hundred (100) years, (Title 261, CH 2 - 005). The total cost of the proposed project is $350,000 of which the LWS is requesting $145,000 in funds from the Water Sustainability Fund. The benefits of this project are to provide the basis in developing a cost effective solution using sound data representative of actual current conditions. Use of assumed or dated data and a less than thorough understanding of arsenic sources and concentrations could lead to an ineffective mitigation system or unnecessary and costly design assumptions. A firm understanding of the influence of arsenic concentrations in the Platte River and its major tributaries on groundwater quality will assist LWS in determining the most logical, cost-effective approach to delivering safe, quality drinking water now and into the future. The capital and O&M cost of arsenic removal is highly dependent on expected source water arsenic concentrations so knowing more information about the source of arsenic and its contribution to levels in raw water supply is key to developing a cost-effective mitigation system.

3.A Describe any relevant cost information including, but not limited to the engineering and inspection costs, capital construction costs, annual operation and maintenance costs, and replacement costs. Cost information shall also include the estimated construction period as well as the estimated project life (005.01). The total cost of the proposed project is $350,000 of which the LWS is requesting $145,000 in funds from the Water Sustainability Fund. The cost of the proposed project covers additional surface-water sampling of the Platte River at

Ashland and will leverage planned sampling at the Elkhorn River at Waterloo. The funding will also cover the cost of USGS personnel to characterize the long-term trends in arsenic concentrations in the Platte River. The proposed project will assess groundwater/surface-water interaction by collecting stable isotope samples from LWS production wells. The data collected and major findings of this study will be published in a USGS Scientific Investigations Report. Availability of an online report helps disseminate the results of the investigations to a broad audience and enables water managers and users to gain access to this information in a timely manner after publication and into the future. All products will adhere to the USGS Fundamental Science Practices including peer review and to all other USGS standards for scientific integrity and quality. USGS will maintain the data collected and the resulting report as part of their national data management that will not include any maintenance costs to the project. There will be no annual operation, inspection, or replacement costs with this project. The estimated project life or the future relevance or applicability of this research project is undeterminable because of the nature of the system being studied that could change with significant natural events.

3.B Only primary tangible benefits may be counted in providing the monetary benefit information and shall be displayed by year for the project life. In a multi-purpose project, estimate benefits for each purpose, by year, for the life of the project. Describe intangible or secondary benefits (if any) separately. In a case where there is no generally accepted method for calculation of primary tangible benefits describe how the project will increase water sustainability, in a way that justifies economic feasibility of the project such that the finding can be approved by the Director and the Commission (005.02). There is no generally accepted method for calculation of primary tangible benefits of this research project. This research will support water sustainability because the information gained will assist the LWS in making future water management decisions to meet the water needs of approximately 300,000 Nebraskans. Information gained through this research will support future decisions on exactly how and when arsenic treatment will be needed and how to design and operate an arsenic treatment and mitigation system cost-effectively. Information gained through this research might also assist LWS in making future decisions on installation, placement, and operation of future horizontal collector wells as the Ashland wellfield is expanded to meet increasing water needs. The LWS takes many actions in the current Water Management Plan to encourage water conservation and ensure water sustainability including, but not limited to, tiered rate structures that increases the individual's unit cost of water as the water usage increases and water shortage or drought rates.

3.C Present all cost and benefit data in a table to indicate the annual cash flow for the life of the project (005.03). Given below is a cost table of the proposed project. Exact benefits can not be described for the research project.

Activity	FY2022	FY2023	FY2024	TOTAL
Platte River at Ashland sampling	$20,000	$10,000	$10,000	$40,000
Sampling Platte River at Leshara and Elkhorn at Waterloo	$35,000	$15,000	$10,000	$60,000
Statistical trend analysis SW	$38,000	$50,000	$40,000	$128,000
Examine GW/SW relationships	$30,000	$27,000	$0	$57,000
Report writing and production		$20,000	$45,000	$65,000
TOTALS	$123,000	$122,000	$105,000	$350,000
Water Sustainability Fund*	$60,000	$44,000	$41,000	$145,000
USGS Cooperative Matching Funds	$33,000	$43,000	$32,000	$108,000
Lincoln Transportation and Utilities Department	$30,000	$35,000	$32,000	$97,000

*The Water Sustainability Funds cover 60 percent of project costs not covered by Federal in-kind contributions (USGS Cooperative Matching Funds).

3.D In the case of projects for which there is no generally accepted method for calculation of primary tangible benefits and if the project will increase water sustainability, demonstrate the economic feasibility of such proposal by such method as the Director and the Commission deem appropriate (005.04). (For example, show costs of and describe the next best alternative.) There is no generally accepted method for calculation of primary tangible benefits of this research project. This research will support water sustainability because the information gained will assist the LWS in making future water management decisions to meet the water needs of approximately 300,000 Nebraskans. Information gained through this research will support future decisions on how and when arsenic treatment will be needed and how to design and operate arsenic treatment most cost-effectively. Information gained through this research might also assist LWS in making future decisions on installation, placement, and operation of future horizontal collector wells as the Ashland wellfield is expanded to meet increasing water needs. The LWS takes many actions in the current Water Management Plan to encourage water conservation and ensure water sustainability including, but not limited to, tiered rate structures that increases the individual's unit cost of water as the water usage increases and water shortage or drought rates.

Prove Financial Feasibility

(Applicant must demonstrate compliance with Title 261, CH 2 - 006)

- Provide evidence that sufficient funds are available to complete the proposal. If this application is chosen for funding, matching fund expenses will be from the Lincoln Transportation and Utilities Department- Lincoln Water System's Capital Improvement Plan budget which is funded principally by water rate revenues, impact fees, tapping fees, and revenue bonds. The U.S. Geological Survey supports this project with funding available yearly through the USGS Cooperative Matching Funds (https://www.usgs.gov/mission-areas/water-resources/science/usgs-cooperative-matching-funds). See attached letters of financial support.

- Provide evidence that sufficient annual revenue is available to repay the reimbursable costs and to cover OM&R (operate, maintain, and replace). This project will have no operation, maintenance, or replacement costs.

- If a loan is involved, provide sufficient documentation to prove that the loan can be repaid during the repayment life of the proposal. No loan will be involved to fund the proposed project.

- Describe how the plan of development minimizes impacts on the natural environment (i.e. timing vs nesting/migration, etc.). Data collection will primarily occur in already developed areas such as the Highway 6 bridge near Ashland, the City of Lincoln wellfield, etc. During sampling, waste produced, and chemicals used for sample preservation and equipment cleaning will be disposed of responsibly, in accordance with the USGS Field Manual, Chapters A4 and A5 (U.S. Geological Survey, variously dated).

- Explain how you are qualified, responsible and legally capable of carrying out the project for which you are seeking funds. The USGS has a major role in studying the Nations water resources and serves as the lead earth science agency of the Federal Government. The Nebraska Water Science Center employs 35 scientists whose mission is to deliver timely, accurate, and relevant information on Nebraska's water resources. The Lincoln Water System and the USGS Nebraska Water Science Center have been working cooperatively for over 30 years on projects related to groundwater quality, streamflow, and groundwater surface-water interaction. The Lincoln Water System is seeking funds to complete a research project with the USGS which will examine the sources and timing of arsenic in the Platte River and its tributaries and study how these surface-water arsenic sources influence groundwater arsenic and concentrations in LWS's source water supply.
- Explain how your project considers plans and programs of the state and resources development plans of the political subdivisions of the state. The proposed project advances the knowledge of the prevalence of arsenic in the Platte River upstream from the Lincoln Water System wellfield and in its major

tributaries. The information regarding arsenic concentrations and transport processes will assist other agencies, such as Nebraska Department of Environment and Energy with their ambient surface-water and groundwater quality monitoring programs which are tasked with describing water quality conditions in Nebraska's rivers, streams, and aquifers which are vital to sustaining irrigation and drinking water supplies, recreational opportunities, and industrial uses. The Lincoln, Nebraska area is in the Lower Platte South (LPS) Natural Resources District (NRD). The LWS's wells and water treatment facilities are near Ashland, Nebraska and are located partly in the Lower Platte North (LPN) NRD, partly in the LPS NRD, and partly in the Papio-Missouri River (PMR) NRD. The LWS wells are hydrologically connected to the Platte River (Lower Platte North Natural Resources District, 2018; Lower Platte South Natural Resources District, 2014; Papio-Missouri River Natural Resources District, 2014). The LWS's wellfield and treatment facilities near Ashland, Nebraska are in a groundwater and surface-water quantity control area (Lower Platte North Natural Resources District, 2018; Papio-Missouri River Natural Resources District, 2014). A goal in the LPN and PMR NRD's Integrated Management Plans are to develop policies, programs, and practices to maintain water supply and water quality and encourage water conservation. A goal of the LPS NRD's Integrated Management Plan is to manage the water supply and support water use. The objective of this project is to provide needed data that will assist the LWS in managing current water operations that maintain arsenic concentrations well below the MCL and plan for future arsenic treatment options as the Ashland wellfield is further developed. The Lower Platte River Basin Coalition, which includes the Nebraska Department of Natural Resources, have developed a Basin Water Management Plan (Lower Platte River Basin Coalition, 2017) to balance the water demands and supplies in the Lower Platte River Basin. One of the goals of this plan is to "Develop and maintain a water supply and use inventory based on the best available data and analysis." Objective 3 of this goal is to "Evaluate potential effects on water inventory of coordination, innovation and technology." The objective of this project is to use existing data and collect additional data to understand the relation between arsenic concentrations in surface water and groundwater to assist LWS in managing the current system of wells and planning for future water treatment needs and wellfield development. The arsenic concentration data collected as part of this study will complement sampling for arsenic in domestic, irrigation, and public supply wells by the LPN, LPS, and PMR NRDs. The NRDs sample groundwater for arsenic as part of their groundwater management plans. Objective 7 in the LPN NRDs groundwater management plan (Lower Platte North NRD, 1994) is to "Maintain groundwater quality and quantity monitoring programs." Objective 7 in the LPS NRDs groundwater management plan (Lower Platte South NRD, 1995) is to "Work collectively with other agencies to evaluate groundwater quantity and quality data". The PMR NRD's definition of groundwater sustainability is defined as "Water use is sustainable when it promotes healthy watersheds and aquifers, improves water quality, protects water supplies through Best Management Practices (BMP), and manages surface and groundwater resources conjunctively

to protect the ability of future generations to meet their needs (Papio-Missouri River Natural Resources District, 2017a and 2017b)." All data and reports from this research project will be shared with these entities and others and the LWS routinely provides these entities and others such as the Papio-Missouri River NRD with pumping data.

- Are land rights necessary to complete your project? YES☐ NO☒

If yes:

10.A Provide a complete listing of all lands involved in the project. Click here to enter text.

10.B Attach proof of ownership for each easements, rights-of-way and fee title currently held. Click here to enter text.

10.C Provide assurance that you can hold or can acquire title to all lands not currently held. Click here to enter text.

11. Identify how you possess all necessary authority to undertake or participate in the project. Click here to enter text.

12. Identify the probable consequences (environmental and ecological) that may result if the project is or is not completed. Click here to enter text.

Section C.

NRC SCORING

In the NRC's scoring process, points will be given to each project in ranking the projects, with the total number of points determining the final project ranking list.

The following 15 criteria constitute the items for which points will be assigned. Point assignments will be 0, 2, 4, or 6 for items 1 through 8; and 0, 1, 2, or 3 for items 9 through 15. Two additional points will be awarded to projects which address issues determined by the NRC to be the result of a federal mandate.

Notes:

- The responses to one criterion ***will not*** be considered in the scoring of other criteria. Repeat references as needed to support documentation in each criterion as appropriate. The 15 categories are specified by statute and will be used to create scoring matrixes which will ultimately determine which projects receive funding.

- There is a total of 69 possible points, plus two bonus points. The potential number of points awarded for each criteria are noted above. Once points are assigned, they will be added to determine a final score. The scores will determine ranking.

- The Commission recommends providing the requested information and the requests are not intended to limit the information an applicant may provide. An applicant should include additional information that is believed will assist the Commission in understanding a proposal so that it can be awarded the points to which it is entitled.

Complete any of the following (15) criteria which apply to your project. Your response will be reviewed and scored by the NRC. Place an N/A (not applicable) in any that do not apply, an N/A will automatically be placed in any response fields left blank.

1. Remediates or mitigates threats to drinking water;

    - Describe the specific threats to drinking water the project will address.
    - Identify whose drinking water, how many people are affected, how will project remediate or mitigate.
    - Provide a history of issues and tried solutions.
    - Provide detail regarding long-range impacts if issues are not resolved.

In 2020, the Lincoln Water System provided drinking water to approximately 300,000 people in the Lincoln, Nebraska area. In 2020, more than 12.5 billion gallons of water was pumped by the LWS wells. An average of about 34.2 million gallons of water per day are used by LWS customers (City of Lincoln, 2014). It is important to note that LWS performs regular master planning activities generally every five (5) years in order to identify, plan, and fund various improvements to provide reliable and safe water supply to the City of Lincoln. Mitigation of arsenic levels under full development of available water supplies within the current wellfields is a significant project identified in the most recent 2020 master plan update. The LWS's water supply is from vertical wells and horizontal collector wells screened in the Platte River alluvial aquifer. The LWS's vertical wells generally are located to the west of the Platte River; the horizontal collector wells are located on the island within the river and eastern side of the channel. The lateral screen projections from the horizontal collector wells, in some locations, extend outward to underneath the existing river channel. It is estimated that from 52 to 97 percent of the horizontal collector wells' discharge is derived directly from the Platte River (Steele and Verstraeten, 1999). The raw water supplied from the vertical wells and horizontal collector wells are treated at two separately regulated treatment facilities. During low water demand, LWS can supply water using only several wells and with only one treatment facility. However, seasonal (summer) demands reduce this operational flexibility and supply is required from both facilities and both vertical and horizontal collector wells. LWS and USGS personnel monitor the concentration of arsenic and other constituents in the source water. LWS collects samples of the source water at various points including from individual wells, the point of entry (POE) into the distribution system, and in the Platte River near the horizontal collector wells. The U.S. EPA's maximum contaminant levels (MCL) for arsenic is 10 parts per billion (ppb, U.S. Environmental Protection Agency, 2009). Arsenic concentrations in the LWS's source water fluctuates seasonally, spatially, and by well location and type (https://ne.water.usgs.gov/projects/col/LWSENV.txt). Since 2019, arsenic concentrations in the LWS source water samples ranged from less than 5 µg/L to near 10 µg/L (John Keith, LWS, written commun. Nov. 2020). USGS has collected 172 samples for arsenic analysis from 15 wells in the LWS wellfield area from 1991 to 2020. Arsenic results in USGS samples have varied from a minimum of 0.34 µg/L to a maximum of 13 µg/L, with a median of 6 µg/L (https://ne.water.usgs.gov/projects/col/LWSENV.txt). The objective of this project is to assist the LWS in understanding arsenic in the surface water of the Platte River and the contribution of the surface water to the horizontal collector wells so future decisions can be made on the best alternative for mitigating arsenic levels at or below 80% of the MCL. The information gained through this research on the sources and timing of arsenic in the Platte River hydrogeology system (fig. 2) is a necessary first step as outlined in the Lincoln Water System's 2020 Facilities Master Plan Update to provide data and information needed to determine future treatment and mitigation to maintain arsenic concentrations below the U.S. EPA maximum contaminant level (MCL). Arsenic removal cost is highly dependent on the desired level of treatment and a zero concentration goal is considered cost

prohibitive. A more realistic treatment goal is between 6 ppb and 8 ppb. A better understanding of how seasonal arsenic concentrations observed in surface water (Platte River) is key to properly evaluating the type of treatment process required and the associated O&M costs. The results of this research will become crucial as the LWS completes the development of its wellfield areas that are directly influenced by surface water quality and is intended to provide water supply capacity through 2045. A firm understanding of the influence of arsenic concentrations of the Platte River and its major tributaries on groundwater quality will allow LWS to determine the most logical, cost-effective approach to delivering safe, quality drinking water to its users.

2. Meets the goals and objectives of an approved integrated management plan or ground water management plan;

   - Identify the specific plan that is being referenced including date, who issued it and whether it is an IMP or GW management plan.
   - Provide the history of work completed to achieve the goals of this plan.
   - List which goals and objectives of the management plan the project provides benefits for and how the project provides those benefits.

   The Lincoln Water System (LWS) serves approximately 300,000 people in the Lincoln, Nebraska area. The Lincoln, Nebraska area is in the Lower Platte South (LPS) Natural Resources District (NRD). The LWS's wells and water treatment facilities are near Ashland, Nebraska and are located partly in the Lower Platte North (LPN) NRD, partly in the LPS NRD, and partly in the Papio-Missouri River (PMR) NRD. The LWS wells are hydrologically connected to the Platte River (Lower Platte North Natural Resources District, 2018; Lower Platte South Natural Resources District, 2014; and Papio-Missouri River Natural Resources District, 2014). The LWS's wellfield and treatment facilities near Ashland, Nebraska are in a groundwater and surface-water quantity control area (Lower Platte North Natural Resources District, 2018; Papio-Missouri River Natural Resources District, 2014). A goal in the LPN and PMR NRD's Integrated Management Plan are to develop policies, programs, and practices to maintain water supply and water quality and encourage water conservation this research will support practices used to maintain both water supply and better understand water quality. A goal of the LPS NRD's Integrated Management Plan is to manage the water supply and support water use. The objective of this study is to assist the LWS in understanding arsenic in the surface water of the Platte River and the contribution of the surface water to the horizontal collector wells so future decisions can be made on the best alternative for mitigating arsenic levels at or below 80% of the MCL.

   The Lower Platte River Basin Coalition, which includes the Nebraska Department of Natural Resources, have developed a Basin Water Management Plan (Lower Platte River Basin Coalition, 2017) to balance the water demands and supplies in the Lower Platte River Basin. One of the goals of this plan is to "Develop and

maintain a water supply and use inventory based on the best available data and analysis." Objective 3 of this goal is to "Evaluate potential effects on water inventory of coordination, innovation and technology." The objective of this project is to use existing data and collect additional data to ascertain relationships between arsenic concentrations in surface water and groundwater to assist LWS in managing and developing their source water supply to ensure arsenic concentration well below the MCL. This research will assist the LWS in choosing the appropriate technology for mitigation of arsenic.

The arsenic concentration data collected as part of this study will complement sampling for arsenic in domestic, irrigation, and public supply wells by the LPN, LPS, and PMR NRDs. The NRDs sampling for arsenic as part of their groundwater management plans. Objective 7 in the LPN NRDs groundwater management plan (Lower Platte North NRD, 1994) is to "Maintain groundwater quality and quantity monitoring programs." Objective 7 in the LPS NRDs groundwater management plan (Lower Platte South NRD, 1995) is to "Work collectively with other agencies to evaluate groundwater quantity and quality data" and with the LPS NRDs current practice to monitor arsenic concentrations in groundwater (Lower Platte South NRD, 2020). The PMR NRD's definition of groundwater sustainability is defined as "Water use is sustainable when it promotes healthy watersheds and aquifers, improves water quality, protects water supplies through Best Management Practices (BMP), and manages surface and groundwater resources conjunctively to protect the ability of future generations to meet their needs (Papio-Missouri River Natural Resources District, 2017a and 2017b)." The LPN and LPS NRDs are working with the University of Nebraska--Lincoln UNL Water Center to facilitate the collection of samples by students from domestic wells for analysis, including the concentration of arsenic (Dan Snow, UNL Water Center, personal commun. June 2021).

All data and analysis from this research will be shared with these state and university water managers and fellow researchers and made publicly available through USGS.

3. Contributes to water sustainability goals by increasing aquifer recharge, reducing aquifer depletion, or increasing streamflow;

   List the following information that is applicable:

   - The location, area and amount of recharge;
   - The location, area and amount that aquifer depletion will be reduced;
   - The reach, amount and timing of increased streamflow. Describe how the project will meet these objectives and what the source of the water is;
   - Provide a detailed listing of cross basin benefits, if any.

If successful, this project will not alter the current area of recharge, or amount of current recharge to or depletion of the Platte River alluvial aquifer, or streamflow in the Platte River. This research will support a cost-effective development of future arsenic mitigation that may include new treatment processes. These new treatment processes are not likely to require additional water but will be costly for initial development and ongoing operation and maintenance. This research will provide information useful as decisions are made on future development of the Ashland wellfields which calls for at least two additional large collector wells. Future build out of the Ashland wellfield will be driven by future water needs and this study will not strongly influence that work but provides needed information to support the LWS in continuing to provide finished water that is well below MCL levels for arsenic.

4. Contributes to multiple water supply goals, including, but not limited to, flood control, agricultural use, municipal and industrial uses, recreational benefits, wildlife habitat, conservation of water resources, and preservation of water resources;

- List the goals the project provides benefits.
- Describe how the project will provide these benefits
- Provide a long range forecast of the expected benefits this project could have versus continuing on current path.

1. Municipal and industrial use
3. Preservation of water resources.

Municipal and industrial use

If successful, this project will contribute to Municipal and industrial use water supply goals by enabling the Lincoln Water System (LWS) to continue to provide clean drinking water to customers in Lincoln, Nebraska. The Lincoln Water System's 2020 Facilities Master Plan identifies the need for a better understanding of the presence of arsenic in the Platte River system as a precursor to the evaluation of arsenic treatment and mitigation options. A thorough understanding of the contributions, trends, and influences of naturally occurring arsenic in groundwater and surface sources is needed to understand the processes and controls that affect aquifer geochemistry and arsenic mobility in the Platte River alluvial aquifer. A firm understanding of the influence of arsenic concentrations of the Platte River and its major tributaries on groundwater quality will allow the LWS to determine the most logical, cost-effective approach to delivering safe, quality drinking water to its approximately 300,000 users. The proposed study will examine existing surface-water and groundwater quality data and include additional surface-water and groundwater sampling to supplement existing data sets that will provide a better understanding of current and historical trends of arsenic in the Platte River and begin to better understand arsenic contributions from the Elkhorn River vs

upstream Platte River as well as seasonal trends in surface water arsenic concentrations. This study will also further examine how surface water is contributing to the raw water collected by different wells in the LWS wellfield. The results of this study will provide necessary information that the LWS needs to continue to manage arsenic concentrations and plan for future wellfield development- both future actions that will likely be required and can be completed most efficiently with a better understanding of arsenic.

Preservation of water resources

Results for this study will provide LWS with information necessary to make well informed water management decisions now and into the future as they work to meet the water needs of the growing community of Lincoln. Specifically, the study will assist the LWS in understanding arsenic in the surface water of the Platte River and the contribution of the surface water to the horizontal collector wells so future decisions can be made on the best alternative for mitigating arsenic levels below 80% of the MCL. The initial design goal of a mitigation system is to supply potable water at 60% of the MCL involving treatment for arsenic removal and other potential mitigation steps. A firm understanding of the influence of arsenic concentrations of the Platte River and its major tributaries on groundwater quality is needed for LWS to determine the most logical, cost-effective approach to delivering safe, quality drinking water. The capital and O&M cost of arsenic removal is highly dependent on removal efficiency so knowing more information about the source of arsenic and its contribution to levels in source water supply is key to developing a cost-effective mitigation system. Cost-effective treatment solution can be developed using sound data that is representative of actual conditions. Use of assumed or dated data and a less than thorough understanding of arsenic sources and concentrations could lead to an ineffective mitigation system or unnecessary and costly design assumptions. Determining the most cost-effective solution is extremely important considering adding an arsenic treatment process to the existing treatment system is estimated to cost $45 million initially based on the Lincoln Water System's 2020 Facilities Master Plan with potentially significant operation and maintenance costs depending the selected treatment process.

5. Maximizes the beneficial use of Nebraska's water resources for the benefit of the state's residents;

- Describe how the project will maximize the increased beneficial use of Nebraska's water resources.
- Describe the beneficial uses that will be reduced, if any.
- Describe how the project provides a beneficial impact to the state's residents.

The Lincoln Water System (LWS) serves approximately 300,000 people in the Lincoln, Nebraska area. Lincoln, Nebraska is in the Lower Platte South (LPS) Natural Resources District (NRD). The LWS's wells and water treatment facilities

are near Ashland, Nebraska and are located partly in the Lower Platte North (LPN) NRD, partly in the LPS NRD, and partly in the Papio-Missouri River (PMR) NRD. The LWS wells are hydrologically connected to the Platte River (Lower Platte North Natural Resources District, 2018; Lower Platte South Natural Resources District, 2014; Papio-Missouri River Natural Resources District, 2014). The LWS's wellfield and treatment facilities near Ashland, Nebraska are in a groundwater and surface-water quantity control area (Lower Platte North Natural Resources District, 2018; Papio-Missouri River Natural Resources District, 2014). A better understanding of arsenic in general in the Lower Platte River system will benefit other water managers, in particular all those noted above and those at the Papio-Missouri NRD and the City of Omaha Municipal Utilities Department, and water users in the State of Nebraska particularly those with private wells who might be effected by high arsenic concentration. Within the glaciated part of eastern Nebraska approximately 5 percent of well owners consume groundwater that exceeds the U.S. Environmental Protection Agency's MCL for arsenic (U.S. EPA, 2017) of 10 parts per billion (ppb, Ayotte and others, 2017). In addition, this research will support decisions made by LWS on current operations and future water supplies. With this additional information the LWS will continue to make the very best decisions with regard for water quality and water quantity that they can in their operations to support Nebraska's water resources in the Lower Platte River Basin.

The objective of this study is to assist the LWS in understanding arsenic in the surface water of the Platte River and the contribution of the surface water to the horizontal collector wells so future decisions can be made on the best alternative for mitigating arsenic levels below 80% of the MCL. The initial design goal of a mitigation system is to supply potable water at 60% of the MCL involving removal and possibly blending of water from different sources. A strong understanding of the influence of arsenic concentrations in the Platte River and its major tributaries on groundwater quality will allow the LWS to determine the most logical, cost-effective approach to delivering safe, quality drinking water. The capital and O&M cost of arsenic removal is highly dependent on the expected arsenic concentrations in the source water and the desired treatment goal. Therefore, knowing more information about the source of arsenic and its contribution to levels in source water supply is key to developing a cost-effective mitigation system. Therefore, this research is needed in order for LWS to continue developing its current wellfield area to full capacity in accordance with the City of Lincoln's Water Facility Master Plan prior to developing additional capacity from a second source of water supply.

6. Is cost-effective;

- List the estimated construction costs, O/M costs, land and water acquisition costs, alternative options, value of benefits gained.
- Compare these costs to other methods of achieving the same benefits.
- List the costs of the project.

- Describe how it is a cost effective project or alternative.

The estimated total cost of this project $350,000, with $97,000 from the Lincoln Transportation and Utilities Department through the Lincoln Water System's Capital improvement Plan budget. This application requests $145,000 for support of this project from Nebraska's Water Sustainability Fund, and $108,000 of Federal funding from the U.S. Geological Survey's Cooperative Water Program. The requested funding will be used to pay lab analytical charges and USGS personnel costs to collect samples, analyze and interpret data, and write a report. None of the funding will be used for construction costs, O/M costs, land and water acquisition costs. The benefits of this project are to provide the basis in developing a cost-effective solution using sound data representative of actual conditions. Use of assumed or dated data and a less than thorough understanding of arsenic sources and concentrations could lead to an ineffective mitigation system or unnecessary and costly design assumptions. Determining the most cost-effective solution is extremely important considering adding an arsenic treatment process to the existing treatment system is estimated to cost $45 million initially based on the Lincoln Water System's 2020 Facilities Master Plan with potentially significant operation and maintenance costs depending on the selected treatment process. The information provided by this project will allow the LWS to make a well-informed management decision on current and future means to reduce arsenic concentration in the water deliver to their customers.

7. Helps the state meet its obligations under interstate compacts, decrees, or other state contracts or agreements or federal law;

   - Identify the interstate compact, decree, state contract or agreement or federal law.
   - Describe how the project will help the state meet its obligations under compacts, decrees, state contracts or agreements or federal law.
   - Describe current deficiencies and document how the project will reduce deficiencies.

   The goals of the LPS NRD's IMP that this project benefits are to manage the water supply and make it available whenever and wherever needed and to support water use. The goals of the LPN NRD's IMP that this project benefits are to formulate practices to maintain water supply and water quality. The goals of the Lower Platte River Basin Water Management Plan that this project benefits are:
   - Goal 1. Develop and maintain a water supply and use inventory based on the best available data and analysis and
   - Goal 3. Develop and implement water use policies and practices that contribute to the protection of existing surface and groundwater uses while allowing for future water development.

The LWS is obligated by the Safe Drinking Water Act to deliver clean water to their customers. This means that the LWS must provide water with the concentration of regulated contaminates, including arsenic, that are less that the U.S. EPA's maximum contaminant levels (MCL; U.S. Environmental Protection Agency, 2009). The source of the LWS water supply are vertical and horizontal collector wells screened in the Platte River alluvial aquifer. Arsenic concentrations in the LWS's source water fluctuates seasonally, spatially, and by well location and type. The current deficiency is the limited understanding of why arsenic fluctuates and what contributes to the changes in arsenic concentrations in LWS groundwater wells. A better understanding of arsenic concentration trends in the Platte River and how this surface water contributes to the different types of wells in the LWS wellfield is needed. The objective of this project is to provide LWS with an understanding of the factors affecting arsenic concentration in groundwater and surface water in the area of the wellfield in order to assist LWS in mitigating high arsenic concentrations and continuing to deliver safe drinking water to LWS customers. These objectives are met through analysis of existing data, further collection of surface water quality samples to understand Elkhorn River vs. Platte River contributions of arsenic to the Lower Platte River, and stable isotope sampling and analysis from samples of the LWS source water from different types of wells to determine what percentage of the water being pumped is from surface water contributions. The information provided by the project will support the LWS in developing and maintaining water supply and water quality advancing the goals of many of these state water management plans.

8. Reduces threats to property damage or protects critical infrastructure that consists of the physical assets, systems, and networks vital to the state or the United States such that their incapacitation would have a debilitating effect on public security or public health and safety;

   - Identify the property that the project is intended to reduce threats to.
   - Describe and quantify reductions in threats to critical infrastructure provided by the project and how the infrastructure is vital to Nebraska or the United States.
   - Identify the potential value of cost savings resulting from completion of the project.
   - Describe the benefits for public security, public health and safety.

This project is not intended to reduce threats to property or infrastructure but will aid the LWS in protecting and managing the water quality in the water supply system for approximately 300,000 Nebraskans. This research will assist the LWS in current management of their wells and maintaining arsenic concentrations below the U.S. EPA's maximum contaminant levels (MCL; National Primary Drinking Water Regulations, 2009) and to plan for meeting future drinking water demands. A firm understanding of the influence of arsenic concentrations in the Platte River and its major

tributaries on groundwater quality is needed for LWS to determine the most logical, cost-effective approach to delivering safe, quality drinking water. A sufficient quantity of safe drinking water is critical to the health of the entire Lincoln community and to the functional needs and safe operation of hospitals, schools, colleges and universities, businesses, police and firefighters, National Guard, and state and federal government offices. The potential health effects to people from exposure to arsenic concentrations above the Maximum Contaminate Level are skin damage, problems with the circulatory system, and possible increased cancer risk (U.S. Environmental Protection Agency, 2009). The information provided by this study will assist the LWS in better understanding arsenic in the surface water and groundwater that is contributing the source water supply from the different types and locations of wells in the wellfield. This information will help LWS design cost effective future treatment for arsenic and will provide data that will be considered when future horizontal collector wells are installed to fully develop the wellfield to meet future water needs of the Lincoln community.

9. Improves water quality;

- Describe what quality issue(s) is/are to be improved.
- Describe and quantify how the project improves water quality, what is the target area, what is the population or acreage receiving benefits, what is the usage of the water: residential, industrial, agriculture or recreational.
- Describe other possible solutions to remedy this issue.
- Describe the history of the water quality issue including previous attempts to remedy the problem and the results obtained.

The primary intent of this project is to support arsenic management in the drinking water supply of Lincoln Water System that serves approximately 300,000 Nebraskans residential water and many industries. Arsenic is a regulated constituent under the Safe Drinking Water Act with a maximum contaminant level (MCL) of 10 parts per billion (ppb) in public drinking water. Considerable variability in arsenic levels observed by the Lincoln Water System suggests that arsenic transport in the shallow alluvium underlying the Platte River near Ashland is impacted by complex temporal and spatial factors. These factors include seasonality of arsenic transport in surface waters, the incomplete mixing of the Platte and Elkhorn Rivers, and shallow groundwater variability from east to west in the Platte River valley (fig. 2). This project will begin to characterize the relative roles of those factors through distributed and frequent monitoring. Because the Platte River alluvium is a drinking water source for several other municipalities, this project may provide indirect benefits to many more Nebraskans. Arsenic became a constituent of higher priority in 2002 when the federal drinking water limit was lowered from 50 ppb to 10 ppb. Previous arsenic monitoring has focused on monitoring wells in and around the LWS wellfield. Although that monitoring has been informative, it has not conclusively identified the factors contributing to the arsenic levels in the LWS drinking water supply. This research will provide more data on arsenic in the surface water and

on the surface water contribution to LWS wells. This knowledge along with past monitoring will continue to improve understanding of arsenic in the Platte River alluvial aquifer system and allow LWS to plan in meeting future water supply demands. This study will not have significant impacts or improvements to water quality in the Platte River or the Platte River alluvial aquifer but will provide water managers with a better understanding of arsenic so future water management efforts might be developed that will lower arsenic concentrations or find new ways of protecting Nebraska drinking water supplies from arsenic contamination.

10. Has utilized all available funding resources of the local jurisdiction to support the program, project, or activity;

- Identify the local jurisdiction that supports the project.
- List current property tax levy, valuations, or other sources of revenue for the sponsoring entity.
- List other funding sources for the project.

The local jurisdiction that supports this project is the Lincoln Water System (LWS) within the Transportation and Utilities department of the City of Lincoln (See attached letter of financial support). Funding to support this project will be available from the Lincoln Transportation and Utilities Department- Lincoln Water System's Capital Improvement Plan budget which is funded principally by water rate revenues. Lincoln Water System's budget for September 1, 2020 to August 31, 2021 is $57.6M. This budget is not funded by a tax levy but rather by the water rate revenues paid by water users in Lincoln as well as other sources of revenue such as impact fees, tapping fees, and revenue bonds. LWS uses both an inclining block rate and water shortage rate structure to secure local sources of funding for the project while at the same time encouraging water conservation. The U.S. Geological Survey is proposed to be the contracting agency to carry out this project and would provide Cooperative Water Program funding of $108,000, or approx. 30% of the $350,000 total project cost. Subtracting these federal funds from the $350,000 project total, the 60% of eligible costs applied for in this application are $145,000, leaving $97,000 for the Lincoln Transportation and Utilities Department to contribute.

11. Has a local jurisdiction with plans in place that support sustainable water use;

- List the local jurisdiction and identify specific plans being referenced that are in place to support sustainable water use.
- Provide the history of work completed to achieve the goals of these plans.
- List which goals and objectives this project will provide benefits for and how this project supports or contributes to those plans.
- Describe and quantify how the project supports sustainable water use, what is the target area, what is the population or acreage receiving benefits, what is the usage of the water: residential, industrial, agriculture or recreational.
- List all stakeholders involved in project.

- Identify who benefits from this project.

- The local jurisdiction for this project is the Lincoln Water System within the Transportation and Utilities department of the City of Lincoln. The City of Lincoln has incorporated extensive water conservation measures into city ordinances and has demonstrated significant conservation efforts in past years. As written into the City of Lincoln Water Management Plan, “It is the policy of the City of Lincoln to promote water conservation. The water supply to the City of Lincoln is a limited resource, and everyone shares in the responsibility for appropriately using and preserving this resource. All customers of the Lincoln Water System are therefore encouraged to voluntarily reduce water usage by daily practicing water conservation, regardless of whether voluntary or mandatory water restrictions are implemented, or certain water shortage rates are applied. There are many simple, cost-effective ways to lower water use and reduce strain on water resources and infrastructure without compromising Lincoln’s quality of life. Customers of the Lincoln Water System are encouraged to follow at all times the water conservation measures found at lincoln.ne.gov, keyword: water conservation.”
  Lincoln’s water conservation efforts date back many years and has been a fundamental part of effectively managing water supply. Efforts include:
  1. A Water Conservation Task Force to advise policy and promote water conservation efforts.
  2. Use of an inclining block rate fee structure where the price per unit of water is increased with high water use beyond normal health, sanitation, and safety.
  3. Development of a Water Management Plan that has specific actions to taken during period of water shortages including voluntary and mandatory restrictions. The plan includes all the necessary ordinances required to implement enforcement of mandatory restrictions.
  4. The use of incremental water shortage rates during both voluntary and mandatory restrictions to provide a financial incentive to customers for reduced water use.
  5. Ordinance requiring all new irrigation systems to have a rain sensor installed.

  The Mayor's Water Conservation Task Force, formed in the late summer of 1988, was created to develop positive approaches to water conservation. They determined voluntary cooperation was the best approach to accomplish conservation practices. The goals of the task force were to maintain a public awareness program to keep peak day water use within the water system's ability to deliver; encourage participation and support for water conservation practices from business, industry and the community; and to identify and promote the adoption of water conserving plant materials and landscape practices.

  The purpose of the Task Force was:

1. Inform and educate the citizens of Lincoln about the importance of conserving our water resources.
2. Increase the acceptance of water conservation measures to reduce outdoor water consumption.
3. Improve domestic in-home water conservation.
4. Improve water conservation and use efficiency of industrial, commercial and business water users.
5. Inform customers regarding water quality issues.

Lincoln's history of sustainable water use is best illustrated by Figure 3. This figure illustrates the per capita water use and population over time. As shown in the graph, Lincoln's population has nearly doubled since the early 70's. Conversely, the per capita water use has decreased by 25% since the early 80's. The result is that the average daily water demand has stayed the same.

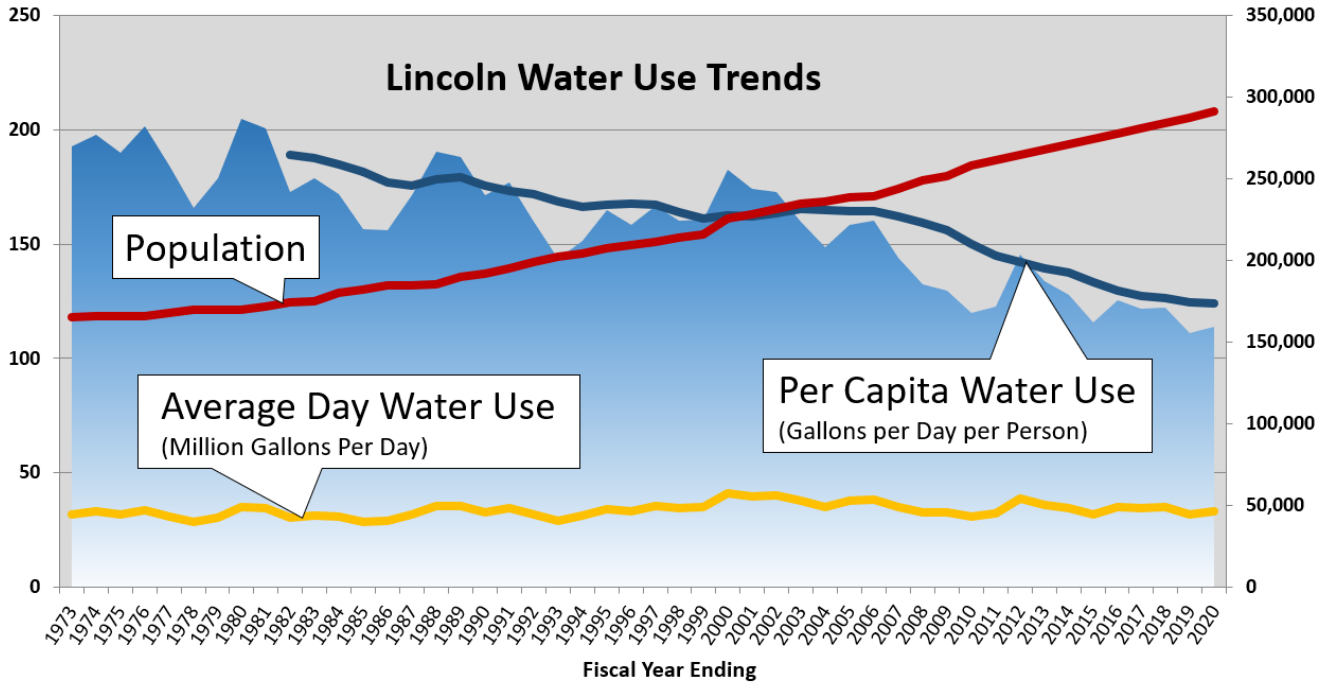

Figure 3. Lincoln Nebraska water use trends vs. population

This is a remarkable record of water conservation that should be a model for many communities across the nation. There is always more that can be done and the City of Lincoln continues to implement water conservation policies that encourage the wise use of water. The citizens that benefit from these practices include over a quarter of million people that live within the City of Lincoln and receive water from the LWS.

- The USGS or LWS have monitored arsenic levels in the Platte River alluvium, the Platte River at Louisville, the Elkhorn River at Waterloo, and the source water produced by LWS wells since at least the 1990s. Some of these monitoring

results are provided on an annual basis to LWS customers as part of its Annual Drinking Water Quality Report (found at www.lincoln.ne.gov, keyword: Drinking Water Quality). More recently, heightened awareness about arsenic levels has led to intensified sampling. The USGS has collected arsenic speciation samples from the Platte River alluvium to characterize the oxidation state of arsenic near LWS wells, with most wells predominated by arsenate (As(V)) but with a few predominated by arsenite (As(III)). In addition, LWS has expanded its capacity to analyze arsenic concentrations and has collected weekly source water and Platte River samples since 2018. This high frequency sampling has revealed seasonal patterns in the arsenic levels with the upper ranges of that seasonality approaching the U.S. EPA's maximum contaminant levels (MCL; National Primary Drinking Water Regulations, 2009) of 10 parts per billion (ppb). The cause of this seasonality is not clear.

- Although this project is focuses on water quality rather than water quantity, there is a clear connection to sustainable water management. By gaining a better understanding of the sources of arsenic variability in the existing LWS wellfield, that wellfield can be managed to optimize the water delivered without exceeding the water quality standard for arsenic.
- The LWS wellfield is the primary area of interest, though the monitoring proposed for this project includes areas beyond the wellfield to better characterize the water sources that contribute to the wellfield. The approximately 300,000 drinking water users within the City of Lincoln will directly benefit from this project, but the nearby communities that also rely on the Platte River alluvium for their drinking supply will benefit indirectly from the understanding that will be gained from this project.
- In addition to the sponsorship of this project by the LWS, the US Geological Survey will be directly involved in the execution of this project and will provide $108,000 in federal matching funding.

12. Addresses a statewide problem or issue;

- List the issues or problems addressed by the project and why they should be considered statewide.
- Describe how the project will address each issue and/or problem.
- Describe the total number of people and/or total number of acres that would receive benefits.
- Identify the benefit, to the state, this project would provide.

- Arsenic is a naturally occurring groundwater contaminant that can adversely affect drinking water quality (Dvorak and others, 2014 and World Health Organization, 2018). Within the glaciated part of eastern Nebraska approximately 5 percent of well owners consume groundwater that exceeds the U.S. Environmental Protection Agency's MCL for arsenic (U.S. EPA, 2017) of 10 parts per billion (ppb, Ayotte and others, 2017). The widespread occurrence of arsenic in groundwater and surface water has long been a concern for municipal water

systems within the state. The Platte River alluvial aquifer is a major source of water for the largest city in Nebraska—Omaha and the only source of water for the second largest city in Nebraska—Lincoln. The potential health effects to people from exposure to arsenic concentrations above the Maximum Contaminate Level are skin damage, problems with the circulatory system, and possible increased cancer risk (U.S. Environmental Protection Agency, 2009).

- This project will explore the source of elevated arsenic levels in the raw water that contribute to the drinking water supply for the City of Lincoln. Paired sampling in the Elkhorn River and the Platte River will allow for differences to be detected between these two surface water sources that are incompletely mixed by the time the Platte River flows past the LWS wellfield. Trend analysis will be completed on existing surface water arsenic data to determine if arsenic concentrations have a consistent change over time. Ongoing groundwater sampling from monitoring wells will characterize arsenic levels in the alluvial aquifer. Isotope sampling of the production wells will shed light on the relative proportion of groundwater and surface water that is present in the water being pumped. Having this information will help ascertain where and when arsenic levels are highest and allow for corresponding management, treatment, and future development of the wellfield to minimize those levels in the source water. This could potentially serve as a model for other similar public supply systems in the state.
- This project would directly benefit the approximately 300,000 customers of LWS and could indirectly benefit the users from several other public water suppliers across the state that rely on the alluvial aquifers as their primary drinking water source.

13. Contributes to the state's ability to leverage state dollars with local or federal government partners or other partners to maximize the use of its resources;

    - List other funding sources or other partners, and the amount each will contribute, in a funding matrix.
    - Describe how each source of funding is made available if the project is funded.
    - Provide a copy or evidence of each commitment, for each separate source, of match dollars and funding partners.
    - Describe how you will proceed if other funding sources do not come through.

- This project relies on direct funding contributions from three sources: Lincoln Transportation and Utilities Department $97,000, U.S. Geological Survey Cooperative Matching Funds $108,000, and Water Sustainability Fund $145,000. Though not included in the funding matrix, this project also leverages existing sampling efforts being done for other purposes. Arsenic sampling of the Elkhorn River at Waterloo is included as part of the US Geological Survey National Water Quality Network. Sampling at the Platte River at Ashland is already scheduled as part of a separate USGS – LWS project evaluating nutrient and DNA levels in the river, so the expense associated with the addition of arsenic is limited

primarily to the analytical cost. If the project is funded, the Lincoln Water System (LWS) (see attached letter of financial support) will contribute $97,000 of funding from the Lincoln Water System's Capital improvement Plan budget. LWS's budget for September 1, 2020 to August 31, 2021 is $57.6M. This budget is not funded by a tax levy but rather by the water rate revenues paid by water users in Lincoln as well as other sources of revenue such as impact fees, tapping fees, and revenue bonds. The U.S. Geological Survey is proposed to be the cooperating to carry out this project and would provide USGS Cooperative Matching Funds of $108,000 (see attached letter of financial support), or approx. 30% of the $350,000 total project cost. The remaining $145,000 is proposed to be funded through the Nebraska Water Sustainability Fund. In the event that the Water Sustainability funding is not obtained, the project will likely move forward but with a reduction in scope and/or an increase in timeline that will hinder the process of addressing arsenic issues in future planning for the LWS.

14. Contributes to watershed health and function;

- Describe how the project will contribute to watershed health and function in detail and list all of the watersheds affected.

The project will provide information that can be used to minimize arsenic levels in the LWS source water if possible and plan for a future safe and effective arsenic treatment processes if needed. Future buildout of the Ashland wellfields calls for at least two additional large collector wells that will be built in response to future water needs, the data provided through this study might influence the placement of the new wells and other decisions that could affect the health of the watershed at a larger scale. In addition, the implementation of a treatment processes might introduce increased waste which will need to be mitigated and disposed of in accordance to state and federal requirements. Therefore, a better understanding of arsenic leading to a more cost-effective installation and operation of an arsenic treatment process could potentially support watershed health and function by minimizing waste. This study hopes to support the LWS in making the most safe and cost-effective decisions on water supply and arsenic treatment. Continuing to only use the existing infrastructure in the Platte River alluvial aquifer will not significantly improve watershed health or function but building more infrastructure or adding new treatment processes could negatively impact watershed health and function that would have to be mitigated. In addition, the LWS has promoted sustainable water use through a tiered rate structure that increases the individual's unit cost of water as the water usage increases in order to promote water conservation. Water shortage or drought rates are yet another step in reducing unnecessary water usage that the City of Lincoln has successfully implemented. Water conservation is a major part of watershed health and function. The watershed most affected by this study is the Lower Platte River but general information on arsenic trends in the Platte River and Platte River alluvial

aquifer could benefit many other Nebraska water managers and water managers in other river basins (even outside the USA) with high arsenic levels.

15. Uses objectives described in the annual report and plan of work for the state water planning and review process issued by the department.

    - Identify the date of the Annual Report utilized.
    - List any and all objectives of the Annual Report intended to be met by the project
    - Explain how the project meets each objective.

- Annual Report and Plan of Work for the State Water Planning and Review Process September 2019 (Nebraska Department of Natural Resources, 2019)
- *Maintain data, information, and analysis capabilities for water planning, including specific programs for collecting, maintaining, and distributing information on streamflows, as well as analyzing water uses and water supplies across the state;* New data will be collected that helps explain arsenic patterns in and around the LWS wellfield. These new data will be compiled with existing data and made available through online platforms of the USGS.
- *Support locally developed water management plans for conjunctively managing hydrologically connected groundwater and surface water supplies;* This project specifically focuses on defining the relative contribution of surface water and groundwater within the LWS wells that are classified as being groundwater under the influence of surface water. In addition, the project will constrain the temporal and spatial patterns of arsenic in the source water that contributes to the water in the LWS wellfield.
- *Participate in interagency collaboration with federal agencies, state agencies, local natural resources districts (NRD's), and other water interest entities on various water resources programs and projects;* The City of Lincoln and U.S. Geological Survey will collaborate closely on the implementation of this project, and will brief other stakeholders (such as the Nebraska Department of Natural Resources, Nebraska Department of Environment and Energy, Lower Platte South NRD, Lower Platte North NRD, and Papio Missouri River NRD) periodically on the progress of the project. In addition, the findings from this project will be presented at Nebraska stakeholder meetings to ensure a wide audience are aware of the results and potential implications from the project.
- C*onsolidate and present information in a form that is understandable and useful to the public and interagency collaborators.* The US Geological Survey will compile the findings of this project into a scientific report, presentations, and a project website that are publicly available.

16. Federal Mandate Bonus. If you believe that your project is designed to meet the requirements of a federal mandate which furthers the goals of the WSF, then:

- Describe the federal mandate.
- Provide documentary evidence of the federal mandate.
- Describe how the project meets the requirements of the federal mandate.
- Describe the relationship between the federal mandate and how the project furthers the goals of water sustainability.

The LWS is obligated by Federal Law 93-523 (otherwise known as the Safe Drinking Water Act (SDWA) United States Code 42 § 300f) to deliver clean water to customers. This means that the LWS must provide water with the concentration of regulated contaminates, including arsenic, that are less than the USEPA's maximum contaminant levels (MCL; National Primary Drinking Water Regulations, 2009). The source of the LWS water supply are vertical and horizontal collector wells screened in the Platte River alluvial aquifer. Arsenic concentrations in the LWS's source water fluctuates seasonally, spatially, and by well location and type. The objective of this project is to provide LWS with an understanding of the factors affecting arsenic concentration in groundwater and surface water in the area of the wellfield in order to assist LWS in managing their wellfield to control arsenic concentration and continue to deliver safe drinking water to LWS customers now and into the future.