Water Pollution Control Project Needs Assessment (PNA) Form
Water Quality Control Division

1. Applicant Information:

Entity Name	City of Boulder				
Facility Name:	BOULDER, CITY OF			Original ID:	
Mailing Address 1:	City of Boulder Po Box 791	Mailing Address 2:		County:	
City:	Boulder	State:	CO	Zip Code:	80306
Property Address 1:	City of Boulder	Property Address 2:		County:	
City:	Boulder	State:	CO	Zip Code:	80306
Latitude :	39.7517291	Longitude :	-104.992107		
Name of Project:	Phosphorus Upgrade Project				

Type of Project (Check all that apply)

- ☐ New domestic wastewater treatment plant
- ☑ Construction project resulting in increase or decrease in design capacity of existing wastewater treatment plant
- ☐ Modification of wastewater treatment plant that will not result in a change to treatment capacity
- ☐ New or relocated wastewater treatment plant outfall
- ☐ New or expansion of lift station
- ☑ Collection system (gravity sewer mains less than 24-inches in diameter)
- ☐ New interceptor (24-inch diameter or larger pipeline)
- ☐ In-Kind Replacement (Replacement of any process or hydraulic treatment conveyance component with an identical or similar component. Usually in cases where equipment has reached end of life and replacement is necessary to maintain compliance)
- ☐ Stormwater
- ☐ Non-Point Source Discharge

Please enter the following information for your organization if you have it. Visit http://fedgov.dnb.com/webform and https://www.sam.gov/portal/public/SAM/ for details. Note: you will be required to obtain both of these items prior to loan execution.

Owner Information:

First Name:	Graham	Middle Name:		Last Name:	Clark
Phone Number:	303-441-3001				
Mailing Address1:	1101 Arapahoe Ave		Mailing Address2:		
City:	Boulder	State:	CO	Zip Code:	80302
E-mail:	clarkg@bouldercolorado.gov				

Consulting Engineer Information:

First Name:	Cody	Middle Name:		Last Name:	Charnas

Phone Number: 303-382-4926

Mailing Address1: 1560 Broadway Suite 1800

Mailing Address2:

City: Denver

State: CO

Zip Code:

E-mail: cody.charnas@stantec.com

Self-Certification:

☐ Yes ☑ No Does the system intend to self-certify all or a portion of the project?

Streamlined Review:

☐ Yes ☑ No Does the system intend to use the streamlined review process for all or a portion of the project?

If yes, please identify the portions of the project that the system will utilize streamlined review process.

☐ Wastewater treatment new construction or modifications that do not include an alternative technology

Yes No Does the system intend to use the streamlined review process for all or a portion of the project?

2. Executive Summary

Through a series of capital improvements and operational optimization projects, the City of Boulder's (CoB) Water Resource Recovery Facility (WRRF) has been out-performing Regulation 85 Nitrogen (N) limitations. To address upcoming Phosphorus (P) removal requirements, the CoB is completing a project that will both enable P removal and enhance its N removal capabilities. The source of the vast majority of P is human waste; therefore, controlling it from commercial and industrial discharges would be an ineffective compliance strategy. In 2021, CoB contracted a consultant to update the Nutrient Compliance Study (NCS). This study identified and evaluated alternatives to implement sustainable P removal, improve N removal efficiency, maintain effective solids processing, and mitigate operational issues associated with sidestream processes. The resulting project scope includes three main elements: upgrades to the secondary treatment system, improvements to sidestream treatment processes, and revitalization of existing facility assets. Secondary treatment system upgrades include modifying the existing aeration basins and associated mechanical equipment to use a low Dissolved Oxygen (DO) Anaerobic/Aerobic (AO) configuration and operational strategy and constructing a hydrocyclone-based sludge densification process. Sidestream treatment improvements include retrofitting the existing pre-dewatering storage tank into a redundant Post-Aerobic Digester (PAD) and installing a chemical storage and dosing system that will allow CoB to experiment with various calcium-based chemicals for P sequestration in the PAD. Asset revitalization efforts include replacing the secondary digester lid and sandblasting and recoating the existing primary clarifier mechanisms.

3.System Structure and Operation

3.1 Legal Ownership of System (TMF: Managerial-1)

First Name: City of Boulder

Mailing Address1: 1101 Arapahoe Ave

Mailing Address2:

City: Boulder

State: CO

Zip Code: 80302

Phone Number: 303-441-3001

Fax:

3.2 Organizational Chart

Include an Organizational Chart as Attachment 2.

3.3 Current Operator in Responsible (ORC) Charge

First Name: Cole

Middle Name:

Last Name: Sigmon

Certification Number: CWP-XA-01083-0514 Certification Expiration Date: 05/26/2023

Operator Certification Level (check one) ☑ Staff Operator ☐ Contract Operator

Treatment	☐ Class D	☐ Class C	☐ Class B	☑ Class A
Distribution	☑ Class 4	☐ Class 3	☐ Class 2	☐ Class 1
Combined Treatment/Distribution	☐ Class S			

3.4 Operator Certification

☑ Yes ☐ No Do the system operators have adequate operator certification levels for the proposed project as defined by Regulation 100 Water and Wastewater Facility Operators Certification Requirements?

Explain the impact of the proposed project on the required operator in responsible charge (ORC) certification level and other predicted staffing changes.

The WRRF has a permitted Maximum Month Flow (MMF) capacity of 25 MGD and uses multiple preliminary, primary, secondary, advanced, and disinfection treatment unit operations and solids handling processes that categorize it as a Class A facility, requiring an Operator in Responsible Charge (ORC) with a Class A certification level. The Phosphorus Upgrades Project will modify some of the solids handling and primary, secondary, and advanced treatment processes as described in Section 8 of this PNA. However, these changes will not impact the ORC's minimum required certification level nor increase the amount or complexity of staffing required. Mr. Sigmon, the facility's ORC, maintains a Class A license.

3.5 20-year cash flow projection

Include a copy of the 20-year cash flow projection as Attachment 4.

4. Project Purpose and Need

Discuss the issue or concern that the proposed project will address. Specific issues are outlined below. All issues must be discussed in each sub section below even if they are not the project driver.

4.1 Compliance

Summarize the system's compliance status that necessitates the proposed project.

The current discharge permit (No. CO-0024147) was originally issued in 2011, and it has been modified by three minor amendments in 2011, 2012, and 2015. The most recent modification was set to expire in April 2016; however, this permit has been administratively extended since then. The permit establishes numeric effluent limits for BOD, TSS, ammonia, nitrate, Total Coliforms, E. coli, Oil and Grease, cadmium, hexavalent chromium, copper, cyanide, mercury, and pH. The permit also requires the City to conduct quarterly Whole Effluent Toxicity (WET) testing and report the effluent flow, temperature, arsenic, manganese, silver, and zinc. The last quality-based exceedance occurred in the second quarter of 2012: a failed WET test resulted in a lethality IC25 of 29.2% below the instream waste concentration of 86% and a 50% Lowest Observable Effluent Concentration (LOEC) for Ceriodaphnia dubia. The WRRF discharge flow exceeded the permitted maximum monthly flow in 2013 and 2015 during local flood events. There have been no water quality-based exceedances in over ten years.
This Phosphorus Upgrades Project enables the WRRF to meet nutrient removal standards consistent with the Regulation 85 effluent limits and the Voluntary Incentive Program (Policy 17-1) targets. This project also directly facilitates the City's ability to comply with future permit limits.

4.2 Existing facility limitations

Summarize existing water system facility(ies) limitations that necessitate the proposed project.

The existing secondary treatment system uses a four-stage Bardenpho bioreactor configuration for nitrogen removal. This sequentially consists of a pre-anoxic reactor, an aerobic reactor, a post-anoxic reactor, and a re-aeration stage. Coupled with ongoing operations optimization efforts, this arrangement is outperforming Regulation 85 nitrogen limitations; however, the absence of an anaerobic selector provides limited phosphorus removal through the plant. The secondary treatment upgrades included in this project will enable phosphorus removal from the liquid stream, and sidestream treatment modifications will enhance nitrogen removal performance. Extensive process modeling concludes the anaerobic selector and low-DO operating configuration will produce effluent quality consistent with Regulation 85 limits and VIP targets for both phosphorus and nitrogen. Dynamic process modeling results were considered alongside an analysis of the existing aeration system. This analysis concluded that the existing blowers do not have the range necessary to both accommodate the low-DO operating parameters while simultaneously balancing required airflow to the PAD. Additionally, construction of the sludge densification facility will allow the WRRF to address a common issue in low-DO applications: sludge settleability. A hydrocyclone system will retain denser biomass and waste lighter MLSS to the solids treatment system, which will also improve sludge settling in the secondary clarifiers.

4.3 Operations and Maintenance Issues

Summarize operational and maintenance (O&M) issues with the existing water facilities.

This project includes asset revitalization efforts that aim to extend the useful life of existing facility infrastructure: namely, the secondary digester lid and the primary clarifiers.

• The secondary digester lid has been in use since 1978, and it has reached the end of its useful life. The roof of the digester is no longer water tight, and the interstitial attic space fills with water during and after precipitation events. After a major flooding event in September 2013, water accumulated unevenly in the attic and tipped the floating lid. Since reinstalling the lid and constructing new roller supports, WRRF staff frequently inspect and repair the roof, and sensors and pumps have been installed in the attic to regularly monitor and drain water. Replacing this existing floating cover with a fixed lid would eliminate these ongoing issues.

• The primary clarifiers were constructed in the late 1960s and early 1970s, and many of the remaining metal components have corroded. WRRF staff routinely respond to high torque alarms, and A 2018 condition assessment recommended immediate, near-term, and long-term rehabilitation efforts. In 2022, the City completed the immediate recommendations by repairing spalled concrete, related reinforcing bars, and scum baffles. The Phosphorus Upgrades Project includes recoating the clarifier mechanisms and replacing the scum baffles, as recommended in the 2018 assessment

This project's scope also includes converting the existing pre-dewatering storage tank into a redundant Post-Aerobic Digester (PAD) unit, which will reduce the downtime of the PAD process during in-tank repairs. This process removes a substantial nitrogen load from plant recycle streams; thus, this redundancy will improve the year-round nitrogen removal and reduce loads returned to the head of the WRRF.

5. Existing Facilities Analysis

5.1 Existing Source Water– Section required for treatment and supply projects

☐ Not applicable (for collection system piping, lift stations, interceptors, only)

Existing Permitted Treatment Capacity: Flow: 25 MGD Loading: 36,000 Pounds per Day BOD5

5.1.1 Area Discharge Permits

Identify all other discharge permits for facilities discharging to the same stream segment as the existing treatment facilities.

The City accessed CDPHE's list of active Colorado Discharge Permit System clean water permits and certifications; this list was most recently updated on 12/1/2022. There are two other permits that discharge to Boulder Creek segment COSPBO09. One is the CDPS General Permit that authorizes stormwater discharges from the City of Boulder WRRF, a non-extractive industrial facility, under certification number COR900986. The other is a CDPS General Permit that authorizes stormwater discharges from the nearby Hogan Keeter sand and gravel mining and processing facility under certification number COG502069.

5.1.2 Service Area

Describe the existing service area including residential, commercial and industrial users, as well as flows and loads from the service area.

The Wastewater Utility Service Area is comprised of 25.9 square miles served by over 380 miles of sanitary sewer lines. There are five sewer basins that convey wastewater to the primary collector, interceptor system, and ultimately to the WRRF. This primarily gravity collection system uses diversion manholes, one inverted siphon, and two lift stations to convey flow to the WRRF. Development in the service area is primarily domestic, and a few portions of the collection system also serve commercial and industrial users. The City maintains and enforces an industrial pretreatment program that regulates wastewater contributions from Significant Industrial Users (SIUs). This program establishes SIU-specific discharge limits and requires regular sampling, monitoring, and reporting. Wastewater flows and loads are discussed in more detail in Section 5.1.5.

5.1.3 Facilities Layout and Description

Describe existing facilities including design capabilities and conditions of existing treatment processes including treatment processes used and major design parameters (e.g. process capacities, unit loading rates, side stream flows, and solids handling).

The WRRF is rated for a hydraulic capacity of 25 MGD Maximum Month Flow (MMF) and 53.5 MGD Peak Hourly Flow. The plant is rated for a BOD loading rate of 60,000 lb/d and an ammonia loading rate of 4,700 lb/d. Influent to the WRRF flows through preliminary treatment at the headworks building, consisting of Parshall flume flow measurement, mechanical screening, & aerated grit removal. Subsequent liquid stream treatment consists of primary clarification, secondary treatment, and disinfection. Three Primary Sedimentation Tanks allow primary solids to settle out, removing TSS and BOD. The Secondary Pump Station conveys PST overflow to the secondary treatment system. Secondary treatment consists of biological nutrient removal activated sludge, mixed liquor wasting, secondary clarification, and RAS recycle. The Aeration Basin (AB) and Solids Contact Tank (SCT) bioreactors use a 4-stage Bardenpho configuration to oxidize BOD, nitrify ammonia, and denitrify nitrates and nitrites. A classifying selector and mixed liquor waste pump station control solids retention time in this system. Effluent from the SCTs is allowed to settle in the Secondary Clarifiers. The RAS pumping system returns underflow to the AB influent; overflow gravity flows to the UV disinfection system. Effluent from the disinfection system is discharged to Boulder Creek. Solids treatment: Gravity thickeners densify primary clarifier underflow, and Dissolved Air Flotation Thickeners (DAFT) concentrate WAS from the mixed liquor wasting station. These process streams combine ahead of the two-stage anaerobic digestion system. A Post-Aerobic Digester (PAD) aerates stabilized solids from the digesters, increasing sidestream nitrogen removal. Effluent from the PAD is transferred to the Pre-Dewatering Storage Tank, and high-speed centrifuges dewater solids for off-site land application. Overflow from the gravity thickeners, underflow from the DAFT, and centrate return to the head of the plant.

5.1.4 Existing Process Flow Diagram

Provide a process flow diagram of the existing treatment system as Attachment 5.

5.1.5 Wastewater Flows

Please describe the existing wastewater flows and influent characteristics (including toxic pollutants), discharge permit limits, and overload conditions. Discuss and analyze the average, peak, dry, and wet weather flows. Describe flow contributions from residential, commercial, and industrial users, as well as infiltration and inflow.

Influent data from 2017 through YE 2022 average an ADF of 12.2 MGD MMF of 16.8 MGD, BOD load of 23,400 lb/d, TSS load of 33,100 lb/d, & NH3 load of 2,900 lb/d. The WRRF monitors influent concentrations of EPA Method 200.8 metals weekly & toxic organics quarterly; these pollutants are not present in concentrations that are toxic to WRRF treatment processes. The City maintains an industrial pretreatment program that issues permits & enforces effluent limits on collection system discharges. The City does not separately permit flows from commercial users. The City collects wastewater samples quarterly from four sub-basins within the collection system that serve mostly commercial users. This monitoring effort allows the City to surveil wastewater from commercial sources & enables detection of flows that require additional scrutiny under the industrial pretreatment program. The City conducts a similar sampling program in two neighborhoods with only domestic users. This sampling allows the City to generally characterize domestic wastewater sources. These sampling programs monitor metals, conventional pollutants (BOD, COD, TSS, TKN, TP), VOCs, semi-VOCs, Hg, & cyanide. 2021 ADF was 12.2 MGD; industrial flows contributed an average of 0.6 MGD, & commercial flows contributed an estimated 3.4 MGD.
The WRRF discharge permit establishes numeric effluent limits for BOD, TSS, ammonia, nitrate, Total Coliforms, E. coli, Oil and Grease, cadmium, hexavalent Cr, Cu, cyanide, Hg, & pH. The permit also requires the City to conduct quarterly WET testing & report effluent flow, temperature, As, Mn, Ag, & Zn.
The groundwater table is relatively high in Boulder; in combination with the localized flood risk, infiltration & inflow can comprise a substantial part of the influent during & after precipitation events. The 2016 Collection System Master Plan estimated a base sanitary flow of 8.9 MGD, base infiltration flow of 6.0 MGD, resulting in an estimated average dry weather flow of 14.9 MGD.

5.1.6 Appropriateness of Treatment Technologies

Discuss if the existing treatment process(es) are appropriate to meet the current discharge permit considering existing influent quality and discharge permit limits.

As illustrated by the last ten years of compliant plant performance, the existing treatment process configuration is appropriate to meet the current discharge permit requirements. In 2017, the City constructed plant upgrades that target nitrogen removal. These upgrades represent both the City’s participation in the Nitrogen Voluntary Incentive Program and in anticipation of future permit-required nitrogen and phosphorus removal standards.

5.1.7 Capacity of Treatment Technologies

☑ Yes ☐ No Is the capacity of the existing wastewater treatment system appropriate to accommodate wastewater flows through the next 20 years?

Please explain:

The most recent population, flow, and load projections estimate an ADF of 15.9 MGD, a MMF of 20.2 MGD, a BOD Maximum Month Load (MML) of 36,360 lb/d, TKN MML of 5,017 lb/d, and TSS MML of 35,207 lb/d. The existing wastewater treatment system has sufficient capacity to accommodate ADF and MMF flows and BOD, TKN, and TSS loading rates. However, the existing treatment process is not equipped to remove phosphorus. The primary drivers for this project include:
1) Enabling phosphorus removal such that the plant meets or out-performs the VIP annual median target of 0.7 mg/L effluent TP; and
2) Improving Total Inorganic Nitrogen (TIN) removal reliability in anticipation of a 10.5 mg/L daily TIN limit while continuing to comfortably meet existing daily ammonia limits.

5.1.8 Operational Controls

Describe if the existing treatment processes have appropriate operational controls.

The existing plant uses a sophisticated, automated controls system to monitor process changes and operate equipment. WRRF staff include teams dedicated to the Process Automation System and Operations. The automated system adapts to changes in flows and influent quality, regularly adjusting operating parameters. Operators monitor outputs from instrumentation and automation systems, responding to system alarms as needed.

5.2 Collection - Required for collection system, lift station, and interceptor projects only

☐ Not applicable (for treatment and outfall projects, only)

5.2.1 Service Area

Describe the existing service area including residential, commercial and industrial users, as well as flows and loads from the service area.

NA (for treatment and outfall projects only)

5.2.2 Overall Collection System Description

Discuss the existing collection system including: gravity collection pipelines, facility age, material type, condition of materials, and amount of AC pipe. Describe the location and capacities of all relevant lift stations and interceptor sewers and their relation to the proposed project. Provide a map of the existing collection system as Attachment 6.

NA (for treatment and outfall projects only)

Provide information on current infiltration and inflow.

NA (for treatment and outfall projects only)

6.Facility Planning Analysis

6.1 Planning Area Description

6.1.1 Project Area Map

Provide a map or maps showing the current and projected service area for the 20-year planning period; identify environmental features such as streams, lakes, wetlands, and floodplains for the entire planning area. On the map, identify the locations of municipal and industrial treatment plants, sludge management areas and facilities, pretreatment plants, lift station sites and any significantly developed areas served by onsite or unconventional systems. Include the map as Attachment 7.

6.1.2 208 Plan Coordination

☑ Yes ☐ No Is the project within or near the boundaries of a 208 Agency or regional council of governments (COG)?

The Denver Regional Council of Governments (DRCOG) and Boulder County Board of County Commissioners (BCBCC) are the planning organizations that establish and coordinate regional planning efforts. DRCOG's Clean Water Plan designates the City of Boulder and Boulder County as management agencies in the Boulder Watershed. The BCBCC approved and adopted the most recent Boulder Valley Comprehensive Plan (BVCP) in January 2021. The BVCP commits the City to "sustainable wastewater treatment processes [that] achieve water quality improvements with greater energy efficiency and minimal chemical use." Energy efficiency and chemical use were among the criteria used to evaluate treatment alternatives in the 2021 Nutrient Compliance Study. The most recently updated City of Boulder Wastewater Treatment Master Plan anticipated TIN and phosphorus removal would be required by future discharge permits. Thus, the aforementioned planning documents decidedly shaped the scope of the WRRF Phosphorus Upgrades Project.

6.1.3 Local and Regional Issues

☑ Yes ☐ No Were local and regional planning efforts considered?

Please describe.

The Denver Regional Council of Governments (DRCOG) and Boulder County Board of County Commissioners (BCBCC) are the planning organizations that establish and coordinate regional planning efforts. DRCOG no longer specifically administers a 208 plan. Instead, DRCOG uses the Clean Water Plan, a companion document to the Metro Vision Plan, to discuss and coordinate regional water quality planning goals. DRCOG's Clean Water Plan designates the City of Boulder and Boulder County as management agencies in the Boulder Watershed. The BCBCC approved and adopted the most recent Boulder Valley Comprehensive Plan (BVCP) in January 2021, and the Boulder Valley Comprehensive Plan relies on the City of Boulder's Planning Department to develop and periodically update service area population and employment projections. Attachment 8 includes the most recent population, flows, and load projections that incorporate the Planning Department's efforts for the planning period that extends until 2040. This project will not modify the existing WWRF service area boundaries.

☐ Yes ☑ No Was consolidation with another wastewater system / treatment facility considered?

Please describe.

Consolidation with another facility or system would require a substantial shift in both policy and infrastructure. The policy changes would require the support of City Council to establish one or more intergovernmental agreements to convey and treat the City's wastewater. Consolidation would also require substantial capital investments in new pumping and conveyance infrastructure. The existing treatment facility is located in a geographically and topographically advantageous place: the majority of the collection system gravity-flows to the WRRF. The investment to modify existing assets to meet the City's needs requires far less capital than consolidation.

6.2 Population and Water Demand Projections (TMF: Technical-2)

For a 20 year planning period, forecast the population growth, projected increase in Equivalent Residential Taps (ERT), and projected drinking water demands.

Current SFEs - As Calculated in the Prequalification Form: 64000

Population and Demand Projections - The department generally accepts two methodologies for projecting water flows over the 20 year planning period. Other methodologies are acceptable with a clear explanation and all assumptions and parameters listed:

☑ Method 1: Population based projections. Recommended for primarily residential systems and/or for systems without potable water meter data.

☐ Method 2: Equivalent Residential Unit (EQR) Analysis. Recommended for systems with a high multifamily, commercial, and industrial users.

Method 1 and 2 templates can be found at the end of this form.
Attach the population projection as Attachment 8.

Discuss supporting data and reasons for projected future growth during the 20 year planning period.
Note: Projects designed solely to serve future development or population growth are not eligible for State Revolving Fund financing.

The Boulder Valley Comprehensive Plan relies on the City of Boulder's Planning Department to develop and periodically update service area population and employment projections. Attachment 8 includes the most recent population, flows, and load projections that incorporate the Planning Department's efforts for the planning period that extends until 2040. During this time, the Planning Department forecasts annual service area and employment population growth rates of 0.55% until 2035. Between 2035 and 2040, annual service area population growth slows to 0.54% and annual employment population growth increases to 0.74%. The City's 2002 Jobs to Population project adopted projection methods that use a combination of a land use model and an economic model to develop these growth estimates.

Identify waste load projections for major effluent parameters such as BOD, TSS, ammonia, phosphorus, metals, etc.

After construction of this project, BOD, TSS, ammonia, Total Inorganic Nitrogen, phosphorus, metals, and other permitted parameters are expected to be below limits expected in future permit cycles, including those associated with Regulation 85 and Policy 17-1.

7.Assessment of Alternatives

This section should contain a description of the reasonable alternatives that were considered in planning a solution to meet the identified needs. If the proposed project includes new technology then the please discuss whether or not the technology is covered in the CDPHE Design Criteria.

7.1 Alternatives

For each alternative, please provide:
1. A description of the alternative addressing the issues identified in Section 4: Project Purpose and Need. (TMF: Technical-7)
2. Capital cost estimates and annual operation and maintenance costs.
3. Advantages and Disadvantages of each alternative.

Alternative 1 Title : Low DO A/O with settling enhancement (liquid), Lime feed to PAD (sidestream)

Alternative 1 Description (2000 character limit):

Please note: the 2021 Nutrient Compliance Study (NCS) evaluated liquid and sidestream treatment alternatives separately.
The Low Dissolved Oxygen (DO) Anaerobic-Oxic (A/O) with settling enhancement liquid stream alternative includes reconfiguring the Aeration Basins (ABs) and Solids Contact Tanks (SCTs) into a treatment train that includes an anerobic selector ahead of aerated bioreactors that operate in sub-oxic conditions (0.2 – 0.7 mg/L DO) and using hydrocyclones to selectively waste solids from the secondary treatment system. Hydrocyclones complement EBPR biological selection and favor accumulation of dense biomass to improve settling in the secondary clarifiers.
The Lime Feed to Post-Aerobic Digester (PAD) sidestream alternative involves converting the existing Predewatering Storage Tank into a redundant PAD and dosing lime or another Calcium-based chemical to the PAD reactor at neutral or slightly acidic pH to form calcium phosphate precipitates (like brushite and hydroxyapatite).

Alternative 1 Capital and Operation and Maintenance Costs (2000 character limit):

The 2021 Nutrient Compliance Study used an Association for the Advancement of Cost Engineering (AACE) Level 5 estimate to develop capital and O&M costs. The O&M costs developed as part of this study were comparative, and these costs are not necessarily an increase over the current operating costs. This analysis estimated the Low DO A/O liquid treatment alternative would require a capital investment of $6.3M and O&M costs totaling a 20-year Net Present Value (NPV) of approximately $21.5M. This analysis estimated the Lime Feed to PAD sidestream alternative would require a capital investment of $1.8M and O&M costs totaling a 20-year NPV of $5.3M.

Alternative 1 Advantages and Disadvantages (2000 character limit):

The Low DO A/O with settling enhancement liquid stream alternative avoids constructing additional secondary treatment tank volume, it simplifies the secondary treatment process within the Aeration Basins, and is more energy efficient than the existing process. With respect to disadvantages, this alternative requires constructing a sludge densification facility, and it requires a sufficient timeline for proper commissioning, tuning, and demonstration.
The Lime Feed to PAD sidestream alternative advantages include improving biosolids dewatering characteristics, brushite has a low scaling risk relative to struvite, it would add alkalinity to biosolids and the centrate return stream, and it would maximize the use of existing assets. However, lime storage requires regular mixing and maintenance of feed systems.

Alternative 2 Title : 5-Stage Bardenpho (liquid), Deammonification (sidestream)

Alternative 2 Description (2000 character limit):

Please note: the 2021 Nutrient Compliance Study (NCS) evaluated liquid and sidestream treatment alternatives separately.
The 5-Stage Bardenpho liquid stream alternative involves modifying the biological treatment train into an anaerobic zone, pre-anoxic zone, aerobic zone, post-anoxic zone, re-aeration zone configuration. This alternative requires feeding supplemental carbon in the post-anoxic zone, recycling internal mixed liquor from the aerobic zone to the pre-anoxic zone, and RAS recycle from secondary clarifier underflow.
The Deammonification sidestream treatment alternative involves dividing the centrate return tank into two reactors and adding carrier media in the second tank. This media provides fixed film surface area within the reactor, enabling Partial Nitritation/Anammox (PN/A). This alternative would substantially reduce nitrogen loads in plant return streams without the use of supplemental carbon or alkalinity feed systems, while reducing the aeration rate required (relative to PAD).

Alternative 2 Capital and Operation and Maintenance Costs (2000 character limit):

The 2021 Nutrient Compliance Study AACE Level 5 cost analysis estimated the 5-stage Bardenpho liquid treatment alternative would require a capital investment of $3.5M and O&M costs totaling a 20-year Net Present Value (NPV) of approximately $23.6M. This analysis estimated the Deammonification sidestream alternative would require a capital investment of $3M and O&M costs totaling a 20-year NPV of $1.2M.

Alternative 2 Advantages and Disadvantages (2000 character limit):

The two primary advantages of the 5-Stage Bardenpho liquid stream alternative include the ability to consistently meet stringent nitrogen and phosphorus limits and that construction would require minimal modifications to implement. The primary disadvantage is a high supplemental carbon feed relative to other secondary treatment alternatives, requiring more frequent truck traffic for deliveries.
The deammonification sidestream treatment alternative requires less alkalinity and lower airflow rates (relative to PAD), which decreases the energy required for treatment. Additionally, this system could be feasibly installed in the existing centrate equalization tank. However, this sidestream treatment alternative requires a greater capital cost investment than the Lime feed to PAD alternative.

Alternative 3 Title : Enhanced Biological Phosphorus Removal with Membrane Aeration Biofilm Reactor (liquid), Magnesium Oxide feed

Alternative 3 Description (2000 character limit):

Please note: the 2021 Nutrient Compliance Study (NCS) evaluated liquid and sidestream treatment alternatives separately.
The Enhanced Biological Phosphorus Removal (EBPR) with Membrane Aeration Biofilm Reactor (MABR) liquid stream alternative involves modifying the biological treatment train into an anaerobic zone, pre-anoxic zone, aerobic zone, post-anoxic zone, re-aeration zone configuration, with MABR modules used in the pre-anoxic zone. This alternative requires feeding supplemental carbon in the post-anoxic zone, recycling internal mixed liquor from the aerobic zone to the pre-anoxic zone, and RAS recycle from secondary clarifier underflow.
The Magnesium (Mg) based chemical feed sidestream treatment alternative involves dosing magnesium hydroxide or magnesium chloride to the biosolids storage tank to elevate the pH and precipitate struvite.

Alternative 3 Capital and Operation and Maintenance Costs (2000 character limit):

The 2021 Nutrient Compliance Study AACE Level 5 cost analysis estimated the EBPR with MABR liquid treatment alternative would require a capital investment of $10.1M and O&M costs totaling a 20-year Net Present Value (NPV) of approximately $16.4M. This analysis estimated the magnesium chemical sidestream alternative would require a capital investment of $680K and O&M costs totaling a 20-year NPV of $3.2M.

Alternative 3 Advantages and Disadvantages (2000 character limit):

The EBPR with MABR liquid stream alternative advantages include increased nitrogen removal performance at lower Solids Retention Times, and low supplemental carbon feed requirements relative to 5-stage Bardenpho, resulting in less truck traffic. This alternative's primary disadvantage is financial: its capital and operating costs far exceed those of other liquid stream alternatives.
The Mg feed sidestream alternative would improve biosolids dewatering characteristics, and it would add alkalinity to biosolids and the centrate return stream. However, magnesium oxide and hydroxide would increase the operational effort for chemical handling, and feeding biosolids with incomplete crystal formation poses a substantial scaling risk in the dewatering centrifuges.

Provide discussions of additional alternatives as Attachment 19.

8. Selected Alternative

8.1 Justification of Selected Alternative

Please demonstrate why the selected alternative best meets system needs based on both monetary and non-monetary considerations.

The 2021 Nutrient Compliance Study considered financial, operational, environmental, and community impacts of the liquid and sidestream treatment alternatives. The financial category included equally-weighted life cycle cost and cash flow criteria. The operational category considered each alternative's human intervention requirements for maintenance and operations activities. The environmental category examined each alternative's potential for new resource recovery, its dependency on external resources, and the net energy impact. The community category considered on-site land use and availability impacts, and non-economic community benefits such as land availability to development, removal of high odor risk facilities, and truck traffic.
The Low DO A/O secondary treatment alternative requires a lower life cycle cost, does not require construction of additional biological treatment basin volume, and offers significant energy savings over other alternatives. Ultimately, this alternative scored highest despite a lower operational scope due to tighter process control requirements, a new operational strategy, and additional equipment that must be operated and maintained. Of the sidestream treatment alternatives, the combination of a redundant PAD and a calcium based chemical feed system requires less chemical, produces less biosolids, more effectively sequestered phosphate in solids, reduced recycle phosphate concentrations, and would result in the lowest amount of truck traffic. Additionally, the asset revitalization included in this project allows the City to maximize its beneficial use of existing infrastructure.

8.2 Technical Description and Design Parameters

For the selected alternative, please describe all proposed project components and assumed design parameters.

The project scope includes three main elements: upgrades to the secondary treatment system, improvements to sidestream treatment processes, and revitalization of existing facility assets. This project does not include changes that will impact the permitted plant hydraulic or organic treatment capacities.
Secondary treatment system upgrades include modifying the layout of diffusers and plugs in the aerated zones, replacing the air control valves, installing a supplemental mixing system in the Solids Contact Tanks, replacing two of the blowers with dual-core units, and constructing a hydrocyclone facility with the capability to densify RAS or MLSS. The total capacity of the aeration system will match that of the existing system; this projects' changes allow the biological system to operate within anaerobic and suboxic conditions for effective BOD, nitrogen, and phosphorus removal.
Improvements to the sidestream treatment processes include retrofitting the existing pre-dewatering storage tank into a redundant PAD and installing a pilot calcium chemical dosing system. Because the modification is designed to construct a redundant unit, the capacity of the PAD sidestream treatment process will remain unchanged. The chemical dosing system will be sized for temporary use.
Asset revitalization efforts include replacing the secondary digester lid with a fixed cover and sandblasting and recoating the existing primary clarifier mechanisms in-kind. More detailed, numeric design parameters will be provided to the CDPHE Engineering Section for technical review as part of the Process Design Report.

8.3 Proposed Process Flow Diagram

Include a proposed treatment facility process flow diagram or map of the collection system, lift station, or interceptor, as applicable as Attachment 10.

8.4 Appropriateness of Treatment Technologies

Discuss appropriateness of the proposed treatment process(es) to meet proposed discharge limits considering anticipated influent wastewater quality.

The 2021 Nutrient Compliance Study used biological process modeling to assess the ability of each secondary treatment alternative to meet anticipated discharge limits. The consultant developed a full plant model in SUMO using measured flow rates, DO set points, influent characteristics, and past operating data. A comprehensive data set from 2018 was used to validate the model performed in a manner consistent with observed plant operations.

One-year dynamic exploratory simulations demonstrated the Low DO A/O treatment alterative resulted in stable effluent phosphorus concentrations well below 0.5 mg/L, stable effluent ammonia concentrations well below 0.15 mg/L, and stable effluent TIN concentrations below 10 mg/L. These simulations included diurnal patterns to capture the response to short-term dynamics.

8.5 Environmental Impacts

Describe direct and indirect impacts on floodplains, wetlands, wildlife habitat, historical and archaeological properties, etc., including any projected permits and certifications. Indicate the need for a stormwater permit application, 401/404 permit applications, and CDOT and railroad permit applications.

The project extents will remain within the existing plant footprint, and the WRRF site is surrounded by a Provisionally Accredited Levy; thus, this project will not impact floodplains, wetlands, or wildlife habitat. As described in detail in Attachment 16, the Class I archeological survey concluded this project will not have any impact on cultural resources within the area of potential effects. This project does not involve disturbance greater than one acre nor will the work occur within 100 feet of a waterway; therefore, neither a stormwater permit not management plan are required by Boulder County. The WRRF maintains a CDPS General Permit that authorizes non-extractive industrial stormwater discharges under certification number COR900986. This project does not involve any activity requiring a Clean Water Act Section 401 permit. Site fill material will not be discharged to waters of the United States; therefore, a CWA Section 404 permit is not required. The project extents will remain within the existing plant footprint; thus, this project will not impact any roadways or railways in a manner or extent that will require a CDOT or a railroad permit.

8.6 Land Requirements

Identify all necessary sites and easements, permits and certifications, and specify if the properties are currently owned, to be acquired, or leased by the applicant.

The extents of this project will be confined by the existing fence line of the WRRF; no additional acquisitions or easements are required. The site is currently owned by the City of Boulder.

8.7 Construction Challenges

Discuss construction challenges such as subsurface rock, high water table, limited access, or other conditions that may affect cost of construction or operation of a facility.

There are no known conditions that may affect the cost of construction or operation of the proposed facilities. A project-specific geotechnical engineering study found non-expansive topsoil and natural granular soils down to a depth of 16ft, well below the extents of excavation required for this project. The study did not encounter groundwater in the exploratory drilling, and liquefaction is not a design concern. This study concluded that the site is suitable for the shallow foundation construction planned for the hydrocyclone facility.

8.8 Operational Aspects

Discuss the operator staffing requirements, operator certification level requirements, the expected basic operating configuration and process control complexities, and the operational controls and equipment that allows operational personnel to respond to routine and unanticipated treatment challenges, such as flow rate, fluctuations in influent quality, process monitoring and chemical feed dosing.

The existing WRRF treatment processes require an Operator in Responsible Charge with a Class A certification level. The proposed project will not change this requirement, nor will the project change the operator staffing requirements. The existing plant uses a sophisticated, automated controls system to monitor process changes and operate equipment. WRRF staff include a team dedicated to the Process Automation System. This system adapts to changes in flows and influent quality, regularly adjusting operating parameters. The proposed project scope includes new blowers with greater turn-down capabilities and additional instrumentation and aeration control logic to allow operators to monitor and operate the treatment system according to the precision required in low DO conditions.

8.9 Costs

Summarize the capital costs associated with the selected alternative. The 20 year cash flow projection included in Attachment 4 must reflect the capital and operation and maintenance costs associated with the selected alternative.

The preliminary design cost model estimates capital costs of approximately $15.7M for the secondary treatment system, $2.9M for sidestream treatment, $3.5M for asset revitalization, and $1.7M for general conditions.

Cost Category Selection (Assign a percent to each applicable category)

Secondary Treatment (Category I)	0
Advanced Treatment (Category II)	100
Infiltration/Inflow (Category IIIA)	0
Sewer System Rehabilitation (Category IIIB)	0
New Collector Sewers (Category IVA)	0
New Interceptors (Category IVB)	0
CSO Correction (Category V)	0
Storm Sewers (Category VI)	0
Recycle Water Distribution (Category X)	0
Nonpoint Source Pollution Control Activities (Category VII)	0
Total: (must equal 100%)	100

Please include an estimate of the projected increase in and total average monthly user charges. Does the user charge system allow for billing, collection, and enforcement?

8.10 Green Project Reserve

Check one or more green category that applies to the project:

☐ Green Infrastructure ☐ Water Efficiency ☐ Energy Efficiency ☐ Environmentally Innovative

Describe any green components incorporated into the selected alternative.

The secondary treatment system modifications fall into the Green Project Reserve energy efficiency category. Additional details are included in the Attachment 11 business case

The system must reference the most recent copy of the EPA Green Project Reserve guidance and procedures. These references are available on the CDPHE WQCD GLU website under "Green Project Reserve": https://www.colorado.gov/pacific/cdphe/wq-green-project-reserve
Include a business case for the project as Attachment 11, if applicable.

8.11 Environmental Checklist

Include the Environmental Checklist for the Selected Alternative as Attachment 12.

8.12 Project Implementation

8.12.1 Proposed Schedule

Request for WQPTs/PELs		Site Application Submittal Date	01/10/2023
Process Design Report/Basis of Design Report Submittal Date	03/31/2023		
Final Plans and Specifications Submittal Date (for Non-Streamlined Review only)	06/01/2023		
Discharge Permit		Miscellaneous Permits	06/01/2023
Public Meeting Date		Loan Application Submittal Date	06/15/2023
Advertisement for Bids Publication Date		Construction Contract Award Date	12/01/2023
Construction Start Date	08/01/2023	Construction Completion Date	09/30/2023

8.12.2 Public Meeting

Provide documentation of a public meeting held or describe when and where the meeting will be held. The meeting must be noticed for 30 days. Provide the public notice, proof of publication, sign in sheet, and agenda as Attachment 14 or provide to your project manager in the Grants and Loans Unit after the meeting has taken place.

☐ Include the public meeting documentation as Attachment 14.

Or, will be provided to the Grants and Loans Unit project manager after the meeting takes place.

9. Projecting Water Flows Method 1: Population based projections

Assumptions/Data	Value	Unit	Information Source
Current System Population		People	
Current Service Area Population (If providing water to neighboring community)		People	
Population Growth Rates		% increase/year	
Average Daily per Capita Flow Rate		Gallons per capita day	
Average Day Maximum Month per Capita Flow Rate		Gallons per capita day	
Maximum Daily per Capita Flow Rate		Gallons per capita day	
Peak Hour Factor			
Average Influent BOD5 Concentration		mg/L	
Average Day Maximum Month Influent BOD5 Concentration		mg/L	

Year	System Population	Service Area Population (if different)	Average Daily Flow	Maximum Daily Flow	Peak Hour Flow	Average BOD5 Loading (pounds per day)
+0	0	0				
+5						
+10						
+15						
+20						

10. Projecting Water Flow Method 2: Equivalent Residential Taps (ERT)

Current Equivalent Residential Taps (ERT)			
A	Number of active residential taps:	0	Units
B	Total Annual Potable Water Use less Irrigation Usage (gallons per year) – Residential	0	
C	Estimated equivalent residential potable water usage Annual flow per EQR = A/B	0	Gallons per SFE
D	Wastewater flow from commercial users	0	Gallons per ft2
E	Equivalent EQRs per 1000 ft2 of commercial space EQRs per 1000 ft2=D*1000/C	0	SFEs per 1000 ft2
F	Commercial space in service area	0	1000 ft2
G	Commercial EQRs Commercial EQRs = F*E	0	SFEs
H	Wastewater flow from industrial users	0	1000 ft2
I	Equivalent EQRs per 1000 ft2 of industrial space EQRs per 1000 ft2 = H*1000/C	0	1000 ft2
J	Industrial space in service area	0	1000 ft2
K	Industrial EQRs Industrial EQRs = H*J	0	1000 ft2
L	Length of sewer pipe in collection system	0	1000 ft2
M	Infiltration/Inflow contribution per 1000 feet of sewer pipe	0	1000 ft2
N	Equivalent EQRs per 1000 feet of sewer pipe EQRs per 1000 LF=M/C	0	1000 ft2
O	Infiltration/Inflow EQRs Infiltration/Inflow EQRs = L/1000*N	0	1000 ft2
P	Total EQR = A + G + K + N	0	1000 ft2

Population and Flow Assumptions / Data		Information Source
Current System Population	____________ People	____________
Current Service Area Population (If providing water to neighboring community)	____________ People	____________
Population Growth Rates	____________ % increase/year	____________

Average daily flow per ERT ____________ Gallons per capita day ____________

Maximum daily flow per ERT ____________ Gallons per capita day ____________

Peak Hour Factor ____________ Gallons per capita day ____________

Year	System Population	Service Area Population (if different)	Residential Taps (ERTs)	Multifamily Residential Taps (ERTs)	Commercial/ Industrial Taps (ERTs)	Irrigation Taps (ERTs)	Total Taps (ERTs)	Average Daily Flow	Maximum Daily Flow	Peak Hour Flow
+0										
+5										
+10										
+15										
+20										