Modernization of the Boulder Canyon Hydroelectric Project

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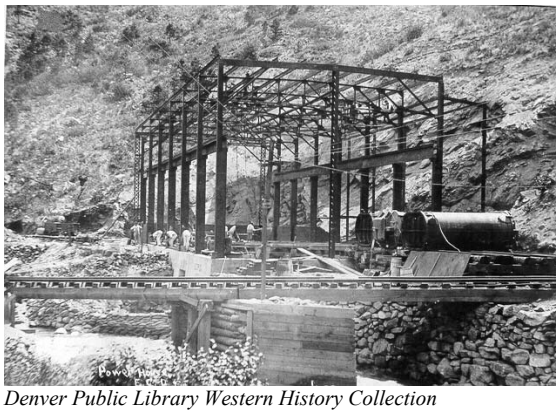

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Project Narrative

City of Boulder, Colorado
Department of Public Works
Utilities Division
P.O. Box 791
Boulder, CO. 80305

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Project Overview and Objectives

The City of Boulder, Colorado ("the city' or "Boulder") is proposing to modernize its existing Boulder Canyon Hydroelectric facility. Boulder Canyon Hydro was originally constructed in 1910 and has continuously produced electricity since that time. Some equipment in the facility has been replaced, but much of it is decades old. The existing turbine and generator are more than seventy years old and should be replaced soon if Boulder Canyon Hydro is to continue operating. The facility is unique due to its history, the very high pressure of its water supply, its construction, and its incorporation into the city's municipal water supply system. Rehabilitating Boulder Canyon Hydro could provide a useful example for owners of other older projects of how to deal with modernizing equipment within an existing building with existing connections to the electrical grid and could also highlight the potential for power generation that might exist within other municipal water supply systems.

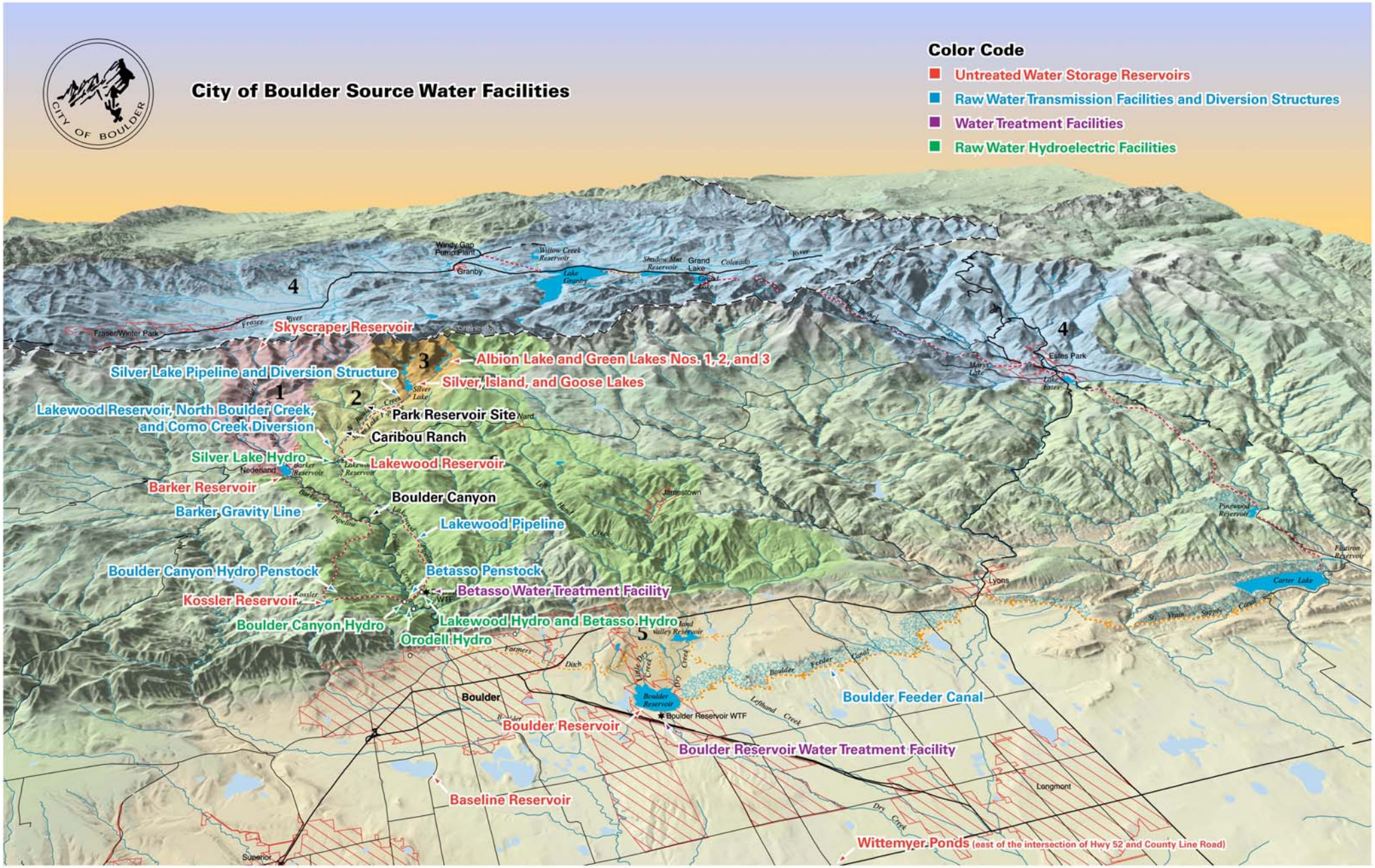
Boulder is located on the Front Range of the Rocky Mountains and provides water service to approximately 29,000 residential, commercial and industrial accounts with an annual treated water demand of approximately 19,000 acre-feet or 6.2 billion gallons. The Boulder Creek watershed is the city's primary municipal water supply source. The Boulder Creek watershed water supply system also provides clean, renewable energy from generation of electricity at hydroelectric plants installed on municipal water supply pipelines.

Beginning in the early 1980s, Boulder recognized the potential for hydroelectric energy generation within its water system and began developing facilities to produce electricity as a by-product of its water utility operations. Today, Boulder owns and operates eight hydroelectric facilities on its raw water transmission and treated water distribution systems (Figure 1). These hydroelectric plants produce environmentally-friendly hydroelectricity by making use of pressure developed in municipal water supply pipelines due to the large elevation drop between the city's diversion points in the mountains and delivery points on the plains. This pressure must be reduced to treat and deliver the water for municipal purposes and would otherwise be wasted through pressure-reducing valves.

The city's hydro plants are operated in a manner that does not diminish the primary purpose of supplying municipal water. Revenue from the sale of the electricity allows the city's Water Utility to maintain lower water rates for its customers. At the end of 2008, the city had generated 468,550,000 kilowatt-hours (kWh) of electricity since its first hydroelectric project went into operation in 1985. Sale of this power has generated $22,674,000 of revenue for the Water Utility, while providing environmental benefits through displacing the need to burn over 241,300 tons of coal and avoiding air emissions resulting from traditional coal-fired generation facilities. The city's hydro facilities have frequently been cited in industry literature as an example of how electricity can be derived with no additional environmental effects from water facilities that are in existence and required for other purposes.

The existing Boulder Canyon Hydroelectric facility is located on Boulder Creek west of the city. The power plant generates using untreated water diverted at Barker Reservoir located near the town of Nederland at an elevation of about 8500 feet. The water is transported approximately 11.5 miles in the Barker Gravity Pipeline to a small regulating reservoir and then through Boulder Canyon Penstock to the Boulder Canyon Hydro building at an elevation that is 1,800 feet lower, thereby producing 840 psi of pressure. Although the hydro plant originally operated with two 10 megawatt (MW) turbine/generators, one of the generators failed in 2000. The remaining operational turbine and generator date to 1936 and are at the end of their expected lives. Without a new turbine and generator, operation of the hydro is expected to cease within 5 years or less.

FIGURE 1: CITY OF BOULDER SOURCE WATER FACILITIES



Originally constructed in 1910 by the Central Colorado Power Company for the sole purpose of hydroelectric power production, the project began delivering water for Boulder's municipal water supply in the 1950s. Almost all of the Barker Reservoir storage space has been converted to municipal water supply storage over the course of the past few decades, so Boulder Canyon Hydro now operates almost exclusively using direct streamflows diverted from Middle Boulder Creek at Barker Reservoir. The city purchased the hydro facilities from Public Service Company of Colorado in 2001 and immediately established a minimum instream flow level below Barker Dam. Most of the water for Boulder Canyon Hydro is now available from April to October when streamflows are higher due to melting of the annual high mountain snowpack. The redirection of much of the historic water flow to meet the city's municipal and minimum instream flow uses means that the existing Boulder Canyon Hydro turbine is too large to operate efficiently. The city is proposing to install a new turbine/generator unit approximately 5 MW in size that is appropriately sized for the available water flow. This unit could generate about 580,000 MW-hours (MW-hr) over its fifty-year life that would not otherwise occur. Even at a smaller capacity, actual annual generation can increase in the future as compared to the past because of increased turbine efficiency with proper sizing and decreased operational downtime compared to that presently experienced with the old equipment.

Objective:

Increase generation and efficiency of the 100-year-old Boulder Canyon Hydroelectric facility

Average annual Boulder Canyon Hydro generation from 2002 through 2008 has been about 8,500 MW-hr, whereas annual generation with the proposed project could average about 11,000 to 12,000 MW-hr. The incremental change in annual generation is an additional 2,500 to 2,600 MW-hr per year, which is a 30% increase in generation over current conditions. However, generation at Boulder Canyon Hydro will soon drop to zero without replacement of the existing turbine and generator because they are beyond their expected life.

Generation will increase by as much as 30%; efficiency will increase by 18-48%, depending on flow

The one currently operational turbine/generator is a single nozzle Pelton turbine with a 5-to-1 flow turndown and a maximum turbine/generator efficiency of 81.8%. The proposed turbine would be a double nozzle Pelton turbine with a 10-to-1 flow turndown and a maximum turbine/generator efficiency of 88%. This alone represents a more than 6% increase in overall efficiency. The existing operational turbine is estimated to operate with actual efficiencies in the range of 40 to 70% due to age and non-optimal sizing of the turbine for the water flow available to the unit. The turbine currently must be shut down whenever water flow drops to less than about 8 cfs. An appropriately sized new turbine could likely operate in the range of 70 to 88% through a large portion of the existing flow range and would not have to be shut down at low flow rates; therefore efficiency will increase by 18-48%, depending on flow

In addition to turbine/generator replacement, upgrades to wiring, improved lightning protection and installation of a remotely operated turbine isolation valve is proposed to address safety and operational efficiency issues with the aging power plant. Deteriorated wiring insulation throughout the plant may cause electrical shorts that can harm both personnel and equipment. The city has purchased a thermal imaging camera to monitor rising temperatures of the high voltage wiring in anticipation of risk increasing to the point that the equipment must be retired.

Objective:

Increase safety at Boulder Canyon Hydro

Asbestos testing on existing wiring has been positive, constituting an additional safety hazard. New electrical and control systems associated with the new turbine/generator installation would address this issue.

Aging transformers with minimal protection from lightning strikes at Boulder Canyon Hydro represent a safety hazard, an environmental threat, and a source of decreased generation. For example, lightning damage caused a two-month outage of the power plant in 2008, resulting in the loss of approximately 5225 MW-hr of generation. Two of the aging transformers are located immediately adjacent to Boulder Creek. If lightning were to strike these transformers directly, it could result in an oil spill into the creek and cause significant environmental damage. An old, on-site single-walled hydraulic oil storage tank is another potential environment hazard. In conjunction with installation of a new turbine/generator, the city proposes to install additional protection from lightning-caused surges, refurbish or decommission the two transformers adjacent to the creek, and replace the on-site hydraulic oil storage tank.

Objective:

Increase protection of the Boulder Creek environment

The existing turbine isolation valve (TIV), which was installed in 1910, cannot be remotely operated, nor does the valve close automatically upon an emergency turbine stop. The existing TIV would be prohibitively expensive to modify. Without remote TIV operation, a runaway turbine condition could occur and cause considerable damage to the turbine or possibly a penstock rupture. The environmental damage to Boulder Creek from rupture of the 840 psi penstock might take decades to mitigate. The only cost effective way to rectify this situation is to install a state-of-the-art TIV at the time the turbine is replaced.

Objective:

Modernize and integrate control equipment into the municipal water system

When Boulder Canyon Hydro was constructed in 1910, it was the highest head hydro plant west of the Mississippi River and possibly in the United States. The project, backed by several investors of historic importance both nationally and within the state of Colorado, was notable in terms of construction difficulty and technological challenges. Due in part to its unique engineering features and innovative construction techniques, Boulder Canyon Hydro is considered eligible for listing on the National Register of Historic Places.[1] The power plant today exists in close to original condition. Prior to modernization, Boulder proposes to document and preserve technical engineering data in accordance with Historic American Engineering Record standards. This effort would include collection, review and organization of the abundant historic documentation that exists for Boulder Canyon Hydro.

Objective:

Preserve significant historical engineering information prior to plant modernization

Completion of the modernization effort would have a long-term beneficial effect on the historically significant Boulder Canyon Project. Modernization will allow for continued operation of the hydroelectric plant, which will preserve the original function and use of the power plant. Retaining original function is commonly recognized as one of the most effective historic preservation strategies.

Boulder has anticipated the need to upgrade and modernize the Boulder Canyon Hydroelectric facility since the city's purchase in 2001 and, as a result, is in a position to move this project forward to completion within two years of grant award. Boulder Canyon Hydro currently operates

Objective:

Complete modernization with minimal regulatory delay

[1] In 1994, the Boulder Canyon Hydroelectric Facility Penstock was awarded the Historical Welded Structure Award by the American Welding Society as it was the first structure to use acetylene welding in conjunction with the ball peen welding procedure and significantly advanced penstock technology when constructed in 1910.

under a license (P-1005) from the Federal Energy Regulatory Commission (FERC) which expires on August 31, 2009. The city began discussing options for relicensing the project with the FERC in 2003. Recognizing both capacity reduction and conversion of project facilities from primarily hydroelectric power generation purposes to municipal water supply objectives, the city completed its consultation process for project reauthorization in 2007 and 2008 and on March 9, 2009 filed its final application for exemption of the Boulder Canyon facilities from licensing as a small conduit hydroelectric facility. The city anticipates issuance of the order granting exemption of the facilities by August 31, 2009. Conduit exemptions from licensing are issued in perpetuity, eliminating the need for time-consuming and costly relicensing efforts in the future.

The conduit exemption order will reflect the continuing operation of a single 10 MW turbine/generator as the project nameplate capacity. While the city is prepared to submit an application to FERC for amendment of the exemption at such time that it replaces the existing turbine unit, the city believes it meets the criteria for implementing the proposed changes without prior FERC review and approval (as provided for in FERC regulations at 18 CFR §4.96). Specifically, the city can provide assurances from fish and wildlife agencies that the proposed change would be consistent with their understanding and expectations for the project. In addition, installation of a new, appropriately sized turbine would not materially alter the design, location or operation of the project.

In 2005, a feasibility study was completed to integrate municipal water supply reliability and hydropower generation which showed that a 4.9 MW unit at Boulder Canyon Hydro would be an appropriately sized replacement for the two 10 MW units currently installed. Modernization of Boulder Canyon Hydro has a positive benefit-cost ratio and would allow the City of Boulder to maintain municipal water supply as a priority, improve reliability and flexibility of the water supply system, reduce production of greenhouse gases in furtherance of the city's climate action goals, and fully utilize hydroelectric potential while maintaining its existing instream flow commitments for Boulder Creek.

Modernization of the Boulder Canyon Hydro equipment was included in the city's master plans for both the Middle Boulder Creek Watershed and the source water system. The Boulder City Council adopted these plans in 2002 and 2009, respectively. The city's 2010-2011 budget includes appropriations sufficient to provide the city's share of the project cost.

Expeditious completion of Boulder Canyon Hydro modernization will contribute to economic recovery by creating or preserving a significant number of jobs. Major contributors to this project include engineering design and construction support personnel, a turbine/generator manufacturer and a general construction contractor. The city estimates that about 20,000 labor hours and as many as 80 different individuals will be required to complete the project within the proposed two-year window.

Objective:

Contribute to economic recovery through the creation and/or preservation of jobs.

Merit Review Criteria

Criterion 1. Technical Merit and Innovation

The city has been a leader in development of hydroelectric potential in municipal water supply systems. Through viewing the city water system and its energy potential comprehensively as complementary resources, the city has developed innovations in methods for proper sizing of turbines when using consistent municipal water flows versus more variable river flows and in use of pump/turbine units to maintain proper pressures between water system

The project is part of a comprehensive program to develop the energy potential within Boulder's municipal water supply system.

pressure zones without wasting the energy. BCH modernization is just one component of the city's overall comprehensive plan to develop the hydroelectric potential of its municipal water supplies. Boulder has identified at least three other potential hydro plant sites within its water system that could be developed if funding can be accommodated within the Water Utility budget. If the city could reduce its costs for BCH modernization, capital improvement budgets for other hydro improvements in the system could be available sooner.

In general, the city policy for hydro potential development relies on economic as well as environmental feasibility. Economic feasibility relies upon a project being able to pay for itself during its expected lifetime. At a cost of approximately $5.155 million, payback would occur in approximately 35 years. With a grant to reduce the city's costs by 48.5%, the city's BCH modernization costs would be paid back in approximately 15 years.

The Boulder Canyon Hydro turbine/generator is at the end of its useful life and is expected to fail in the next 5 years. Table 1, below, summarizes the incremental increase in energy production and environmental benefits that would result from power plant modernization at the current time.

Table 1: Increase in Energy Production and Environmental Benefits of the Proposed Project

	Existing 10 MW Unit	Proposed 5 MW Unit	Change from Existing
Expected Life	<5 years	50 years	>45 years
Average Annual MW-hr	8,500	11,660	3,160
Total lifetime MW-hr	42,500	583,000	540,500
Offset in Coal Consumption (tons)	22,000	300,000	278,000
Offset in SO_2 Emissions (tons)	30	450	420
Offset in NO_X Emissions (tons)	70	900	830
Offset in CO_2 Emissions (tons)	22,000	303,000	281,000

Required lead time for delivery of a turbine generator in the U.S. is currently approximately 16 months. Notwithstanding, the city believes project completion within 2 years of award is very possible for the following reasons:

Boulder believes this project will be operational within 2 years of grant award.

- Feasibility studies, including turbine sizing, have been completed. This will allow the city to order the turbine/generator as owner-procured materials shortly after grant award.
- The city has completed the necessary consultation and application processes for the FERC authorization of this project and expects to have a conduit exemption from licensing in hand in the next several weeks.
- AECOM will be the design engineer for this project. AECOM completed the feasibility study for turbine replacement, has designed and constructed two of the city's other hydroelectric plants and is very familiar with the existing and proposed facilities.
- Final design, contracting, remaining minor permitting efforts, and other aspects of the project (historic documentation, surge protection, transformer refurbishment/decommissioning and oil storage tank replacement) can be completed in advance of turbine delivery.
- The power house is an existing structure. Therefore, modernization of the interior equipment can be undertaken with no seasonal restrictions or weather-related delays.

The engineer's estimate for completion of the Boulder Canyon Hydro modernization effort includes over 10,000 hours of construction contractor labor within a 5 month period, as well as direct material and equipment costs. The project also includes owner-procured materials with a value of $2.5 million and engineering fees of $640,000 over the two-year period of project completion.

Hydroelectric projects involve significant commitments of manpower for design, construction, operation and maintenance

City staff time in completion of this project is considered part of the normal staff work plan. The city estimates that total staff time spent in the completion of the Boulder Canyon Hydro modernization project will represent one full-time equivalent position for two years (or about 4,000 hours) at a cost of approximately $150,000.

Additional information concerning the number of jobs created or preserved is presented under "American Recovery and Reinvestment Act Information" on page 15 of this narrative.

Criterion 2. Technical Approach and Project Research Plan

The City of Boulder has successfully completed seven hydroelectric installations on its municipal water supply system and has contracted with AECOM on its two most recent hydroelectric projects. Past experience has resulted in a proven, successful approach which will be of immeasurable value in the completion of Boulder Canyon Hydro modernization.

The Boulder/AECOM project team has a proven approach to successful completion of hydroelectric project design and construction.

AECOM has an extensive history of engineering consultation for the City of Boulder's utility department and prepared the analysis of hydroelectric potential for the Boulder Canyon Hydroelectric facility. The proposed modernization of the Boulder Canyon Hydroelectric Project includes decommissioning the two existing 10 MW units, removing one of the existing units, and installing a new 4.9 MW unit in its place. The proposed technical plan includes the following major categories:

1. Equipment Procurement (turbine/generator and appurtenances)
2. Engineering Design and Construction Phase Services
3. Construction

Year 1 Activities

1. Equipment Procurement

The projected lead time for the turbine and generator package is estimated at 490 calendar days (approximately 16 months) from receipt of Purchase Order. In order to assure construction is completed by the end of the second year, issuance of the Purchase Order for the turbine and generator package will be the first priority.

Initial engineering design efforts will consist of preparing technical specifications and drawings for the 4.9 MW turbine generator procurement package by mid-February 2010. It is anticipated that the Request for Proposal (RFP) document will be issued by the beginning of March 2010. The bid review process is anticipated to be complete within two months, and a purchase order will be issued to a vendor in mid-May 2010.

2. Engineering Design Services – Submittal coordination with turbine vendor

The technical specifications provided in the RFP document will include requirements for equipment design submittals. It is anticipated that the following submittals will be reviewed for conformity to the contract drawings and specifications:

- Manufacturer's design calculations including inertia calculations
- Manufacturer's design drawings of the turbine, generator, tailrace, hydraulic power unit, and turbine inlet valve.
- Product data sheets of specific instrumentation.

3. Engineering Design Services – Preparation of final construction specifications and drawings

Final design and preparation of a complete specification and drawing bid package for replacing the existing 10 MW Pelton unit at Boulder Canyon Hydroelectric facility with a modern, more efficient 4.9 MW Pelton unit will be performed. The following technical components will be included in final design activities:

- Geotechnical review – a review of the existing geotechnical data will be performed to analyze the impact of the proposed modifications described below.
- Structural design – the existing unit is embedded in concrete. This concrete will be removed and new concrete supports will be installed for the new unit.
- Civil design – minor modifications may be required in the tailrace area depending on the new unit orientation. Piping modifications will be required upstream of the new turbine to accommodate the smaller size and possibly a lower turbine setting.
- Hydro-mechanical – the design of the hydro-mechanical equipment will be in close consultation with the turbine generator manufacturer. The equipment includes the turbine, generator, hydraulic power unit, controls and switchgear and inlet valve.
- Tie-in locations – two tie-in locations will be required. One will be for the new turbine and one will be for the by-pass to the Betasso Hydro unit and the Water Treatment Plant.
- Electrical and Controls – electrical and controls design will be based on upgrading the existing equipment to meet the requirements of the new unit. The new unit will be fully operational on the City's SCADA system.
- Operations and Maintenance Access – existing access to the facility will be maintained for use with the new unit.
- Final permitting activities.
- Historic preservation considerations – the design will consider the requirements for historic preservation of the existing facility.

Existing specifications used on previous City of Boulder projects will be used as a basis for the Boulder Canyon Hydro specifications. Utilization of the existing technical specifications will result in efficient use of the time and budget. AECOM understands the need to be efficient and will thoughtfully implement measures to maximize the use of existing information for this project.

The specifications and drawings will be prepared in consultation with the City and issued for bid. Final design efforts will occur during the second, third and fourth quarters of the first calendar year (2010). The final design package and construction bid documents will be completed and ready for bid by the end of the first year (2010).

Year 2 Activities

1. Engineering Construction Phase Services – Issue for Bid – Construction

It is anticipated that four months will be necessary to complete the bid process and select a qualified contractor. The process will consist of the following components:

- Minimum 30 day bid period including advertisement, pre-bid conference and addenda (if required)
- Bid review
    - Notice of award
    - Contract negotiations
    - Notice to proceed

To facilitate contract award, conformed contract documents, which incorporate all addenda will be prepared.

2. Construction

Appropriate supervision will be provided to assure that the construction is in accordance with the design intent. It is anticipated that the contractor will incorporate the following construction sequence during construction of the Boulder Canyon Hydroelectric Project:

- Mobilization – the contractor will move its construction trailer and necessary equipment to the project site.
- Prepare Access – access to the Boulder Canyon Hydroelectric Project is readily available off of Hwy 119. Additional temporary bridge support may be required for the plant modernization.
- Remove Hazardous Items – any potentially hazardous items such as lead paint or asbestos will be removed through an approved abatement process as outlined in the specification documents.
- Refurbish Transformer – The existing transformers are outdated. One transformer will be refurbished and updated based on the new load requirements. The other transformer will be decommissioned and left in place.
- Deactivate Units A and B – the two existing units will be deactivated.
- Remove Unit A – one of the existing units will be removed with careful consideration to the historic preservation process.
- Install Betasso Bypass – a bypass pipeline to the Betasso Water Treatment Plant will be re-routed to provide uninterrupted supply to the plant.
- Prepare Area for New Unit – the area for the new unit will be constructed with the new structural and civil supports as designed.
- Deliver and Install New Unit – the new unit will be installed in the area once occupied by the existing unit.
- Install electrical and control equipment – new electrical cabinets, programmable logic controllers and all necessary wiring will be installed so that the new unit will be fully operational on the City's SCADA system.
- Test and Commission – testing and commissioning of the new unit will take place in the presence of the turbine generator manufacturer, the engineer and the owner. Efficiency requirements and start up procedures will be demonstrated.
- Clean Up and Demobilize.

A construction quality monitoring program is required to assure that a specified level of quality is built into the project. The contractor will be responsible for independent quality control and quality assurance.

It is anticipated that the contractor will complete construction in November of 2011.

Licenses and Permits

Most non-federal hydroelectric projects in the U.S. are under **Federal Energy Regulatory Commission** (FERC) jurisdiction and subject to a FERC authorization process. The FERC issues licenses and exemptions, including conditions governing the construction and operation of hydroelectric projects. The city has applied for and anticipates receipt of an order granting a conduit hydroelectric exemption during August 2009. Conduit exemptions are considered to be categorically exempt from compliance with the National Environmental Policy Act and are issued in perpetuity.

Boulder has completed the Federal Energy Regulatory Commission requirements to receive an exemption from licensing process for this project.

The conduit exemption order for Boulder Canyon Hydro will reflect the continuing operation of a single 10 MW turbine/generator as the project nameplate capacity. The FERC has specified procedures for amending conduit exemptions in its regulations (18 CFR 4.96). Briefly, these regulations state:

> A holder of an exemption may file an application to amend its exemption, but changes can be made in some cases without the need for an application and the FERC's approval. The exemption holder may implement the changes without the FERC's approval if:
>
> - After being notified in writing by the exemption holder of its intended changes, the appropriate fish and wildlife agencies determine that the proposed changes would not cause the project to violate the terms and conditions imposed by the agencies, and
> - The changes would not materially alter the design, location, or method of construction or operation.

The city believes installation of a new, appropriately sized turbine/generator at the Boulder Canyon Hydro facility meets these two conditions. Future replacement of the single operational turbine was identified as a possibility in the city's exemption application. The involved fish and wildlife agencies are already aware that this future improvement would not change existing project operations and have approved the existing project operations without additional conditions. Because a new turbine/generator would be installed within an existing powerhouse, there would be no change to the existing design or location of the facilities.

In accordance with FERC guidelines, the city will contact the FERC Division of Hydropower Administration at project commencement to determine if any additional FERC action would be required to complete the proposed project. From its previous experiences with exemption amendments, the city believes that an amendment could be applied for and issued within two years of grant award.

Because this project would be completed with federal monies and its operation is under federal jurisdiction, the city believes it will need to demonstrate **federal agency compliance with the National Historic Preservation Act**. The Boulder Canyon Hydroelectric Project is considered eligible for nomination to the National Register of Historic Places. The power plant today exists in close to original condition, but the interior equipment would be significantly modified by the proposed project. While it would not be possible to modernize this facility without significant modification to power plant contents, the city can preserve the historic engineering and construction data from the original power house prior to modernization. To do this, the city proposes to complete detailed records of the powerhouse interior and

equipment prior to its replacement. Following grant award, the city will consult with the Colorado State Historic Preservation Officer (SHPO) concerning the requirements for and acceptability of such a study. The study itself would be completed by an outside consultant approved by the SHPO and experienced in completing Historic American Engineering Record documentation.

Because most of the proposed modifications will take place inside the powerhouse, few if any additional permits commonly required for a new hydroelectric project or new ground disturbing activities (e.g., as would be required for **Endangered Species Act or Clean Water Act compliance**) will be required. The project is covered under a 1994 Biological Opinion from the U.S. Fish and Wildlife Service for both municipal and hydropower uses of the project facilities. The U.S. Fish and Wildlife Service affirmed during the FERC exemption process for Boulder Canyon Hydro that the city has implemented the reasonable and prudent alternative for the project. As a result, no further action will be needed for this project. Similarly, the U.S. Army Corps of Engineers commented during the exemption process that future work requiring the placement of dredged or fill material or excavation in an aquatic site will require a permit pursuant to Section 404 of the Clean Water Act. Impacts to wetlands and waters of the U.S. which may occur as a result of this project (e.g., improvement of access to the power plant) will most likely be qualify for authorization under a Nationwide Permit from the U.S. Army Corps of Engineers.

Endangered Species Act Section 7 consultation is complete for the Boulder Canyon Hydro modernization project

The city has its own **Community and Environmental Assessment Process** (CEAP), which is usually required for capital improvement projects. A CEAP normally analyzes the social, environmental and economic impacts of proposed capital improvement project alternatives. City staff routinely completes CEAP analyses, would commence the CEAP process, if one is required, upon grant award, and anticipates the CEAP could be completed within 6 months of grant award.

Local support for development of environmentally and economically feasible hydroelectric opportunities within the city's water supply system is high. The city recently convened a community study group to provide input into the Source Water Master Plan. Support from this group of interested citizens was quite high for continuing to operate and develop the hydroelectric potential within the city water system. Renewable energy is a key component of the city's climate action plan goal to be in alignment with the Kyoto Protocol target of reducing greenhouse gas emissions seven percent below 1990 levels. An increasing number of Boulder residents are calling for the local electric utility, Xcel Energy, to provide more of Boulder's electricity needs from renewable sources.

The city does not operate an electric utility. All hydroelectricity generated within the municipal water supply system is sold wholesale to Xcel Energy subject to the term of **power sales agreements**. The existing power sales agreement for the Boulder Canyon Project expires on August 31, 2009. The city has reached an agreement with Xcel to extend the existing power sales agreement for Boulder Canyon Hydro until December 31, 2009 when it is expected that a new twenty-year power sales agreement will be completed and signed. Terms for the new Boulder Canyon Hydro agreement have been negotiated to allow for replacement of the existing turbine/generator without triggering termination of the agreement or any change in its twenty year term.

Project Impacts and Impact Mitigation Plan

Boulder Canyon Hydro has been in existence since 1910, and most construction-related **environmental impacts** happened long ago. Some of the on-going effects of project operation under prior ownership have been mitigated by the city since purchase of the facility in 2001, including:

- The previous owner of Boulder Canyon Hydro used the facility primarily for peaking power, mainly during winter evening hours. This resulted in high, pulsed surges in creek flows, which affected aquatic habitat. With the full conversion of the project from hydropower generation to municipal water supply, the city does not use the facility for peaking power, and winter flow surges no longer occur.
- Under the previous ownership, Middle Boulder Creek below Barker Dam frequently dried up. Boulder has implemented voluntary instream flow releases from Barker Dam to maintain minimum flows of 3 cfs in winter and 4 cfs in summer. Flows below the dam are typically higher and natural peak flows of hundreds of cfs will continue to occur during spring snowmelt in the mountains. The minimum flow levels will be maintained except during drought or other emergency conditions for the city's municipal water supply system.
- The city installed a fish passage structure around a concrete-encased pipeline crossing of Boulder Creek at the power plant.
- The city supported Boulder Flycasters Chapter of Trout Unlimited in its efforts to obtain funding to improve fisheries habitat on Middle Boulder Creek below Barker Dam.

Environmental impacts related to this project will be minimal, because most construction will occur inside the existing power plant, and no operational changes will occur as a result of plant modernization.

Plant modernization will result in the replacement of historic equipment and fixtures within the power plant building. Impacting a nationally significant historic resource and proposed mitigation strategy are discussed under "Licenses and Permits," on page 10 of this proposal.

Completion of this project would mitigate existing environmental hazards associated with the existing equipment. Installation of additional protection from lightning-caused surges, refurbishment or decommissioning of the two transformers adjacent to the creek, and replacement of the on-site hydraulic oil storage tank will mitigate potential environmental dangers which currently exist (see page 4).

The renewable energy generated by this project would reduce the need to generate a like amount of power from a traditional, coal-fired generation plant, thus reducing off-site mining and transportation impacts, air pollutant emissions and consumption of fossil fuels (see page 6). ,

Socio-economic effects of Boulder Canyon Hydro modernization are considered to be positive:
- Expenditures for construction would positively benefit the Colorado construction industry, which has experienced a 15.8% job loss since the recession began.
- Over the fifty-year lifetime of the project, the city expects to generate $4.6 million in revenue from the sale of electricity for the City of Boulder water utility. Water utility revenue from the sale of hydroelectricity offsets costs that would otherwise be paid by the city's water customers.
- The project would generate income to the water utility in approximately 15 years, thus freeing up funds for other capital improvement projects within the city's water system.

There will be no **recreation impacts** associated with this project. Current recreation opportunities at city facilities – including picnicking, shoreline fishing, hiking, kayaking/tubing on Boulder Creek and nature appreciation - would be unchanged. The Boulder Canyon Hydro power plant is currently closed to public access for safety and security reasons. No change in public access would occur as a result of this project.

Criterion 3: Qualifications and Resources

The city has completed two hydroelectric facility installations and many general water supply infrastructure projects with AECOM. The result of this long-standing association is that there is an existing project team experienced with working together to complete this project. The availability of an

existing, experienced project team assures that team members are already familiar with project roles and responsibilities, communications with other project team members, early recognition of problems and innovative, effective approaches to problem resolution. The city has found that all of these factors are essential to completing a project on schedule and within budget.

The proposed project organization is shown in Figure 2. Resumes for the identified key project team members are included in the attached resume file.

Carol D. Ellinghouse, P.E, Water Resources Coordinator for the City of Boulder, will serve as Principal Investigator for the project. Ms. Ellinghouse has been in charge of overseeing the planning, operation and maintenance of the city's eight hydroelectric plants since 1994 and also manages the city's water rights portfolio, and raw water storage and delivery systems.

Joseph J. Taddeucci, P.E, will manage the project for the City of Boulder. Mr. Taddeucci has extensive experience in feasibility studies, design and construction of large water resource projects including hydroelectric plants and penstocks. He has been involved in managing large complex projects, preparing designs, drawings and technical specifications, and coordinating with and managing contractors, equipment and material suppliers during construction. Joe has worked in and around hydroelectric facilities and appurtenant features throughout his entire engineering career.

Rajesh Dham, P.E., P. Eng., will be AECOM's Project Manager for this project. His experience includes the planning and design of water resource projects, hydromechanical equipment design and selection including high pressure gates and valves, water conductor systems, hydro power generation systems, and design and implementation of numerical and physical hydraulic model studies. Rajesh is experienced in design of large underground pumped storage schemes and has provided rock mechanic design of large underground caverns and tunnels. He is responsible for preparing designs, drawings, technical specifications, cost estimates, and reviewing contractor shop drawing submittals for mechanical equipment associated with dam, high pressure flow control systems and hydropower projects.

Criterion 4: Deployment Plan

City staff and contractors routinely work together to communicate with other water industry professionals through papers, publications, conference participation, etc. Project team members have contributed to publications and conferences of the American Society of Civil Engineers, American Water Works Association, the Waterpower conference, Colorado Water Resources Research Institute, Colorado Water Congress and Colorado Municipal League. The attached resumes list some of the team member's publications and papers.

Preparing technical publications and participation in conferences and seminars is highly encouraged for AECOM employees for them to present the innovative solutions for the exciting and challenging projects that are presented to them on a daily basis. Within the hydro world, AECOM employees regularly participate in numerous conferences and publications including the following:

- Hydrovision
- Waterpower
- Journal of Hydraulic Engineering
- Hydro Review

These represent a broad body of other consultants, utilities and government entities who use these resources to stay abreast of current resources and technologies in the water and hydro industry.

Boulder's Utilities Division uses its Web site (www.boulderwater.net) to keep the public informed concerning current projects. Information about the Boulder Canyon Hydro Modernization Project will be included among the city's current projects. Web sites for construction projects are regularly updated (as often as weekly) to provide current information and photos. While security procedures prevent the city from making detailed or technically sensitive information available on the internet, project Web sites contain current contact information should professionals with a specific interest desire further project information.

Please see pages 4 and 6 of this narrative for information on status of permitting and minimization of regulatory delay.

Project Schedule/Timetable

The project schedule, Figure 3, illustrates the sequencing and duration of the work efforts associated with Boulder Canyon Hydro modernization.

Roles of Participants

As the owner of the Boulder Canyon Hydro project, the city will enter into contracts with all other firms or individuals participating in the project.

The city's Water Resources Coordinator will act as the designated Principle Investigator for the project. The Water Resources and Hydroelectric work group is responsible for planning, operation and management of the city's municipal raw water supplies and the hydroelectric plants. The Coordinator is familiar with all of the facilities, the FERC conduit exemption status, the power purchase agreement, and the water supply availability for the hydro project.

The city's designated Project Manager has the following responsibilities:

- Ensuring that all project expenditures meet the terms and conditions associated with the grant.
- Determining and implementing processes to acquire owner-procured equipment needed for the project (in this project, the new turbine/generator).
- Supervising the implementation of all contracts related to this project.
- Judging the performance of all contractors in terms of compliance with drawings and technical specifications and quality of workmanship and materials.
- Final decision-making authority for all matters relating to contracts for the project.

The city intends to contract with AECOM to act as the Architect/Engineer (A/E) for the project. A/E responsibilities include:

- Preparation of technical drawings and specifications for the project.
- Assisting the Project Manager in administering contracts.
- Consulting with the Project Manager concerning performance and acceptance of work.
- Participating in the approval of progress and final payment estimates.
- Participating in inspections while the work is in progress and prior to final acceptance by the city.

The General Contractor for this project will be selected through a bidding process. The successful contractor will have the following responsibilities:

- Supervision and direction of the work included in its contract.
- Means, methods, techniques, sequences and procedures and their coordination.
- Responsibility for all acts and omissions of its agents and employees, subcontractors and their agents and employees.

The city will enter into contracts with other consultants as needed to ensure successful completion of the project within the terms and conditions of the grant. Additional outside support is anticipated for completion of historic documentation, additional permitting, etc.

The city strives to implement a "team" or partnership approach with its contractors on all major construction projects as a means to ensuring a successful project. When each participant's role and responsibilities are acknowledged and respected by other team members, the city is most likely to end up with a project that is technically excellent, economically successful, and environmentally sound.

Facilities and Other Resources

The Boulder Canyon Hydroelectric Project is an existing hydroelectric generating facility, so all equipment and facilities necessary for interconnecting a new turbine and generator are currently in existence. The pipelines associated with the project, including the penstock, are routinely maintained and repaired as critical elements of the city's water supply system. The city owns all land used and useful in completion of the proposed modernization project. Electrical transmission infrastructure and connections are maintained by Xcel Energy, the local electric utility.

The city's eight hydroelectric facilities are operated and maintained by a three-person, full-time hydroelectric staff, with assistance from city water treatment and water system maintenance staff, outside consultants and contractors as needed. The hydroelectric staff is based at the Betasso Water Treatment Plant, located one half mile south of the Boulder Canyon Hydro power house.

City administrative and management personnel are located in downtown Boulder, Colorado, approximately five miles east of the project site. The primary responsibility for completion of the Boulder Canyon Hydro modernization will be shared between the Water Resources and Hydroelectric work group and the Utilities Planning and Project Management work group.

AECOM has been ranked No. 2 as a Global Design Firm and No. 1 in Hydroplants in the July 2009 publication of Engineering News Record (ENR). AECOM's Denver office brings focused, streamlined solutions to hydroelectric projects, providing complete engineering services from conceptual design through final design, construction and commissioning of hydropower plants. The strength of the AECOM Denver office includes about 40 engineers, including a staff of about 20 dedicated to dams and hydropower. Projects typically include field investigations, laboratory testing programs, hydrologic and hydraulic analyses including transient analysis, seismic studies, static and earthquake stability analyses, preparation of construction plans, specifications and cost estimates and construction management. AECOM has recently completed the addition of a 3.1 MW hydropower unit to the Lakewood Pipeline for the City of Boulder, Colorado. Currently AECOM is providing design consultation services to add a 7 MW unit to an existing power plant for Yukon Energy Corporation. Additionally, AECOM is providing design services to Los Alamos County, New Mexico for the addition of a new 3 MW unit to an existing 14 MW facility.

American Recovery and Reinvestment Act Information

Upgrading the Boulder Canyon Hydroelectric project with a new turbine/generator will involve three primary workgroups: 1) a design and construction support consultant; 2) a manufacturer for the turbine/generator package; and 3) a general construction contractor to remove the old equipment and install the new turbine/generator system.

In addition to the three primary workgroups associated with the project, the City of Boulder has its own management and hydroelectric/water resources staff. However the City's staff level is not anticipated to change with or without this project.

For the consultant, the work effort will be broken into two categories, including design and construction support. The design phase will last approximately one year and will involve a project team consisting of a project manager and an average staff of three (with varying staff size during any given month). During the average month of the design phase, it would be anticipated that about 50% of the project manager's and 25% of each of the three staff member's available time would be dedicated to this project. The construction phase will also last approximately one year and will involve a project team consisting of a project manager and an average staff of three. During the average month of the construction phase, it would be anticipated that about 30% of the project manager's and just under 20% each of the staff member's available time would be dedicated to this project. As many as 10 different individuals would have a role in design and construction support. The consultant would use about 4,500 labor hours over a two year period.

The manufacturer of the turbine/generator package would involve about 40 different employees who would have varying levels of involvement in the project for the better part of a year. The turbine would involve about 3,000 labor hours, the generator would involve about 1,500 labor hours and the switch gear and controls would involve about 1,000 labor hours. The total labor hours for the turbine manufacturer would be about 5,500 hours. Despite the fact that hydro equipment manufacturing is largely done overseas, Boulder has received supplier information indicating it will be possible to meet the Buy American Requirements of the 2009 American Recovery and Reinvestment Act.

The engineer's estimate for completion of the Boulder Canyon Hydro modernization effort includes over 10,000 hours of contract labor within a 5 month period. This equates to the equivalent of 11.5 people working full time for 5 months. It is more likely that the contractor would have a full-time crew of five to seven workers, supplemented by many other project staff for shorter durations. By the time the project is finished it would be likely that 20 to 30 different workers would have a role in the project during construction.

Combined, the design and construction support consultant, turbine/generator manufacturer and general contractor would have about 20,000 labor hours and as many as 80 different individuals involved during the two year window required to execute the project. This project will make a significant contribution to the required workload of the primary workgroups and will also provide numerous opportunities for smaller project roles such as welders, testers, truckers, steel manufacturers, etc.

Figure 2: Project Organization

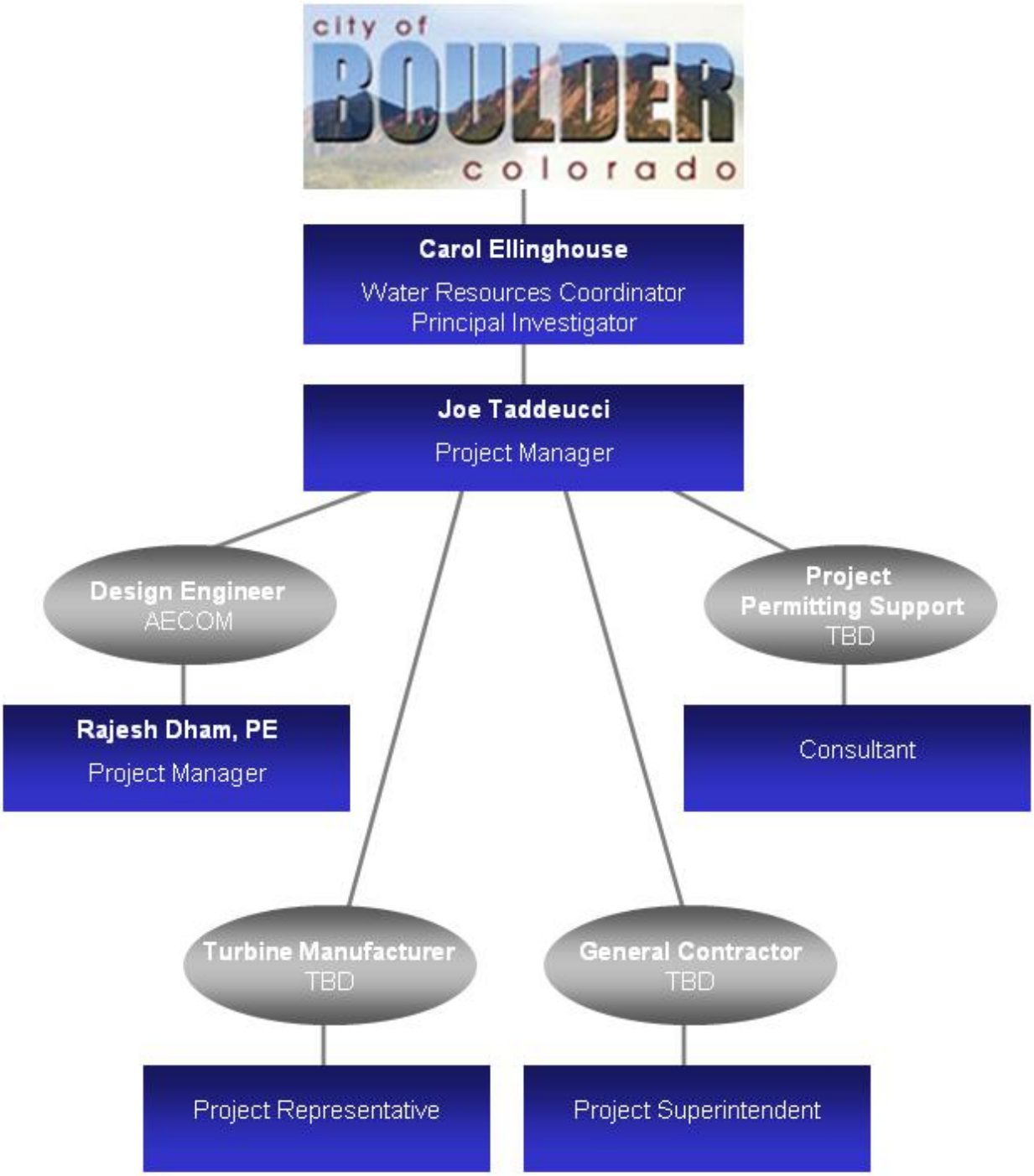


Figure 3: Project Schedule