

Project Description

PIC's Project Role

PIC staff members supported the planning, routing, permitting, design, bidding, and construction of the project's eight phases. Specific support activities included alternatives analysis, extensive U.S. Army Corps of Engineers, U.S. Fish and Wildlife, and local permitting; detailed pipe design, utility coordination, public outreach, easement acquisition support, and construction administration services.

Project Participant Roles

The following participants supported the 60-inch Bellvue Water Transmission Pipeline Project:

- **City of Greeley**
Project Owner
- **Providence Infrastructure Consultants**
Lead Project Designer
- **Brierley Associates**
Geotechnical Engineering and Design
- **Lithos Engineering**
Geotechnical Engineering and Design
- **BT Construction**
Phase 1 Contractor
- **Garney Construction**
Phase 2, 3, 4, 6, and 7 Contractor
- **Reynolds Construction**
Phase 5 Contractor
- **Southland Construction**
Phase 8 Contractor

Entrant's Contribution

Uniqueness and/or Innovative Applications of New or Existing Techniques

The project's long distance and challenging alignment presented numerous opportunities to explore and implement creative project solutions.

Recognizing the City's desire to be good financial stewards associated with near-term capital costs and long-term operating costs while minimizing impacts to environmental and public resources, the planning and design team implemented the following strategies:

Detailed Alignment Studies – Each project phase involved detailed alignment studies that were used to adjust to changing circumstances as the project was being implemented. A key objective of the alignment studies was to select pipeline alignments that reduced costs, avoided environmental resources, and minimized temporary public impacts, all the while ensuring the overall 26-mile transmission line would flow by gravity. Alignment studies were based on individual GIS-based intersect models that quantified the length impact through various land uses, environmental resources, developed and undeveloped land, as well as transportation corridors.

Use of Expanding Trenchless Technologies – Trenchless technologies were expanding and the resources and equipment of qualified trenchless contractors were changing during the course of the project. As such, the PIC-led design team developed specifications resulting in quality installations and competitive pricing. The project's final phase involved two deep rock tunnels and over 2,500 feet of excavation using an 84-inch Tunnel Boring Machine. The more notable of the two tunnels involved a 1,900-foot drive on a contractor-selected curved alignment immediately adjacent to the Cache La Poudre River.

Aggressive Installation Techniques – A competitive bidding process allow contractors to install either ductile iron pipe or steel pipe. While each of the project phases used contractor-selected pipe material, the large majority of the project was installed using steel pipe. A key challenge with installing steel pipe is that a significant amount of pipe joints are required to be welded by a specialty construction subcontractor and can slow overall installation schedules. As such, the design team developed installation specifications that allowed a Weld-After-Backfill (W-A-B) installation process to increase productivity, reduce schedules, and lower costs. The W-A-B process involved connecting bell and spigot pipe, installing joint coatings, and backfilling the pipe prior to internal welding. With the development of high pipe wall temperatures during welding, many owners

avoid a W-A-B process over concerns that elevated pipe temperatures will damage exterior pipe coatings. In order to mitigate against W-A-B coating damage, the design team required the following: 1) Contractor proof of qualifications to perform the W-A-B process, 2) a trial W-A-B test be performed based project specifications, 3) backfill be placed a minimum of 20-feet each side of the pipe joint, and 4) a minimum two-person crew apply a specially designed W-A-B exterior joint sleeve with protective underlayment.

Future Value to the Engineering Profession and enhanced public awareness/enthusiasm of the role of engineering

For over 100 years, the City of Greeley has conveyed water between its treatment facility in Bellvue and its service area using two smaller transmission lines. With the addition of the 60-inch Bellvue Pipeline, the City can continue delivering high-quality treated water to its customers. One of the unique characteristics associated with the City's transmission lines are they rely fully on gravity to convey treated water across Larimer and Weld counties to the distribution system. With the project now operational, the City can deliver over 50 mgd of treated water in addition to the 20 mgd currently provided by the older transmission lines.

By designing for gravity operations, the City will save millions of dollars in operating costs that would be required by pumped conveyance. In addition, the project team was sensitive of energy usage and gravity operations are now significantly reducing energy consumption by forgoing pumped conveyance. During project planning, the design team calculated using gravity flow operations, the City is able to reduce annual energy consumption equivalent to the operations of nearly 400 passenger vehicles or approximately 300 homes. While not typically evaluated when comparing gravity versus pumped operations, gravity flow significantly reduced potential carbon dioxide (CO₂) / green-house emissions. It was estimated the carbon footprint for operating a pump station on the pipeline would be equivalent to burning over 11 railcars worth of coal

annually. As such, the design team aggressively endeavored to ensure the pipeline would flow by gravity.

Social, Economic, and Sustainable Development Considerations

As part of the planning efforts, a detailed evaluation of continuing to convey treated water nearly 26 miles to the City's service area was performed. An alternative to installing the gravity-flow pipeline was to abandon water treatment at the existing Bellvue WTP and move treatment operations to within City boundaries. However, it was determined that the City's source water to be captured along the Cache La Poudre River within its service area would be of much poorer quality requiring more expensive and maintenance intensive treatment processes. The existing Bellvue WTP, with its location along the Cache La Poudre River at the base of the Rocky Mountain foothills, has higher quality source water that is not influenced by urban and agricultural runoff or wastewater plant outfalls. Should treatment processes have been moved southeast to the City, source water quality would lower, and the City would be in a prolonged battle involving increasing costs and every increasing water quality regulations. To better manage the City's overall public water drinking system in an economically favorable and sustainable manner, the Bellvue Pipeline was installed to reduce energy consumption, treat higher quality water, and better adjust to an increasingly stringent water quality regulations.

Complexity

Over its 26-mile corridor, the pipeline construction worked its way through the growing municipalities of the Towns of Windsor and Timnath, the City of Fort Collins and numerous environmentally and culturally sensitive areas. A guiding principal of the project was to closely coordinate with federal, municipal and private stakeholders to select alignments and incorporate design features that would protect resources and minimize distributions and impacts along the project's corridor. In numerous areas, trenchless pipe installations were implemented

to avoid impacts to the traveling public, sensitive wetland areas, and documented cultural resources.

The design team took particular care to coordinate with the City of Fort Collins on an agreeable alignment north of City's downtown district. The team spent over 12 months coordinating the 60-inch pipe's horizontal and vertical locations to properly align with and accommodate a future City of Fort Collins 4-lane roadway and its associated storm drainage facilities. Furthermore, the design team also worked in close coordination with the U.S. Corps of Engineers, the U.S. Fish & Wildlife Service, and the Colorado State Historic Preservation Office to completely avoid or minimize and properly restore temporary impacts. Within the project's eighth construction phase, the design team worked with the City to implement a nearly 2,000-foot long, 50-foot deep curvilinear tunnel through rock to avoid impacts to several irrigation ditches, a registered historical site, and a geologic formation that held value to local residents.

In another location along the eighth construction phase, the pipeline was installed through Lyons Park which is state-owned land along the Cache La Poudre River that is managed by the City of Fort Collins. As part of restoring the project's temporary impacts within the park, the project involved enhancing riparian habitat along the river's edge to facilitate growth of sustainable habitat, increase bank stability, and prevent erosion. In order to facilitate these riverine enhancements, an irrigation system was installed to provide critical moisture so the enhancements would properly establish.

Successful Fulfillment of Client/Owner Needs

Over the course of 14 years, design team members worked with the City in a trust-worthy, transparent, and proactive manner and generally operated as an external extension of the City's engineering staff. The design team made this partnership a priority through regular meetings involving planning, permitting, easement acquisition, design, and construction. Based on this partnering relationship, the design team responded to City needs in an efficient and

cost-effective manner and mitigated project risks to the greatest extent possible.

Despite the challenges of constructing the Bellvue Pipeline outside of its service area and through urban corridors and difficult landscapes, the project was successfully completed to the satisfaction of the City and the various outside stakeholders that had an interest in the project.

Closing Summary

During the planning phase that led to the development of the project, it was expected that the City of Greeley's population would double within a planning horizon of 30 years. Rather than waiting for an increasing population to significantly influence water demands and put significant burdens on City resources, the City proactively addressed its future treatment and transmission needs in an aggressive manner by planning, permitting, designing, and constructing the 26-mile, 60-inch Bellvue Pipeline Project. Though the plan install the large diameter transmission main was aggressive, the actual implementation took a measured approach over the course of 14 years. Over this time period, the City was able to execute the project in eight separate phases thus allowing it to better manage its City-wide capital expenses. Furthermore, the City and the PIC design team were able to concentrate efforts on each specific phase of the project in a focused manner. One of the key benefits of the project being phased over a longer implementation period was the City was able to understand the project's growing financial impact on allocated budgets and implement cost-saving approaches as the project progressed. With the project now complete and successfully operating, project team members are proud the 26-mile gravity flow pipeline, was able to meet the budget goals, protect environmental and cultural resources, and minimize public impacts. In addition, the project team is pleased the project enables the City to reduce its energy consumption, treat a higher quality source water, and more easily and cost-effectively adjust to water quality regulations that are becoming increasingly stringent.