Iron Woman Construction and Environmental Services
Waldorf Mine Closure Project
Category 2 – Meeting the Challenge of a Difficult Job – Specialty Contractor

Water is one of our planet's most precious resources. In its purest form, water is the source of life for all things on earth. When water is contaminated, repercussions ripple through eco systems, sometimes causing catastrophic effects. This resource is finite, necessary, and delicate. Today, the United States mining industry is well informed on sustainable practices, careful to preserve water systems and life they support. However, for decades mines were built, used, and abandoned with little consideration for environmental ramifications left in their wake. Cleaning up these now toxic sites can be challenging and dangerous, but critical to sustaining our fragile ecosystems. Recently, Iron Woman completed a high-altitude remediation and watershed protection project at an abandoned mine, saving the watershed and surrounding ecosystems from toxic mine spoils and preserving precious water resources for generations to come.

The Historic Waldorf Gold Mine, near Georgetown, Colorado, sits at 11,640 feet above sea level. Water discharged from the mine feeds into Leavenworth Creek in the Colorado Mineral Belt. The creek flows through Arapahoe National Forest, South Clear Creek and Clear Creek Watersheds. The ore mine operated from 1850 to 1950 before it was abandoned and eventually collapsed, leaving behind contaminated waste tailings. Water from Wilcox Tunnel (Waldorf Mine's adit) drained continuously through these tailings, carrying contaminates with it. The project's goal was to improve discharge water quality that would protect downstream watersheds and vibrant mountainous ecosystems. Abandoned mine remediation and water quality enhancement projects present a particular set of challenges that our Mining team loves. At the forefront of such projects are transportation and logistics, sustainability, safety, and stakeholder collaboration. Iron Woman partnered with Trout Unlimited (client), Wenck Engineering (engineer), and the United States Forest Services (owner). The reclamation project was safely and successfully executed, making a lasting environmental impact to Colorado's precious water resources.

Solutions of Special Project: The Waldorf Mine Closure Project's objective was to improve the quality of water discharging from the mine's adit with minimal impact on the surrounding

environment. As water discharged to the surface, it passed through historic mine tailings and waste rock, becoming laden with pollutants: arsenic, heavy metals, acidic mine water, copper, molybdenum, cadmium, and zinc. The contaminated water flowed into the valley's wetlands affecting wildlife populations and vegetation, eventually moving downstream to other watersheds. The multi-phase solution utilized a Passive Water Management System.

Phase one involved temporarily rerouting discharge water away from waste rock piles and wetlands at the Wilcox tunnel. Water was diverted for several months, allowing the area to drain so equipment could track to construction areas with minimal impact on the land. Extremely saturated areas were stabilized with native rock for construction. Once dried, rock-lined channels were also used as transport roads for equipment, again minimizing impact on the natural state of the wetlands.

Once the wetlands were dry, the Iron Woman team constructed a Passive Water Management System specifically designed to minimize environmental impact while naturally ridding water of pollutants. The system utilizes a series of lined channels and ponds that capture and control water flow. Water moves from one pond to the next; each pond layered with its own unique script that naturally cleans water and supports vegetation designed to absorb pollutants. Suspended solids in the ponds drop out. Eventually, stabilized water descends to the watershed. Passive Water Management Systems aesthetically blend into the environment it supports. No electricity or long-term maintenance is needed, and it is entirely natural. The system was built utilizing site sourced resources. The Iron Woman team made soil through a grizzly onsite. Boulders and other natural structures were utilized to stabilized water channels. After completion, any disturbed ground was brought back to life with native plants.

Revitalization of the Waldorf Mine wetlands did not come without challenges. High altitude, extreme weather, delicate landscapes, and a remote location all required thoughtful navigation. The site is accessible only by Leavenworth Creek Road, a historic landmark, where changes to the road were not permissible. Travel time included a 45–60-minute pass with several narrow sections spanning only 11 feet wide. Mobilization was challenging and often dangerous. Once on site, Iron Woman utilized low ground pressure equipment designed specifically to work in the fragile mountain wetland environment. Standard equipment would have sunk into the saturated grounds, damaging the landscape. Care was taken at every step to maximize safety while

minimizing construction footprint. The result was an aesthetically pleasing, natural water cleaning system that will ensure safe water for generations to come.

Excellence in Project Execution and Management/ Team Approach: Phasing this project required extensive planning and logistical coordination. Based on multiple site visits, transport logistics and safety were identified as the primary challenges and Iron Woman puts safety above everything else. The team scrutinized the plans laid out by Trout Unlimited and Wenck Engineering. We analyzed site conditions and weather daily and consistently monitored activities and environment throughout the work. Each morning the team held safety meetings and reviewed work plans. End-of-day meetings were conducted to discuss progress, share challenges, and monitor health and awareness of each team member.

The biggest priority outside of safety was the essential collaboration between Trout Unlimited, Wenck Engineering, and the USFS. Because the team worked together daily to discuss approach and execution, there was very little need for inspection or changes.

The dedicated Iron Woman project team consisted of Carl Crews (Mining Service Vice President), John Trujillo (Senior Program Manager), Chris Alvarez (Health & Safety Manager), Brad Pesika (Lead Operator), and Ben Litsey (Project Consultant). In addition, four field crew members worked to deliver this project. Given the challenging conditions, working cohesively became a necessity and every team member represented equal value. For instance, Mr. Crews frequently drove a 20-ton articulated haul truck through 7 ½ miles of rough mountainous roads to deliver materials and equipment. The team worked 12-hour days and spent nights on site, bunking up in a nearby off-the-grid forest service cabin. The high altitude required slow movement during acclimation, but the remote location invited an intimacy with the land they were working to save. The entire team was committed to seamless, cohesive project execution.

Construction Innovations/ State-of-the-Art Advancement: Iron Woman considers Passive Water Management Systems as one of the most effective methods for improving water quality at historic mine sites. However, passive water management systems do not perform their intended function if not installed correctly. An understanding of hydrology, chemistry, and ecology is required. Iron Woman considers passive water management an engineering, scientific, and construction innovation that could majorly impact historic mine site water quality if used more frequently.

Project execution required creative solutions to minimize the construction footprint. Specialized equipment was used in water-logged areas to reduce ruts and ground disruption. Material had to be site-sourced because bringing in material would have been challenging if not impossible. Maintaining the environment's aesthetic and natural state was an added benefit.

Environmental/ Safety: Safety is at the heart of all we do at Iron Woman. While finished projects have value, none is greater than the value of our people. Our Mining crews are accustomed to working in challenging conditions and undergo extensive and ongoing health and safety training. Even for seasoned crews, this project presented challenging environments and conditions where maintaining health and safety best practices was critical.

Due to the high altitude, hydration was vital to prevent hypoxia. The crews were monitored regularly for fluid intake and screened for altitude-related illnesses. On site housing minimized hazardous daily travel and helped acclimate crew members to the altitude. The isolation also protected employees from the COVID-19 pandemic. Weather conditions in the mountains can be unpredictable. Though work was conducted in the spring and summer months to avoid snow, the team encountered extreme lightning, heavy rain, snow squalls, radical temperature swings, and winds topping eighty miles per hour. Maintaining safety in volatile weather conditions required quick reaction times in dismantling equipment and seeking shelter.

The Iron Woman crew had zero safety incidences and remained healthy, thanks to diligent planning and attentiveness to health and safety best practices.

Excellence in Client Services and/or Contribution of the Community: Trout Unlimited' s mission is to conserve, protect and restore Colorado's coldwater fisheries and watersheds. The project improved water quality at the headwaters of a major watershed system contaminated by the abandoned Waldorf Mine, serving both the ecosystem and the communities relying on Clear Creek. The cities of Georgetown, Dumont, and Idaho Springs, Colorado, are the primary beneficiaries of the project; however, every downstream user will see an impact in improved water quality, including local wetlands and the wildlife it supports. Without resolution, the contaminated wetlands would have continued degrading and destroying water quality for generations to come. With the solutions envisioned by Trout Unlimited, designed by Wenck Engineering, supported by USFS, and executed by Iron Woman, the Clear Creek wetlands region will heal, and the ecosystem will return to its natural, healthy state.


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