Hooper's reservoir

Balancing irrigation and potable water needs

Project information

Project manager: Tracy Allen, P.E., J-U-B Engineers Inc.

Geotechnical Consultant: Terracon

Contractor: Brian Hamson, Whitaker Construction

Liner (geomembrane): Pondguard® EPDM from Firestone Building Products Co.

Geogrid: BX1200 from Tensar Earth Technologies Inc.

Hooper, Utah has been a farming community since 1854. As the local population grows, however, this small northern Utah town continues to see homes replace crops. With this shift in land use, Hooper faces the challenge of providing utility service to new customers.

As with any growing community, a dependable drinking water supply stands highest on the list of infrastructure priorities. In the arid West the need for a dependable drinking water supply is often closely followed by the need for a dependable irrigation water supply.

A dilemma

Developing communities still use canals and other surface water improvements to maintain the viability of the remaining farmland, but increased residential and commercial development has forced municipalities and water companies to reassess their ability to provide stable drinking water for these new developments.

Drinking water is typically delivered in a pressurized system. Customers take advantage of this pressure to run lawn and garden sprinklers, albeit at a relatively high cost. Some communities continue to irrigate lawns and gardens through flood irrigation. This method of irrigation, however, may not be compatible with residential and commercial developments.

Herein lies the dilemma many arid-region communities face: An existing canal and turnout system for irrigation delivery exists, but it is no longer functional in the context of residential and commercial development; and drinking water systems may be used for watering lawns and gardens, but the expense of treating this water and improving under-capacity distribution systems is often cost-prohibitive to the customers.

The Hooper Irrigation Co., which has provided the area's irrigation water for just over 100 years, resolved this dilemma with a simple and effective solution: a pressurized irrigation system. Through a low-interest loan from the Utah State Board of Water Resources, the irrigation company funded the construction of 15 miles of pipe, a 640 horsepower pump station, and a 24 acre-foot reservoir.

Photo 1. **The irrigation reservoir prior to the installation of an EPDM liner. The storage and pressurized system helped balance the area's residential and farm water needs.**

The reservoir

Whitaker Construction—a contractor located in Brigham City, Utah—installed the distribution system and the pump house as the initial components of the overall pressure irrigation system. The contractor then built the reservoir as the final component of this first phase.

The reservoir was designed by J-U-B Engineers, a civil and environmental engineering firm with headquarters in Boise, Idaho. This particular design was completed by engineers in the Kaysville, Utah office.

The challenges of building a reservoir in Hooper became apparent in the early stages of investigation and design. One of the first indications of poor soil and high groundwater conditions arose during a simple excavation at the proposed site. The president of the irrigation company used a small backhoe to excavate eight feet beneath the existing ground surface. The uppermost soils, consisting primarily of fine sands and silt, were saturated to within two feet of the ground surface. At six to eight feet the sand and silt gave way to very soft clay.

This poor soil structure came as no surprise to the engineer or the irrigation company, as these soils are common along the shore areas of the Great Salt Lake. (The reservoir site is less than three miles from

By Paul Burnham, P.E.

***Photo 2*. The completed reservoir. Differences in polymeric liner costs (materials and installation) were found to be comparable; hence, an EPDM liner was chosen for what the client and designer saw as a future repairability advantage (after performance needs were met).**

the normal shoreline of the Great Salt Lake). For a complete geotechnical investigation, the engineer requested the services of Terracon, a national geotechnical consulting company, with a local office in Draper, Utah.

The geotechnical consultant investigated the samples from bore holes on the site, and made recommendations regarding maximum embankment slopes and other design options. From these recommendations, and from conditions observed on the site, two challenges came to the forefront of the design approach: first, how to build a lined reservoir below groundwater level; and, second, how to construct a reservoir floor that could handle construction, operation and maintenance loading.

The engineer solved the first challenge through the design and construction of a passive drain system. This system allows groundwater to drain into the reservoir only when reservoir levels fall below groundwater levels.

A series of pipes and filter drains under the reservoir collect and convey groundwater to a single point, where the water passes through a gasketed flap gate into the reservoir. During maintenance or other times when the reservoir might be empty, the groundwater is simply pumped away from the site. In the winter months, the reservoir remains full. This eliminates the need to run the groundwater pump in the off-season and protects the reservoir liner from potential uplift.

The second challenge, that of developing a reservoir floor structure, provided an opportunity to consider relatively new methods of foundation construction. The soils near the designed floor elevation had a penetration resistance of three to five blows per foot. At lower depths (20 ft.), the geotechnical consultant found soils with essentially no penetration resistance. In any case, these soils would not be able to support repeated loading with large machinery.

The engineer first considered the amount of granular fill material that would be required to support heavy machinery during construction, as well as machinery during operation and maintenance. Initial calculations showed that the contractor would need to import nearly three feet of granular materials. On this particular site, this would require nearly $280,000 of excavation and fill. The total cost of the finished reservoir (without the pump house) was $1,023,000.

With an estimated excavation and fill cost of 27% the total project cost, the engineer considered other approaches to building the reservoir foundation. After reviewing available soil stabilization techniques and products, the engineer chose a geogrid that could significantly decrease the foundation thickness.

In this case, the engineer specified a high strength polymer geogrid. (See "Project information.") Final calculations and a review with the product representative showed that this geogrid would decrease the imported fill section by 52%. This translated to a net savings of $104,000, or 37% of the fill/excavation item, and 10% of the original total cost estimate.

With the foundation designed, the engineer then reviewed various impermeable liners. The liner selection was based on three factors: material cost, the ease of installing the liner, and the ease of repairing the liner.

The costs of installing the various liners appeared to be fairly comparable. Hence, the final selection was weighted more by the ease of repairing the liner than by the other two criteria. Based on the simple nature of repairing EPDM (ethylene propylene diene monomer rubber), the engineer selected this liner.

The liner was sandwiched between two layers of native sand. Of the manufacturer's suggested protective measures, native sand appeared to be the least expensive option, and it provided an excellent layer of protection from sharp stones and maintenance equipment.

The reservoir has now been through its first season. Residents of Hooper have a viable, cost-effective supply of pressurized irrigation water. Perhaps the best aspect of this project is that the local irrigation company now has the capacity to continue serving Hooper residents for another 100 years. GFR

Paul Burnham is a civil engineer licensed in the state of Utah. He works for J-U-B Engineers Inc., www.jub.com.