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NEW RECLAIMED WATER PIPELINE EXPANSION SAVES PRECIOUS DRINKING WATER

Mike Massaro¹, Gayleen Darting², and Rick Evans³

¹ Bennett Engineering Services, Roseville, CA

² Sacramento Regional County Sanitation District, Sacramento, CA

³ The HDD Company, Cameron Park, CA

ABSTRACT: In September of 2013, the Sacramento Regional County Sanitation District (Regional San) approved the SPA Water Recycling Pipeline Project. The first phase will carry 1,000 acre-feet per year (AFY) of tertiary filtered and disinfected recycled water for industrial cooling water at the Sacramento Power Authority Cogeneration Plant. The second phase provides an additional 1,700 AFY for landscape irrigation once the Sacramento Regional Wastewater Treatment upgrade project (known as EchoWater) is complete.

A portion of the pipe's alignment carries it below the Regional San's new Flow Equalization Basin, two levees, and a creek, while also crossing under environmentally sensitive areas. In order to minimize the pipe's impact on these areas, horizontal directional drilling was chosen as the major installation. Two drills were required, one 3220-feet of 18-inch pipe for the recycled water pipeline and another 3220-feet of 10-inch pipe as part of the EchoWater project treatment plant upgrades. In addition 2,470-feet of both 18- and 10-inch pipe were installed via open cut.

The focus of this paper will be on Phase 1A of the overall project; the design development, the material choices, and the impact on the surrounding area while also looking at the benefits of trenchless methods for discreet reclaimed water transportation.

1. INTRODUCTION

The City of Sacramento has a had a long history as a leading city in California. Often referred to as "River City" due to its location at the confluence of the Sacramento and American Rivers, the settlement was originally established to be an agricultural community.

The city continued to grow as the years passed; it saw its biggest population boom during and after World War II. As California became increasingly important to the South Pacific war effort, Sacramento's proximity to the new McClellan Air Force Base, the new Army Depot, and the revived Mather Air Force Base meant that thousands of new military men and women were coming through the city on their way to bases and on to San Francisco. It also meant that a large group of laborers who began working at the newly opened bases needed somewhere to raise their families. The increased interest in the area led to an influx of new residents, and thus, a much greater demand for water and wastewater services.

In order to handle this new wastewater demand, a series of wastewater collection systems and treatment plants were established. By the 1970s, there were 20 separate treatment plants servicing the 600,000 people living in the Sacramento area. In an effort to establish a more singular and centralized wastewater treatment facility for the region, the City of Folsom and both the City and County of Sacramento joined forces to create the Sacramento Regional County Sanitation District (Regional San) in 1973. Funding for the new development was provided through a series of federal and state grants. Over the following ten years, a state of the art wastewater treatment facility was built near Elk Grove, CA and a series of interceptor pipelines were installed throughout the region to link each community's local sewer collection systems to the larger treatment system. The Sacramento Regional Wastewater Treatment Plant (SRWTP) began operations in 1982 – cleaning the region's wastewater and safely discharging the treated water into the Sacramento River – and has been in service ever since (see Figure 1).

Today, Regional San services 1.4 million residents and business on a daily basis and holds the position as the largest inland wastewater treatment plant west of the Mississippi River. Regional San actively invests in water quality research in order to ensure that the best treatment methods are being used and also advocates and supports scientific research to improve the surrounding natural area. One of the core values of Regional San is its responsibility to environmental stewardship. It has a staff dedicated to monitoring and conserving the surrounding wetlands, renewing woodlands and grasslands, and protecting the valuable "Bufferlands" (see Figure 1).

The Bufferlands is the area surrounding the SRWTP, which Regional San itself owns. Wastewater treatment plants need to be good neighbors to the local community. That's why in the 1970s, Regional San decided to purchase the property surrounding the treatment plant to develop a buffer between treatment plant operations and its nearest neighbors. This 2,150-acre expanse of open space minimizes the potential for odor and other nuisances that could impact the surrounding neighborhoods; however, the Bufferlands provides much more than a nuisance buffer. This important nature area provides hundreds of acres of high quality wildlife habitat, farmland, and open space in a rapidly urbanizing area of California. It has both upland and wetland habitats, which include 230 species of birds and 25 species of native mammals, as well as 20 species of rare plants and animals. Regional San's natural resources specialists who maintain the Bufferlands operate an extensive outreach program in order to better educate those in the surrounding area about the plants and wildlife that call their neighborhoods home.



Figure 1. Map of the Bufferlands surrounding the Regional San

In terms of its material ownership, Regional San owns and maintains the following:

- 169 miles of 36-inch to 144-inch gravity interceptors throughout Sacramento and Yolo Counties
- 46 miles of 16-inch to 66-inch force mains
- 11 wastewater pumping facilities that each pump between 10 and 264 million gallons per day (MGD)

Regional San provides wastewater conveyance and treatment services to residential, industrial, and commercial customers throughout unincorporated Sacramento County; the cities of Citrus Heights, Elk Grove, Folsom, Rancho Cordova, Sacramento, and West Sacramento, as well as the communities of Courtland and Walnut Grove. Each day, an average of 127 MGD of wastewater is treated and then safely discharged by Regional San to the Sacramento River.

2. PROJECT BACKGROUND

In 2003, Regional San completed its Water Reclamation Facility (WRF). This small-scale water recycling plant was initially designed to provide up to 5 MGD of Title 22 disinfected tertiary recycled water. Title 22 is a California regulation set forth by the California Department of Health (now known as the Division of Drinking Water) in regards to the quality of water that is to be used for specific purposes. For example, in order for water to be used for public park irrigation, residential landscape irrigation, agricultural irrigation, and industrial cooling towers, the water must reach a level of disinfection that is nearing that of potable water. By using recycled water, the demand on potable water is lessened, which is crucial given the recent state of drought in California.

In 2007, Regional San completed the Water Recycling Opportunities Study (WROS). This study took a county-wide look at a variety of potential recycled water projects. The WROS concluded that water recycling projects near the vicinity of the SRWTP were the most promising projects for implementation, since they were the closest to a recycled water supply from the WRF. The City of Sacramento, in collaboration with Regional San and other stakeholders, initiated the process of updating its Water Supply Master Plan (WSMP) in 2009. The feasibility of using recycled water within the City's service area was evaluated and it was found that the most promising recycled water opportunities were located in the southwest portion of Sacramento. In particular, the Sacramento Power Authority (SPA) Cogeneration Plant, located in unincorporated Sacramento County and currently using potable water to supply its cooling tower water needs (approximately 1 MGD), could be converted to recycled water without significant changes to its operation.

Regional San completed the SPA/City of Sacramento Recycled Water Feasibility Study in 2013, which concluded that a phased project should be initiated to first provide recycled water to the SPA Cogeneration Plant and then to expand service to other users in the area. This phased approach would allow for other non-potable uses, such as irrigation to parks, schools, and golf courses, as Regional San expanded its supply of recycled water.

While the feasibility of the SPA project was being studied, a new National Pollutant Discharge Elimination System (NPDES) permit was issued to Regional San by the state in December 2010. In order to maintain its discharge permit, Regional San would need to implement a greater degree of treatment for discharged wastewater. This level of treatment included increased ammonia and nitrate removal as well as enhanced filtration and disinfection. Importantly, this would allow virtually all the treatment plant's effluent to meet the requirements for Title 22 disinfected tertiary recycled water or equivalent effluent.

In order to meet the new 2010 permit requirements, Regional San has undertaken the largest public works project in the county's history. This project has been named the EchoWater Project. The EchoWater Project will provide ammonia and nitrate removal, filtration, and enhanced disinfection treatment required to meet the standards for tertiary recycled water. The EchoWater Project is estimated to cost between \$1.5 and \$2.1 billion overall and must be completed by 2023. The new treatment processes are expected to provide up to a 95 percent reduction in the ammonia discharge of treated water. Regional San was approved to receive approximately \$1.6 billion in financing through the

California State Clean Water State Revolving Fund. This low-interest financing will save rate-payers nearly half a billion dollars in interest while the project itself negates the need to expand the WRF to provide the recycled water capacity for the Sacramento Power Authority Cogeneration Recycled Water Project (SPA Project).

Prior to the SPA Project, the WRF produced 2.2 MGD of recycled water seasonally for landscape irrigation in the Elk Grove area, south of the SRWTP. The WRF was ultimately designed to be expanded to a 10 MGD facility.

3. PROJECT DESIGN

The SPA Project was divided into two phases. The initial phase (subdivided to Phases 1A and 1B) provides a recycled water transmission line from the SRWTP to the SPA Cogeneration Plant (see Figure 2 for Phase 1A). The pipe itself is sized to convey up to 4.2 MGD for possible future expansion, as well as local irrigation use. Phase 2 will supply irrigation water to parks, schools, and golf courses near the Phase 1 alignment. The recycled water supply for Phase 2 will be available once the EchoWater Project is complete in 2023.

As a service to the City, and at its request, the Phase 1 pipeline will also include stub outs for recycled water fill stations. These can be used by residents and commercial users to obtain recycled water to irrigate their property or for other allowed uses. These additional uses from the fill stations will not markedly increase the overall draw on the recycled water supply, benefitting all at a near negligible cost. The sum of these uses will also assist the region in meeting water recycling goals set from a local level all the way up to a federal level.

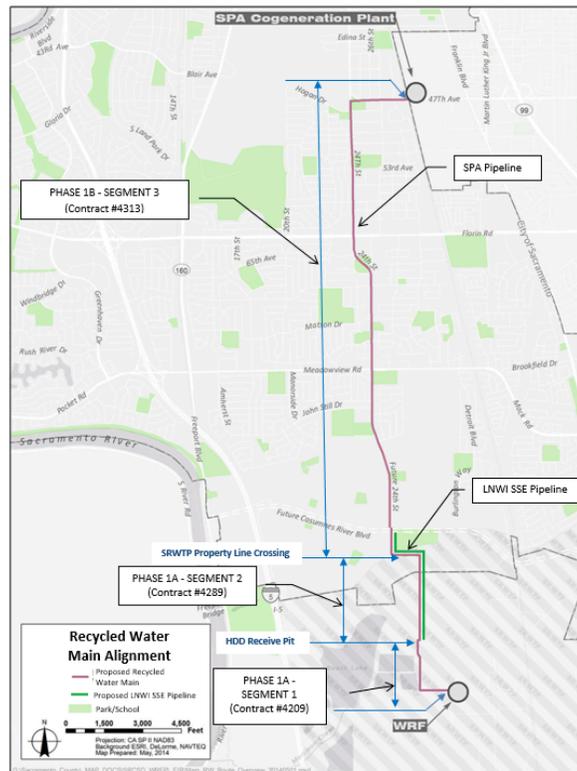


Figure 2. Vicinity map for SPA Project Phase 1 and SSE Pipeline.

At the beginning of design, Phase 1 was estimated to cost \$15.2 million. Funding was provided by a number of grants through California Propositions 1, 50, and 84, totaling approximately \$8 million. An additional \$8 million low-interest loan was awarded through the State Revolving Fund Loan Program. The

pipeline was designed to be 6 miles long and involved a levee crossing, a future street expansion, and an alignment along 24th Street and 47th Avenue to the Cogeneration Plant. The alignment crosses an existing urbanized area and a new mixed-use development for residential, commercial, and industrial customers called Delta Shores. The design had to coordinate with the future extension of 24th Street and take future utilities in Delta Shores into account, altering the depth required for pipe installation.

The Phase 1 design and construction was further split into three pipeline segments in order to maximize funding opportunities and minimize local impacts while also taking advantage of available land use rights (see Figure 2). Phase 1A includes two segments on land that is owned by the Regional San, so once permitting was completed, work could begin. Phase 1B, the third segment, is designed to be constructed on publicly and privately owned land through the City of Sacramento. The alignment crosses two private properties, which required the acceptance of easements on the land.

Regional San issued a request for proposals in 2013 and selected MWH, now part of Stantec, to design the SPA Project. In total, the project consisted of 5,690-feet of pipe for both the SPA recycled water transmission main and the EchoWater's Nitrified Sidestream Effluent (SSE) pipeline. The SSE pipe's purpose is to connect a pipeline, set to be installed at a later portion of the project, to the Lower Northwest Interceptor sewer force mains in order to carry nitrate rich effluent water into the sewer collection system. This effluent provides odor control while the sewer flows to the SRWTP. The pipeline was to run parallel to the SPA Project, which provided significant opportunity for savings by constructing both at the same time.

During the design process, a few concerns arose about the project's alignment as it would be crossing utilities that already existed as well as through areas that were actively under construction for the EchoWater Project. Regional San and MWH worked diligently to ensure that all aspects of both the projects would remain stable during both installation and operation of the pipelines.

In order to coordinate better with the EchoWater Project, the first segment (which overlapped the EchoWater Project's Site Prep Project construction area) was handed over in 2014 to the Site Prep Project designer, Kennedy-Jenks, and contractor, Overaa Construction.

Among the most important aspects of the project for Regional San was to commit to its core value of environmental stewardship in the area. Regional San maintains an environmental stewardship statement which is one of the defining aspects of its business. It was paramount to Regional San that the local, sensitive habitats, such as those of the Burrowing Owls and Swainson's Hawks (see Figure 3) remain as untouched as possible.



Figure 3. (left) Burrowing Owl (Brian E. Small); (right) Swainson's Hawk (Jack Binch, 2009)

It became apparent that splitting the project into two separate installation methods was really less of a choice and more of a necessity. The United States Army Corps of Engineers (Corps) maintains a 200-year levee protection area around the SRWTP that which could not be breached, effectively eliminating

the option of open cut installation from the area. Trying to use an open cut method through the creeks and wildlife sanctuary would have required significantly more permitting, which would have delayed the contract by two years and increased costs by a large margin.

A trenchless method would be best for crossing the environmentally sensitive areas. Horizontal Directional Drilling (HDD) was chosen as the best option for the project because it allowed an installation depth that would pose no harm to the ground level plant life, would not disrupt the creek beds, and would not conflict with existing utilities and ongoing EchoWater construction. It was to be used to cross below Morrison Creek, two levees, wetlands, and the EchoWater project's Flow Equalization basins that were already under construction.

In order to cross below the levee, the installation had to begin a minimum of 300 feet away from the edge of the levee and cross at least 30 feet below it. During the design process, it was discovered that the new EchoWater Project's flow equalization basins were going to be de-watered and excavated to a deeper level in the same time frame that the pipeline was due to be installed. Though it presented a challenge at that time, it ultimately resulted in a positive change because it meant the depth of the pipelines would be well below what was required for crossing below the creeks and levee.

Overall, ground conditions were favorable, mostly consisting of soil with sands and silts. There had been some gravels identified in the geotechnical work, but it was the clay layers that raised the most concerns. The HDD contractors were worried about the efficiency of slurry separation and bentonite reclamation after similar projects involving HDD recorded a higher volume of off-haul than anticipated due to separation challenges with the bentonite slurry.

The existing levee toe relief wells posed another problem in the alignment. There are between 30 and 50 wells in operation north of the north Morrison Creek levee, operated by the Sacramento City Department of Utilities. In order to ensure that the pipe passing between two of the wells had caused no damage to the wells, Regional San agreed to pay for the cleaning and pump testing of the wells both before and after the HDD installation process. The utility department agreed and received two free well cleanings. The Sacramento Area Flood Control Agency's (SAFCA) levee relief wells were not affected by the HDD installation of the two pipelines.

In areas that were not particularly sensitive, such as farm-land and other land that was regularly disturbed, open cut was chosen as the best option. It was more cost effective, and in one area, there was already an open trench for another portion of the project so less work was required. A portion of the open cut did run through an area that had been leased by the Regional San to a farmer, but due to the dryness of the season, that tract of land was not to be in use during construction. The contractor was directed to stockpile the topsoil and return it to the area to ensure that the farmer would be able to use the field again.

At the beginning of the design process, the project was designed around the use of high density polyethylene (HDPE) and ductile iron pipe because that was what had traditionally been used by Regional San. Once the project had been advertised, however, a potential bidder submitted a request for information, requesting that fusible polyvinylchloride pipe (FPVCP) be allowed as an alternate.

Regional San contacted agencies who had completed similar projects using FPVCP to study whether it was a viable option. After hearing from a number of different agencies that they had had good experiences with the material, it was decided to allow an FPVCP option into the bid in Amendment 2. This also alleviated some concern held by Regional San about the ability of the HDPE pipe to successfully complete the longer crossings based on the maximum pull strength of the material.

With the option to use FPVCP available on six separate bid items, all bidding contractors chose to bid with the FPVCP option over HDPE or ductile iron, as it provided the greatest cost efficiency overall. Though the material itself may be slightly more expensive, the smaller outer diameter of the pipe for a comparable inner diameter (see Figure 4) meant that smaller boreholes would be required, which lowered equipment, material, and labor costs.

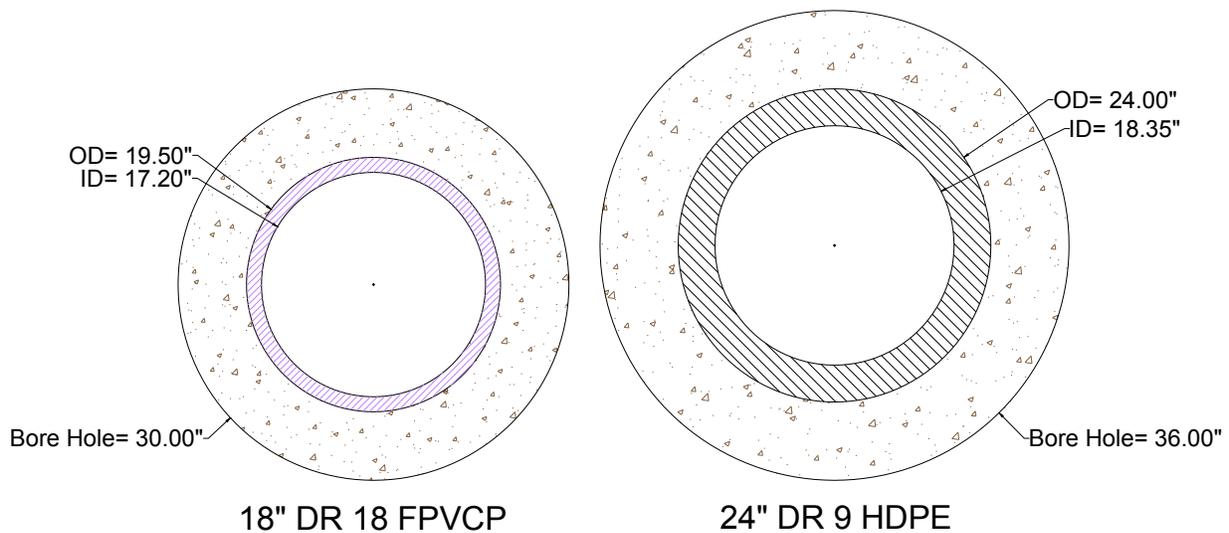


Figure 4. Size comparison of 18-inch DR18 FPVC and 24-inch DR9 HDPE

The cost of Phase 1A at the end of design was estimated by the engineer to be approximately \$3 million.

4. PERMITTING

In order to begin construction, Regional San needed to work through a large amount of permitting from a number of different agencies. Once it was determined that the project would cross below the levee, the Army Corps of Engineers (Corps) had to be contacted. The Corps is the responsible agency for levees passing through populated areas (see Figure 5), though the levees themselves may be owned by the city or county, and as such has final approval on any alterations. Due to the depth of the drill passing below the levee, the Corps found no issue with the project and approved construction in the area.

As another regulatory body that deals with the levees of the region, the Central Valley Flood Protection Board (CVFPB) also approved construction. The CVFPB is responsible for making sure that the flood control system of California's Central Valley is protected through the enforcement of standards. They issue the encroachment permits needed to begin construction and work with other agencies to continuously improve the Central Valley's flood management system.

The Sacramento Area Flood Control Agency (SAFCA) was also involved in approving the construction project. Due to Sacramento's delicate position at the meeting of two major rivers, there is the potential for catastrophic flooding throughout the city. SAFCA's purpose is to increase flood protection along both the American and Sacramento Rivers. Their involvement with the project was limited to approving the installation's alignment to ensure that it would not cause additional flood risks to the surrounding areas.

Another benefit of the use of HDD in construction projects is how much permitting can be avoided under the right conditions. The California Department of Fish and Wildlife was able to write a letter of no interference for the project because the proposed drill would pass far enough below the wetlands to cause no alterations to the creek floors.

5. BIDDING & CONSTRUCTION

At the time of bidding, Garney Construction (Garney) was determined to be the lowest responsible bidder on the project. They would function as the general contractor for the overall project. In order to complete the HDD portion of the project, Garney chose to bring in The HDD Company. The HDD Company in turn

subcontracted the drilling of the smaller SSE line to J-C General Engineering (J-C). The general contractor was not involved in the majority of the work completed on site during the HDD portion of the project's execution. Instead, each driller was responsible for their own bores; The HDD Company for the 18-inch line and J-C for the 10-inch.

Both HDD drills were completed within the same time frame. At the start, two rigs were used. The HDD Company used a "Rig 3" 900 k-lb drill rig to install the larger 18-inch pipe while J-C General Engineering used an "American Augers" 200 k-lb drill rig for the 10-inch pipe. J-C General Engineering had the misfortune of intersecting the first local area of cobble discovered by drill, geotechnical report, or survey in 50 years. They were alerted to the problem when, while drilling, they lost 100 gallons of drilling fluid. There were no detrimental effects to the surrounding area or the equipment; the fluid seeped into the space between the cobbles. In an effort to reduce the downhole fluid pressures generated by the drill, another rig, an "American Augers" 60 k-lb drill rig was set up at the north side of the drill to meet in the middle. This allowed the drill mud to better circulate, reducing the threat of a frac-out.

One additional issue arose during the drilling of the SPA line; there was a small frac-out that took place 100-feet to the side of the drill alignment while in the farmer's field. Upon inspection, it was discovered that there was a vein of gravel running into the drill hole that allowed the drilling fluid to escape. There were no resulting issues from this occurrence. Most of the mud was vacuumed up at no detriment to the project or farm.



Figure 5. Aerial view of pipe string courtesy of John Coughran, owner of J-C General Engineering.

Each of the drilled portions of the project were 3,220-feet long. The SPA recycled water line consisted of a single pull back of 18-inch FPVCP and the EchoWater SSE Project pipeline consisted of a single pull of 10-inch FPVC. Both lines were installed using a pull head of comparable size to the pipe itself. Pull back for the SPA line was completed in approximately 14 hours while the SSE line only took about 8 hours.

The open cut portions of the project went equally as smoothly. Both lines consisted of 2,470 feet of pipe, the same diameter sizes as the drilled portions (see Figure 6). Once both lines had been installed, the trenches were filled and the remaining aggregate soil was left on site for the farmer to till into his fields.

Also near the open cut area of the project was an access road that is used by many different utilities in the area, such as gas lines, county streams and creek maintenance, raw water maintenance, and levee maintenance. A fair amount of coordination amongst the utilities had to take place to ensure that all

parties had appropriate access to their holdings when needed, without disrupting the progress of the project.

There was a hard deadline set for the drillers to have their installations completed and to have vacated the premises by February 26, 2016 in order to clear the way for additional work on the EchoWater Project. The 10-inch SSE line was pulled into place on December 22, 2015 with the 18-inch line following on the 29th (see Figure 6). Since the open cut installation went equally as smoothly, the lines were quickly connected. Final pressure testing on both lines was completed on February 12, 2016.



Fig 6. (left) Prepping the 10-inch SSE line for installation. (right) 18-inch SPA ling enters insertion pit.

6. CONCLUSION

Due to the efficiency of the drillers and contractor, the Phase 1A project was completed well ahead of schedule. In addition, only one change order was needed for the entire project; when J-C General Engineering located the buried cobble, it set their schedule back one day which was deemed acceptable because of the unforeseen condition of the geology discovered. The project was bid under the engineer's estimate and finished only \$3,000 over the bid budget, keeping both the anticipated and executed budget at the \$2.9 million mark. With the completion of pressure testing, the project was executed well, finished early, and finished under budget. The result was much appreciated by Regional San. In total, the final costs of Phase 1A came to \$3,195,762, which was approximately \$100,000 under budget.

7. REFERENCES

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