Managing the deluge

The Trinity River Authority builds a flexible peak flow storage system with robust and repurposed preliminary treatment

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When confronted with increasing peaking factors and excessive wet weather flows, many utilities are faced with the decision of whether to expand existing water resource recovery facilities or build high-rate, blended-flow facilities specific to wet weather treatment to provide storage for wet weather flow management or both. The Trinity River Authority (TRA; Arlington, Texas) selected a treatment and storage approach to wet weather management. This option made it possible to uprate the facility’s daily average capacity, provide cost savings over conventional expansion and blended flow treatment methods, and increase flexibility in wet weather flow operations.

As part of this program, TRA has constructed a 605,700-m³ (160-million gal), concrete-lined storage basin with preliminary treatment and multiple diversion and return capabilities to store flows in excess of what can be hydraulically processed through the facility. As peak flows subside, the stored flows can be returned to several points in the process for treatment. Combined, all the components of the peak flow management system are termed the On-Site Storage System (OSSS) and provide TRA with a robust and flexible facility to manage not only the peak wet weather flows but also to provide diversion capabilities during emergencies and shutdowns. Figure 1 (p. 29) shows a schematic of how the OSSS interconnects with the Central Regional Wastewater System (CRWS) Wastewater Treatment Plant.

Evolution of the TRA system

The CRWS water resource recovery facility is the largest of TRA’s wastewater facilities. The CRWS facility has been serving the Dallas–Fort Worth metropolitan area since 1959 and currently is permitted to treat up to 613,200 m³/d (162 mgd) on an average.
daily basis. The CRWS facility consists of preliminary, primary, and secondary treatment, effluent filtration and chlorine disinfection, solids handling, and odor control facilities.

In May 2005, TRA finalized its Phase IV Expansion Master Plan that outlined improvements needed to increase processing capacity to 715,500 m$^3$/d (189 mgd) average daily flow (2.36 million m$^3$/d [623 mgd] 2-h peak flow).

The improvements were required to keep up with the rapidly growing service population and increases in wet weather flows. TRA also recently had implemented the Texas Commission on Environmental Quality sanitary sewer overflow (SSO) program and committed to minimizing SSOS.

TRA chose high-rate clarification (HRC) treatment of the peak wet weather flows. HRC-treated wet weather flows then would bypass secondary treatment and be blended with base flow through the facility prior to disinfection and discharge. The discharge permit requirements of the combined flow would be intended to be met at all times.

This blending strategy not only was gaining popularity at the time, but also was significantly less expensive than constructing conventional primary and secondary treatment facilities to handle peak flows. After Phase IV recommendations were made, U.S. Environmental Protection Agency Region 6 withheld the internal bypass permit until TRA could engage each of its member cities in new capacity, management, operations, and maintenance requirements.

To avoid time delays with permitting, TRA commissioned a Phase IV Expansion Master Plan Bridge Document. Finalized in September 2006, the bridge document recommended HRC treatment with off-line storage in lieu of HRC treatment and blending.

On-site storage became a more viable option when it was identified that a potential location existed on the current treatment facility site. The table below shows the cost comparisons among the various options.

Ultimately, the concept of peak flow storage would not only allow the authority to move forward in the uncertain regulatory environment, but also would prove cost-effective, when compared to other alternatives.

### Projected costs of the Phase IV expansion peak flow management options

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Cost (2010 U.S. dollars)</th>
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<tbody>
<tr>
<td>High-rate clarification with conventional expansion</td>
<td>$98,414,000</td>
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<tr>
<td>High-rate clarification with blending</td>
<td>$55,082,000</td>
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<tr>
<td>On-Site Storage System</td>
<td>$42,820,910*</td>
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* Actual project cost through October 2013.

**Providing flexibility**

Constructing the OSSS inside the facility boundary presented TRA with an economical opportunity to provide multiple wastewater diversion capabilities from various points along the treatment process. The current OSSS is capable of diverting the following flows for storage at the on-site storage basin:

- Influent wastewater (up to 185,500 m$^3$/d [49 million gal]) can be transferred by gravity directly from the interceptor system at a maximum rate of 832,800 m$^3$/d (220 mgd).
- Screened and degritted preliminary effluent can be diverted at a maximum rate of 832,800 m$^3$/d (220 mgd).
- Primary effluent can be diverted at a maximum rate of 832,800 m$^3$/d (220 mgd).
- Secondary clarifier effluent can be diverted at a maximum rate of 567,800 m$^3$/d (150 mgd).

Diversion of influent wastewater was made possible by constructing 670 linear m (2200 linear ft) of 2400-mm (96-in.), fiberglass reinforced plastic (FRP) pipe inside a 2850-mm (114-in.) tunnel as deep as 12 m (40 ft) underground and adjacent to existing treatment facilities and the onsite landfill. The FRP pipe was connected to the existing 2800-mm (110-in.) West Fork Interceptor – which is the largest diameter in the CRWS collection system – followed by isolation and screening structures prior to surfacing in the east basin of the OSSS.

Diversion of the preliminary, primary, and secondary effluent flows was accomplished by constructing a parallel 1830-mm (72-in.) FRP pipe from individual process connection points to the east basin of the
To avoid the possibility of secondary effluent contamination, an air gap structure with double isolation was constructed in the secondary effluent channel.

The project included building an onsite storage pump station. The purpose of this pump station is to lift flows into the basin from the influent interceptor once the gravity diversion capacity is diminished due to filling of the basin and the reduced driving hydraulic head. Additionally, this pump station is designed to dewater the basin once the peak flow event subsides.

Stored flows from the basin can be returned either to the preliminary treatment area for grit removal or directly to the aeration basins, bypassing the preliminary and primary treatment. At 2240-kW (300-hp) each, the triplex submersible pump station is sized nominally at 189,300 m³/d (50 mgd). However, depending on sump water surface elevation and discharge location, the pump station is capable of pumping flows that range between 30,300 and 303,000 m³/d (8 and 80 mgd).

Minimizing solids

To protect the pumps, minimize odors, and reduce cleaning efforts following peak flow storage event, the OSSS is designed with a system of robust preliminary treatment components. The OSSS junction box 15 (JB-15) diverts peak flows from the collection system to a 2400-mm (96-in.) line that fills the basin. As shown in Figure 2 (p. 32), JB-15 encapsulates a 6-m (20-ft) segment of the existing 2800-mm (110-in.) West Fork Interceptor where a 5.5-m (18-ft) long side weir was cut at the centerline of pipe. The side weir accommodates routing of flow to the OSSS, but retains the invert of the pipe to channel grit and other heavy materials toward the facility’s headworks.

During the onset of a peak flow event, the first flush of suspended grit and rags will be conveyed to the headworks; only solids that are carried above the centerline of the interceptor pipe
will be diverted to on-site storage basin (OSSB).

Downstream of this junction box, the isolation and coarse screening structure was constructed within the interior of the facility levee. The fabricated 316 stainless steel gate ensures that flow normally is directed toward the headworks until TRA operators elect to engage the OSSS. For bulky debris that enters the OSSS, the isolation structure is equipped with a coarse screen to offer protection for the fine screens and pumps downstream. The coarse screen consists of a 316 stainless steel bar field with 63.5-mm (2.5-in.) bar spacing and a hydraulic-powered gripper rake that conveys screenings to a container via an overhead monorail. Further downstream, toward the OSSB, lies the fine screening structure and pump station. The fine screening structure consists of an influent channel, which can direct flow to one of three channels. Two outside channels are equipped with continuous belt element fine screens that have 6.4-mm (0.25-in.) spacing. TRA seized the opportunity to save costs and capitalize on existing resources by rehabilitating and repurposing these two existing screens from another application within the facility. The third channel in the fine screening structure allows an overflow diversion of unscreened flow into the basin in the event of an equipment malfunction.

The collected screenings are conditioned with two washer/compactor units, which also were rehabilitated and repurposed. The washer/compactor units discharge into a covered shaftless screw conveyor that subsequently discharges the washed and pressed screenings into a self-contained waste compactor and container unit. The pump station adjacent to the screening structure serves as a junction box during the gravity fill phase of operation of the system.

Operating in series, the combination of the influent diversion...
and treatment structures is anticipated to minimize significantly the amount of solids that will be diverted to the OSSB for storage during peak wet weather events.

**Reducing cleaning efforts**

Even with robust preliminary treatment systems, the OSSB will act similarly to a settling tank with a long detention time. Large amounts of sediment are expected to accumulate on the basin floor following basin dewatering. To minimize basin cleaning needs, several features were implemented into the design and construction of the basin.

One of the main features of the OSSB is that it was designed and constructed with two sides separated by a 6-m (20-ft) tall partition wall. The east basin is approximately 5.5 m (18 ft) deeper than the west basin to enable gravity diversion of wastewater flows directly from the

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*Five strategically located 1500-mm x 1800-mm (60-in. x 72-in.) butterfly valves are positioned along the partition wall to enable the automated opening and closing cycles needed to let the water pass from the upper west basin to the lower east basin and scour the settled solids toward the pump station.*

Freese and Nichols Inc.
interceptor. Due to this configuration, cleaner secondary effluent can be diverted and stored in the upper west basin following a storm. Using these clean flows, the elevation difference, and five strategically located butterfly valves on the partition wall, TRA can wash down solids from the floor of the west basin toward the pump station after emptying the basin. The transition between the west and the east basin provides a sloped surface that allows the flow coming out from the west basin to spread while maintaining scouring velocities. The intent of this design is to push as many solids into or as close to the pump station as possible to minimize manual floor cleaning over the 18,600-m² (200,000-ft²) area of the basin bottom.

In addition to the floor scouring design, a provision was made to wash down the concrete side slopes of the basin. To accommodate this, a 203-mm (8-in.) effluent diameter, high-pressure reclaimed water (chlorinated-treated) loop was installed around the basin and connected to the facility’s water system. Connected to the loop are 18 high-powered, articulating water cannons. Each cannon can rotate 360 degrees and pivot 180 degrees up from vertical. The cannons are positioned to provide complete coverage of the basin side slope around the perimeter.

Successful storage
When utilities are faced with a challenge of managing peak wet weather flows, offline storage can prove to be an economical alternative to treatment or blending options. Depending on the site availability, it is possible to lay out a peak flow storage system to provide multiple diversion options and cleaning capabilities. Along with these features, the peak flow storage system can provide additional backup during facility emergencies and shutdowns, provide preliminary treatment of stored flows, and minimize the cleaning efforts after system use.

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