

## Ultraviolet Disinfection System Replacement



### Project Purpose:

The purpose of this project is to provide a replacement for the current effluent ultraviolet disinfection system.

### Project History and Status:

The present ultraviolet disinfection system (UV System) is the second system installed at the Nine Springs Wastewater Treatment Plant. The District installed the system in the mid-1990s as part of the Plant's Ninth Addition. While the system has worked well to disinfect the wastewater, it has required substantial attention to address ongoing electrical system problems and keep the system operational. Most of the repairs are handled during the offseason (October 16 – April 14) when disinfection is not required. System repairs include ballasts, control boards, lamps, and lamp racks. Although original parts are no longer made, the District has been able to obtain parts through a third party vendor and a local engineer who makes control boards for the system.

The UV System also experiences disinfection and hydraulic limitations. Each of the ten lamp banks is designed for 10 MGD of flow. The Plant has experienced hourly flow rates of up to 145 MGD. With the start-up of Pumping Station 18, the potential exists for the collection system to pump at even higher flow rates to the Plant. Higher flow rates could result in flooding of the UV units and subsequent damage to electrical components of the system. Power loss to the effluent pumps provides an additional hydraulic consideration at the Effluent Building. Surges created by loss of the effluent pumps can exert a significant uplift force on the top of the well between the UV units and the effluent pumps. The electrical gear for the pumps is located on the top of this well.

### Alternatives:

The following alternatives were evaluated in detail in the 2016 Liquid Processing Facilities Plan:

#### Alternative D0–Maintain Existing F&P UV System (Null Alternative)

This alternative would maintain the existing UV disinfection system without expanding the system or replacing equipment. Since the equipment is no longer manufactured, parts must be

obtained through a third-party vendor. In addition, the control boards are currently supplied by third-party vendors. The ability to maintain a reliable supply of replacement parts and control boards may be limited in the future. This alternative also does not include expanding the system capacity beyond 100 mgd.

The existing system is operating at or beyond the normal useful service life of UV technology. It is recommended to replace or significantly refurbish the UV system within the next 10 years to avoid a catastrophic system failure, as well as to safeguard against reliance on third-party vendors selling replacement parts for systems that are no longer manufactured. The collective market demand for such parts will reduce over time as the F&P systems installed in the 1990s are taken out of service, and at some point availability of parts will become critical. Therefore, it is assumed that the system will need to be replaced and/or refurbished within 10 years to avoid a significant risk with respect to parts availability and system failure.

#### Alternative D1–UV Disinfection (Trojan Technologies)

This alternative would replace the existing UV system with the Trojan Technologies Signa UV system. Trojan Technologies' design for the 100-mgd system would require three channels with three UV banks per channel. The lamps for this system are 1,000-watt lamps provided only by Trojan Technologies or its equipment representatives. Trojan offers a 15,000-hour prorated warranty on each lamp. The lamps are 100 percent replaced up to 9,000 hours; the warranty is prorated from 9,000 to 15,000 hours.

The Signa UV system will require the channel bottoms to be lowered by approximately 14 inches because of the longer bulbs and taller overall height of the equipment. Raising the channel walls to provide the additional 14 inches of depth would not be feasible because of the upstream hydraulic control requirements. In addition to the equipment and structural costs to lower the channels, additional costs include new aluminum checker plate to cover the channels.

#### Alternative D2–UV Disinfection (WEDECO-Xylem)

This alternative would replace the existing UV system with the Duron UV system manufactured by WEDECO-Xylem. WEDECO-Xylem's design for the 100 mgd system would require five channels with three UV banks per channel. The lamps for this system are 600-watt lamps provided by WEDECO and other equipment vendors. WEDECO offers a 14,000 hour prorated warranty on each lamp. The lamps are 100 percent replaced up to 9,000 hours; the warranty is prorated from 9,000 to 14,000 hours.

The Duron banks will fit in the existing channels and only require the channels to be narrowed by approximately 2.25 inches. In addition to the equipment costs, additional costs include new aluminum checker plate to cover the channels and the cost to grout the channel walls.

Alternative D7–Refurbish Existing UV System (IronbrookUV)

This alternative includes refurbishing the existing UV system with similar equipment provided by IronbrookUV. The refurbishment would include replacing control boards, ballasts, breakers, transformer, cables, UV intensity monitors, lamps and sleeves, among other items. The lamp racks would also be refurbished. Several F&P systems have been similarly refurbished by IronbrookUV in recent years, including the systems installed at the Glenbard Wastewater Authority in Illinois (16 mgd average, 47 mgd peak) and the San Bernardino facility in California (33 mgd peak capacity). This alternative does not include expanding the system beyond the existing five channels, although expanding into the two empty channels would bring total system capacity up to approximately 140 mgd.

Costs for equipment upgrades were provided by IronbrookUV and include removal and installation. In addition to the equipment costs, the opinion of probable cost for this alternative also includes replacement of the existing flow control gates with new downward opening weir gates. Confirmation of this style of level control for a refurbished horizontal UV system is pending at this time. If new weir gates are not sufficient for level control, then new weighted effluent gates would be included.

**Key Risks and Issues**

The key social, environmental, and other nonmonetary considerations of each alternative are summarized in Table 1.

**Table 1 - Disinfection Alternative Nonmonetary Considerations Summary**

Alternative	Benefits	Limitations
D0—Maintain Existing F&P UV System (Null Alternative)	<ul style="list-style-type: none"> <li>▪ District staff is familiar with system and equipment.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Since this original equipment is no longer manufactured, replacement parts must be obtained through third-party vendors.</li> <li>▪ Replacement control boards must be obtained from third-party vendors.</li> <li>▪ The system is more than 20 years old now and is operating at or beyond its anticipated useful service life. This system will likely require more maintenance and attention over time than a new system would require.</li> <li>▪ Future availability of replacement parts may be diminished as other F&amp;P installations are replaced. This is a critical consideration and could result in a loss of parts availability over a relatively short period of time, especially if IronbrookUV would cease operations.</li> <li>▪ Because of the number of lamps and associated head loss, capacity beyond 140 mgd is not possible without changing the system hydraulics and layout.</li> <li>▪ Existing flow control gates do not operate properly at high flows because of high water level in the downstream UV effluent channel.</li> <li>▪ Level control in the UV channels is more critical with horizontal UV lamps, which likely requires the continued use of the weighted level control gates. Continued evaluation of downward opening weir gates should be considered when this system is replaced.</li> </ul>
D1—UV Disinfection (Trojan Technologies)	<ul style="list-style-type: none"> <li>▪ Proven technology developed by a world leader in UV system technology.</li> <li>▪ Fewest number of lamps of all alternatives.</li> <li>▪ Fewest number of channels required (3), which would allow the system to be expanded easily to 180 mgd.</li> <li>▪ System includes both mechanical and chemical cleaning.</li> <li>▪ Most installations greater than 50 mgd of the short-listed alternatives.</li> <li>▪ Angled bulb arrangement requires less stringent flow control and provides the ability to replace the weighted gates with downward opening weir gates for level control.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Requires channels to be lowered to accommodate the equipment.</li> <li>▪ Utilizes 1,000-watt bulbs that must be purchased from Trojan currently; this could change in the future if 1,000-watt bulbs become more common. Guaranteed lamp pricing would need to be established.</li> <li>▪ Utilizes hydraulic system for sleeve cleaning that adds complexity and potential maintenance issues to system.</li> </ul>
D2—UV Disinfection (WEDECO-Xylem)	<ul style="list-style-type: none"> <li>▪ Proven technology developed by a world leader in UV system technology.</li> <li>▪ Does not require channels to be lowered; simpler retrofit than Alternative D1.</li> <li>▪ System includes mechanical cleaning.</li> <li>▪ Angled bulb arrangement requires less stringent flow control and provides the ability to replace the weighted gates with downward opening weir gates for level control.</li> </ul>	<ul style="list-style-type: none"> <li>▪ None identified.</li> </ul>
D7—Refurbish Existing UV System (IronbrookUV)	<ul style="list-style-type: none"> <li>▪ District staff is familiar with system and equipment.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Future availability of replacement parts may be diminished as other F&amp;P installations are replaced. This is a critical consideration and could result in a loss of parts availability over a relatively short period of time, especially if IronbrookUV would cease operations.</li> <li>▪ Because of the number of lamps and associated head loss, capacity beyond 140 mgd is not possible without changing the system hydraulics and layout.</li> <li>▪ Older UV technology.</li> <li>▪ Minimal energy savings are anticipated.</li> <li>▪ Existing flow control gates do not operate properly at high flows because of high water level in the downstream UV effluent channel.</li> <li>▪ Level control in the UV channels is more critical with horizontal UV lamps, which likely requires the continued use of the weighted level control gates. Evaluation of downward opening weir gates or new weighted gates could be considered if this alternative is selected. Capital costs include replacement of the existing weighted gates.</li> </ul>

**Economic Analysis**

The present worth analysis completed for the Liquid Processing Facilities Plan is presented below.

	<b>Alternative D0 Existing F&amp;P</b>	<b>Alternative D1 Trojan</b>	<b>Alternative D2 WEDECO</b>	<b>Alternative D7 IronbrookUV</b>
Total Opinion of Capital Cost	\$0	\$3,593,000	\$3,797,000	\$2,153,000
Annual O&M	\$70,000- 106,000 <sup>1</sup>	\$52,000	\$55,000	\$70,000
Present Worth				
O&M	\$1,207,000	\$684,000	\$723,000	\$920,000
Replacement	\$1,403,000 <sup>2</sup>	\$0	\$0	\$0
Salvage	(\$276,000) <sup>3</sup>			
<b>Total Opinion of Present Worth</b>	<b>\$2,334,000</b>	<b>\$4,277,000</b>	<b>\$4,520,000</b>	<b>\$3,073,000</b>

<sup>1</sup> \$70,000/year is for years 11–20; \$106,000 is for years 1–10.

<sup>2</sup> Capital cost for Alt. D7 assumed in year 10, brought back to the present.

<sup>3</sup> Salvage costs assume 50 percent of system life remaining at year 20, which is 10 years after replacement.

**Project Recommendation**

The recommended alternative for long-term disinfection at the NSWWTP is Alternative D1 or D2, which include a new UV system using the latest in UV disinfection technology. While these alternatives have a higher present worth than Alternatives D0 and D7, the newer technology offers many advantages as described below.

- These systems provide improved electrical efficiency.
- These systems provide improved maintainability.
- These alternatives provide lower risk associated with the older UV technology not being supported throughout the useful service life of the equipment.
- As with any item that is improved over time, having the most recent technology may allow it to be upgraded more readily as the systems continue to improve.

**Project Schedule:**

	Start Date	Completion Date
Planning	2016	2017
Design	2018	2019
Construction	2020	2021

**Financial Summary (2019\$):**

<b>Total Project Cost</b>	
District Staff & Engineering	\$666,000
Contractor	\$3,364,000
<b>Total</b>	<b>\$4,030,000</b>

**Fiscal Year Allocation (2019\$):**

	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>
Engineering	\$7,000	\$186,000	\$160,000	\$156,000	\$157,000
Construction	\$0	\$0	\$0	\$1,682,000	\$1,682,000
<b>Total</b>	<b>\$7,000</b>	<b>\$186,000</b>	<b>\$160,000</b>	<b>\$1,838,000</b>	<b>\$1,839,000</b>