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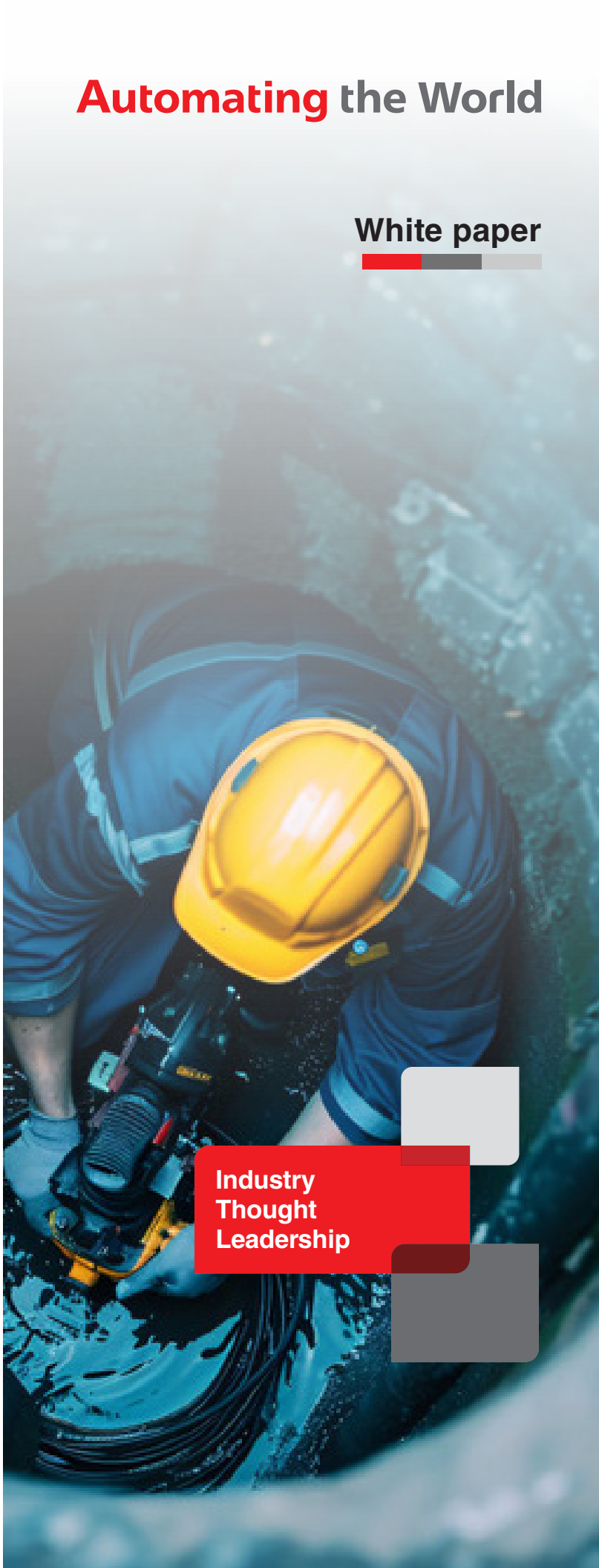
FACTORY AUTOMATION

Automating the World

White paper

How to enable operational, labor, and energy efficiency in wastewater lift stations



Abstract

This guide outlines the many challenges in wastewater treatment, specifically regarding lift stations. The guide cites compelling reasons why wastewater lift station control panels should be upgraded to include variable frequency drives (VFDs) in retrofit projects. It also defines an end-to-end control panel modernization solution for expanding or building new lift stations and provides the operational, labor and energy benefits of doing so. Two midsize municipality case studies provide proof points. Finally, the guide provides reasons for working with Mitsubishi Electric Automation on your next wastewater lift station project.

Contents

About the author:
Ben Strong, Product Marketing Manager, Mitsubishi Electric Automation, has spent the last 20 years helping customers improve their processes and machines with automation. He has a wide range of experience across multiple industries with a focus on making things move.

Wastewater Treatment Lift Stations are in Dire Need of Modernization

Wastewater lift stations move wastewater from a lower to a higher elevation. Each lift station has at least two induction motors driving sewage pumps in a wet well. There are three types of lift station pumps: non-clog pumps, cutter pumps, and grinder pumps. Our focus in this guide is on the traditional non-clog pump variety in midsize municipalities. A large percentage of these wastewater treatment operations are dealing with several serious issues in their wastewater lift stations.

1. **Mechanical pump and control panel failures** increase the number of required maintenance visits. The American Society of Engineers (ASCE) reports that over 50% of the approximately two million lift and pump stations in the U.S. were constructed in the 1970's and early 80's. The average life of lift station control equipment is 20 years. In its latest Report Card for America's Infrastructure, ASCE gave the wastewater infrastructure a D+.
2. **High energy usage** due to inefficient pumps operating outside of their optimal range because of higher-than-expected community growth. Inefficient energy use increases costs and negatively impacts the environment. According to the Smart Energy Design Assistance Center (SMDAC), lift station operation represents as much as 30% of total wastewater energy consumption and presents great opportunities for energy savings. As the world strives to reduce carbon emissions, optimizing lift stations to reduce energy should be top of mind.

THE STATUS QUO FOR WASTEWATER LIFT STATIONS

- **Manual declogging of pumps**
- **Unplanned system downtime**
- **High labor and energy costs**
- **Premature equipment failures**

3. **Chronic pump clogging** caused by fats, oils, and grease (FOG), disposable wipes, and debris. Pump clogs don't necessarily prevent flow altogether, but commonly result in decreased output, longer pump runtimes, foul odors, and eventually sewage overflows. Declogging is commonly achieved by reversing the pump, which is a temporary fix that causes unnecessary wear and tear on pumps and shortens pump life.

4. **A lack of data,** which typically means pump issues are not detected until they are so severe that the pump can't keep up with demand. This can cause sanitary sewer overflows (SSOs). In its 2021 Report Card for America's Infrastructure, ASCE found that the average wastewater treatment plant functions at 81% of design capacity.
5. **Increased costs** due to high energy consumption, raw sewage cleanup, unplanned maintenance, and equipment replacements. The National Association of Clean Water Agencies (NACWA) says, "Flushable wipes (and other items) cause approximately $441M annually in additional operating costs at U.S. wastewater treatment plants. The average cost per plant per year is about $30,467."
6. **A reactive versus proactive maintenance posture**. Outdated control panels leave lift stations stuck in the status quo. The thought of changing from familiar technology is disconcerting for maintenance personnel. Operators need training and support to implement new technologies that reduces need for manual declogging of pumps.

DELOITTE RECOMMENDS:

- **Generating operational efficiencies to better use dwindling water, power, and labor resources**
- **Prioritizing investments to consider whole life costs versus just capital expenditure (CAPEX)**
- **Improving the quality and speed of decision-making throughout the organization**

There is a modern alternative to outdated pump controls that addresses all of these issues by proactively preventing clogged pumps, increasing performance, lowering labor and energy requirements/costs, extending system life, and reducing energy consumption.

Definitions of Key Terms

Below are the key terms used in this guide.

Check Valve – A unidirectional valve, which is opened by the fluid in one direction and which closes automatically to prevent flow in the reverse direction.

Dry Well – A dry compartment in a pumping station, near or below pumping level, where the pumps are located.

Lift Station – A system that includes pumps, tanks, appurtenant piping, valves, and other mechanical and electrical equipment for pumping water or wastewater (See Pumping Station).

Non-Clog – A pump designed to pass solids of a specific size. For example, a submersible pump with a 4-in. discharge may be capable of passing 3-in. spherical solids.

Peak Flow – Maximize flow.

Pumping Station – Discharges into a pressurized force main (see Lift Station).

Retrofit – The addition of new technology or features to older systems.

Sanitary Sewer Overflow (SSO) – When raw or partially treated sewage leaks or overflows from a sewer system before it can be treated.

Wastewater – The spent or used water of a community or industry, which contains dissolved and suspended matter.

Wet Well – A tank or pit, which receives drainage, stores it temporarily, and from which the discharge is pumped.

Retrofitting Lift Station Control Panels with Variable Frequency Drives (VFDs)

Today, clearing clogs is a time-consuming process. It involves disabling the problematic pump and opening the associated check valve to allow pressure from the alternate pump to create backwards flow through the pump. All of these starts and stops generate heat in the motor, which can reduce the life of the motor and other equipment. This manual process can be eliminated by retrofitting an existing pump station control panel with properly-sized VFDs that have built-in anti-clogging capabilities.

The Smart Energy Design Assistance Center (SEDAC) says, "VFDs can soft start motors, adjust speed to match flow, reduce motor wear, and smooth out pressure fluctuations in sewer piping." SEDAC recommends using VFDs for pumps that experience large changes in flow, because VFDs support adjustable speed.

> *"VFDs provide up to 30% overall reduction in energy consumption for significantly lower power bills."*
>
> *— U.S. Department of Energy*

Managing variable flows in lift stations significantly reduces energy consumption. VFDs with built-in anti-clogging ensures pumps run at peak flow, which reduces runtime. VFDs also reduce facility operating costs, improve motor service life and reduce service calls.

SUCCESS STORY

Conquer clogs automatically. A midsize U.S. municipality wastewater treatment plant put today's advanced VFDs to the test. It deployed VFDs with built-in anti-clogging technology in one lift station system, which serves a metropolitan area of about 150,000 people and treats 20 million gallons per day.

Previously, technicians had struggled with pumps getting clogged primarily with "flushable" wipes, shop towels, feminine hygiene products, and other unflushable items. Clearing clogs meant a technician had to open the pump access plate and manually clean out the blockage by hand. For some pumps, declogging required technicians to remove the back suction part of the pump. The plant experienced about two clogs a week and each clog took several hours to resolve.

The VFD was configured to run proactively every 12 hours and anti-clogging operations happened automatically with no intervention from maintenance personnel.

The results thrilled plant managers. **A 33% decrease in pump runtime. A 53% reduction in duty cycle. And ZERO clogs.** The plant went from manual declogging twice a week to zero clogs. This was a huge boost in productivity and uptime that freed technicians for more critical tasks.

Figure 1. Mitsubishi Electric Automation VFD FR-F800 Series with Built-In Anti-Clogging Technology Extends Service Life of Existing Lift Stations and Increases System Functionality

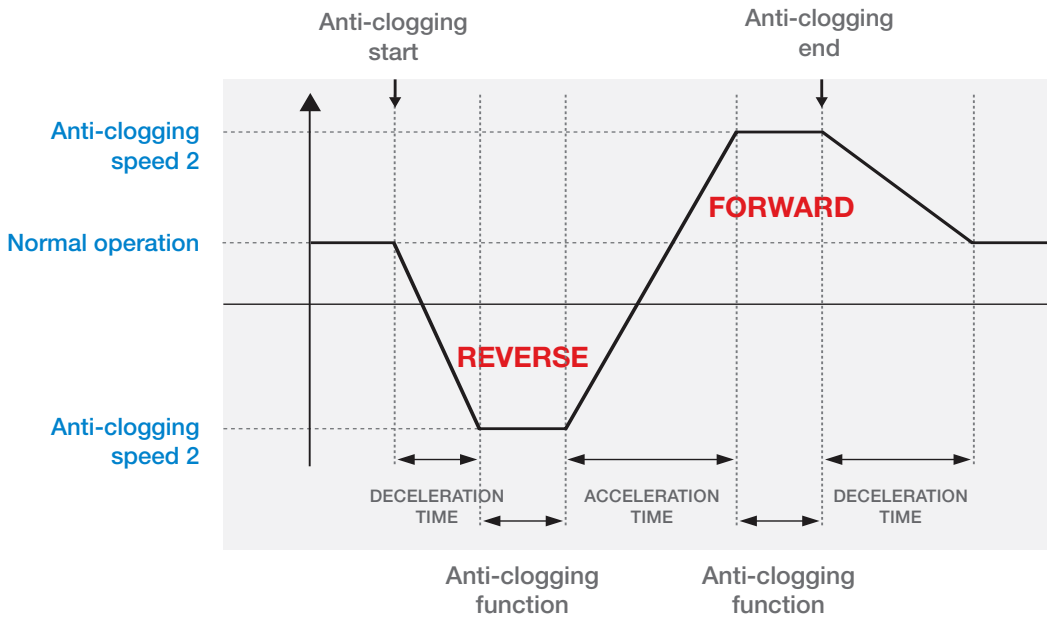
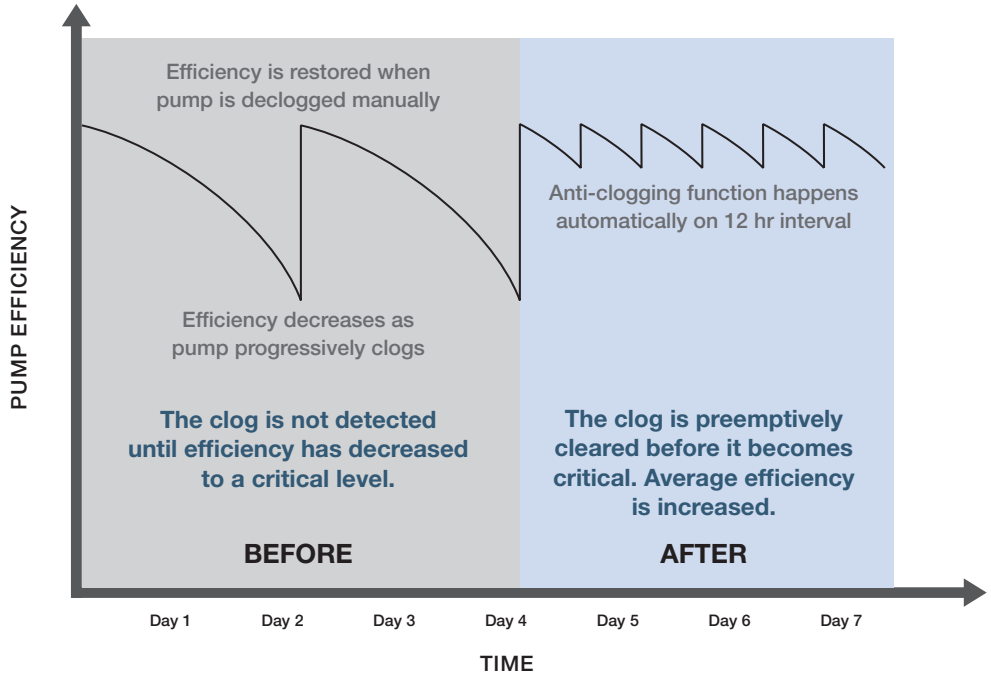


Figure 2. A Proactive Versus Reactive Approach Clears Clogs Before They Become Critical and Increases Average Pump Efficiency



Modernize End-to-End to Optimize Efficiency

For new or expanded lift stations, upgrading the entire control panel is recommended. Components for new control panels include:

- **Programmable Logic Controller (PLC)** to maximize component life, minimize maintenance and operation (M&O) expenses, and extend service life of lift stations
- **Variable Frequency Drive (VFD)** to increase system functionality, operate the pump system at optimal efficiency, reduce maintenance requirements and significantly lower energy costs
- **Human Machine Interface (HMI)** so technicians can monitor pumps on-site
- **Supervisory Control and Data Acquisition (SCADA) Software** for monitoring and analyzing lift station performance and triggering alarms for equipment failure, motor temperature fluctuation, and changes in flow data.

These components work together to enable operational efficiency, energy efficiency, and labor efficiency. Here's how.

Operational efficiency. An automated anti-clogging routine proactively stops clogs from becoming sewage spills. Operational analytics provide remote alarms and controls to operators. The ability to adjust operations remotely can:

- Maintain pump capacity
- Reduce energy costs
- Shrink carbon footprint
- Decrease cyber security risks
- Lower maintenance and operation (M&O) expenses

Energy efficiency. SEDAC says, "The ability to control motor speed during starts, stops, and throughout the cycle can achieve up to 40 percent energy savings." Reduced power consumption helps move municipalities closer to a sustainable wastewater infrastructure, which yields significant environmental, economic, and social benefits.

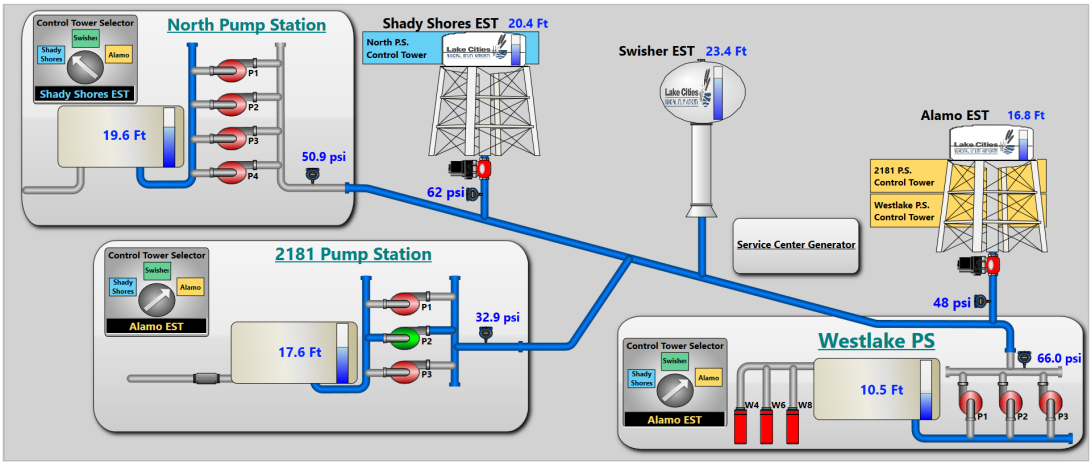
Labor efficiency. Instead of manually declogging the pump when there's a problem, the pump is automated anti-clogging occurs on startup or at set times. This frees technicians to service more lift stations because they spend less time at each site. They no longer have to climb down in the hole or back-flush pumps to clear their jams.

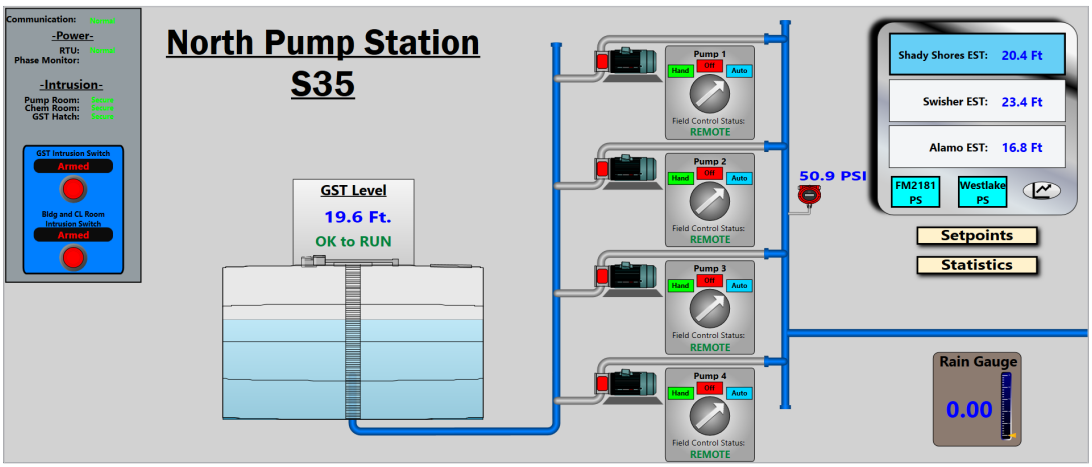
SUCCESS STORY

Real-time data delivers real value. By implementing a new HMI/SCADA system, Lake Cities Municipal Utility Authority (LCMUA) has 24/7, real-time operational visibility of its water and wastewater system. Personnel use iPads to monitor and control connected systems from the field. Instead of everyone getting the same alarms, managers decide who gets what alarm and when.

LCMUA benefits include secure visualization of water and sewer levels, as well as monitoring and control of potable water and wastewater, elevation, PSI, pump monitors and controls, pump failure status, and temperature. LCMUA considers their visualization to be “top notch,” their alarming to be “solid,” and their data mobility to have an “impressively fast response time.”

Figure 3. Lake Cities Municipal Utility Authority (LCMUA) SCADA monitoring screens





Why Mitsubishi Electric Automation?

Mitsubishi Electric Automation is a complete solution provider for wastewater treatment. Known for quality, performance, and forward/backward compatibility, we can help you retrofit your control panel with our reputable anti-clogging VFD or we can replace your aging and outdated equipment with a complete control panel solution. Through the right combination of our proven technologies, Mitsubishi Electric Automation can create the best solution for your lift station modernization project. We can also be a single vendor for your pump manufacturer and our solutions can network seamlessly with third-party components, which can lower your total investment.

Our wastewater treatment solutions deliver industry-leading quality for high reliability, mobile monitoring and operation, energy savings, easy system construction, and nearly zero downtime through preventative maintenance.

HOW OUR SMART SOLUTIONS ARE DIFFERENT

- **VFDs have built-in PLCs, machine learning and energy-saving capabilities**
- **PLCs have onboard analytics to help optimize performance**
- **HMIs have native connectivity to VFDs and PLCs for aggregated learnings and optimal viewing**
- **Intelligent automation software delivers real-time, role-specific visibility**

Mitsubishi Electric Automation offers assistance with system design, programming, and installation. Our certified VFD start-up services are performed by factory-trained technicians and include 5 years of extended warranty coverage on all FR-800 VFDs. These services ensure optimized system performance, faster return on investment, and assurance that the unit will be supported throughout its life.

Once installed, we offer multiple layers of support, so no matter what the issue is, it is going to get resolved. These different layers of support include:

- Highly trained distributors who bring industry-leading know-how to water and wastewater operations. These distributors typically handle approximately 90% of technical calls
- National service and engineering support team, with regional focus, who provide technical service and support both online and onsite
- Automation Center of Excellence (ACE) group, which delivers direct access to factory representatives. This factory-direct connection means the level of expertise is higher and their commitment stronger

More automation. Less human intervention. Timely and expert support. Significantly longer system life. Expect this and more when you work with Mitsubishi Electric Automation.

OUR VFD QUALITY IS A PROVABLE PROMISE

Legendary quality, performance, and compatibility are the hallmarks of our VFDs. Mitsubishi Electric VFDs undergo rigorous environmental tests and come standard with built-in communications and pump control features, including mechanical failure prevention, flow monitoring, and extra energy reduction.

Transform Your Wastewater Treatment Lift Stations

Now that you know how to enable operational efficiency, labor efficiency, and energy efficiency in wastewater lift stations, it's time to determine where you want to be when it comes to enabling the benefits of automation. Whether you decide to retrofit, expand, or build new lift stations, Mitsubishi Electric Automation can provide build-to-spec services to an existing design or engineer a completely new design.

To **learn more**, visit https://us.mitsubishielectric.com/fa/en/solutions/industries/water-wastewater/lift-stations/

Let's talk!

If you're ready to modernize water operations, we're ready to help. We're committed to achieving sustainable water supplies, reducing energy consumption, and enabling more efficient wastewater management operations.

Automating the World

Life has become more complex and to some degree more confusing.

Manufacturing, and from a larger perspective Society, has gone through huge challenges and resultant changes.

The most impactful have been the rapid adoption of digitalization, the pressing need to become “sustainable” in all aspects from energy consumption to pollution reduction, and the need to cope with shrinking populations in many nations. It is important to address these social issues in order to realize a sustainable global environment while striving to realize a safe, secure, and comfortable society that respects all people.

Despite all these changes it’s comforting to know that there are companies and partners you can rely on.

Mitsubishi Electric has consistently focused on creating “Changes for the Better” for a vibrant and sustainable society through continuous technological innovation and ceaseless creativity, and its Factory Automation Systems team are proudly finding new ways through the application of advanced technology, sharing know how and actively collaborating with one goal, to apply and utilize automation for the betterment of all.

We look forward to partnering with you to help automate the world of your industry.

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e-F@ctory

e-F@ctory Alliance

Mitsubishi Electric’s e-F @ctory concept utilizes both FA and IT technologies, through collaboration with e-F@ctory Alliance Partners, to reduce the total cost of development, production, and maintenance, with the aim of achieving manufacturing that is a “step ahead of the times”.

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