

THERE'S NO USE CRYING OVER SPILLED SEWAGE: USING STANDBY LIFT STATION PUMPS TO PREVENT SSOS *BEFORE* THEY HAPPEN

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ABSTRACT

Power outages and unforeseen mechanical failures create the potential for system distress and sanitary sewer overflows (SSOs) in wastewater collection and treatment systems. In accordance with a lawsuit initiated by Mobile Bay Watch (Mobile, Alabama), the Mobile Area Water and Sewer System (MAWSS) chose to install an automatic dry priming backup system to increase system reliability and enable scheduled preventative maintenance and repair.

KEYWORDS

Sanitary sewer overflow, SSO, dry prime, backup, lift station, power outage, Mobile, Godwin, pump, generator, repair, preventative maintenance, severe weather.

INTRODUCTION

Human nature tells us there will always be wastewater. Mother Nature tells us that there will always be extreme weather conditions. The problem arises when the two collide. Severe weather that results in power outages or storm surges and unforeseen mechanical failures – regardless of their source – create the potential for system distress and sanitary sewer overflows (SSOs) in wastewater collection and treatment systems. SSOs that make their way to state waters are classified as unpermitted discharges. As a result of a lawsuit initiated by Mobile Bay Watch in 1999 and decreed in 2002, all SSOs and unpermitted discharges are to be eliminated within the MAWSS by September 2007 (Volkert, September 2005). Given this decree, the MAWSS set forth a plan of action to improve lift station reliability.

As a part of its \$60 million effort to eliminate SSOs, the MAWSS identified several key lift stations in need of immediate improvement in reliability. Due to their vulnerability to lightning strikes and mechanical-related failures, MAWSS sought a solution to improve upon the existing lift station design featuring a back up generator that only provided back up power during service interruptions.

UNDERSTANDING EMERGENCY BACKUP PUMPING

Sewage lift stations are a necessary component in most wastewater systems. These stations provide the pumping necessary to raise liquids from lower elevations to higher elevations. Due to the environmental impact of SSOs, lift station pumping must be reliable and continuous – including the ability to respond to varying flow demands regardless of day, hour, or availability of electricity.

Traditional lift station design has addressed the issue of reliability using multiple, electric-driven pumps. A duplex lift station typically contains a primary pump that is designed to handle peak flow rates with a secondary pump that handles the load of the primary pump in the event of a failure. Diesel-powered generators provide electrical power in the event of a power outage; however, many sewage spills have occurred as a result of mechanical pump failures *and* storm surges or power outages, despite redundant design and backup systems.

Traditional Lift Station Emergency Backup Pumping Design

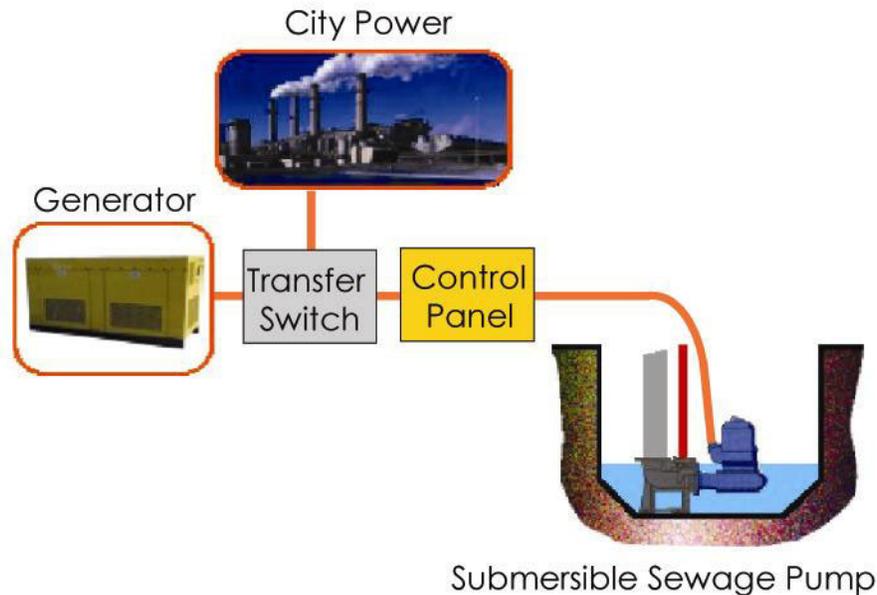
Since lift stations require constant power, emergency backup systems are required. Many systems are designed with a backup diesel-driven generator to provide power to the lift station pumps during an electrical outage. Backup generators are sized to handle the maximum horsepower requirements of the pumps during peak lift station flow demands. When a lift station experiences an electrical outage, the main control reacts to the power loss by starting the diesel-driven generator, and power is directed through a transfer switch to the breaker panel controlling the pumps. Lift station operation will continue as long as there are no failures to the diesel engine, transfer switch, or sewage pumps.

Line power outages occur for various reasons and have higher rates of incidence depending on the power supplier and regional conditions. Lightning, traffic accidents, high wind, rodents, and utility preventative maintenance procedures are a few of the common causes of power outages. Depending on the conditions of the region, environment, and utility supplier, lift stations may have fewer or greater occurrences of power loss. Power suppliers are generally able to provide their customers with outage occurrence reports containing time, date, and duration. This information is useful in the planning process for future municipal infrastructure and emergency plans.

During electrical power outages, lift stations experience interruptions in pumping due to mechanical and electrical failures. The diesel engine, generator, transfer switch, pump control, and pump are the necessary components in the backup system. If all five components of the system work during the power outage, lift station pumping will continue uninterrupted. Should any of the five components fail, pumping will cease and a sewage spill could occur depending upon:

- The prevailing flow
- Duration of the outage
- Surge capabilities of the gravity sewer lines feeding the station

All links in the system need to work successfully for the entire emergency system to function.

Figure 1 – Typical Lift Station Configuration

Diesel-powered electrical generators need to be maintained and load tested on a scheduled basis to ensure reliability. However in many municipalities, emergency system maintenance is limited to a six-month exercise of all system generators including an annual oil change. Transfer switches, disconnects, and controls are rarely cleaned or tested.

Challenges of the Hostile Environment

The loss of electrical power is one issue of lift station pump reliability. Permanently installed lift station pumps often experience mechanical failure as a part of their duty and environment. Sewage pumps are located in a hostile environment. This environment forces mechanical equipment to be reliable in abrasive, caustic, and non-homogeneous conditions. Pump design and material selection are vital in providing the required duty and life. Solids handling is one of the primary problems for pumps in this environment and a leading cause of failure. To ensure system reliability, preventive maintenance should be performed on all rotating equipment including diesel engines and generators. Due to the remote location and continuous duty of lift stations, regular and scheduled pump maintenance is a challenge for all municipal sewage authorities. Often, maintenance is determined by failure, i.e. little or no service is done until the unit actually fails. Since the majority of sewage lift stations are designed using electric submersible pumps, repairs can be difficult and undesirable. In most cases, the entire pump unit needs to be elevated out of the station liquid/wet-well vault, brought to the surface for observation and repairs.

RE-THINKING THE CONTINGENCY PLAN

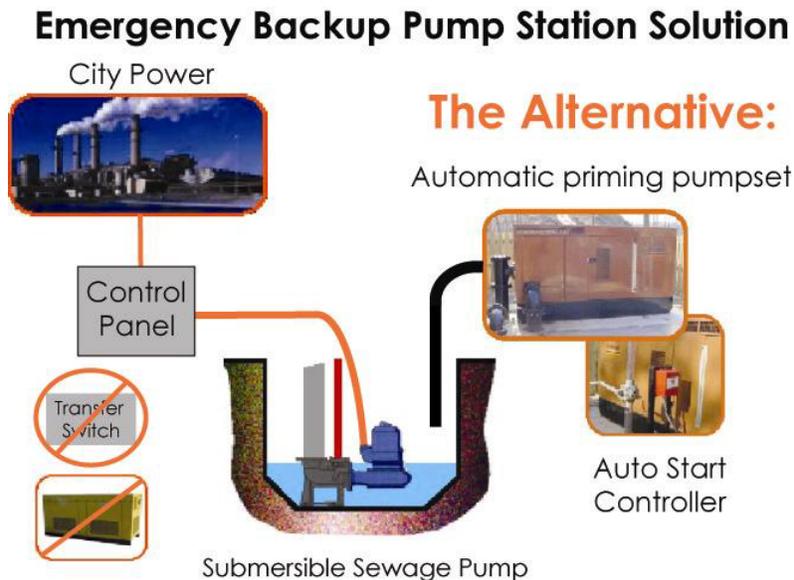
Traditional thinking and design of lift stations has called for backup electrical generation to power existing electric sewage pumps. Since the station has been engineered with an adequate number of pumps to handle normal and peak demands, supplying alternative power in the event of an outage has seemed the most cost effective and logical approach to system reliability. However as mentioned earlier, there are inherent flaws and risks associated with this approach. The challenge then becomes shifting traditional ways of thinking to another solution to satisfy the requirement of system reliability.

For decades, surface-mounted, diesel-driven trash pumps featuring automatic priming and solids handling capabilities have been the staple of sewer bypassing applications. Design features such as venturi air evacuation for automatic priming and oil bath mechanical seal design for indefinite dry running have brought simplicity and reliability to the portable pumping market. As MAWSS has verified, the stationary lift station market can benefit from these same features.

Backup *pumping* instead of backup power

Backup pumping provides simplicity because the automatic self-priming pumpset is a stand-alone unit. The system is independent of utility line power and lift station pump control. Start and stop controls are provided by either a pressure transducer or float switches located in the wet well that activate the diesel- and natural gas-driven pumps when wet well sewage level rises to a predetermined height. The automatic priming feature removes air from the suction line, creating a vacuum that allows the sewage to rise, which then primes the pump. The pumpset continues to operate and pump the required flow and shuts off when either the wet well is lowered or the electricity is restored and the primary system re-takes control. The net effect is that the emergency backup pumping system and the lift station pump system are separate, independent, and do not rely upon each other.

Figure 2 – Emergency Backup Pumping



PUTTING THEORY INTO PRACTICE

When the Mobile Bay Watch filed suit against MAWSS, it did so claiming that MAWSS had violated the Clean Water Act more than 1,000 times over five years. The Mobile Bay Watch suit was then accompanied by separate suits from the U.S Environmental Protection Agency and the Alabama Department of Environmental Management. (Finch 2002) As a result of these suits MAWSS is required to provide a number of plans and programs to be initiated and/or completed by September 30, 2007 including a system capacity assurance program with long- and short-term subgroups, an SSO reporting and notification program, legal support programs for its facilities, contingency plans for its facilities, a pump station operation program and pump station preventative maintenance program, a corrosion control and grease control program, a gravity line preventative maintenance program, a maintenance rights-of-way program, and unscheduled maintenance program, etc. Based on these requirements, it was clear that maintenance and upgrade projects for lift stations must facilitate stoppage of SSOs via:

- Automatic and adequate emergency pumping, regardless of availability of power
- Portability
- Reliability

Since the Consent Decree was issued in early 2002, MAWSS has incorporated 23 surface-mounted, diesel- or natural gas engine-driven trash pumps.

Examining the Results

According to the Consent Decree, SSOs are defined as

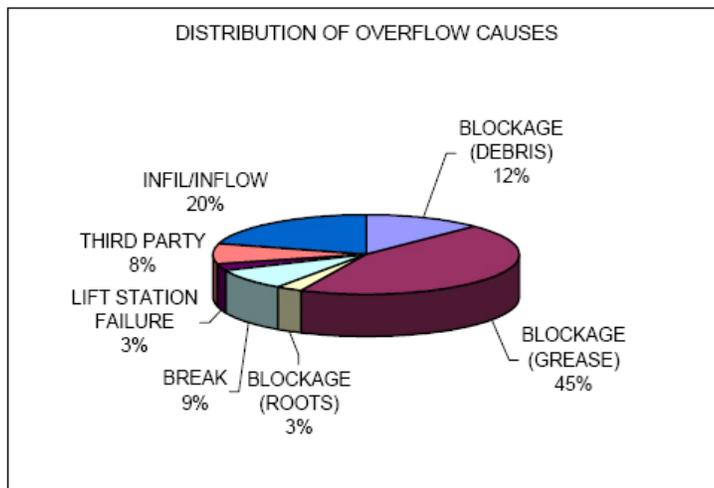
...the intentional or unintentional diversion of flow from any part of the Wastewater Collection and Transmission Systems which occurs before the headworks of a Wastewater Treatment Facility. SSOs include discharges to waters of the United States and the State, as well as discharges to public or private property that do not reach waters of the United States or the State, such as to land surfaces or structures. A diversion of flow at or upstream of the connection of the Board's Wastewater Collection and Transmission Systems with an individual customer or a wastewater collection and transmission system owned and operated by such other party shall not be considered an SSO unless the Board's acts or omissions caused or contributed to a discharge or a failure in the connection between the two systems. The Board shall have caused or contributed to a failure in the connection between the two systems if, at the time of the diversion of flow, it knew or had reason to know of the failure in the connection and did not take steps to correct the failure in the connection or to terminate the connection. (US et. al. vs. The Board of Water and Sewer Commissioners of the City of Mobile, Alabama 2002)

While unpermitted discharges are defined as

...the discharge of pollutants from a point source into waters of the United States or the State which is not authorized by an NPDES Permit, including but not limited to any SSO which reaches waters of the United States or the State indirectly. (US et. al. vs. The Board of Water and Sewer Commissioners of the City of Mobile, Alabama 2002)

In understanding why MAWSS experiences SSOs, it is important to note its susceptibility not only to normal system deterioration, but an increased tendency towards overflow due to severe weather. At the start of its reporting in 2002, MAWSS could identify the distribution of overflow causes as follows:

Figure 3 – Distribution of Overflow Causes

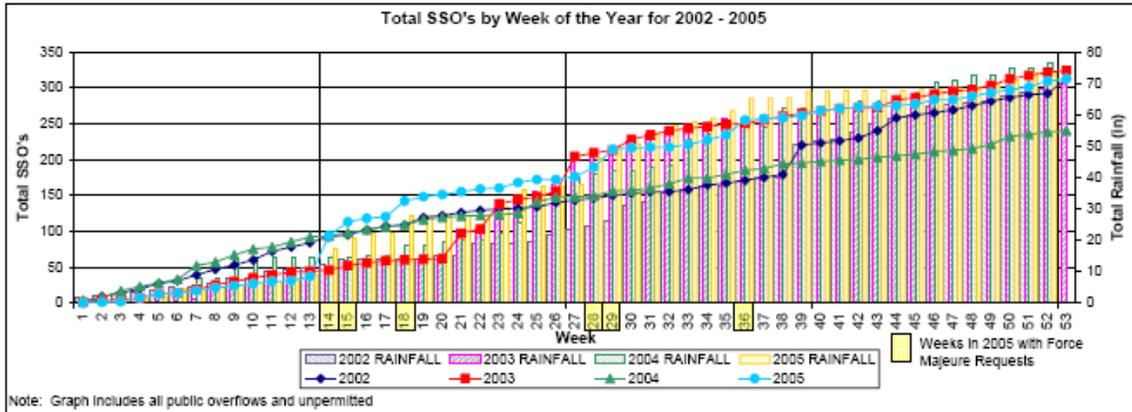


(Annual Report 2002)

As shown, infiltration and inflow make up 20% of the SSO occurrences. In fact, in a year that saw six severe natural events hit the MAWSS service area, 73 of its 313 overflows were attributed to severe natural events, with 39 of those occurring during Tropical Storm Isidore alone.

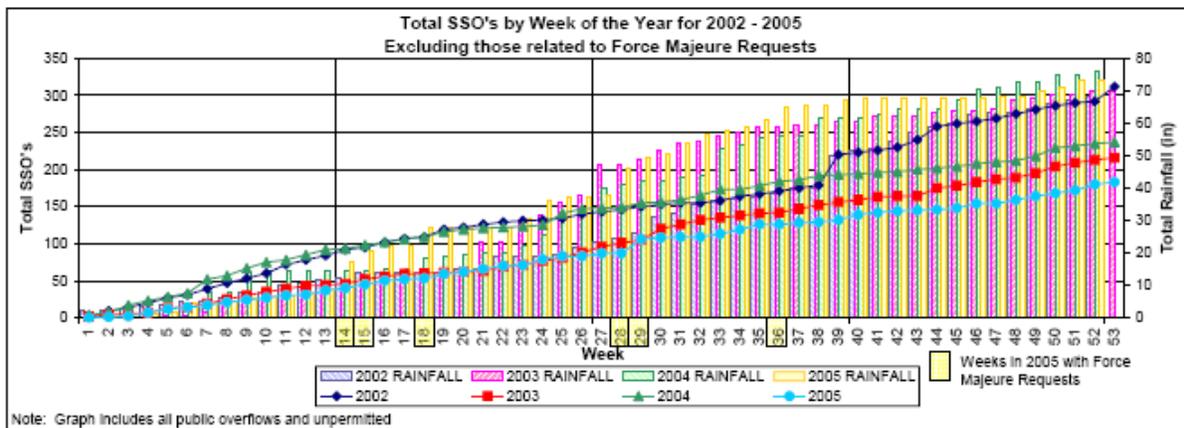
MAWSS has therefore, made its goal to find “an optimal distribution of resources between wet weather related SSOs and non-wet weather related SSOs.” (Annual Report 2002) As more backup lift stations have gone online throughout its system, MAWSS has reported a steady decrease in weather-related SSOs, despite the increase in frequency and severity of severe events in the past several years.

Figure 4 – Cumulative Overflow Totals by Week of the Year Including Force Majeure Events



(Annual Report 2005)

Figure 5 – Cumulative Overflow Totals by Week of the Year Excluding Force Majeure Events



(Annual Report 2005)

In 2005, severe natural events surged in the Mobile and surrounding areas. According to its 2005 Annual Report, of the eight Force Majeure events (an event arising from causes beyond the control of the Board...which delays or prevents the performance of any obligation under [the] Consent Decree, despite the Board's best efforts to fulfill the obligation) submitted since the Consent Decree was issued, six occurred in 2005. Those events accounted for 124 of the 215 unpermitted discharges in 2005. The 2005 Annual Report continues, "Excluding the Force Majeure events, the relatively unchanging slope of the 2005 charted data demonstrates that the collection system is less responsive to rain events."

BENEFITS OF THE SOLUTION

Increased Reliability of Emergency Backup Pumping

Storm surges are not the only cause of lift station system distress. Utilizing an automatic priming emergency backup pump (vs. power), the station operator now has increased reliability in terms of pumping capacity. Standby generators that create electrical power are useless in the event of a mechanically-oriented pump failure.

Increased Flexibility for Pump Repair

With its automatic priming emergency backup pumps MAWSS has found that the additional pumping capacity of the backup system has increased its flexibility to perform repairs or preventive maintenance on permanently installed pumps. MAWSS mechanics can devise a rotating schedule of wet well submersible pump outages with the confidence that flow demands will be met by the surface-mounted diesel- or natural gas-driven backup pump during planned maintenance. Costly emergency pump repairs will not be required as a result of an unplanned failure.

Reduced Costs Associated with Generator Maintenance

Generators are usually load tested on an annual basis to ensure reliable power generation in emergency situations. The costs associated with load testing generators is significantly higher than those associated with flow testing an automatic priming emergency backup pump. Contract electricians are often called upon to load test generators to satisfy local requirements. Flow testing automatic priming emergency backup pumps is routinely handled by operators at no appreciable cost. In cases where it was not cost-effective to provide a backup pump (stations with low horsepower requirements - less than four), MAWSS has elected to upgrade, replace, or purchase generators.

SUMMARY

MAWSS continues to see a decline in SSOs related to infiltration and inflow and lift station failure. Using an automatic priming emergency backup pump has enabled MAWSS to meet the requirements of the consent decree, while also exercising cost-effectiveness and pumping efficiency.

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