# Hillsborough County Pump Station Rehabilitation Program

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The Hillsborough County Public Utilities Department (department) has two distinct wastewater collection and transmission system service areas (Northwest and South-Central) that are separated by the City of Tampa's wastewater service area (Figure 1). The department owns, operates, and maintains over 780 wastewater pump stations, with new additions each year from development. The systems also include 1,400 privately owned pump stations. Wastewater is conveyed through the collection and transmission systems consisting of 630 mi of force main, and 1,400 mi of gravity collection pipe.

The county's service area is limited by the urban service area boundary that is defined by the Hillsborough County comprehensive plan. Parcels within this boundary are allowed to connect to the county's utility services; parcels outside of the boundary are considered rural and do not have access to the department's utility system.

## History

The department's oldest stations have been acquired from private utilities over the years. These stations were constructed in the 1950s through the 1970s, prior to the existence of department standards. Since then, the department has constructed master pump stations to consolidate area wastewater flows, and developers have continued to construct pump stations for both private and public ownership. Figure 2 illustrates the growth over the last 15 years. Stations built for public ownership are now constructed to meet department standards.

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Figure 1. Wastewater Service Area

In the mid-1990s, the department established a master renewal and replacement program, also referred to as a "master project," for wastewater pump stations. The department funded this project through the utility's capital improvement program (CIP). To provide services through the master project, the department bid a multi-year contract to begin rehabilitation or replacement of wastewater pump stations in order to bring them into compliance with current county standards. This contract included a list of bid items pertaining to all aspects of pump station rehabilitation, including mechanical, electrical, and structural components.

More recently, the department started a more methodical approach to its pump station rehabilitation program, breaking it down into the following three categories:

- Funding – The department allocates dollars per year based on the number of pump stations rehabilitations to be conducted per year.
- Prioritization – The department establishes a ranking system to determine the order in which the department's pump stations should be rehabilitated, based on an objective condition assessment system.
- Delivery – The department generates multiple contracts, utilizing the allocated funding and targeting the highest-ranked stations (those in the worst condition).

## Current State of the Program

Over the years, the department's pump station rehabilitation program has evolved with expanded funding and additional contracts. The department now has six contracts in place for both partial and full pump station rehabilitation projects. In the past 11 years, the department has completed 247 pump station rehabilitation projects (>$30K/station) and more than double that many partial rehabilitations (<$30K/station). Utilizing the same contracts, the department has installed seven emergency backup generators and 19 diesel backup pumps over the same time period. For rehabilitation of the department's largest pump stations (>3 mil gal per day [mgd]) or stations that require complete replacement, separate bid contracts (i.e., "stand-alone" CIP contracts) are created.

Table 1 shows the number of stations rehabilitated or replaced (>$30K each) per year and the corresponding costs from 2005 through 2015. A fully rehabilitated pump station is expected to have a useful life of twenty or more years, requiring only minor repairs within that time period.

Now that a majority of the pump stations in poor condition have been addressed, the department is in a position to begin actively renewing and replacing assets. The goal is two-fold:

1. Eliminate pump station sanitary sewer overflows (SSOs).
2. Provide a finished project that meets the department's current standards and is safe and reliable, and therefore can be efficiently maintained.

In the pursuit of minimizing SSOs, the department has also been steadily incorporating a supervisory control and data acquisition (SCADA) system into its wastewater collection/transmission system. Though a work in progress, it is intended to provide real-time monitoring of all department pump stations. This will allow field maintenance services (FMS) staff to not only monitor performance and predict maintenance, but also identify faults and malfunctions as they are occurring, improving response times.

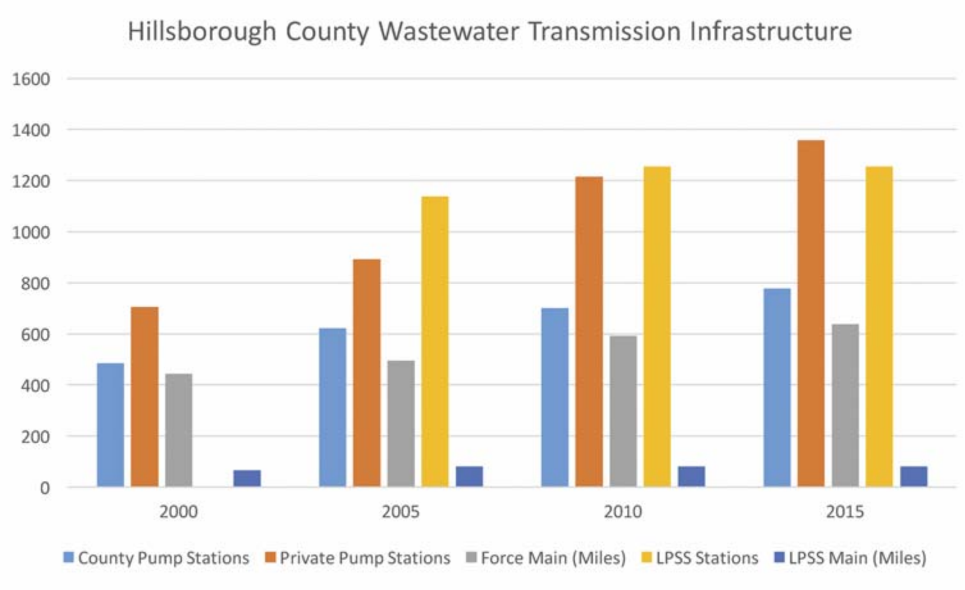


Figure 2. Wastewater Infrastructure Inventory

Table 1. Historical Program Expenditures

| Year | No. of Rehabs | Cost * | Avg. Cost * /Rehab |
|---|---|---|---|
| 2005 | 7 | $1,100,000 | $157,143 |
| 2006 | 9 | $1,165,000 | $129,444 |
| 2007 | 21 | $2,434,000 | $115,905 |
| 2008 | 30 | $3,513,000 | $117,100 |
| 2009 | 21 | $2,757,000 | $131,286 |
| 2010 | 27 | $3,584,000 | $132,741 |
| 2011 | 26 | $3,048,000 | $117,231 |
| 2012 | 27 | $3,209,000 | $118,852 |
| 2013 | 27 | $2,968,000 | $109,926 |
| 2014 | 31 | $3,166,000 | $102,129 |
| 2015 | 21 ** | $3,079,000 | $146,619 |
| **Totals** | **247** | **$30,023,000** | **$121,551** |

* Costs shown do not include materials supplied by the department, such as control panels and pumps.

** The number of rehabbed stations declined during 2015 because a larger number of minor rehabs (<$30K) were performed.

## Pump Station Prioritization

Historically, pump stations would be ranked for rehabilitation based on condition assessments conducted during field visits by the department's pump station rehabilitation team. The team includes representatives from engineering (planning, design, and project management) and FMS. In a given year, 20 or 30 of the department's worst pump stations would be selected for site assessments based on input from FMS staff.

The team evaluated these stations using a comprehensive checklist of some 40 components (i.e., assets) that included such things as pumps, piping, grounds, fences, driveways, and electrical equipment. The condition of each individual asset was scored on a 1-to-5 scale (from excellent to very poor, respectively) based on team consensus. The pump stations deemed to be in the poorest condition (highest score) would then be added to the list for rehabilitation.

In 2015, the department decided to pursue a more precise ranking and prioritization system where the department collects asset data in its comprehensive asset management system (CAMS), a database that includes assets and work orders. Every pump station has a series of records, one for each individual asset. Every asset is assigned a condition score from 1 to 5 (same as previously mentioned) for both functional and physical conditions.

The condition-score rating system is defined as follows:

**Physical Condition Definitions**

The current state of repair and operation for the asset as influenced by age, historical maintenance, and service/operating conditions.

1 – *Excellent*: Fully operable, well-maintained, and consistent with the current standards. Little wear shown and no further action required.

2 – *Good*: Sound and well-maintained, but may be showing slight signs of early wear or not up to current standards. Delivering full efficiency

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with little or no deterioration in performance. Only minor renewal or rehabilitation may be needed in the future.
3 – *Moderate* (within five to10 years of failure): Functionally sound and acceptable, and showing normal signs of wear. May have minor failures or diminished efficiency and some deterioration in performance or increase in maintenance cost. Moderate renewal or replacement required.
4 – *Poor* (within one to five years of failure): Functions, but requires a high level of maintenance to remain operational. Shows abnormal wear and is likely to cause significant performance deterioration in the near term. Near-term scheduled replacement or rehabilitation needed.
5 – *Very Poor* (immediate to one year for failure): Effective life exceeded and/or excessive maintenance cost incurred. High risk of breakdown or imminent failure with serious impact on performance. No additional life expectancy, with immediate replacement or rehabilitation needed.

**Functional Condition Definitions**
1 – *Excellent*: Meets all design and legal/regulatory requirements in all demand conditions. Overall performance is excellent and meets all future requirements.
2 – *Good*: May not meet current standards, but overall performance is excellent. May have minor risk under extreme conditions. Will likely meet expected future requirements.
3 – *Moderate*: Current performance is acceptable, but would likely not meet any future additional requirements or increased demand.
4 – *Poor*: Current performance is marginal and will not meet future additional requirements or increased demand.
5 –*Very Poor*: Current performance is unacceptable and does not meet currently required performance criteria, such as capacity or regulatory requirements.

These scores are based on field observations by the team. The department's goal is to assess the condition of all 780 pump stations every 10 years, or roughly 78 per year; master pump stations will be assessed on a more frequent basis—every five years. The department is evaluating additional measures to define a "master" pump station as having a peak flow greater than 1,000 gal per min (gpm) and/or a station that requires a stand-alone diesel-driven backup pump or backup generator.

In addition, weighting factors of 1, 3, or 5 are applied to address the varying degrees of importance associated with each asset (e.g., condition of the fence [weighting factor of 1] versus condition of the discharge piping [weighting factor of 5]). The weighted scores are averaged into overall condition-code scores for the pump station.

Every pump station is assigned a criticality score. The criticality scores are 5, 7, and 9, and result from the number of other pump stations that contribute flow to the station; master pump stations are designated as those with a criticality score of 9. The department's wastewater collection and transmission system is a networked system of small pump stations pumping into larger pump stations, ultimately pumping into "master pump stations." The majority of stations are small, neighborhood stations that do not repump flows from other pump stations. The largest stations collect and repump flow from nine or more other pump stations. In general, the department decided to assign criticality based on a score from the following equation:

Repump Score = No. of County Stations + 0.5*No. of Private Stations

County-owned stations generally serve developments of single-family homes. Private stations tend to have less flow than county-owned pump stations. Exceptions are for large multifamily developments, although in general, multifamily homes use less water and produce less wastewater than single-family subdivisions. The county has few large industrial customers for wastewater; therefore, the private stations were weighted at 50 percent of the value of county-owned stations for scoring purposes

Table 2 lists the criticality score as it corresponds to the repump score.

With the criticality scores in place, all county-owned pump stations are ranked based on an existing risk assessment formula used for force mains:

Overall Risk = Criticality*Condition + [Consequence of Failure Factors (i.e., environmental, health and safety, and public service]

In the original formula, the consequence of failure factors is based on quantifiable measures, such as the asset's proximity to waterbodies, arterial or collector roads, and hospitals or schools.

Using this formula, the stations with the highest criticality score topped the list, regardless of condition codes, and the high criticality scores for very few pump stations skewed the results. In addition, the original consequence of failure factors was designed based on force main assets and was not necessarily applicable to pump stations in the same way. For example, a force main break results in a discharge at the location of the break; therefore, that force main's proximity to a waterbody can be easily correlated with the risk to the waterbody. However, a pump station malfunction may cause a wastewater backup in the contributing gravity system. The vulnerable point is usually the manhole lowest in elevation. The risk will not necessary correlate with the pump station's proximity to a waterbody if the manhole that first experiences the overflow is thousands of feet upstream of the station.

Therefore, the team began modifying the equation to better suit the needs of the pump station network. Philosophically, the team decided that the overall risk should be mostly a function of the condition codes, with some influence of environmental factors and criticality. The new equation is as follows:

Overall Risk = w1*Criticality + w2*Condition + w3*∑Consequence of Failure Factors

Where w1, w2, and w3 are weighting coefficient for each component of the risk score.

The team completed a sensitivity analysis of the overall risk and weighting factors. For each step of the sensitivity analysis, the team reran the pump station prioritization report. Increasing the weight of the condition codes drastically changed the pump station priorities.

Table 2. Criticality Score from Repump Score

| Repump Score | Criticality Score |
|---|---|
| 9 or higher | 9 |
| 6 to 8 | 9 |
| 5 | 7 |
| 4 | 7 |
| 3 | 7 |
| 2 | 5 |

Table 3. Total Number of Pump Stations and Sanitary Sewer Overflows by Year (2011–2015)

| Year | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| Total No. of Stations | 705 | 711 | 722 | 744 | 777 |
| Total No. SSOs | 81 | 53 | 43 | 49 | 50 |

The prioritized list was more in line with the department's current projects and opinions from FMS. Currently, the values are set to 0.1, 0.7, and 0.2, respectively.

However, there remains a complicating factor: Not all of the condition data currently in the CAMS system are accurate. There are pump stations rated in "moderate" and "good" condition that are actually in need of repair. There are also many stations that have been recently rehabilitated to "excellent" condition, but still have condition codes of "poor" or "very poor."

The team is working on improving the data; however, this puts it in an iterative loop of creating the list based on the revised risk equation and then completing a thorough condition assessment of the top-ranking six to eight pump stations. This is where the team often identifies discrepancies in the data. The revised data is entered into the CAMS system and a new report is created. The pump station team then visits the next top-ranking six to eight pump stations that were not previously visited and completes the assessments. These new condition scores are then entered and the process repeats.

This effort is a "work in progress." The existing condition code data define which pump stations will be assessed in this first year of the program, but the only way to improve this data is to assess the stations and correct discrepancies; this results in the team frequently visiting stations in good condition. While time may be better spent assessing stations in poor condition, this iterative process is the only way to improve the condition scores.

In the next year of the program, the team will repeat the iterative process and assess a different set of 78 pump stations. As each year progresses, the team expects the data to improve and for the report to more accurately reflect actual field conditions. The team is still evaluating program components, such as:

- The final value of the weighting coefficients.
- How to update the condition codes over time with a 10-year cycle between condition assessments.

## Project Delivery

Pump stations with the highest overall risk scores are identified for rehabilitation. In order to qualify for full rehabilitation, a sufficient number of assets need to be identified for replacement, such that a "tipping point" is reached. A full rehabilitation typically includes removing/replacing all assets, with the exception of the wet well. If it is determined that the wet well is beyond repair and needs to be replaced, then a complete replacement project (stand-alone CIP) is required.

Full rehabilitations or replacements involve a multistep process that is a full-team collaborative effort. Team members are integrally involved throughout assessment, planning, design, and construction. First, the design process is initiated, starting with obtaining a topographic and boundary survey of the site. The designers commence creating a new design with a proposed layout that meets current standards and can be more safely and efficiently maintained than the existing pump station. Prior to preparing the new layout, design staff conducts a preliminary site visit, creates a photographic record, and identifies any unusual concerns that need to be addressed. For example, site issues, such as traffic or adjacent homeowner concerns, aesthetic issues (e.g., trees, fencing), and constructability limitations, are

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identified. Where possible, space for a portable diesel backup pump is set aside within the pump station footprint.

In the meantime, planning staff will review flow data and provide recommendations for pump size and horsepower. At 60 percent design, the team holds an onsite review meeting where comments are gathered for design modifications. At 90 percent design, the project management team assigns the project to one of the department's pump station rehabilitation contractors, and the project manager then schedules an onsite review meeting with the contractor and the other team members. With constructability comments from the 90 percent meeting, design staff will bring the project to 100 percent, the project manager issues a work order, and construction commences under the supervision of project management.

As mentioned previously, the department utilizes six different contracts for pump station rehabilitation, which are characterized as work order construction services (WORCS) contracts; all six of these contracts are intended to last for multiple years. Typically, the department will issue an initial one-year term for a given contract, with options for several (two or three) annual renewals.

During the procurement process, potential bidders are issued a set of the department's standard drawings for wastewater pump stations. Potential bidders are also issued a short list of example pump stations that require some level of rehabilitation, but with the understanding that a preponderance of stations needing rehabilitation will remain undisclosed prior to bidding.

Four of these WORCS contracts (issued to four different contractors), are based on a long list of bid items (over 200 items). In addition, there are provisions for nonpriced items to address unusual or unique work items. Upon receiving the 100 percent design, the project manager will create a work order based on the proposed items and their corresponding quantities for that particular pump station rehabilitation.

The two other WORCS contracts are time and materials contracts. These are typically used for partial rehabilitation projects.

For rehabilitation of the department's largest pump stations or stations that require complete replacement, including the wet well, a separate, competitively bid contract is generated for the project, usually funded by a separate "stand-alone" CIP, rather than one of the master-project CIPs.

The team holds monthly pump station rehabilitation coordination meetings, providing updates on upcoming and ongoing projects. The goal of these meetings is to ensure that the effort keeps moving forward, rehabilitating pump stations at a steady pace and continually identifying new projects.

## Results

Using the system described, the department has successfully rehabilitated or replaced hundreds of wastewater pump stations over the last 20 years. During this time, the department has refined the process, continually seeking ways to improve it. While the effort remains a

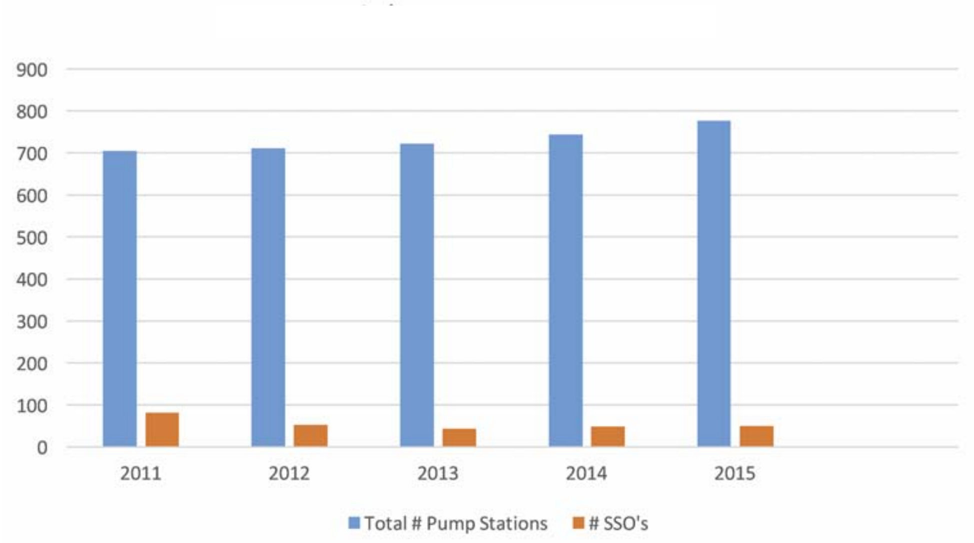


Figure 3. Total Number of Pump Stations and Sanitary Sewer Overflows by Year (2011–2015)


Figure 4. "Before" Images of Pinewood Pump Station (clockwise from upper left): Old Pump Station Overview Looking East With Control Panel in Background; Old Pump Station Looking West; Pump Station Wetwell and Electrical Vault; and Looking Into Wetwell.

Figure 5. "After" Images of Pinewood Pump Station (left to right): New/Rebuilt Pump Station Overview, Looking East; New Pump Station, Looking South.

work in progress, the department can demonstrate that it has already created an effective program. Despite inheriting pump stations up to 60 years old from private utilities, the department has been able to overcome a litany of problem pump stations in various stages of disrepair and bring them up to current standards. In so doing, the department has significantly minimized SSOs caused by pump station failures (Table 3 and Figure 3), while creating a safer and more efficient work area for maintenance purposes.

The photographs in figures 4, 5, and 6 show images before and after construction of two pump stations.

## Steps to Begin Implementing a Program

- Create a project team of experienced staff, including engineers and pump station technicians.
- Develop a comprehensive condition assessment program, where pump stations are prioritized for rehabilitation based on an objective protocol, preferably using an asset management system.
- Develop a thorough checklist of pump station assets with appropriate ranking and weighting factors.
- Develop a schedule of site visits for gathering condition scoring, visiting each pump station on a cyclical basis.
- Conduct onsite condition scoring with the project team.
- Enter condition scoring into a comprehensive data base or asset management program.
- Create one or more "bid item" contracts, with appropriate items for pump station rehabilitation.
- Procure construction contractor(s) based on the lowest responsive and responsible bid(s).

Figure 6. Lumsden No. 5 Pump Station: "Before" Images Showing Old Suction Lift Pump Station With Discharge Force Main (white polyvinyl chloride) Exiting Through Block Wall (top); "After" Rehabilitated Pump Station (bottom).

The Hillsborough County Public Utilities Department has a large network of wastewater collection and transmission infrastructure. In order to reliably serve its customers, the department must maintain all 780 pump stations. In the department's early decades, pump stations were repaired and rehabilitated when failure had occurred or was imminent. With this rehabilitation program, the department has moved toward proactive pump station rehabilitation. The result is more reliable, safer stations and fewer SSOs. The department will continue to adjust the risk equation to identify stations for rehabilitation, and expand the contracts where necessary to include new line items and services. The department's passionate team of pump station professionals looks forward to continuing positive results from this program.