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WHITE PAPER

Proactive Wastewater Master Planning Reveals Attainable Improvements for Small Communities

All communities, regardless of size and financial resources, eventually face wastewater collection system trials and tribulations. Reactive remedies can temporarily plug the gaps in wastewater collection and treatment processes, but proactive approaches can avoid scenarios in which systems are exposed to eventual failure or even emergency situations.

Development of a proactive wastewater master plan (WWMP) that considers a community's existing assets, prioritizes immediate trouble areas and addresses future needs can help avoid costly and cumbersome scenarios.

A comprehensive wastewater planning process may seem overwhelming to a town of 25,000 or fewer people. However, by breaking down each area of need and tailoring the scope of work across time, a master plan is the most viable and sustainable option in the long term. It can set up a community for future success.

Wastewater Systems

Many wastewater collection and treatment systems were built decades ago through major public and private investments.

The two parts of a utility system are wastewater collection and wastewater treatment. Wastewater collection systems consist of a network of gravity mains, manholes and lift stations, which collect wastewater flow in the system and transport it to treatment plants that serve each community. Private sewer laterals collect flow from homes and businesses and connect to public sewer mains. These large public collector lines and trunk sewers move the flow to treatment plants. Prior to being discharged into the environment, the wastewater is properly treated.

Much attention has been paid in recent decades to effluent water quality after treatment, even as the infrastructure required to support the entire system has deteriorated. Small-town wastewater collection systems were typically built to handle a volume of sewage for several thousand single-family residential utility accounts, plus a normal level of impacts and runoff from rainwater. Over time, physical components of the collection system deteriorate from age and use, resulting in larger impacts from inflow and infiltration (I/I). In addition, these systems can become overtaxed by unforeseen population growth or flow from commercial developments such as warehouse distribution centers or truck stops.

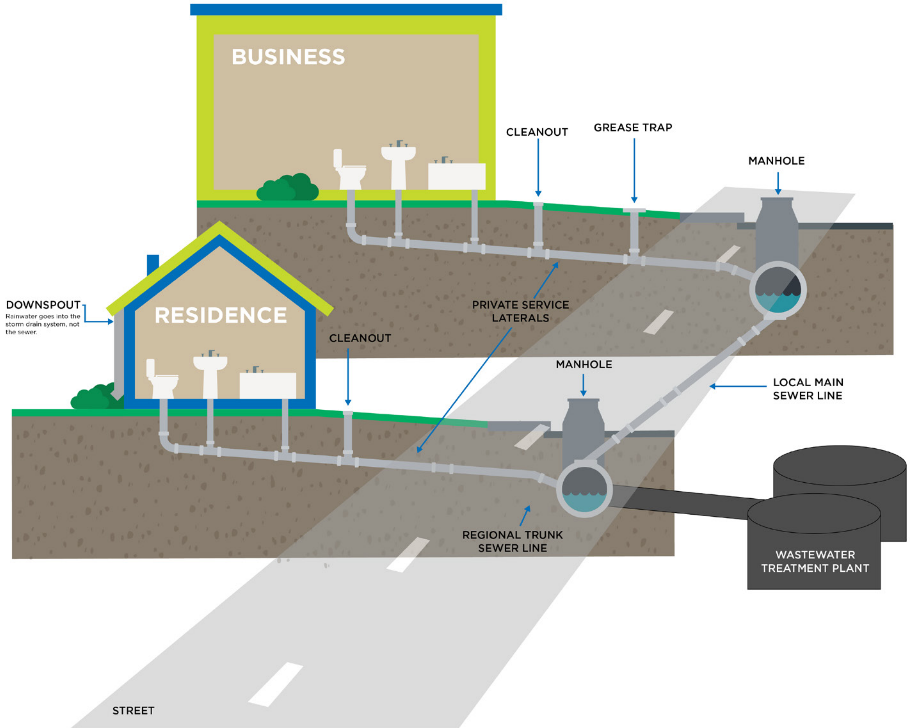

***Figure 1:** Typical Components of Wastewater Collection System.*

A common difficulty facing community leaders and utility crews is that their communities are unprepared for wastewater system failures related to aging infrastructure and increased or increasing system needs with competing interests for budget allocations. Releases and bypasses may occur unknowingly due to pipe breakage or system overloads from heavy rains. Regardless of the source, such releases and bypass actions lead to permit violations and potentially even regulatory compliance enforcement actions that are costly and time limited.

A WWMP allows a community to get ahead of sewer problems, providing strategic insight and incremental upgrades that are financially achievable and can be accomplished on a predictable and managed timeline.

Wastewater Master Planning

A WWMP is an adaptable document tying together important issues facing the community or region, current conditions and assets, and paths forward that improve existing infrastructure and incorporate new components and necessary system improvements.

The first stage of WWMP development involves assessing a community's assets while considering difficult environmental and economic conditions, as well as key concerns held by stakeholders regarding wastewater and master plan elements.

In this stage, the project team identifies existing wastewater system resources and those that are missing to create a complete asset inventory. Utilizing a geographic information system (GIS), a computer maintenance management system

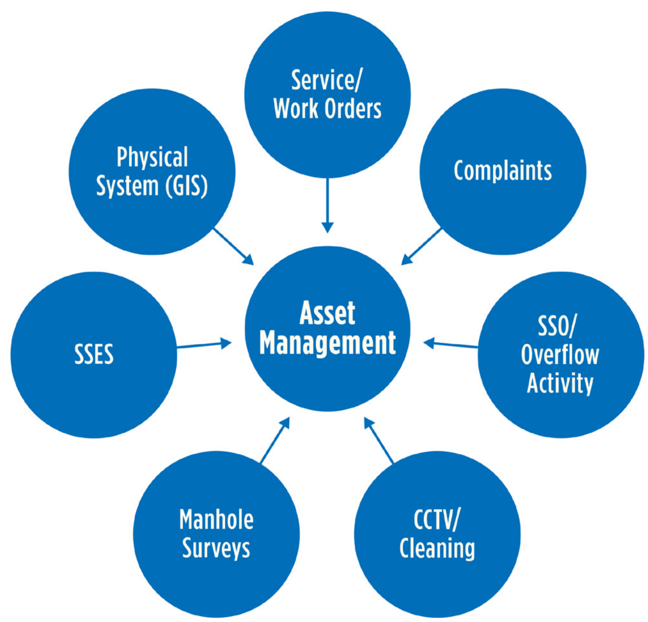

***Figure 2:** Typical Components of a Wastewater Asset Management Program.*

(CMMS) and other integrated modeling software tools to help better understand history of work and preventative maintenance, an asset management approach establishes an interactive system linking customer complaints to real-time water department actions and infrastructure status.

This first step of a WWMP can sometimes seem overwhelming to a small community. Historical data, such as sanitary sewer overflow (SSO) activity and customer complaints, usually is recorded in hard copy files rather than digitally. Sanitary sewer evaluation survey (SSES) inspections are completed, but rehabilitation data may not be tracked. Often, a comprehensive database of the physical system is incomplete or has not been kept current, resulting in a lack of confidence in the data that is stored.

As illustrated in Figure 2, development of an asset management strategy involves the integration and understanding of sanitary sewer system data across multiple systems of record. Many times, this requires a digital transformation of historical records. The most critical component of this process is the digital representation of the sanitary sewer system assets (manholes, gravity sewers, lift stations and force mains), and may include a combination of CAD-to-GIS conversion to digitize historical paper maps or GPS survey acquisition of the sanitary sewer collection system.

After the sanitary sewer system is spatially established in the GIS, the remaining record systems — including available work or service request information, SSO inventories, or operation and maintenance (O&M) records — can effectively be linked to the sanitary sewer system assets. Once these systems of record can be effectively understood spatially across the sanitary sewer system, the history of the collection system performance is more easily understood.

Developing an effective asset management strategy and advancing the digital transformation far enough to allow for a thorough understanding of the historical collection system performance is the goal. Reviewing and coordinating with stakeholders about collection system performance provides a uniform vision for WWMP execution and the major initiatives and objectives to be completed.

The second stage of a WWMP process is conducting flow monitoring to understand typical dry weather flow patterns and to evaluate I/I and its impact on the collection system. Inflow is stormwater that is directly connected to the sewer system by drains such as catch basins and sump pumps.

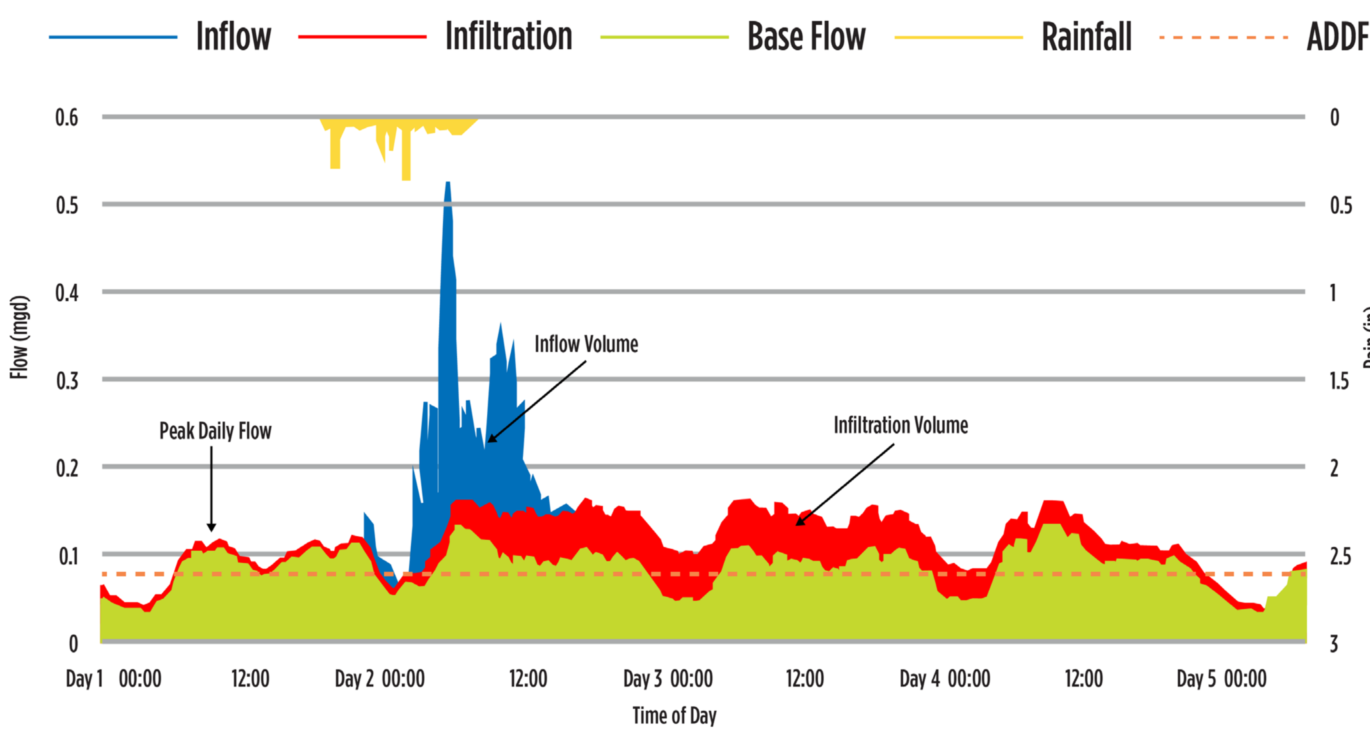

***Figure 3:** Components of a Hydrograph*

The green area indicates average daily dry weather flow from uses like dishwashers and showers. The blue (inflow) and red (infiltration) areas show wet weather components that do not need treatment and can overwhelm the system.

Infiltration enters the sewer system through cracks in manholes and gravity mains or through elevated groundwater levels. Flow monitoring allows a project team to assess and quantify amounts of I/I in the system flowing to the treatment plant during wet and dry weather conditions.

Following the monitoring period, an analysis of I/I observed in the system is performed to separate flow meter data into dry weather and wet weather components. Dry weather flow is present in the system under all weather conditions, and includes daily activities such as contributions from showers and dishwashers. These calculations provide the average daily dry weather flow experienced in the system. Wet weather components include I/I and are experienced during and after rain events. Each of these elements is illustrated in Figure 3. This breakdown allows for communities to identify locations in the system that contribute to high levels of I/I.

Through flow monitoring, areas of excessive I/I are defined and then used to advance SSES activity, which can include smoke testing, closed circuit television, dye flooding and building inspections to identify specific sources of I/I entry. Flow monitoring data maximizes the return on investment by prioritizing SSES investigations, and in many cases, reduces the quantity of SSES investigations that are required for I/I source identification to those areas found with excessive I/I.

I/I source identification through the SSES investigations becomes the basis for planning I/I removal and sewer rehabilitation as part of the WWMP. Sewer rehabilitation planning is conducted to reduce the risk of failure due to aging infrastructure while I/I removal becomes part of the planning strategy for improvements to collection system conveyance.

The third stage of a WWMP process is putting all the various survey and monitoring data into a hydraulic model and using it to evaluate the level of I/I removal within the sanitary sewer system so that performance goals can be established. In addition, the impacts from population growth and economic development can be evaluated within the model to determine what long-term improvements may be necessary to facilitate the growth.

The final step in the WWMP process includes developing a time-phased, long-term capital improvement plan (CIP), which includes a combination of these major elements:

- **Sewer rehabilitation plan:** Reduces the risk of sanitary sewer collection system failures due to aging infrastructure.
- **SSES and I/I mitigation plan:** Cost-efficient removal of I/I sources, which contribute to collection system conveyance.
- **Capacity projects plan:** A combination of sanitary sewer improvements to mitigate existing collection system performance issues and provide long-term sanitary sewer conveyance considering the impacts of future growth.

The CIP provides the basis for the community to follow a time-phased plan in order to address community needs with an appropriate, prioritized and manageable level of effort and expense.

Together, the asset management program, flow monitoring data and hydraulic model guide a WWMP, enabling a community to adapt the same plan for many decades rather than having to start anew. The final master plan document lends itself to fully informed CIPs, which are important for allocating funds and coordinating and collating other utility upgrade activities. The WWMP can be utilized as a living document and flexibly managed for future improvements. Imminent upgrades may be quickly incorporated into an already developed hydraulic model and used in conjunction with the WWMP to effectively address new system concerns such as swift funding allocations, emergency response and new developments.

Conclusion: Proactivity Versus Reactivity

There are many benefits of a WWMP that can set up a community for future successes. By committing to these proactive processes, a community can:

- Guide necessary capital expenditures for the system — today and in the future.
- Heighten public trust through transparency and clarity of priorities.
- Identify strategies to meet wastewater system infrastructure needs.
- Improve water department employee satisfaction and retention.
- Keep wastewater systems in compliance.
- Provide cost-effective solutions to aging infrastructure.
- Provide guidance to enhance necessary renewal and replacement strategies.
- Streamline preventive and corrective maintenance activities.

Proactive strategizing leads to effective and efficient wastewater systems in the present and future for all sizes of communities. A comprehensive approach to wastewater master planning takes care of immediate trouble areas, prioritizes future needs and adapts to unforeseen changes. Greater investment of community resources on the front end of a WWMP project — collecting baseline data and assessing asset strengths and weaknesses — results in an organic set of programs and plans that need only to be updated, not replaced, and can be implemented readily upon completion. The benefits of a WWMP greatly outweigh the pitfalls of ongoing stopgap measures, which keep communities from comprehensively protecting their residents' quality of life.

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