4.0 Conclusions and Recommendations

4.1 Conclusions

4.1.1 System-Level Evaluation

The following conclusions are made based on the system-level evaluation:

- Wastewater production is affected by potable water usage, rainfall, groundwater elevation, and tidal elevation. Data evaluated for this study indicate that of these variables, groundwater elevation and rainfall exert the most consistently observable influence on wastewater production. Rainfall, it should be emphasized, is also seen to have a direct influence on groundwater elevation.
- On an average daily basis for the period studied between January 2008 and March 2011, approximately 43 percent (2.9 MGD) of the total wastewater flow delivered to the City of Hollywood for treatment and disposal is estimated to be infiltration and inflow. This value is arrived at by assuming that 70 percent of potable water produced ultimately enters the sewer through sinks, toilets, and showers. At an average rate of $2.60 per 1,000 gallons, this amounts to an expense of $2.75 Million annually. It must be emphasized that the infiltration and inflow calculated in this fashion is highly dependent on the percentage of potable water assumed to enter the sewer, and this estimate should be refined if data are available to permit the assumed percentage to be more reliably quantified.
- The system-level monthly data do not allow infiltration and inflow to be separately quantified with much accuracy. It should be noted that a significant portion of the infiltration that affects South Florida's gravity collection systems is in fact rainfall-dependent infiltration that derives from a temporarily higher groundwater table caused by rainfall percolating through pervious surfaces into the groundwater. In general, however, it is estimated that the level of baseline, dry weather infiltration on an average daily basis is approximately 2 MGD for the period studied, and the remaining fraction of extraneous flow is comprised of direct inflow and rainfall-dependent infiltration. Peak monthly inflow (and rainfall-dependent infiltration) during the period studied was approximately 75 MG.
- Flow patterns for each of the four separate metered connections to the City of Hollywood system closely resemble that of the overall system; that is, each sub-system appears to be similarly affected by the variables that affect wastewater production. Wastewater production for basins tributary to Meters 1 and 2, however, appears slightly more variable than that for basins tributary to Meters 3 and 4.

4.1.2 Basin-Level Evaluation

The following conclusions are made based on the basin-level evaluation:

- The basin-level flow data are of good quality overall and permit the individual basins to be characterized and prioritized with respect to inflow and infiltration. This method of flow data collection can also be used in the future to document flow reductions following rehabilitation.
- Data evaluated for this study indicate that as with the system-level evaluation, groundwater elevation and rainfall exert the most consistently observable influence on basin-level flow, and rainfall is seen to have a direct influence on groundwater elevation.

- While tidal elevation undoubtedly influences infiltration in coastal basins, this influence is difficult to observe.
- In general, those basins located East of U.S. 1 exhibit higher levels of inflow and infiltration than those basins located further to the West.
- While direct inflow is observable in multiple basins following rain events, a significant percentage of rain-related flow increases appears to be rainfall-dependent infiltration deriving from a temporarily higher groundwater table. For many basins, this effect continues for multiple days following rainfall events.

4.2 Recommendations

Overall, both the system-level and basin-level findings described herein appear relatively typical of coastal South Florida collection systems, and indicate that a program of assessment and repair is warranted both to limit I-I and help maintain a reliable and structurally sound system. Field investigations for both infiltration and inflow are recommended as outlined below. To the extent possible, the City's in-house capabilities should be utilized in this process to help control the overall cost of the program.

4.2.1 Infiltration and Inflow Investigation

Infiltration investigation activities should ideally coincide with periods of high tide and high groundwater to approximate worst-case conditions, and should include night flow isolation followed by television inspection of gravity mains. Television inspection of suspect laterals should be performed as warranted following inspection of mains. The data analysis conducted for this study indicates that basins may be prioritized for the infiltration investigation as summarized below.

Infiltration Prioritization

Priority	Basin	Night Flow (GPDIM)
1	06	16,545
2	01	14,270
3	15	13,109
4	02	9,187
5	04	6,132
6	14	4,553

Inflow investigation activities should ideally coincide with periods of dry weather and low groundwater, and should include manhole inspection and smoke testing. During the investigation activities, inflow dishes should be installed in manholes and missing or damaged cleanout caps should be replaced. The data analysis conducted for this study indicates that basins may be prioritized for the inflow investigation as summarized below.

Inflow Prioritization

Priority	Basin	Total Inflow for Storm Event (1,000 Gallons per manhole)	Total Inflow for Storm Event (1,000 Gallons)	Peak Hourly Flow for Storm Event (GPM)	Time from Start of Storm Event to Peak Inflow (Hours)
1	15	63	252	175	14
2	01	33	1,915	771	35
3	06	29	3,600	2,800	22
4	05	18	141	75	20
5	11	16	93	64	20
6	02	15	597	448	7

[1] Data for 3.2-inch, 21-hour storm event of September 29, 2010

Analysis of I-I data for the remaining basins indicates that they represent lower priorities at this time, and that I-I levels in these basins may not be sufficiently great to warrant the expense of a focused investigation and repair program. Since aging and deterioration of gravity collection systems is an ongoing process, however, the overall system should be re-evaluated at a future date and basins should be reprioritized for detailed investigation and rehabilitation as warranted.

Following the recommended infiltration and inflow investigation, the following actions should be completed in preparation for the rehabilitation phase of work:

- Process, evaluate, and electronically store the results of inspection activities. Estimate flow rates associated with I-I sources and develop repair recommendations with preliminary repair cost estimates.
- Prioritize the recommended rehabilitation work based on cost-effectiveness and other factors. Rehabilitation of a collection system main line, manhole or service line is typically termed "cost-effective" when the cost of rehabilitation to remove a given amount of extraneous flow is less than the cost of continuing to transport, treat, and dispose of that same amount of extraneous flow over some specified number of years. In addition to cost-effectiveness, factors such as structural condition, public nuisance, health hazards, system hydraulics, and operation and maintenance demand may become the determining factor as to whether a given repair is assigned a higher priority for rehabilitation.
- Generate rehabilitation summary sheets that identify each defect and provide the following associated information:
    - Collection basin number.
    - Upstream and downstream manhole number.
    - Pipe length, diameter, depth and material.

- Defect description, I-I quantification estimate, recommended repair method, estimated repair cost, and estimated payback period.

4.2.2 Expected Benefits

Condition assessment and rehabilitation of the collection system can be expected to provide benefits as outlined below.

- Continue I-I reduction to decrease system wastewater flows and (a) lower the costs of collection, pumping, treatment, and disposal; (b) reduce the potential that I-I may overwhelm the system and lead to overflows; and (c) increase service reliability and system capacity for the benefit of current and future customers.
- Maintain quality and reliability of service to wastewater customers through early identification and correction of problems in the system.
- Create additional system capacity for base and peak flows.
- Reduce long-term sewer infrastructure preservation costs by proactively repairing lines prior to advanced degradation.
- Reduce high-cost emergency repairs by identifying and repairing lines in a state of very poor condition or imminent failure.
- Focus and conserve resources by identifying and prioritizing short- and long-term actions to address structural deficiencies in the system, and by lowering priority for those portions of the system that are in good condition.
- Strengthen preventive operation and maintenance (O&M) activities by identifying lines that are susceptible to recurring blockages due to surcharging, excessive grease buildup, dips, inadequate slopes, offset joints, or heavy root intrusion; these lines can then be placed on a program of regular maintenance cleanings to pre-empt a potential blockage and sanitary sewer overflow (SSO).
- Reduce costs from SSO response including in-home backups and related cleanup expenses.
- Reduce potential enforcement liability, both by reducing the probability of SSOs and through the creation of an *affirmative defense*; that is, a demonstration that the utility has a program in place to avoid SSOs.
- Increase the availability of reliable sewer system service to attract additional tax base and growth.

The City's decision to continue investigation and rehabilitation activities in the wastewater collection system will support the objective of maintaining a well-functioning and reliable collection system to provide improved service to the community at a lower cost to the utility.