VERSAILLES SANITARY SEWER EVALUATION SURVEY

I. Introduction

A. Description of Study

The Sanitary Sewer Evaluation Survey (SSES) is an investigation of a Utility's collection system in order to evaluate the deficiencies and needs of the system and the cost effectiveness of repairs and improvements. The Survey includes various investigative methods such as Manhole Inspections, Smoke Testing, Flow Monitoring, Dye Tracing and Video Inspection by closed circuit television camera. The information obtained from the investigations is studied and compared to determine the significance of the various components and their relationships within the system.

B. City's Need for Study

The City has been experiencing the effects of rain events on their wastewater facilities for several years. The flows at the Wastewater Treatment Plant increase significantly during wet weather, and there are several locations in the system where wet weather induced overflows occur on a regular basis. In 2009, the City requested GRW to prepare a Sanitary Sewer Overflow Plan which identified seventeen (17) known overflow points and proposed plans to eliminate them. By the end of 2010, three (3) of the overflow points were eliminated by maintenance and repair efforts. The southwest interceptor and pump stations project was constructed and placed in service in 2012, and those new facilities resulted in the elimination of seven (7) of the overflow points, by rerouting the flow of the sewage. Seven (7) overflow points remain, with five (5) of these considered "problem" overflows. These are the Charmill, Woodlands, Stonegate and Cedar Ridge Pump Stations, and Manhole 3-06-002 at the Big Spring City Park. While the elimination of these overflow points is a great improvement, the impact and significance of the wet weather flows that are transported to the Treatment Plant are still a concern.

II. Sewer System Mapping

The City of Versailles began upgrading the Sewer System Map in 2010, locating and labeling manholes by GIS methods referenced to state plane coordinates. This was performed in conjunction with the Manhole Inspection program. They now have a digital map and database of their system. The system was divided into four (4) zones, and then into drainage basins within each zone, with a total of thirteen (13) drainage basins. The manholes were identified by the zone number, the basin number and an individual number. Appendix A contains the Wastewater Collection System Map.

III. Manhole Inspections

Manhole inspections were performed by City forces using the standard report form included in Appendix B. Two thousand one hundred sixteen (2,116) manholes were identified, with sixteen (16) of these being inaccessible or otherwise unable to be inspected. One thousand sixteen (1,016) manholes were reported as having no defects. All drainage basins contain manholes with identified defects, although they may or may not contribute to the wet weather inflow & infiltration problem. The types of defects that were identified are as follows:

1	No rehabilitation	14	Plug Vent Holes in MH Lid
2	Replace MH Lid	15	Plaster and Waterproof Brick MH Walls
3	Raise MH Lid/Frame	16	Seal Joint Sections of Precast MH
4	Replace Frame	17	Repair MH/Pipe Connection (Internal)
5	Reset Frame to MH	18	Repair MH/Pipe Connection (External)
6	Grout MH Interior	19	Repair MH/Drop Pipe Connection (Internal)
7	Install _____ MH Steps	20	Repair MH/Drop Pipe Connection (External)
8	Reconstruct Trough/Aprons	21	Repair MH/Service Line Connection(Internal)
9	Replace MH Cone	22	Repair MH/Service Line Connection(External)
10	Replace MH Barrel	23	Clean MH
11	Construct New MH	24	Other Utilities Passing Through MH
12	Remove MH Obstruction/Rots	25	Replace MH Riser
13	Plug Lift Hole In Precast MH		

The following table lists the totals and the types of defects in each basin. A detailed list of each manhole with associated defect codes for each basin is included in Appendix B.

Manhole Defect Summary by Basin

Defect Description	Defect Code	Basin 01	Basin 02	Basin 03	Basin 04	Basin 05	Basin 06	Basin 07	Basin 08	Basin 09	Basin 10	Basin 11	Basin 12	Basin 13	# of Defects
No Defect	1	277	58	70	7	60	161	105	70	45	41	3	30	89	1016
Replace MH Lid	2	4	0	1	0	2	4	0	0	0	2	0	0	1	14
Raise MH Lid/Frame	3	1	0	1	0	2	1	3	3	1	0	0	0	8	20
Replace Frame	4	8	3	1	0	2	12	2	0	2	3	0	0	2	35
Reset Frame to MH	5	187	93	37	14	25	77	9	24	23	14	6	15	6	530
Grout MH Interior	6	22	4	0	11	2	6	13	0	1	0	0	1	1	61
Install MH Steps	7	7	0	0	0	0	4	2	3	0	2	0	0	2	20
Reconstruct Trough/Aprons	8	28	8	12	6	5	16	3	2	3	5	0	3	1	92
Replace MH Cone	9	6	3	2	2	6	15	2	0	1	4	0	0	0	41
Replace MH Barrel	10	7	3	2	2	1	11	0	0	1	4	0	0	0	31
Construct New MH	11	2	14	9	1	0	5	1	0	0	1	0	2	0	35
Remove MH Obstruction	12	12	19	9	0	3	5	1	0	3	2	1	0	6	61
Plug Lift Hole in Precast MH	13	1	1	0	0	0	0	1	0	0	0	0	0	0	3
Plug Vent Holes in MH Lid	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plaster & Waterproof Brick MH Walls	15	6	0	3	0	2	0	0	0	0	1	0	0	1	13
Seal Joint Sections in Precast MH	16	9	0	3	0	0	1	15	0	4	2	0	0	0	34
Repair MH/Pipe Connection - Internal	17	15	6	10	5	0	11	4	0	1	1	0	0	1	54
Repair MH/Pipe Connection - External	18	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Repair MH/Drop Pipe Connection - Internal	19	1	0	1	1	0	0	0	0	0	0	0	0	0	3
Repair MH/Drop Pipe Connection - External	20	0	0	0	0	0	0	0	0	0	0	0	1	1	2
Repair MH/Service Line Connection - Internal	21	15	7	2	1	5	6	3	2	2	1	0	1	0	45
Repair MH/Service Line Connection - External	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clean MH	23	85	57	52	6	15	80	25	2	41	9	1	16	5	394
Other Utilities Passing Through MH	24	1	0	0	0	0	4	0	0	0	0	0	0	0	5
Replace MH Riser	25	93	22	27	2	7	31	2	2	14	3	3	7	3	216
TOTAL NUMBER OF DEFECTS		787	298	242	58	137	450	192	108	142	95	14	76	127	

Each manhole defect was assigned a “corrective action”, with some defects being grouped together into one category. For the identified twenty-five (25) defects, there are eleven (11) corrective actions, or types of repairs. The corrective action was assigned an estimated cost, and the total repair cost estimate for each manhole was calculated.

Corrective Action	Estimated Cost
Replace Frame and Lid	$750
Reset Frame	$400
Seal Interior Joints/Cracks	$800
Install MH Steps	$500
Reconstruct Trough	$1,000
Replace Cone or Barrel	$1,500
Replace Manhole	$4,000
Clean Manhole	$350
Seal Pipe Connections	$600
Other Utilities in Manhole	$3,000
Replace MH Riser	$600

The detailed cost information for each manhole in all basins is presented in Appendix B. The following tables present a summary of the corrective actions for each drainage basin, and the total estimated cost per basin for repairing all manhole defects.

Corrrective Action Summary by Basin

Basin Number	No Action Required	Replace Frame and Lid	Reset Frame	Seal Interior Joints/Cracks	Install MH Steps	Reconstruct Trough	Replace Cone or Barrel	Replace Manhole	Clean Manhole	Seal Pipe Connections	Other Utilities in Manhole	Replace MH Riser	Total No. of Repairs
Basin 01	277	11	187	38	7	28	10	2	97	29	1	93	**503**
Basin 02	58	3	93	5	0	8	4	14	67	12	0	22	**228**
Basin 03	70	3	37	6	0	12	2	9	52	12	0	27	**160**
Basin 04	7	0	14	11	0	6	2	1	6	6	0	2	**48**
Basin 05	60	4	25	4	0	5	6	0	17	5	0	7	**73**
Basin 06	161	15	77	7	4	16	16	5	84	16	4	31	**275**
Basin 07	105	5	9	19	2	3	2	1	26	6	0	2	**75**
Basin 08	70	3	24	0	3	2	0	0	2	2	0	2	**38**
Basin 09	45	3	23	5	0	3	2	0	43	3	0	14	**96**
Basin 10	41	4	14	3	2	5	5	1	11	2	0	3	**50**
Basin 11	3	0	6	0	0	0	0	0	2	0	0	3	**11**
Basin 12	30	0	15	1	0	3	0	2	16	2	0	7	**46**
Basin 13	89	11	6	2	2	1	0	0	9	1	0	3	**35**
TOTAL	**1016**	**62**	**530**	**101**	**20**	**92**	**49**	**35**	**432**	**96**	**5**	**216**	**1638**

Cost Estimate by Basin

	Number of Repairs	Estimated Cost
Basin 01	503	**$278,100**
Basin 02	228	**$157,300**
Basin 03	160	**$114,450**
Basin 04	48	**$34,300**
Basin 05	73	**$43,350**
Basin 06	275	**$179,250**
Basin 07	75	**$47,450**
Basin 08	38	**$18,450**
Basin 09	96	**$46,700**
Basin 10	50	**$35,350**
Basin 11	11	**$4,900**
Basin 12	46	**$28,800**
Basin 13	35	**$19,800**
TOTAL	**1638**	**$1,008,200**

IV.

V. Flow Monitoring

A. Flow Meters

Flow Monitoring was performed in the spring of 2012 for sixty-six (66) days from March 6 to May 11. Meters were installed at nine (9) locations. A rain gauge was installed at City Hall to record the amounts and duration times of rainfall events. All flow meters showed evidence of increased flows during wet weather events. The most extreme effect was observed for Flow Meter Location 1, which recorded flows from Basin 4 and Basin 12, an area near the WWTP. The second highest increase in flow was at Flow Meter Location 2, which recorded flows from Basin 3, a neighborhood at the north end of the service area. All areas of the

collection system appear to contribute increased flows during wet weather events. The Flow Meter location map showing the metered areas corresponding to each flow meter is in Appendix C. Also included is a map that illustrates the relationship between the flow-metered areas and the drainage basins, with the dry day flows and the maximum flows for each flow metered area, as tabulated below.

Flow Meter Number	Maximum Dry Day Flow (gpm)	Maximum Recorded Flow (gpm)
1	40	650
2	170	1200
3	560	1200
4	870	2800
5	50	340
6	125	210
7	120	500
8	125	500
9	1740	4600

B. Pump Stations

City Utilities staff routinely record the "run-time" of the pumps at each pump station in the system, if the station is equipped with run-time meters. This is useful to monitor the capacities of the pump stations, and to see if the two pumps are alternating and operating fairly equally. This data was used to compare daily run times with rain gauge data during the period of March 6 through May 11, 2012. Many of the pump stations exhibited a direct effect of increased run time with a recorded rain event, which indicates that wet weather flows are entering those particular areas of the collection system. Appendix D contains the graphical comparisons of run times to rainfall events for each of the twenty-one (21) pump stations for which the City had recorded data.

The following table lists the City's pump stations and their capacities:

Versailles Wastewater Pumping Stations		
Pump Station Name	**Motor Size**	**Capacity (gpm)**
Lift Station No. 1	30 HP	800
Lift Station No. 2	30 HP	1,075
Lift Station No. 3	70 HP	1,550
Lift Station No. 4	70 HP	1,850
Adena Woods	7.5 HP	180
Ball Park	10 HP	600
Bryanwood	5 HP	100
Cedar Ridge	7.5 HP	100
Charmill	10 HP	500
Colony 1	15 HP	300
Crossfield	7.5 HP	125
Dan Drive	5 HP	Unknown
Hellard Trailer Park	5 HP	80
Homestead	7.5 HP	90
Huntertown Glenn	5 HP	80
Lanes View	10 HP	150
Locust Grove	2 HP	100
Merewood	10 HP	225
Methodist Home	10 HP	225
Stonegate	20 HP	475
Woodland	5 HP	100

VI. Smoke Testing

Based on the recommendations of City personnel, several areas of the collection system were designated to be included in Phase I of the smoke testing investigation. These areas are known to City personnel as chronic problem areas, and were determined to be a priority for the smoke testing investigation. Smoke testing is performed using a blower and "artificial" smoke, a harmless chemically-induced vapor that is blown into the sewer manholes and lines. During periods of dry weather, the smoke may find its way to the surface through openings in the collection system. This method can result in a visual demonstration of general locations of cracks, defects or unauthorized connections to the system. Smoke testing was performed in six (6) basins of

the system, resulting in the location of one hundred thirty-seven (137) defects. The sources of the defects are as follows:

Type	Number
Private Property	70
Roof Drains	13
Storm Sewer	12
Main Line	16
Manhole	26
TOTAL	**137**

It was observed that eleven (11) of the manholes that were identified by smoke testing as defective were not noted as defective in the Manhole Inspection. A summary of the number of defects in each basin and their rate of severity is shown below. A detailed list of each of the defects is in Appendix E, along with a map showing the locations of the discovered defects.

Summary of Smoke Defects				
Basin	**Severe**	**Moderate**	**Minimal**	**Totals**
2	6	3	2	11
3	20	11	9	40
5	11	4	6	21
6	32	19	6	57
10	3	1	0	4
13	1	3	0	4
TOTALS	73	41	23	137

Video Inspection of Sewer Lines

A. General

Video Inspection is performed by a heavy-duty closed circuit television (CCTV) camera that is slowly advanced through the cleaned sewer pipe. The operator of the camera equipment is trained through the Pipeline Assessment Certification Program (PACP) in the observation and analysis of the pipe conditions. These are noted and recorded per industry standards. CCTV investigation may typically show such conditions as cracked, broken, or collapsed pipe, offset or leaking pipe joints, roots that have penetrated the joints or cracks, service connection defects, obstructions, and misalignment and sags in the pipe line.

B. Video Inspection of Versailles Collector Lines

The video inspection that was performed by an outside contractor in 2012 included areas of Basin 1, Basin 5, Basin 6, and Basin 10. These particular areas were determined by City personnel to be the ones in greatest need of inspection and repair. A map showing the areas that were video-inspected is included in Appendix F. The pipes in Basin 6 in particular were discovered to be in bad condition, with many locations of roots obstructing the lines, and structural issues of cracks and collapses. Additionally, city forces performed video inspection of areas in Basin 4.

As video inspection was taking place defects were compiled in a database. Along with this database a report was created for each section of line that was inspected. This information was used to verify the condition of the pipe as well as make decisions on what work would be needed to rehabilitate the line. The following table is a quantity breakdown of all the proposed work to be done within the areas that were video inspected. Without reviewing each video the severity of certain defects such as broken pipe and large joint offset were assumed to have been severe enough to require point repairs prior to installing a cured in place pipe liner. It was assumed that service connections with medium roots or root balls would need to be replaced instead of being cured in place. It was also assumed that one out of every five break-in (or “hammer”) taps would need to be cured in place. Following a future, more detailed review of videos, the amount of point repairs and service connection replacements could be reduced depending on the severity of breaks and

offsets as well as the size of the roots. The following table presents estimated costs of various repairs:

Corrective Action	Estimated Cost
6" dia. CIPP	$27 per lf
8" dia. CIPP	$27 per lf
CIPP spot repairs	$2,200 ea.
CIPP service connection	$2,000 ea.
Replace service connection (open cut)	$2,000 ea.
Point repair (open cut)	$3,000 ea.
Replace service connection in 6" dia. main	$1,800
Lateral reinstatement–CIPP	$100

The detailed cost information for each inspected line in the five basins is presented in Appendix G. The following tables present a summary of the corrective actions for each drainage basin, and the total estimated cost per basin for repairing all mainline defects.

Summary of Rehab Line Work by Basin						
Type of Repair	**Basin Number**					
	1	**4**	**5**	**6**	**10**	**Total**
6" CIPP (lf)				2,256		**2,256**
8" CIPP (lf)	8,675	2,785	4,409	34,376	2,171	**52,416**
Spot Repairs (CIPP)	14	0	7	29	14	**64**
CIPP Service Connection	11	1	11	77	9	**109**
Replace Service Connection (open cut)	7	3	7	6	2	**25**
Point Repair (open cut)	32	20	12	136	10	**109**
Replace Service Connection in 6" dia. (open cut)	0	0	0	23	0	**23**
Lateral Reinstate (CIPP)	151	28	75	603	45	**902**

Summary of Line Repairs for Inspected Lines (does not include manholes or other project costs)	
Basin Number	**Estimated Cost**
Basin 1	$412,138.50
Basin 4	$146,003.10
Basin 5	$213,945.70
Basin 6	$1,690,688.30
Basin 10	$146,333.20
TOTAL	**$2,609,108.80**

For this study approximately 570 sections of line, totaling 106,000 linear feet of sewer line, were included in the video inspection project. This is approximately 25 percent of the total length of 438,211 linear feet of lines in the Versailles sewer collection system. Due to obstructions, bends, or other issues, 22,000 linear feet were not accessible, so the actual inspection reports are for 94,000 feet of sewer line. The lines that were not accessible should be included in the first construction project for further investigation.

During the video inspection of the five basins, multiple discrepancies between existing mapping and actual conditions of the collection system were found. The table below contains a list of previously unidentified manholes that were found during the inspection, along with their upstream and downstream manholes. In addition to new manholes being found during video inspection, two additional discrepancies were found regarding lines that are shown on the existing mapping. The existing mapping shows Manhole 1-05-092 as being an upstream manhole flowing into two lines, one to MH 1-05-091 and one to 1-05-92A. During inspection, it was observed that both manholes -091 and -092A had lines going toward MH -092, which seemed to agree with the mapping, however, it was discovered that flow was actually from MH -092 to MH -091 and both lines leading toward each other out of manholes -092 and -92A were only short stubbed sections of lines. A similar issue occurred at MH 1-05-089A. Flow is actually going into MH 1-05-088 with stub lines out of MH 1-05-089A and MH 1-05-89, toward each other. These

discrepancies were reported to the City/County GIS coordinator for amendment of the mapping and database.

New Manholes Located During Video Inspection of Basins 1, 4, 5, 6, & 10		
New Manhole	**US MH**	**DS MH**
3-10-900DS	3-10-014	3-10-010
3-06-075B	3-06-126	3-06-075
3-06-063A	3-06-063	3-06-061
3-10-9000RM	3-10-029	3-10-030
3-06-096A	3-06-096	3-06-095
3-06-067A	3-06-067	3-06-065
3-06-078A		3-06-077
1-05-091A	1-05-091	1-05-077
3-06-900055	3-06-249	3-06-247
3-06-9000JC	3-06-144	3-06-143
3-06-9002JC	3-06-167	3-06-9003JC
3-06-9003JC	3-06-9002JC	3-06-166
3-06-9001JS	3-06-181	3-06-181
3-06-9007JC	3-06-050	3-06-049
3-06-900JSC	3-06-110	3-06-108

Several areas within this study were both video inspected and smoke tested. A map of these areas can be found in Appendix H. For line sections where both were completed, locations with mainline smoke testing defects were further reviewed to look for a possible cause. Following the review it appeared that there is one mainline smoke testing

defect in the area that had both TV and smoke testing data. This defect appeared close to the location of an intruding hammer tap which is likely faulty. Based on previous experience it is likely that other mainline smoke testing defects are the results of faulty taps, fractured and broken pipe, or collapsed pipe.

VII. Summary, Conclusions and Recommendations

A. Inspection Results

Flow monitoring results indicate significant wet weather Inflow and Infiltration in Basins 4 and 3. Pump Station Run Time records indicate that all the pump stations are affected by rainfall events, with the most significant being Bryanwood and Methodist Home, serving Basin 1, and Stonegate and Woodlands, serving Basin 2. The Manhole Inspection program that was performed resulted in the following list of basins with the highest proportion of manholes in need of repair:

Basin 4: 73%
Basin 11: 70%
Basin 2: 67%
Basin 3: 58%
Basin 1: 51%

Smoke Testing and CCTV Inspections were performed in Basins 1, 2, 3, 4, 5, 6, 10 and 13.

Based on these inspection results and the City's and GRW's observations, we have proposed a priority list of the areas and tasks that are recommended as part of the City's master sewer collection system rehabilitation plan. Because we have the video inspection results for areas in Basins 1, 4, 5, 6, and 10, we would proceed with preparing a construction/repair project for those lines as the first project in the rehabilitation program. Basins 1, 2, 3, 4, 6, 11, and 12 appear to be the basins most in need of repair. Areas in those basins would be the priority for CCTV investigation and evaluation for a second construction project.

The City of Versailles has acquired state of the art CCTV equipment and software, and have trained the utilities personnel in the PACP techniques

and codings. The intent of this program is to have a continuous schedule for investigating the sewer lines over the next several years. These inspection results would be evaluated by the engineer as they are received from the City, to determine the scope of the future construction projects.

Considering the newer age of the facilities in Basins 7, 8, 9, and 13, we would assume that no further investigation of these areas will be required. Those areas contain 96,397 linear feet of collector sewer, which will be subtracted from the total to be evaluated. It is also reasonable to assume that some areas of the remaining basins will not need investigation, perhaps because they are newer, or have been repaired in the recent past. For this study, we have designated an average amount of 10% of the remaining areas to be subtracted from the total line length to be investigated. This amount could be adjusted from basin to basin as more field data is obtained in future phases. Reports of current field data can be found in Appendix J on the attached DVD. This includes reports for Smoke Testing, Manhole Inspections, and CCTV.

B. Sewer System Rehabilitation Schedule

Approximately 106,000 linear feet of the collection system was designated for CCTV inspection as part of this SSES Report. Assuming the elimination of Basins 7, 8, 9, and 13 from the project, and the 10% reduction discussed above, there remains approximately 203,125 linear feet of sewer to be inspected. As part of Division of Water requirements, the City of Versailles must complete all rehabilitation work on their system in the next 5 years. In order to meet this deadline a recommended project schedule has been prepared. This schedule can be found in Appendix I. The schedule is based on performing one construction project per year, so the system rehabilitation program has five (5) phases.

The first phase of the schedule includes the investigation and evaluation included in this Sanitary Sewer Evaluation Study. In addition the recommended first phase includes preparing a detailed schedule of work and ultimately a construction project based on the 106,000 linear feet of sewer that has been CCTV inspected as part of this report (Parts of Basins 1, 4, 5, 6, and 10). The preliminary evaluation indicates that repairs are needed on 47% of the lines that were inspected. This would result in a project that includes 55,520 linear feet of rehabilitation, along with various associated repairs. The scope of work of such a project may

be excessive in terms of the City's capital improvements plan, so it may be wiser to divide it into two construction projects, one of which would be planned for Phase 2. We would also recommend a manhole repair project and pump station rehabilitation in Phase 1.

The remaining 203,124 linear feet of sewer line has been divided into four phases. Each phase would generally span 26 months with tasks and projects overlapping. This allows for city personnel to CCTV lines year-round following periods of wet weather, and provide the opportunity of on-going review of video information so that severe defects can be handled quickly when found. The detailed schedule can be found in Appendix I. Both basin sizes as well as potential for defects were considered when separating basins into phases.

Phase 1 will include part of the areas that were CCTV inspected as part of the SSES report. Phase 2 would include the reminder of the needed repairs determined from the Phase 1 CCTV inspections, manhole repairs and pump station repairs. Phase 3 would include remaining areas of Basins 4, 5, 10, and Basin 2. Phase 4 would include Basins 3, 11, 12, and areas of Basin 1. Phase 5 would include remaining areas of the system that are considered "problem" or "potential problem" areas.

C. Sewer System Rehabilitation Budget

Following a preliminary review of the CCTV information, which includes inspection of 116,120 linear feet of line, it appears approximately 47% of the system needs to be rehabilitated with Cured-in-Place (CIPP) pipe. Based on this review an approximate budget to complete all CIPP pipe, point repairs, spot repairs, and service connection replacements from the CCTV inspection done for the SSES would cost $2,609,108. We have divided this work into two construction projects, designated as Phase 1 and Phase 2.

Preliminary budgets for remaining mainline rehabilitation have been created. These budgets can be found in the table below. We have assumed that future areas of the system will not need the amount of repair work that the first two phases will, based on the knowledge that the pipelines are newer, and the City's experience with "problem" areas. This estimate does not include costs for CCTV work that would be done by a contractor, manhole rehabilitation costs, or design costs. It is assumed

that CCTV work for each phase would be completed by the City personnel throughout the year during periods of wet weather.

Preliminary Budgeting Line Rehabilitation - Construction	
Phase	**Estimated Cost**
Phase 1	$1,349,783
Phase 2	$1,148,400
Phase 3	$1,480,500
Phase 4	$900,000
Phase 5	$900,000
TOTAL	**$5,778,683**

D. Manhole Rehabilitation

Manhole Inspections that were performed resulted in the identification of defects in 1,031 manholes. The total cost estimate of $1,008,200 presented in Section III and Appendix B assumes repair of 100% of the defects that were identified. From the standpoint of evaluating the extent of inflow and infiltration to the system from the manhole sources, it can be assumed that only certain types and/or locations of defects actually contribute to the wet weather flow issues. Other types of defects may have very little effect on the operation or performance of the collection system and can be considered low priorities. For example, replacing or resetting manhole frames would be a task to be performed by city forces, and not included in a construction project. These determinations will be made during the design phase of the construction project preparation. From the numbers of the types of repairs in our summary and from past experience, we can estimate that 40% of the cost of the manhole repairs will be determined to be unrelated to wet weather flow contribution or such low priority as to be eliminated from the rehabilitation program. The resulting $600,000 cost of manhole repairs would be divided up among the proposed phases of the rehabilitation program.

Preliminary Budgeting Manhole Repair - Construction	
Phase	**Estimated Cost**
Phase 1	$90,000
Phase 2	$127,000
Phase 3	$125,000
Phase 4	$223,000
Phase 5	$35,000
TOTAL	**$600,000**

E. Pump Station Rehabilitation

As of the spring of 2013, the Versailles Collection System has twenty-one (21) pump stations in operation. These stations were listed in a table in Section IV. The Crossfield Drive Pump Station was rehabilitated in 2013. Four other stations are in need of repairs and/or improvements. These are the Charmill PS, the Stonegate PS, the Woodlands PS, and the Methodist Home PS. These pump stations will be evaluated for capacity, code regulations and Division Of Water requirements. Improvements may include pump replacement, electrical improvements, backup pumping and power, and increased storage, in accordance with "Ten States Standards". Some options for achieving the required back-up capabilities are adding backup generators for each station or having sufficient portable generators; providing dual electrical feeds from separate substations; providing backup (emergency) pumps at each station; and assuring that there are two hours of storage capacity in the wet well and associated piping. A preliminary average cost estimate for the rehabilitation of these pump stations is $100,000 each.

F. Summary

The Sanitary Sewer Evaluation Study was performed in order to determine the sources of wet weather inflow and infiltration and to identify repairs

and improvements needed for the purpose of reducing overflow incidents and excessive influent flows at the Wastewater Treatment Plant. Mapping of the entire collection system was updated and incorporated into a GIS database. Manhole inspections were performed on 98% of the manholes in the system, excluding only those that were inaccessible at the time, or unknown manholes that were found during smoke testing and CCTV investigation. Smoke testing of 46% of the collection system was performed. Approximately 25% of the lines in the system have been video-inspected. Flow and rainfall events during the spring of 2012 were monitored and recorded. These investigative and evaluative methods were used to examine the system's structural, hydraulic, and capacity characteristics.

The purpose of the Sanitary Sewer Evaluation Survey is to discover the sources of wet weather inflow and infiltration (I&I) and the extent of the repairs needed to the system. Upon obtaining this information, an evaluation of the amount of wet weather flow that a source or defect contributes versus the cost of repair is considered. The goal is to eliminate sanitary sewer overflows to the environment, and to reduce the amount of wet weather flow to the WWTP. Upon achieving the elimination of overflows, the cost of further repairs for the purpose of reducing I&I are compared to the cost of allowing the I&I to continue to enter the system and flow to the treatment plant.

The conclusions obtained will result in recommendations for repair work that will have a significant impact on the reduction of overflows and wet weather flows to the WWTP, and on the performance of the collection system, while considering the cost effectiveness of the repairs.

G. Recommendations

Taking into consideration the results of the sanitary sewer investigations, the evaluation of found conditions of investigated areas, the projection and estimation of conditions of the remainder of the collection system, the imposed schedule for completion of the rehabilitation program, and the realities of scheduling and budget, a five-phase Rehabilitation Program is recommended. The following tables list the details of each phase, and a summary of work per basin. Upon completion of the program, approximately 73% of the total collection system will be investigated and evaluated, and an estimated 30% of the total will be rehabilitated.

Versailles Sanitary Sewer Collection System Recommended Rehabilitation Program			
Phase	**% of system investigated**	**% of system repaired**	**Estimated Project Cost**
1	36.36	6.9	$1,773,992
2	15.98	5.9	$1,588,404
3	15.98	7.7	$1,959,474
4	15.98	4.8	$1,417,723
5	15.67	4.7	$1,090,235
Totals	**72.79**	**30**	**$7,829,828**

Versailles Wastewater Collection System Rehabilitation Program						
Phase	**1**	**2**	**3**	**4**	**5**	**Total**
LF CCTV	105,903	51,000	51,000	51,000	50,000	319,000
LF Rehab	30,000	25,520	32,900	20,000	20,000	128,420
Line Rehab Cost	**$1,349,783**	**$1,148,400**	**$1,480,500**	**$900,000**	**$900,000**	**$5,778,683.00**
MH Repairs	82	132	112	252	30	608
MH Repairs Cost	**$90,000**	**$127,000**	**$125,000**	**$223,000**	**$35,000**	**$600,000.00**
Lift Station Rehab	1	1	1	1		4
Lift Station Rehab Cost	**$100,000**	**$100,000**	**$100,000**	**$100,000**	**$0**	**$400,000.00**
Basins	1, 4, 5, 6, 10	1, 4, 5, 10,	4, 5, 10, 2	1, 3, 11, 12	Remaining areas	1, 2, 3, 4, 5, 6, 10, 11, 12
Schedule	Sept. 2013 – Nov. 2014	July 2013 – Sept. 2015	July 2014 – Sept. 2016	July 2015 – Sept. 2017	July 2016 – Sept. 2018	Sept. 2013- Sept. 2018
Total Estimated Construction Costs	**$1,539,783**	**$1,375,400**	**$1,705,500**	**$1,223,000**	**$935,000**	**$6,778,683**
Other Project Costs	**$234,209**	**$213,004**	**$253,974**	**$194,723**	**$155,235**	**$1,051,145**
Total Estimated Project Cost	***$1,773,992***	***$1,588,404***	***$1,959,474***	***$1,417,723***	***$1,090,235***	**$7,829,828**

Versailles Wastewater Collection System Rehabilitation Program

Basin Summary

Basin	Manholes	Total Basin Line Length	Line Length CCTV Inspected in Phase 1	MH Defects	% CCTV Complete	Line Length Smoke Tested in Phase 1	% of Lines Smoke Tested	Number of MH's with Defects	% of Defective MH's	Proposed Phase 2 CCTV	Proposed Phase 3 CCTV	Proposed Phase 4 CCTV	Proposed Phase 5 CCTV	Proposed % CCTV Complete
1	**620**	123,485	21,111	787	17%	10,613	9%	315	51%	38,000		26,000	27,200	91%
2	**210**	50,333		298	0%	45,579	91%	140	67%		41,000		4,600	91%
3	**179**	38,779		242	0%	38,035	98%	104	58%			17,057	18,200	91%
4	**30**	6,005	3,012	58	50%		0%	22	73%	1,200	1,300			92%
5	**119**	26,154	7,648	137	29%	23,630	90%	51	43%	9,000	6,000			87%
6	**344**	72,200	65,196	450	90%	61,349	85%	165	48%					90%
7	**178**	35,234		192	0%		0%	65	37%					0%
8	**104**	17,031		108	0%		0%	30	29%					0%
9	**106**	14,000		142	0%		0%	52	49%					0%
10	**77**	16,032	8,936	95	56%	16,473	103%	30	39%	2,800	2,700			90%
11	**10**	4,348		14	0%	186	4%	7	70%			3,913		90%
12	**57**	4,478		76	0%		0%	24	42%			4,030		90%
13	**121**	30,132		127	0%	7,863	26%	26	21%					0%
Total	**2,155**	**438,211**	**105,903**	**2,726**	**26%**	**203,728**	**46%**	**1,031**	**48%**	**51,000**	**51,000**	**51,000**	**50,000**	**73%**