MID-POINT REPORT

LAKE ST. LOUIS SEWER IMPROVEMENT PROGRAM

Peer Review

B&V PROJECT NO. 188860

PREPARED FOR

Public Water Supply District No.2 of St. Charles County, MO

15 JULY 2015

BLACK & VEATCH
Building a world of difference.

Table of Contents

Mid-Point Progress Summary 2
1. Introduction and Background 3
   Purpose and Scope for Peer Review 4
2. Document Review 5
   Lake St. Louis Emergency Response Plan 5
   Lake St. Louis Subaqueous Conceptual Improvement Plan (Alternatives Report) 7
   Lake Saint Louis Sewer Improvement Program Engineering Report (Engineering Report) 11
3. Inspection of Existing Subaqueous Sewer System 13
   Necessity of Inspecting the Subaqueous Sewers 13
   Sewer Inspection Technology Review 13
   CCTV Inspection 14
   Exterior Pipe Inspection 15
   Key Requirements and Cost 15
4. Alternative Evaluation Methodology 16
   Selection Criteria Definitions 16
5. Alternative Evaluation 20
   Alternative 1 – Maintain Existing Subaqueous Sewers 20
   Alternative 2 – Rehabilitate Existing Subaqueous Sewers 20
   Alternative 3 – Lift Stations and Force Mains 20
   Alternative 3A – Lift Stations and Force Mains (Minimize) 20
   Alternative 3B – Lift Stations and Force Mains (Fewer Larger PSs) 20
   Alternative 4 – Reroute Gravity Sewers 20
   Alternative 4A – Parallel Replacement of Existing Sewers (Drained Lake) 20
   Alternative 5 – Hybrid (Big Lake: Lift Stations and Small Lake: Rehabilitate Sewers) 20
   Alternative 5A – Hybrid (To be developed) 21
   Alternative 5B – Individual Grinder Pumps and Low Pressure Force Mains 21
   Alternative 5C – Hybrid (To be developed) 21
6. Comparison of Alternatives 22
7. Recommendations 23

MID-POINT PROGRESS SUMMARY

At 45 days into the Peer Review our progress is satisfactory. Work that has been started or completed on the tasks identified in the scope of work is described below.

- *Kick-off Meeting.* We participated in a kick-off meeting with Public Water Supply District No. 2 (PWSD2) staff to confirm the scope of work and begin orienting ourselves with the Lake St. Louis Sewer Improvement Program.
- *Document Review.* The applicable reports have been reviewed and comments are documented in the report. In addition, many other supplementary documents and data have been reviewed to develop an informed understanding the LSL sewer system and the organization that operates and maintains it. We submitted a request for information (RFI) to PWSD2 ranging many topics from the costs to operate and maintain the current LSL system, to background reports on the existing sewer system and the lakes, to PWSD2 capabilities to perform maintenance in a marine environment, to complaint records and so on. PWSD2 provided an extensive amount of information in response to our RFI that has already been very helpful in the peer review.
- *Field Visit.* On June 11, 2015 Black & Veatch staff visited the majority of the impact points/manholes where the sanitary sewers connect to the subaqueous laterals leading to the main trunk sewer. Our goal was to gain an appreciation for sites where the improvements are proposed and to understand the accessibility constraints.
- *Evaluation of Inspection the Subaqueous Sewers.* Our effort to evaluate the necessity and feasibility of inspecting the subaqueous sewer system is underway. We have had many discussions with a group of contractors we feel are capable of performing the inspection in an effort to prepare a successful inspection plan. We may not be able to inspect the entire extent of the system without additional access, but were working with these contractors to develop an inspection means without additional access if at all possible. We've also evaluated some of the cutting edge technologies in this field to determine if any are applicable and cost-effective. We've also consulted with DIPRA (the Ductile Iron Pipe Research Association) in developing the best available data to forecast life expectancy of the existing subaqueous sewers.
- *Alternative Evaluation Methodology.* The draft Selection Criteria Matrix has been developed (Table 1 later in the report). We have identified a set of criteria which we feel incorporates a broader set of criteria than the criteria included in the Decision Matrix provided in the Alternatives Report. The new set of criteria includes the parameters identified in our Scope of Work and the concerns presented by the public. Also, we have provided a weighting factor to make sure the more important ones receive more influence over the selection score. A preliminary rating was prepared for the five alternatives include in the Alternatives Report.
- *Alternative Evaluation.* The alternative evaluation is underway, but not complete. This effort will be completed over the next 45 days as we prepare for the 90% draft report submittal.

1. INTRODUCTION AND BACKGROUND

The Public Water Supply District No. 2 of St. Charles County (District) is preparing to initiate a sewer improvement program (Program) in Lake St. Louis, Missouri (LSL) at an estimated capital cost of $33 million (2014 dollars). PWSD2 owns and operates the LSL sanitary collection system, a significant portion of which is situated beneath Lake Saint Louis (Big Lake) and Lake Saint Louise (Small Lake). Approximately 36,000 linear feet of trunk sewer and associated laterals are in service in a buried, subaqueous state beneath the lakes. There is very limited access to these sewers, which range in size from 8-inch diameter to 24-inch diameter. The main line sewer under Lake Saint Louis is approximately 11,000 linear feet with no intermediate access points within the lake. Operating and maintaining infrastructure to which there is no access is difficult and can be expensive to determine the condition of the sewer or make repairs to the sewer.

Under these conditions, the District began to consider how they would address a sewer collapse or other failure within the reaches of the subaqueous sewer system. Gonzales Companies, LLC — a Missouri-registered Professional Engineering Corporation — was retained by the District to prepare a response plan which is documented in a report titled *Lake St. Louis Emergency Response Plan* (ERP), dated December 13, 2011. This plan identified the significant and potentially expensive effort which would be required to address an emergency situation in the pipeline under the lake, including requisite diversions, by-pass pumping, divers and coffer dams to access the pipe.

From this understanding the District began to consider the long-term risks associated with their subaqueous assets. Gonzales was selected to perform a conceptual study to develop alternatives to mitigate these risks. These alternatives included rehabilitating the existing subaqueous sewers, replacing the subaqueous sewers with a series of new pump stations and force mains, and by re-rerouting gravity lines around the lakes, among others. The recommended alternative was to install new pump stations. That recommendation was based on: a favorable cost position; high ratings for its suitability for phasing construction over a multi-year program; for eliminating the risk associated with the subaqueous pipelines; and for providing a conveyance system that was accessible. The study findings and conclusions are documented in a report titled, *Lake St. Louis Subaqueous Conceptual Improvement Plan*, dated July 9, 2012 (Alternatives Report).

Finally, Gonzales was contracted to prepare a preliminary design report to refine and develop the pump station alternative, which consists of 30 sanitary lift stations and 62,000 linear feet of new sewers and force mains. The Engineer's opinion of probable capital cost was $33 million and was recommended for implementation over a 12-year period. The details of the recommended plan are documented in a report titled, *Lake Saint Louis Sewer Improvement Program Engineering Report*, dated June 2014 (Engineering Report).

Some residents expressed concern to the District's Board over the recommended plan. The residents expressed concerns about safety, odor, noise and aesthetics stemming from the plan to locate many of the proposed lift stations in close proximity to homes. Residents were also concerned that the chosen alternative may lower property values and require frequent District access to maintain the stations. One particular group was critical of the decision to replace the existing sewer system without first inspecting the subaqueous pipelines and understanding the condition of the sewers. The subject pipelines have not been inspected due to the noted access limitations and the potential consequences should the inspection equipment become stuck in the sewer.

The District agreed to have a peer review performed on the recommended plan and to consider other alternatives, including exploring the feasibility of inspecting the sewer system. The peer review is the subject of this report.

Purpose and Scope for Peer Review

The purpose of the peer review will be to provide an independent evaluation of the conceptual analysis and recommendations provided in the Alternatives Report. This effort consists of the following high level tasks:

1. Review the LSL SIP Reports.
2. Evaluate the five alternatives developed in the Alternatives Report. The scope of work identified specific parameters against which the alternatives are to be evaluated.
3. Develop and evaluate up to six additional conceptual alternatives and sub-alternatives. The scope of work identified specific parameters against which the alternatives are to be evaluated.
4. Evaluate the decision methodology used in the original alternatives analysis and prepare an expanded decision scheme to include the evaluation parameters identified in the scope of work.
5. Evaluate the necessity and feasibility of inspecting the existing subaqueous sewer system. If feasible, prepare a plan to inspect the sewer.

2. DOCUMENT REVIEW

Lake St. Louis Emergency Response Plan

The *Lake St. Louis Emergency Response Plan* (ERP), dated December 13, 2011 and prepared by Gonzalez Companies, identifies the potential emergency which could occur if the subaqueous sewers under either lake were to fail and frames a response plan to address such an emergency. Likely failure modes discussed include pipe blockage, pipe collapse, a major leak and the potential damage that could occur during lake dredging. The report is neatly organized and provides all the requisite information that the District's operations and engineering staff will need on very short notice should an emergency occur. Furthermore, the report identifies symptoms that might be indicative of such a failure. The practice of comparative wastewater sampling is recommended in the report to identify dilution across many of the physical, chemical and biological characteristics of wastewater which might indicate infiltration or more serious inflow into the subaqueous pipeline as it reaches under the lake.

The report is organized in three sections which correlate to the anticipated stages of the response: *Flow Diversion* to protect health, property and environment, *Identify the Emergency* and finally *Emergency Repair*.

The diversion plan is based on plugging all tributary points impacted by the Emergency and pumping those flows with temporary pumps to temporary storage tanks, the flows from which will be drained and transported to treatment daily by a tanker truck. The noted pump stations were sized based on the peak hourly flow rate determined as follows:

- The peak hourly flow equals the average daily flows tributary to each impact point (derived from actual water usage) multiplied by a peaking factor of 10, plus an allowance for infiltration and inflow (I/I) equivalent to 600 gallons per inch of pipe diameter per mile of pipe per day (gal/i·m·d) of tributary sewer pipe. Refer to this report's Appendix E, Table E-1 for details.

This formula is structured in the same format as the Missouri Department of Natural Resources (MDNR) design guide, codified under Missouri 10 CSR 20-8. For systems with normal infiltration (built with modern construction techniques), 10 CSR 20-8.110(4)(C)4.C suggests a peaking factor on the order of 4 (based on tributary population) and an I/I allowance of 100 gal/i·m·d. The increased peaking factor (10 instead of 4) and the increased I/I allowance (600 instead of 100) is appropriate given the swing in peak flowrate than has been measured between dry-weather flow and wet-weather flow in the LSL system. This conforms with 10 CSR 20-8.110(4)(C)4.B(I), which indicates that flow projection shall be based on actual flow conditions. The increased peaking factor and infiltration allowance is on par with the measured peaking factors recorded in the *Lake St. Louis Sanitary Sewer System Modeling Study*, dated December 2001 and prepared by Sverdrup Civil (Sverdrup 2001).

In summary, we found no technical flaws which would jeopardize the proposed emergency response plan. Our review produced several comments, which may add value to the plan. Our comments are summarized below:

1. *Lowest Basement Elevation (Page 11 of 36, 5th paragraph, last sentence).* The report indicates that staff will operate the pumping operations to ensure there are no sanitary

sewer backups. We recommend identifying the lowest service connection tributary to each impact point and surveying the basement elevation before an emergency occurs to facilitate quick and informed operational decisions.

2. *Dropping Lake Level (Page 18 of 36, under the heading, "Assumed Types of Failures," 5th paragraph, last sentence).* It would be helpful to understand the range of tributary flow into each lake. It's possible that the baseflow entering Lake St. Louis from Peruque Creek is more than can be conveyed through a full diameter 24-inch pipe under 30 feet of head, in which case the lake level may not drop upon a pipe failure.

3. *Flow Trending at Permanent Flow Meter (Page 19 of 36, 2nd paragraph, last sentence).* The ERP states that it is likely the District would be notified by staff at the O'Fallon wastewater treatment plant if LSL was discharging excessive flows. We recommend installing a permanent flow meter in the sewer below each lake. Flow metering data will then form an historical record for trending and in conjunction with precipitation information (from an permanent in-system rain gauge) would be used to identify potential emergency conditions and prompt an investigation to confirm the departure in the flow meter trend data.

4. *Inspection Equipment Stuck in Sewer (Page 20 of 36, under the heading "Additional Considerations").* The ERP indicates that "the possibility of a CCTV camera becoming stuck is significant." The text goes on to indicate that it will be the CCTV contractor's responsibility to extract CCTV equipment that becomes stuck in the pipe. This risk represents a potentially significant cost to these contractors that is primarily a result how these sewers were installed. In fact the District could not get contractors to provide a budgetary quotation from its February 2015 Request for Proposal (RFP), which included similar language regarding retrieval of stuck equipment. One of the respondents to the referenced RFP indicated that they would not accept responsibility for stuck equipment under these conditions. We recommend the District reconsider this position. A compromise position may be required to get a field of contractors to bid this inspection work.

5. *Access Options: Draining the Lake (Page 25 of 36).* Regarding options for accessing the pipe to make necessary repairs. Though it's an extreme measure, such an emergency may warrant draining the lake. According to the *National Dam Safety Program Phase 1 Inspection Report for Lake St. Louis Dam*, dated May 1978 and prepared by Horner & Shifrin, Lake St. Louis is equipped with a 72-inch drain with an invert elevation of approximately EL 470, which is controlled by a 72-inch sluice gate. Its condition is not presently known. According to the *National Dam Safety Program Phase 1 Inspection Report for Lake St. Louise Dam*, dated September 1978 and prepared by Horner & Shifrin, Lake St. Louise is not equipped with a drain to fully dewater the lake. It was originally equipped a drop inlet and valves to lower the lake elevation (about 4 feet below normal pool), but these gates were noted in the referenced report to be dysfunctional. While there is no gravity drain, it is plausible that the stored volume could be dewatered with portable pumps over the course of a week or two (1,170 Acre-feet or 381 million gallons of stored volume at normal pool).

6. *Supplemental Bedrock Elevation (Page 27 of 36).* The aforementioned Dam Report for Lake St. Louis included limited soils information at the dam. Rock was show in the report at to be at approximately EL 450 for many of the sections provided of the dam.

7. *Pressurizing the Subaqueous Sewers (Page 34 of 36, under the heading "Additional Pipe Location Options(s)," in the second paragraph).* Regarding pressurizing the subaqueous sewers, the text states that pressurizing the sewer pipe is not recommended. It should be understood that these subaqueous sewers surcharge during most wet-weather events, as recorded in the flow metering data provided in the 2001 Sverdrup Report and is thus under pressure during most precipitation events. So a limited amount of surcharging (low pressure) should be acceptable.

8. *Emergency Service Contract (Page 35 of 36, under the heading, "Standard Contracts").* It may be beneficial for the District to engage and contract with a Contractor/Engineer in advance of an emergency situation. Having an emergency service contract ahead of the emergency provides assurance of a contractor response with acceptable terms already negotiated.

Lake St. Louis Subaqueous Conceptual Improvement Plan (Alternatives Report)

The *Lake St. Louis Subaqueous Conceptual Improvement Plan* (Alternatives Report), dated July 9, 2011 and prepared by Gonzalez Companies, is a document that was prepared to accompany the engineering study conducted to identify and evaluate alternatives to improve or replace the subaqueous sewers beneath Lake St. Louis and Lake St. Louise. In total, nearly 36,000 linear feet of sewers are situated beneath the lakes. The sewers range in size from 8-inch diameter up to 24-inch diameter. In the opinion of the Ductile Iron Pipe Research Association (DIPRA) (consulted by Black & Veatch in conjunction with the Peer Review) the sewers greater than or equal to 16-inches in diameter are most likely ductile iron pipe (DIP) with a Class 1 wall thickness and the sewers 14-inches and smaller are most likely cast iron pipe (CIP) with a Class 2 wall thickness — based on the pipe specification notation provided on the 1969 as-built drawings and the types of pipe manufactured at that time.

Under the 2001 study, five alternatives were developed to varying degrees and are summarized as follows:

- Alternative 1 – Maintain the Existing Subaqueous Sewers
- Alternative 2 – Rehabilitate the Existing Subaqueous Sewers
- Alternative 3 – Lift Stations and Force Mains
- Alternative 4 – Reroute Gravity Sewer (Microtunneling)
- Alternative 5 – Combination: Lift Stations on Lake St. Louis and Sewer Rehab on Lake St. Louise

For alternatives requiring new conveyances or pumping (Alternative 3, 4 and 5) the design flow rates were developed in a manner similar to the approach used to develop flows during the ERP. The peak hourly flow rate for each impact point was determined as follows:

The peak hourly flow equals the average daily flows tributary to each impact point (derived from actual water usage) multiplied by a peaking factor of 4, plus an allowance for infiltration and inflow

(I/I) equivalent to 200 gallons per inch of pipe diameter per mile of pipe per day (gal/i·m·d) of tributary sewer pipe. Refer to Appendix B in the Alternatives Report for details.

This peaking factor and I/I allowance are much less conservative than the flow rates developed under the ERP and in our opinion are not representative of the wet-weather responses measured in the flow metering documented in the 2001 Sverdrup Report; nor in the wet-weather responses identified in the *Lake Saint Louis Sanitary Sewer System Hydraulic Model Development Report*, dated April 2011 and prepared by the Burns & McDonnell Engineering Company (2011 B&M Report).

Ultimately, Alt 3 – Lift Stations and Force Mains was recommended in the Alternative Report. This alternative was justified for the following reasons:

- Alt 3 has the lowest estimated cost
- Alt 3 is the best option for decommissioning the subaqueous sewers
- Alt 3 provides the most accessible facilities
- Alt 3 can be implemented in small phases, providing the District a manageable implementation pace

All five alternatives were evaluated on the basis of five selection criteria: Cost, Risk, Feasibility, Operation & Maintenance and Ability to Repair. The report provides no description of these criteria other than the criteria name. Each criterion was given equal weight in the overall score (1 in 5 or 20%), so each criterion had the same influence over selection. We recommend tailoring the importance weighting of each criterion to align with factors that are most important to the stakeholders influenced by the project. Also, the alternatives were "ranked" for each criterion, meaning that only one alternative could be scored the best even if two alternatives performed similarly against a given criterion. Our preference is to allow the flexibility to give alternatives the same score if they are equally suited in regard to the criterion.

We have several comments on the report, which are summarized as follows:

1. *Present Worth Analysis (Page 3 of 28, 3rd Para. and other locations).* A present worth analysis (PWA) was utilized in the Alternatives Study to account for future operation, maintenance and equipment replacement (OM&R) costs over a 20-year period. Present worth OM&R costs were presented for Alts 3 and 5, but not for Alts 1, 2 & 4.

   Our first concern is that the life-cycle cost comparison does not use the same basis for each of the alternatives. Gravity sewer systems — even rehabilitated sewer systems like the one proposed under Alternative 2 — require some O&M attention, albeit less than a pumped system. It is a commonly recommended practice to clean and inspect gravity sewers on a regular basis as part of a CMOM (Capacity, Management, Operation and Maintenance) Program — generally every 10 years unless experience justifies otherwise. This cost should be included in the PWA. Furthermore, the 20-year return period does not account for the longevity that a gravity sewer system has over a pumped system. This can be addressed by either extending the return period — to 75 years — or by accounting for the residual value (also known as salvage value) of the assets at the end of the evaluation period. Without the longer present worth period or the residual value to account for these differences, the total cost of the alternatives is not being fully considered.

We recommend preparing the cost evaluation using the same basis for all the alternatives. Please refer to ASTM C1131-10 for a more detailed description of Least Cost (or Life Cycle) Analysis. Table 2-1 in *The Clean Water and Drinking Water Infrastructure Gap Analysis*, dated September 2002 and prepared by USEPA, provides a reference for the industry's collective experience on the useful life for typical wastewater facilities.

2. *Isolation Valves (Page 5 of 28, 1st Para. and other locations).* As an alternative to installing permanent isolation valves (estimated at nearly $1.9M), consider using temporary inflatable rubber plugs (as identified in the ERP). The plugs could be installed as part of the bypass pumping operation at a cost significantly less than $1.9M. It is granted the permanently installed valves offer operational convenience during an emergency, but the District will likely have specialized staff (divers) on site anyway and could be installed as the pumping assembly is installed.

3. *Access Shaft (Page 9 of 28, Figure 2).* We are suggesting a couple of modifications to the permanent base for the temporary access shaft. To make the connection to the existing sewer, in lieu of a concrete junction box, we recommend cutting/removing a section of the existing DIP/CIP sewer pipe and replacing it with a 48-inch x 48-inch DIP Tee (branch facing up for access) with mechanical joint (MJ) eccentric reducers on either end to connect to the sewer. Alternatively, a manhole base can be fabricated from preferred materials to meet specific needs. The MJ fitting provides a tighter joint in the connection to the existing sewer, thereby reducing I/I in this subaqueous connection. This assumes that the condition of the existing pipe is in suitable condition. The upward facing flange on the "Tee" will be fitted with a fabricated flange assembly with an inner flange mated with a blind flange to seal the access portal and an outer flange to receive the flanged base of the access tube. The entire assembly will be cradled and encased in concrete. We also recommend fabricating the removable access tube from aluminum for handling convenience, rather than from steel.

4. *Peak Hourly Flow Development (12 of 28 and Appendix B).* We recommend using a hydraulic model of the sewer system, calibrated to actual in-sewer flow measurement, to determine peak hourly flow (design capacity) for each lift station. We're concerned that the allowance for infiltration identified in Appendix B does not represent the amount of I/I observed in the flow metering (Sverdrup 2001 and Burn & McDonnell 2011). The peak hour design flow rate listed in Appendix B is calculated by using the tributary average daily flow based on actual water usage multiplied by a peaking factor of 4.0, plus an infiltration allowance equivalent to 200 gal/i·m·d for tributary sewers. While this infiltration allowance is twice (200 gal/i·m·d versus 100 gal/i·m·d) the rate noted in MDNR's design guide {10 CSR 20-8.110(4)(C)4.C(II)}, MDNR's rate is for a newer systems constructed with modern construction techniques (i.e. a system with limited infiltration). Clearly the LSL system has excessive I/I. The Sverdrup 2001 Report identified a peaking factor of 8+ for the system as a whole (Table 5-2 - Lake Sewer @ Hwy 70) and peaking factors as high as 30 for specific branches (Table 5-2: Lake Sewer Woodlands Area). It is our opinion that the pump station capacities listed in the Alternatives Report are under capacity for the actual peak hour flows measured in the LSL system. The MDNR Design Guide on Hydraulic Capacity for existing systems {10 CSR 20-8.110(4)(C)4.B(I)} requires the use of actual flow data to make

hydraulic flow projections. [*Note: This appears to be corrected in the Engineering Report, which uses a computer-based hydraulic model, calibrated with in-sewer flow metering in conjunction with rain gauge measurements.*]

5. *Detention for Pump Stations (Page 12 of 28).* We recommend more than 2 hours of detention. While 2 hours of detention satisfies MDNR's Design Guide {10 CSR 20-8.130(8)} [2 hours of detention at the anticipated overflow rate], practical experience suggests that a conservative estimate of the utility's response time should be factored into this calculation. Other communities, like nearby Wentzville, MO, require 8 hours of detention based on peak dry-weather flow plus a nominal infiltration rate (200 gal/i·m·d). [*Note: Detention was increased to 4 hours in the Engineering Report, based on PWSD2's estimated response time. It's also important to note that the 4 hour detention is based on calibrated model with inflow/infiltration under worst-case condition produced by precipitation from a 10-year/3-hour storm. Therefore 4 hours of detention based on the 10-year/3-hour storm is adequate.*]

6. *Level of Service (General Observation).* It should be noted that the five alternatives do not all solve the same problem; nor do they provide the same level of service (LOS). For example, Alt 1 will provide the same current-day LOS and Alt 2 provides the same current-day LOS, but adds accessibility, the ability to maintain the system and renewed infrastructure. Alt 3 improves the LOS in that it is designed to convey peak hourly flows plus an allowance for actual I/I per the MDNR Design Guide. [*This was upgraded in the Engineering Report to modeled peak hourly flow which includes I/I from the 10-year/3-hour storm.*] This would control surcharging and provide better overflow control, a benefit which is not afforded Alts 1 & 2. Alt 4 provides upgraded conveyance capacities, controlling surcharging and providing improved overflow control compared to Alts 1 and 2. Alt 4 also includes additional capacity to convey flow from the four existing major lift stations (40/61 Lift Station, Woodlands Lift Station, Henke Lift Station, and Lakewood Lift Station) and proposed to abandon these stations, a benefit none of the other alternatives include. Alt 5 combines facets of Alternative 2 & 3. Overall, these varying levels of service complicate the effort to compare and contrast the alternatives on a fair basis, particularly with regard to cost.

7. *Conclusions (Page 28 of 28, 1st Para.).* The text includes a statement favoring Alt 3 because it is "…more accessible for operations and maintenance than any other alternative discussed in this report" among other justifications. It is true that the pump stations and force mains will be physically more accessible in that they are on land versus at the bottom of the lake thru a portable access tube. However, there are more pump station locations and more footage of pipe in Alt 3 than there are access points and sewers in Alt 2 (29 new pump stations versus 13 access points and 46,000 linear feet of new force main versus 36,000 linear feet of rehabilitated sewer). Furthermore, there will be a more frequent need to visit those pump stations than there will be to visit those 13 access points (monthly versus every few years). The point is that "accessibility" may not be perceived in the same way by all the stakeholders. O&M staff may have a preference for easy foot access to the pump stations, while home owners may not prefer the frequent visits to their backyards. So the 29 new pump stations in Alt 3 will require frequent but easy access for O&M staff that is unwanted by the adjacent homeowner. While the 13 access points in Alt 2 will require much less

frequent, but much more challenging access for O&M staff that may be more appreciated by residents. So the determination of which alternative is more "accessible" is not clear.

8. *Decision Matrix (28 of 28, Table 9).* The decision matrix provided is adequate for simple decisions with a limited stakeholder group and is a good way to document the factors deemed important in the decision-making process. However, the selection parameters included in the decision matrix are focused on facets important to the utility and do not include parameters typically associated community stakeholders, who will be impacted by the program.

In summary, while we (Black & Veatch) would have taken a few different approaches and made a few different decisions and recommendations, there are no major technical or engineering flaws which jeopardize the objectives of the Alternatives Study. [*Note: The Peer Review cost estimate is forthcoming in this midpoint report. At the midpoint is appears difficult to see how Alt 2 could overcome Alt 3 in terms of cost, but if the cost for Alt 3 increases (as it does in the Engineering Report) it represents a scenario where we may have recommended a different alternative. Furthermore, the outcome of the new Selection Criteria Matrix may impact the recommended alternative.*]

Lake Saint Louis Sewer Improvement Program Engineering Report (Engineering Report)

The *Lake Saint Louis Sewer Improvement Program Engineering Report* (Engineering Report), dated June 2014 and prepared by Gonzalez Companies, is a document that was prepared to develop the design of the recommended alternative in the Alternatives Report. The engineering effort included preparing a computer-based hydraulic model to analyze and size the proposed improvement under dry-weather and wet-weather conditions. The report documents the modeling approach and the standards used to calibrate the model.

We have several comments on the report, which are summarized as follows:

1. *Estimated Capital Cost (Page 4 of 28, Executive Summary).* The estimated capital cost is significantly higher than identified in the Alternatives Report ($33M versus $22M). Much of this increase resides in the marked increase in the estimate for the pump stations themselves (up from about $5M in the Alternative Report to $10.6M in the Engineering Report, both figures exclude easements). This appears to be the result of multiple factors, but primarily because of increased pumping capacity (nearly 40% more total pumping capacity than identified in the Alternatives Report) and the inclusion of rock excavation costs. The estimate was also impacted by the addition of six vortex drop shafts to address the potential for corrosion and odor at major dropshafts and the addition of four trailer-mounted generators (from 2 to 6). It should also be recognized that the cost in the Alternatives Report were based on 2011 dollars and the Engineering Report based on 2014 dollars. The Engineering News Report Construction Cost Index rose more than 11% from January 2011 to December 2014. Also added was an allocation for construction phase engineering services equivalent to 5%. Also noted is the reduction in contingency from 25% in the Alternatives Report to 20%, which is appropriate as detail is added to the design.

2. *Model Calibration (Pages 8 and 10 of 28).* The report includes a dry-weather flow (DWF) calibration goal of 20% and a wet-weather (WWF) calibration goal of 30%. IN other words,

the model is considered to be suitably calibrated if the model-predicted DWF is within 20% of the metered DWF and the model-predicted WWF is within 30% of the metered WWF flow. We'd recommend considering the modeling guidance contained in the *Code of Practice for the Hydraulic Modeling of Sewer Systems*, dated November 2002 and prepared by the Wastewater Planning Users Group. This group suggests that for dry-weather calibration, predicted peak flow rates should be in the range +10% to -10% compared to observed peak flow rates and predicted volume of flow should be in the range +10% to -10% of observed volume of flow. For wet-weather calibration, predicted peak flow rates should be in the range +25% to -15% compared to the observed flows and predicted volume of flow should be in the range +20% to -10% of the observed volume of flow. The Code provides some additional criteria to assist in verifying model calibration.

3. *Multiple Pumping Units (Page 17 of 28, Table 3).* MDNR's Design Guide {10 CSR 20-8.130(4)(C)1} requires pump stations handling flows in excess of 1 million gallons per day (694 gpm) to be equipped with a minimum of three pumps. Table 3 indicates that LSL-16 and Lakewood will be provided with two pumps.

4. *100-Year Flood Elevation (Page 21 of 28 and 15 of 28, Table 2).* The report indicates that the pump stations should be designed above the 100-year flood elevation, which is consistend with MDNR's design guide. Note that the 100-year flood elevation is EL 505 on Lake St. Louis. In Table 2, several of the Lake St. Louis pump stations are indicated to have a Rim Elevation below EL 505.

In summary, we found no technical flaws which would jeopardize the proposed sewer improvement plan describer in the Engineering Report.

3. INSPECTION OF EXISTING SUBAQUEOUS SEWER SYSTEM

Necessity of Inspecting the Subaqueous Sewers

There are at least two drivers which would necessitate the inspection of the LSL subaqueous sewers. The first driver is the sewer improvement program itself. If the path forward includes utilizing the subaqueous sewers, then in our opinion inspecting the sewers, assessing their condition and repairing known defects is a requirement.

There's also a regulatory driver than may or may not apply to the District. The majority of wastewater treatment plant permits contain a requirement to develop and implement a program to maintain and repair the collection system serving the plant. Many communities develop a Capacity, Management, Operation and Maintenance (CMOM) Plan, which would include sewer inspection and cleaning, as a way to satisfy their permit requirements.

In our opinion inspection (and cleaning) is prudent and necessary if there is a medium or long-term plan to use the subaqueous sewers. The sewer inspection will determine the existing condition of the pipes and provide information that will be used to determine the most cost effective method to ensure adequate service is provided and to extend the service life of the system.

Sewer Inspection Technology Review

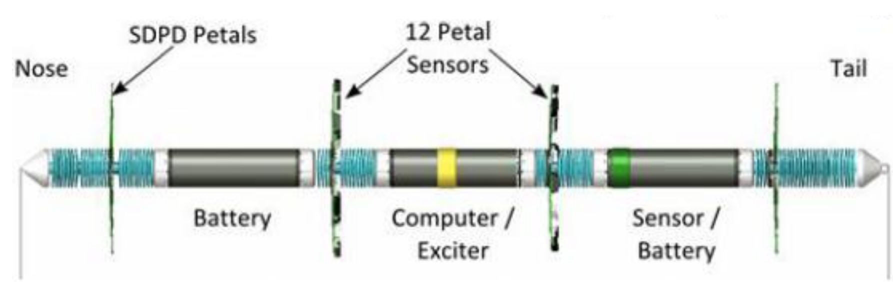
A review of the technologies available for inspecting ductile and cast iron pipe identified remote field electromagnetic technologies as a potentially feasible option for the LSL sewer to identify areas of wall loss along the pipe alignment. This technology provides key information regarding any corrosion or wall loss that has occurred along the pipeline. However, inspection with this technology is very expensive and requires cleaning and access to the pipe. This technology is furnished by two vendors: Pure Technologies and Pipeline Inspection & Condition Analysis Corporation (PICA).

Inspection of the interior of the pipe with closed circuit television (CCTV) technology was determined to be a feasible alternative but the data collected is limited to the visually observed defects. The use of laser and sonar technology was reviewed but typically it is only suitable for pipe larger than 24-inches.

The ability of these technologies to "map" the exact location and depth of the pipeline is currently not available. There may be some modifications that could be developed that can provide some information using GPS technology as part of the project scope.

Description of PURE Remote Field Electromagnetic Technology

The enhanced electromagnetic (EM) sensors detect pipe wall defects and provide axial location and qualitative ranking of the defects in the pipe. The EM platform detects changes in the pipe's properties (material, diameter, wall thickness) as part of the data collection. An electromagnetic field is introduced into the pipe by an exciter coil and the detectors

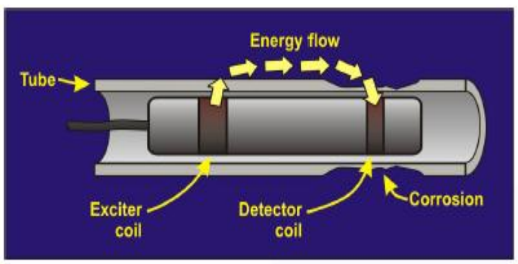


spaced around the circumference of the pipe measure the local magnetic field. In areas where the pipe is in good condition the current flows uniformly through the pipe but in areas with deterioration the discontinuity is detected in the current.

Because of the restricted access to the pipelines the platform recommended for Lake St. Louis is, PipeDiver® a free-swimming or tethered floating array of sensors, batteries and a computer. The system is neutrally buoyant and has flexible fins that are used to center the tool in the pipe. The use of PipeDiver® will require some modifications to the operation of the system in order to inspect the pipe. Modifications to using this tool in a gravity system would include filling the pipeline full of water and using a tag line to pull the platform through the sewer main. The PipeDiver® would be inserted at various manholes to accommodate each pipe diameter throughout the system. The PipeDiver® is limited to pipe 12-inch diameter and greater.

Description of PICA Remote Field Electromagnetic Technology

This electromagnetic assessment provides relative wall loss data for the full alignment of each force main. Remote Field Technology (RFT) is used to measure pipe wall thickness. RFT works by detecting changes in an AC electromagnetic field generated by the tool. The field interacts with the metal in the pipe and becomes stronger in areas of metal loss. The field interactions are measured by on-board detectors, and subsequently processed on the tool itself using A/D converters and DSPs. The processed data is either stored on board or sent to storage on a computer. Once all the data is acquired, sophisticated analysis software is applied to generate accurate information on the wall thickness of the pipe.



This technology, "sea snake" is a flexible tool that does not require intimate contact with the pipe wall to detect changes in the wall thickness. Therefore, internal scale, sludge, and liners, such as cement mortar, do not significantly impact the results. The pipeline to be inspected would have to be clean to ensure the passage of the tool. The amount of cleaning required would be determined following the CCTV inspection. The technology is sensitive to internal and external wall loss but cannot distinguish which it is. The tool can negotiate short radius bends and can be free swimming or tethered but for the Lake St. Louis inspections the system would be tethered. The sea snake can inspect pipe 8-inch and larger.

CCTV Inspection

The inspection of the pipelines can also be completed using existing CCTV technology. The CCTV provides inspection of the interior of the pipe and only visual indication of defects. We identified four contractors that indicated the inspection of the 12-inch and larger sewer pipelines is feasible, but challenging. The four contractors are:

- Doetsch Environmental
- Hibbard Inshore

- Interactive Pipeline Inspection (IPI)
- RedZone Robotics

The approach recommended by Doetsch, Hibbard and RedZone applies only to pipelines 16-inch and larger, namely the Lake St. Louis trunk sewer, as the long tethered equipment limits this approach to larger diameter pipes. The inspection would be conducted with a floating platform. The long reach tether is a fiber optic cable, not the typical copper wire used on standard CCTV. This allows the tether to be much longer and able to inspect several thousand feet from a single insertion. The inspection procedure would require the use of a tag line floated through the system that would be used to pull the inspection platform upstream or downstream as needed to accommodate the limited access. These contractors indicated installation of additional access points would improve the ability to inspect the pipeline.

The approach by IPI is a combination of multiple platforms that would include the 8-inch and larger pipelines. IPI has worked with RedZone Robotics to make modifications to some of RedZone's smaller crawler vehicles, called Solo, for the 8-inch pipelines. The installation of additional permanent access manholes was recommended to facilitate the inspection but is not required.

The inspection of the larger Lake St. Louis trunk lines would provide data that would be representative of the entire system. The inspection of the Lake St. Louise trunk would provide additional information but since it is an 8-inch pipe it was not addressed in the proposals by Doetsch, Hibbard and RedZone and would require construction of additional access manholes before these firms would consider inspecting this pipeline. The inspection of the shorter laterals with access from the shore could be conducted with a smaller crawler system and would be considered by these firms if the results of the larger pipe inspection indicated the pipe was in good condition.

Exterior Pipe Inspection

Additional information on the condition of the pipe can be obtained by inspecting the exterior of the onshore pipe. The onshore pipe conditions will be considerable different than the subaqueous but this will provide useful data for the condition assessment. We are recommending an inspection of the exterior of the sewer at representative locations around the lakes in two or three locations. Exterior corrosion of cast and ductile iron pipe represents another potential failure mode for the subaqueous sewer system. The inspection would consist of excavating the pipe at the lakeshore, sampling the soil around the pipe, inspecting exterior condition of the pipe, use non-destructive ultrasonic testing to measure the wall thickness and backfilling. The Ductile Iron Pipe Research Association (DIPRA) was consulted regarding the inspection and they recommended the soil sampling as a way for predicting the life expectancy of the pipe. AWWA C105, Appendix A provides a 10-point soil evaluation procedure to determine if soil is considered corrosive to DIP. According to DIPRA, if the soil conditions are determined to be non-corrosive, the life expectancy could be 100 years or more.

Key Requirements and Cost

This section is in progress.

4. ALTERNATIVE EVALUATION METHODOLOGY

As part of the peer review, the five alternatives developed under the Alterative Report and up to six new alternatives developed under the peer review effort will be evaluated using decision science methodology. Using this approach, each of the alternatives will be rated against a set of selection criteria/parameters. The rating will be on a scale of 1 to 10, with 10 being the most favorable rating. If two alternatives provide identical benefits toward a given criteria, they can be given the same rating. However, the objective is to distinguish the alternatives, so rating the alternative across the entire range is beneficial to the process.

Each of the selection criteria is weighted based on its relative importance to projects stakeholders (or in this case, the Peer Review Engineer's perception of importance to the stakeholders). The total weighting adds up to 100% and may be divided among the criteria in any manner that reflects the stakeholder importance profile. The score for each alternative is calculated by multiplying the rating times the weight for each criterion and then totaled to determine the overall score. The process is capture in the Selection Criteria Matrix, presented in Table 1. The highest score is indicative of the alternative that best satisfies the weighted criteria set.

The highest score may not represent the best and recommended alternative. If the low cost alternative does not receive the highest score, then the additional cost must be evaluated to determine if the additional benefits (or better performance) associated with the high score alternative are worth the additional cost.

Selection Criteria Definitions

The Selection Criteria are defined as follows:

- *Capital Cost.* This criterion represents the cost estimated to implement the project, including engineering, administration, permitting and construction, plus a contingency. The rating is inversely proportional to the cost. In other words, the lower the capital cost, the higher the rating.
- *OM&R Cost.* This criterion represents the cost to operate, maintain and replace equipment of the evaluation period. The rating is inversely proportional to the cost. In other words, the lower the capital cost, the higher the rating.
- *Property Value Impact.* This criterion represents the potential impact the project's improvements may have to local property values. Improvements with minimal impact receive higher, more favorable ratings.
- *Level of Service Upgrade.* Since some of the alternatives provide a level of service (LOS) greater than the current LOS, this criterion was added to recognize those upgrades in the selection process. Alternatives improving conveyance capacity, thus reducing surcharging, receive higher, more favorable ratings.
- *O&M — Health & Safety/Accessibility.* This criterion represents ease of access to the infrastructure for the purposes of operating and maintaining the improvements proposed in the alternative. It also recognizes the health and safety issues that will need to be overcome at sites with more challenging access. The alternatives with the best and easiest accessibility for O&M Staff receive the higher, more favorable scores.

- *O&M — Frequency.* This criterion represents the frequency at which the infrastructure proposed in an alternative requires on-site O&M attention. Based on experience, a gravity sewer system requires less frequent O&M attention than does a mechanical/electrical facility like a pump station. Alternatives requiring less frequent attention receive the higher, more favorable scores.
- *O&M — Complexity.* This parameter characterizes the typical effort and complexity required during an O&M visit to the sites/facilities proposed in the alternative. Based on experience, most of the visits to a pump station are minor in nature — an inspection, checking a tripped breaker, etc. Some visits are more involved and longer in duration, but many are just a quick check-in to confirm satisfactory operation. However, cleaning/inspecting a sewer, checking on a potential sewer issue, etc. is typically more involved than a visit to a pump station, particularly when that O&M visit involves a boat/barge, installing a temporary access tube to get access to a subaqueous sewer system. This criterion recognizes that complexity. Alternatives with typical O&M service calls determined to be simpler and straightforward receive the higher, more favorable scores.
- *Public Impact — Aesthetics/Odor.* This factor recognizes the impact that some of the alternatives have visually and through scent. Those with fewer impacts receive the higher, more favorable scores.
- *Public Impact — Disruption during Construction.* This factor recognizes that some alternative will disrupt the public more than others. For example, a sewer or force main installed by trenching often will impact roadways, with detours and road closures. Tunneled/trenchless installations are typically less disruptive to the public-at-large. Those with fewer impacts receive the higher, more favorable scores.
- *Public Impact — Health & Safety/Accessibility.* This factor represents the accessibility the public has to the improvements proposed within an alternative. Sewers with limited access are a lower risk to the public and receive the higher, more favorable scores. Pump stations with security fencing are more accessible (and interesting to the curious). At grade, submersible pump stations, with lockable access hatches are the most accessible and receive the lowest scores.
- *Individual Property Owner Impact.* This parameter focuses on the impact that the alternative has on individual property owners or small groups of owners (not the public-at-large). Those with fewer impacts receive the higher, more favorable scores.
- *Constructability/Risk.* This criterion captures the constructability of the improvements proposed within an alternative. Alternatives which are considered to be typical and common receive the higher, more favorable scores. Alternative which require more challenging and risky construction techniques, receive the lowest ratings.
- *Risk of Operational Failure.* This criterion recognizes the risk of an operational failure occurring. A power failure at a pump station is a more likely occurrence than a sewer blockage or collapse. If a pump station has provisions to which to connect a mobile generator, the risk is reduced. On-site back-up power or on-site storage reduces that risk further.
- *Consequence of Operational Failure.* This criterion represents the consequences of failure. If a main trunk sewer becomes blocked, the consequences extend to every household tributary to that point in the system. However, if that area is served by a number of pump stations, it is much more unlikely that all those stations would fail at the same time.

TABLE 1 Draft Selection Criteria Matrix		**ALT 1** Use Existing Sewers		**ALT 2** Rehab Existing Sewers		**ALT 3** New Lift Stations and Force Mains		**ALT 4** New Gravity Sewers, Tunneled		**ALT 5** Hybrid - ALT 2 Big Lake / Alt 3 Small Lake		**ALT 6** Alt Description	
Capital Cost:		$3,655,000		$35,400,000		$21,920,000		$75,000,000		$36,207,000		$1	
OM&R PW Cost:		$0		$0		$6,676,000		$0		$5,386,000		$1	
Total PW Cost:		$3,655,000		$35,400,000		$28,596,000		$75,000,000		$41,593,000		$1	
Selection Criteria	Weight Factor	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Capital Cost	25%	**9**	2.25	**5**	1.25	**10**	2.50	**1**	0.25	**4**	1.00	**0**	0.00
OM&R Cost	10%	**1**	0.10	**9**	0.90	**3**	0.30	**10**	1.00	**5**	0.50	**0**	0.00
Property Value Impact	10%	**1**	0.10	**10**	1.00	**3**	0.30	**7**	0.70	**5**	0.50	**0**	0.00
Level of Service Upgrade	5%	**1**	0.05	**3**	0.15	**9**	0.45	**10**	0.50	**6**	0.30	**0**	0.00
O&M - H&Safety/Accessibility	4%	**1**	0.04	**7**	0.28	**3**	0.12	**10**	0.40	**5**	0.20	**0**	0.00
O&M - Frequency	4%	**9**	0.36	**7**	0.28	**3**	0.12	**10**	0.40	**5**	0.20	**0**	0.00
O&M - Complexity	4%	**1**	0.04	**7**	0.28	**3**	0.12	**10**	0.40	**5**	0.20	**0**	0.00
Pub. Impact - Aesthetics/Odor	4%	**3**	0.12	**10**	0.40	**3**	0.12	**5**	0.20	**5**	0.20	**0**	0.00
Pub. Impact - Disruption d. Con.	4%	**7**	0.28	**10**	0.40	**3**	0.12	**5**	0.20	**5**	0.20	**0**	0.00
Pub. Impact - H&Safety	4%	**1**	0.04	**10**	0.40	**3**	0.12	**5**	0.20	**5**	0.20	**0**	0.00
Ind. Property Owner Impact	6%	**9**	0.54	**9**	0.54	**1**	0.06	**2**	0.12	**5**	0.30	**0**	0.00
Constructability/Risk	6%	**1**	0.06	**3**	0.18	**10**	0.60	**1**	0.06	**6**	0.36	**0**	0.00
Risk of Op Failure	7%	**1**	0.07	**7**	0.49	**3**	0.21	**10**	0.70	**5**	0.35	**0**	0.00
Consequence of Op Failure	7%	**1**	0.07	**3**	0.21	**7**	0.49	**3**	0.21	**5**	0.35	**0**	0.00
TOTAL SCORE:	**100%**	**4.1**		**6.8**		**5.6**		**5.3**		**4.9**		**0.0**	

TABLE 1 Draft Selection Criteria Matrix		**ALT 7** Alt Description		**ALT 8** Alt Description		**ALT 9** Alt Description		**ALT 10** Alt Description		**ALT 11** Alt Description		**ALT 12** Alt Description	
Capital Cost:		$1		$1		$1		$1		$1		$1	
OM&R PW Cost:		$1		$1		$1		$1		$1		$1	
Total PW Cost:		$1		$1		$1		$1		$1		$1	
Selection Criteria	Weight Factor	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Capital Cost	25%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
OM&R Cost	10%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
Property Value Impact	10%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
Level of Service Upgrade	5%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
O&M - H&Safety/Accessibility	4%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
O&M - Frequency	4%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
O&M - Complexity	4%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
Pub. Impact - Aesthetics/Odor	4%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
Pub. Impact - Disruption d. Con.	4%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
Pub. Impact - H&Safety	4%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
Ind. Property Owner Impact	6%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
Constructability/Risk	6%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
Risk of Op Failure	7%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
Consequence of Op Failure	7%	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00	**0**	0.00
TOTAL SCORE:	**100%**	**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**	

5. ALTERNATIVE EVALUATION

Alternative 1 – Maintain Existing Subaqueous Sewers

Description

This section is in progress.

Evaluation Parameters

- Repair and Maintenance Requirements
- Risk Assessment
- Feasibility, Complexity and Implementation Timeline
- Health and Safety Impacts
- Aesthetical Impacts
- Property Value Impacts
- Vulnerability to Power Outage and Storm Impact
- Capital Cost
- Decommissioning Cost
- Operation and Maintenance Costs
- Total Cost of Ownership (Life Cycle Cost of 20 Years)
- Expected Life of System

Commentary

This section is in progress.

Alternative 2 – Rehabilitate Existing Subaqueous Sewers

This section is in progress.

Alternative 3 – Lift Stations and Force Mains

This section is in progress.

Alternative 3A – Lift Stations and Force Mains (Minimize)

This section is in progress.

Alternative 3B – Lift Stations and Force Mains (Fewer Larger PSs)

This section is in progress.

Alternative 4 – Reroute Gravity Sewers

This section is in progress.

Alternative 4A – Parallel Replacement of Existing Sewers (Drained Lake)

This section is in progress.

Alternative 5 – Hybrid (Big Lake: Lift Stations and Small Lake: Rehabilitate Sewers)

This section is in progress.

Alternative 5A – Hybrid (To be developed)

This section is in progress.

Alternative 5B – Individual Grinder Pumps and Low Pressure Force Mains

This section is in progress.

Alternative 5C – Hybrid (To be developed)

This section is in progress.

6. COMPARISON OF ALTERNATIVES

This section is in progress.

7. RECOMMENDATIONS

This section is in progress.