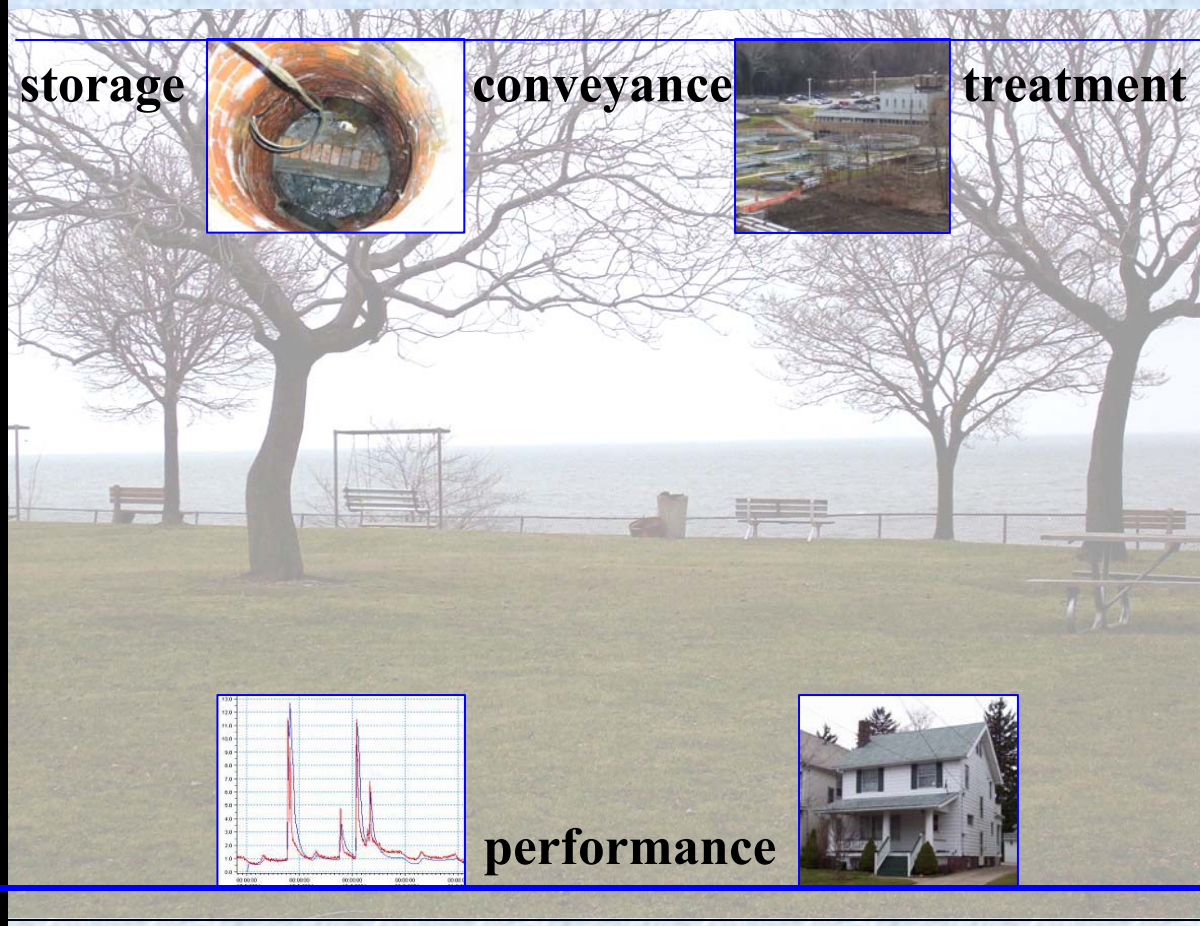
CITY OF LAKEWOOD

COMBINED SEWER OVERFLOW LONG-TERM CONTROL PLAN
Executive Summary

MAY 2006



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LONG-TERM CONTROL PLAN
EXECUTIVE SUMMARY

INTRODUCTION

This Executive Summary of the Long-Term Control Plan for the City of Lakewood, Ohio provides, in an abbreviated format, the process and results of the three (3) year Combined Sewer Overflow (CSO) Long-Term Control Planning (LTCP) effort. This planning effort was undertaken to identify the causes of discharges from the City's collection system to the two receiving waters, Lake Erie and the Rocky River, and develop an approach to controlling the discharges in compliance with the CSO Policy. The LTCP is presented in its entirety in the Draft Combined Sewer Overflow Long-Term Control Plan, February 2006.

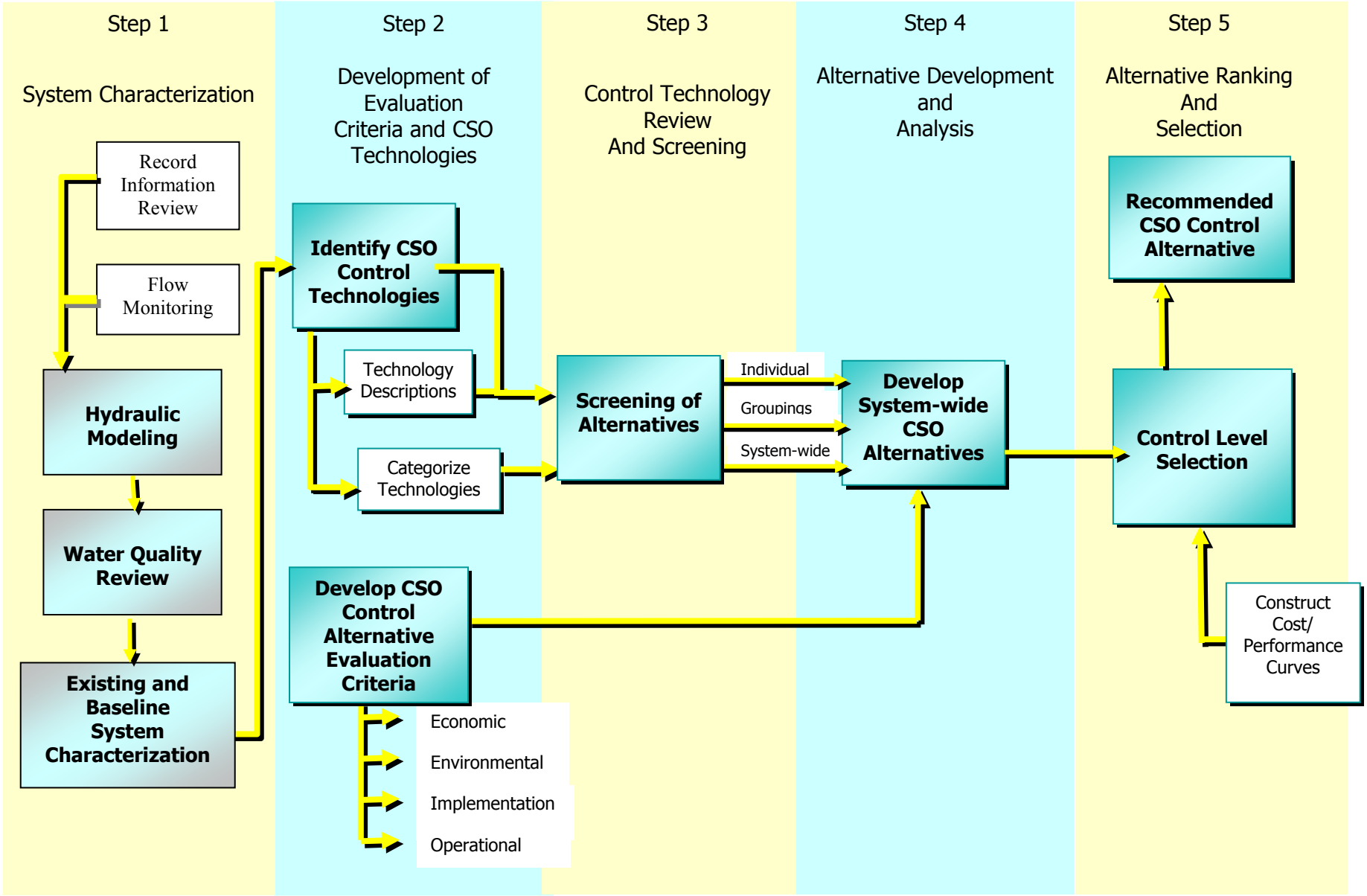
PLANNING OVERVIEW

The recommended LTCP was the result of a process that first sought to understand how the system currently performs, then identified feasible approaches to reducing the incidents of overflow discharges and finally, selected a level of control appropriate for the economic and environmental conditions. The process is shown graphically in Figure 1.

CSO discharges are subject to the requirements of the U. S. Environmental Protection Agency's (U.S. EPA) NPDES. These requirements are implemented through the NPDES permit system. This system, created under the Federal Clean Water Act, is administered by the Ohio Environmental Protection Agency (OEPA).

The City of Lakewood Wastewater Treatment Plant (LWWTP) is the permittee responsible for CSOs in the Lakewood Collection System. In 2001, under NPDES permit application No. OH0026018, the Ohio EPA issued NPDES permit number 3PE00004*MD, which the City appealed. In the period between the initial issuance of the permit and the printing of the LTCP, OEPA and the City negotiated the final language of the permit. Although not executed at the time of printing, the LTCP was developed in accordance with the agreed upon language of this permit.

Figure 1. Alternative Development and Selection Methodology



While the overall purpose of the CSO LTCP project was to develop a plan that satisfied the goals and requirements of the CSO Policy and the City's draft NPDES permit, a strategy that would control the CSO discharges in a manner that reflected the priorities, culture, capabilities and limitations of the City of Lakewood was needed. The goals of the project reflected the priorities of the community:

- Responsible, cost-effective use of rate payer dollars
- Reduce environmental impact on community
- Minimize construction related impact on residents
- Emphasize operability of new and existing facilities

SYSTEM CHARACTERIZATION

The City of Lakewood is a residential community of 56,646 people living in a 5.66-square mile area. The City is the densest residential community between New York and Chicago, containing many duplex, apartment and high-rise style housing units. The City and the collection system were developed within the thirty year period of 1900 to 1930. The City is nearly completely built-out.

The sewer system was constructed using two types of systems. As shown in Figure 2, in the southeast section of the City, combined sewers were constructed in the middle of the streets. In the remainder of the City, a system of piping called "over/under" (O/U) sewers were constructed. In the O/U system, the sanitary sewer and storm water pipe were laid in one trench, with the storm water pipe laid directly on top of the sanitary sewer. This is demonstrated in Figure 3. The two pipes were serviced by common manholes. Steel plates in the invert of the storm water pipe, called "invert plates", separated the two systems and provided access to the sanitary system underneath. Manhole inspections found that a significant number of the invert plates are missing. Some were removed by design to abate basement flooding. Others have been dislodged by surcharging of the system. Without the plates, the flows generated in the two systems thoroughly mix, creating a combined sewer flow.

Figure 2. City of Lakewood Collection System Combined and Over/Under Areas

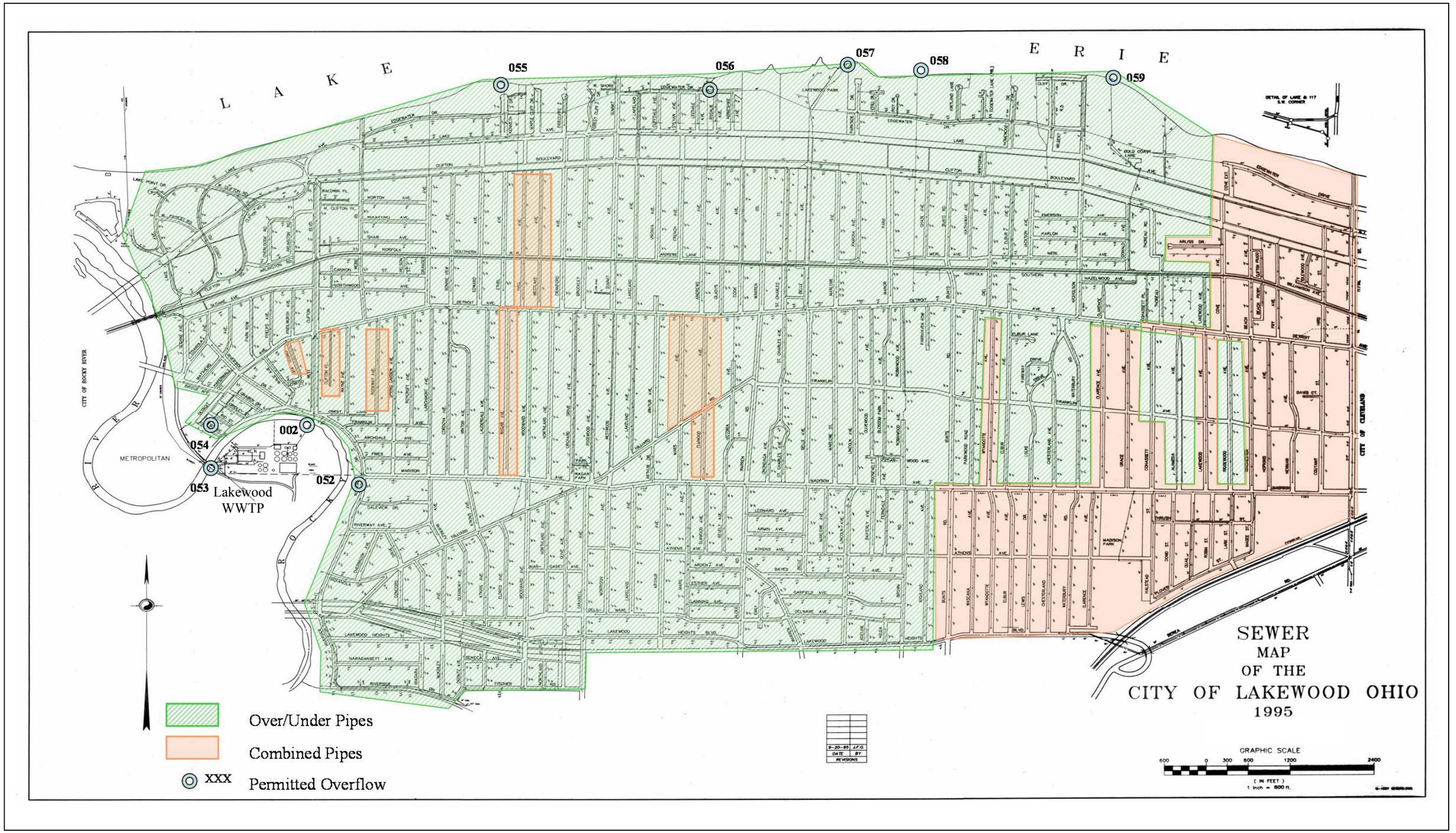
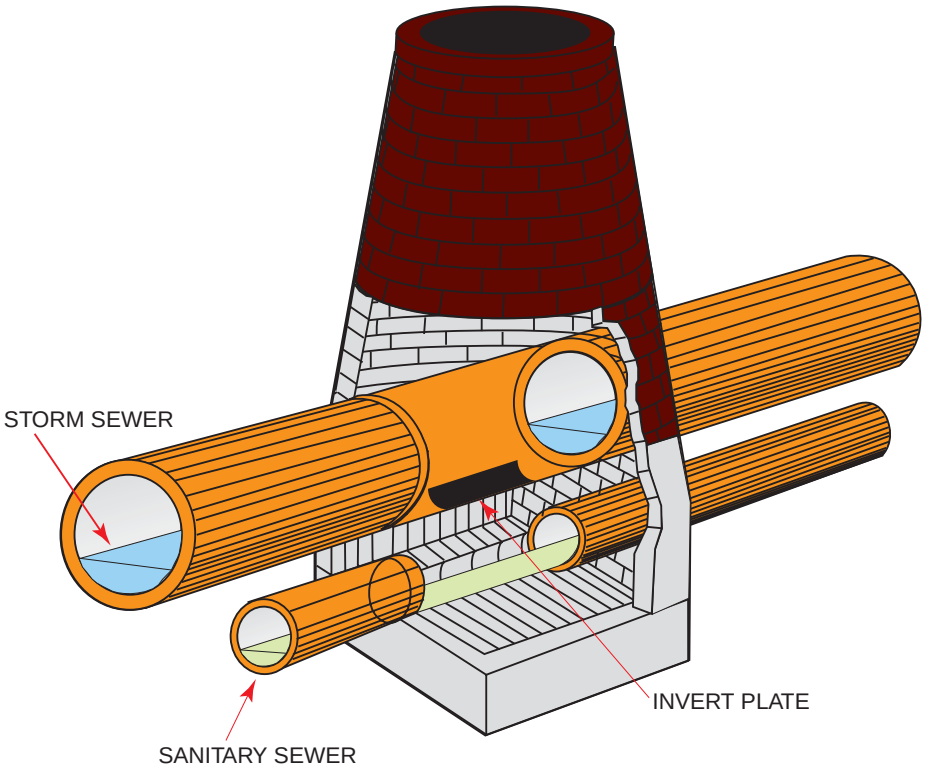


Figure 3. Over/Under Sewer Configuration



In 2003, the LTCP process began with the review of record information, consisting primarily of engineering reports dating back to the 1970s. This information was supplemented with flow monitoring data collected at twenty (20) locations throughout the City over an eight (8) week period from April to June, 2004. Water quality sampling at three overflow locations were performed in conjunction with the flow monitoring and supplemented water quality sampling performed by the City on a routine basis.

The data was used to calibrate a hydraulic model. The model was constructed using system configuration information from record drawings and from previously conducted manhole inspections. The model was calibrated for dry weather and a wet weather period that included several storm events. The model was then used to assess the performance of the collection system under various conditions including small and large rainfall events.

This was accomplished using a “typical year” rainfall. The 121 rainfall events are actual rainfall events that occurred at Cleveland Hopkins International Airport over a 49-year period, normalized to represent a statistically typical year of rainfall.

Understanding of the collection system operations was supplemented with a review of the performance of the LWWTP and the water quality of the receiving waters. Using a hydraulic model and standards for wastewater treatment, the processes that make up the LWWTP were analyzed under average and peak flows and loads to determine the physical and treatment limitations of the plant. The existing conditions of the Rocky River and Lake Erie were also compared to the current and projected CSO loading rates to assess the impacts the CSO discharges have on the receiving water system.

The collection system operates on two levels. The near-surface system consists of the sewers and trunk sewers that receive flows directly from the houses, apartments and businesses. The trunk sewers convey flow to the Edgewater Interceptor. The interceptor runs parallel to the Lake Erie shoreline from West 117th Street and Edgewater Drive to Webb Road, where it turns south and enters the treatment plant at West Clifton. While actual depths vary with location, the interceptor is significantly deeper than the trunk sewer system. Flow monitoring and hydraulic modeling showed that the two systems operate independently. Operationally, this means that surcharging in the interceptor system does not affect the trunk sewers or basements. The data shows that both systems are overloaded during medium and large rain events. This results in the overflow system being activated and the occurrence of CSOs.

The LWWTP provides secondary treatment and disinfection for the collection system. The LWWTP is rated for 18-mgd of flow. Currently, average dry weather flows are about 6-mgd. Wet weather flows as high as 40-mgd have been treated successfully. Flows above 40-mgd begin to flood the LWWTP. Upgrades to the headworks of the LWWTP completed in 2004 lowered the hydraulic gradeline in the interceptor system. It is estimated that the implemented improvements decreased the amount of CSO discharged in an average year by approximately 50%, increasing the percent capture of the system from 68.3% to 79.0%. Flooding of the LWWTP must be avoided because high water levels can damage

mechanical equipment that is not designed to be submerged and because the bacteria used to treat the waste can be lost. Loss of equipment or biological process wash-out can result in the plant being off-line or operating in a diminished capacity for days. To protect the plant, the LWWTP operators use three gates, located on the aerial sewer pipes, to limit the flows into the plant to 40-mgd. A flow metering device inside the plant indicates the flow rates and is used to select the gate settings.

ALTERNATIVES DEVELOPMENT

With the system fully characterized, the process of developing feasible control alternatives began. The process consisted of three-steps that eliminated infeasible control methods early and allowed development of feasible alternatives that could control the discharges. The first step, called the Technology and Initial Analysis review, screened technologies for applicability in the Lakewood collection system. Many technologies, especially those related to source control, were eliminated during this step based on the configuration and degree of build-out within the City. Technologies passing the first step were reviewed with respect to the specific control and site requirements of the individual CSO locations. This second step, called the Alternative Screening review, also looked to group CSOs together to access any economy that could be realized from a solution combining two or more outfalls. Alternatives passing this step were developed in detail in the Alternative Development step.

Alternatives Development created 37 alternatives over seven control levels. Control levels are categories of specific performance. The seven control levels considered for the LTCP were: 90% capture, 95% capture, 99% capture 100% capture, 4 overflows per year and 1 overflow per year. The control levels to be considered were prescribed in the draft NPDES permit. Percent capture control levels looked to capture a specific percentage of the combined sewer generated in the City in an average year. Under baseline conditions, the collection system is already estimated to capture 80% of the combined sewage generated in the City. Alternatives for the 90%, 95%, 99% and 100% capture control level were developed that would increase the amount of combined sewage collected and treated.

An alternate way of prescribing CSO control is to identify the number of times in an average year that the CSO system will activate. Using this approach, activation of any individual CSO counts as an activation for the system. However, activation of more than one outfall during a single rain event also is counted as one activation. Alternatives for 4 overflows and 1 overflow per year were developed to decrease the number of CSO activations in an average year from 38.

Alternatives that successfully passed the screening process involved the construction of a CSO piping system that would relieve the Edgewater Interceptor and specific parts of the trunk sewer system. The alternatives and components are summarized in Table 1. In some alternatives, this CSO piping system operated as a storage pipe; in others it operated as a conveyance or transport pipe. This primary component was complimented with projects such as sewer separation and relief sewers to develop complete system alternatives addressing all CSOs. Components of each system-wide alternative were sized based on the volume and peak flow rates that needed to be controlled to meet the respective control levels. The cost of construction and of annual operation and maintenance were developed for use in evaluating and selecting alternatives.

Within each control level, alternatives were rated in 5 categories: economic impact, environmental impact, feasibility of implementation, operability, community impact. Using a decision analysis software, Criterium Decision Plus, the ratings of each alternative were compared against each other to identify the alternative within each control level that most closely matched the City's priorities. For each control level, the alternatives that utilized a CSO storage pipe with subsequent treatment at the LWWTP scored the highest. This was because utilizing the existing infrastructure, i.e. the LWWTP, was far more cost effective than constructing a new treatment facility. Additionally, as a pipe was required to convey CSO flows to the WWTP, the additional cost to use the pipe as a storage pipe was highly cost effective. A summary of the total cost and annual CSO volume controlled for each control level is provided in Table 2.

Table 1. Control Level Alternative Components

Control Level	Alternative	CSO Storage Pipe	CSO Conveyance Pipe	CSO Storage / Conveyance Pipe	WWTP Upgrade	New Wet Weather Treatment	Madison Avenue Relief	Over/Under Separation	Redirect West End	Weir Modification	Gated Control	Edgewater Interceptor Rehab
90%					✓		✓	✓	✓		✓	✓
95%, 99%, 100%, 4 O/F, 1 O/F	A1	✓			✓		✓	✓	✓	✓		✓
	A2		✓		✓	✓	✓	✓	✓	✓		✓
	A3			✓	✓	✓	✓	✓	✓	✓		✓
	B1	✓					✓	✓	✓	✓		✓
	B2		✓			✓	✓	✓	✓	✓		✓
	B3			✓		✓	✓	✓	✓	✓		✓

Table 2. Summary of Preferred Alternatives for Each Control Level

Control Level	Total Cost	Annual CSO Volume Controlled
	$ Mil	MG
90% Capture	220.5	1,526
95% Capture	297.2	1,565
4 Overflow/ Yr	309.1	1,597
1 Overflow / Yr	312.8	1,608
99% Capture	324.8	1,624
100% Capture	324.8	1,626

CONTROL LEVEL SELECTION

The selection of the control level for the Long-Term Control Plan was based on several factors including cost/benefit analysis, economic affordability analysis, sensitive area considerations, construction feasibility and "small community" status. The cost/benefit analysis compared the cost of construction versus the volume of CSO captured on an annual basis for all of the control levels being considered. This analysis found that the

point of diminishing returns, that is the point at which additional investment provides less than an equal return, occurs at the four overflows per year point. The economic affordability analysis was performed in accordance with the EPA CSO Affordability Guidance Document. This analysis found that the two lesser control levels, 90% control and 95% control, impose a “medium burden” on residents. The remaining control levels, 4 OF/Y, 99% control, 1 OF/Y and 100% control, impose a “high burden” on residents. As required by the CSO policy, the LTCP reviewed Lake Erie and Rocky River with respect to the sensitive area criteria and found that while both water bodies have primary contact recreation designations, the City of Lakewood does not have any primary contact recreation facilities, such as public beaches with life guards and bathroom facilities. The one private primary contact recreation facility located within city limits is the private beach of the Lagoons. There are no overflows at the Lagoons and water quality calculations found that for control levels of 4 OF/Y and higher that water quality standards would be met.

Separation of the over/under sewer system is an on-going Operation and Maintenance (O&M) effort performed as part of the Streets program. The separation program was started to reduce basement flooding but has the added benefit of controlling the discharge of CSO flows from non-permitted pipes, which impacts approximately 60-miles of pipe, or about ¾ of the City. Effective performance of this work is limited by the City’s ability to fund, design and inspect the work. With a population of approximately 56,000, the City is classified under the CSO policy as a “small community”. This recognizes that some aspects of the policy may be difficult for a small community to comply with and allows for discretion to be used in the selection of controls.

Based on these factors, the control level selected for the LTCP is four (4) overflows per year. This control level is fiscally responsible, as higher levels of control provide diminished return on investment, yet places a “high burden” on the residents. The control level places the highest priority on protecting the receiving waters by increasing the annual CSO volume controlled to 98.6% of the CSO volume generated.

RECOMMENDED PLAN

The Recommended Long-Term Control Plan is based on a CSO pipe storage system, shown in Figure 4. This capture and conveyance system is supplemented with separation of the over/under sewers, rehabilitation of the Edgewater Interceptor, relieving the Madison Avenue collection system and bringing the West End neighborhood into the Edgewater Interceptor system. The recommended plan was identified as alternative B1 in the alternative develop and evaluation work. The following paragraphs provide an overview of these components.

The LTCP is based on several assumptions. The attainment of CSO control levels was based on results of hydraulic modeling of the typical year of rainfall. The sizing of the CSO storage facilities was based on reducing stormwater levels in the interceptor system from an average of 30% to 10%.

The proposed CSO storage facility included in the LTCP is a 22.5 MG storage tunnel system that is 17,000-ft long and 15-ft in diameter. The intent of the proposed facility is to intercept combined sewage from the local system along the lake front, relieve the Edgewater Interceptor and receive flows from the Madison Relief Sewer.

Separation of the over/under system was included in the LTCP to reduce stormwater inflow, reduce basement flooding and eliminate the discharge of flows from the over/under system through the non-permitted “storm” outfalls. By removing the connection points and physically separating the two systems, a portion of the flow that originated in the “over” storm system that was reaching the interceptor system, will now discharge as stormwater. Over/ under separation is incorporated into the LTCP based on the construction of a new sanitary sewer and connection of existing sanitary laterals. A stormwater level of 10% was used in the LTCP to reflect an average system.

Figure 4. LTCP CSO Storage Facility

The assumption of this 10% stormwater condition is the basis for sizing of the CSO storage system that is used to capture and store CSO volume for treatment. Failure to reduce the stormwater rate will result in the recommended LTCP infrastructure being undersized. Achieving stormwater rates less than 10% will result in the facilities being oversized.

The City has recently had the opportunity to inspect select locations along the existing interceptor. It has been reported that, aside from two damaged sections, the interceptor is in good condition. Because the interceptor is a critical component of the City's infrastructure and to the LTCP, one component of the plan is to line the length of the existing interceptor with a structural lining.

The existing sewer system serving Madison Avenue operates at high water levels during dry weather flows. During even small wet weather events, elevated water levels can affect basements and discharge to the storm system. The proposed Madison Avenue Relief System relieves the surcharging in the existing sewer system and intercepts two existing overflows from the combined system to the over/under system.

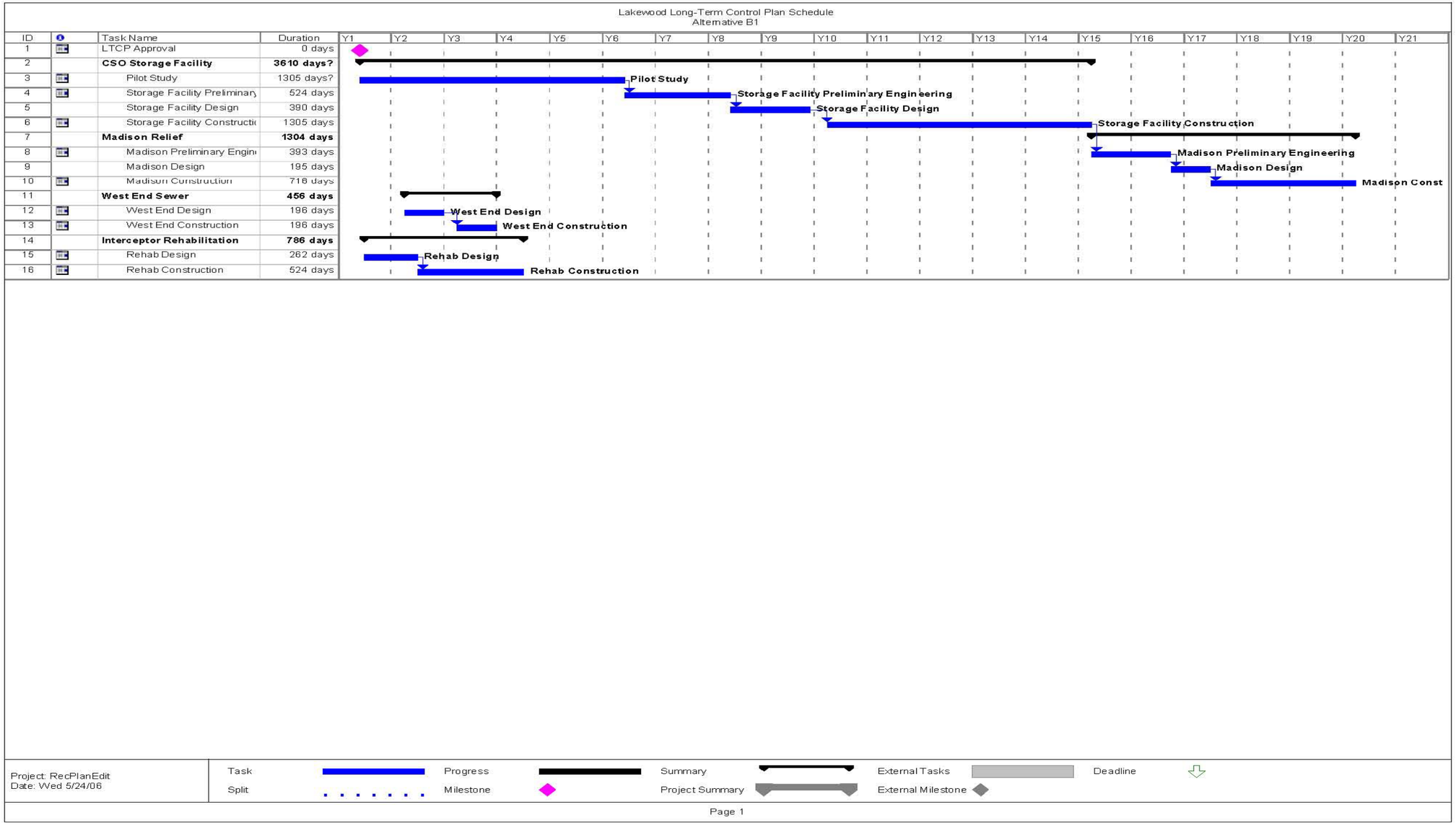
The proposed West End sewer system would redirect the flow that currently drops down approximately 50-ft and is then pumped into the LWWTP headworks to the Edgewater Interceptor system.

IMPLEMENTATION

Implementation of the LTCP is based on the approval of the plan by Ohio EPA and the verification of the stormwater reduction assumption upon which the LTCP is based. The CSO LTCP schedule, shown in Figure 5, is a 20-year schedule. The first activity of the CSO LTCP schedule is the pilot study on sewer separation to verify the sizing basis of 10% stormwater infiltration.

Structural rehabilitation of the Edgewater Interceptor is currently scheduled simultaneously with the pilot study as the rehabilitation is not dependent upon the results of the study.

Figure 5. LTCP Implementation Schedule



However, this project does not have a direct impact on CSO discharges and can be performed later in the program with no impact on CSO performance.

The West End project is scheduled early in the implementation phase because it does not require the results of the separation pilot study to proceed. This project eliminates two (2) CSOs (053 and 054).

The preliminary study and engineering required for the CSO Storage system is scheduled to begin after the results of the pilot study are finalized. This will allow for revisions to the original concept to be incorporated into the design and avoid potential delays in moving to construction..The sewer separation program is a on-going, long-term operation and maintenance (O&M). To date, the separation program has included both the construction on new pipes and the reuse of the existing pipes with construction of new manholes. The separation program work is generally performed with the streets program work.

COST

The cost of studying, designing and constructing the LCTP have been developed using planning level cost estimates, a financing period of 20-years and an interest rate of 5%. The total program cost of $309 million consists of $142 million in new capital projects and $167 million of O&M cost for sewer separation. New capital projects begin with agreement on the LTCP by EPA/ OEPA and the City. Some O&M costs associated with the new capital project extend beyond the 20-year LTCP based on the proposed schedule. Annual O&M costs for sewer separation have not been determined. One possible distribution of costs is provided in Table 3 for information.

Table 3. Annual Cost of LTCP

CAPITAL PROJECT	$mil	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19	Y20
CSO Storage System																					
Pilot Study	0.50	0.05	0.10	0.10	0.10	0.10	0.05														
Preliminary Engineering	4.21						1.05	2.11	1.05												
Design	8.43								3.37	5.06											
Construction[1]	84.30										12.64	16.86	16.86	16.86	16.86	4.21					
O&M[2]	2.52															0.13	0.13	0.13	0.13	0.13	0.13
Madison Ave Relief																					
Preliminary Engineering	0.64															0.32	0.32				
Design	1.27																0.42	0.85			
Construction[1]	12.74																	1.91	3.82	3.82	1.91
O&M[2]	0.29																				
West End Sewer																					
Design	0.05		0.05																		
Construction[1]	0.48			0.48																	
O&M	0.009				0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
Interceptor Rehabilitation																					
Design	0.88	0.44	0.44																		
Construction[1]	8.78		2.20	4.39	2.20																
SUMMARY CAPITAL PROJECT																					
Preliminary Engineering	4.85						1.05	2.11	1.05							0.32	0.32				
Pilot Study	0.50	0.05	0.10	0.10	0.10	0.10	0.05														
Design	10.63	0.44	0.49					3.37	5.06								0.42	0.85			
Construction[1]	106.30		2.20	4.87	2.20						12.64	16.86	16.86	16.86	16.86	4.21		1.91	3.82	3.82	1.91
Preliminary Engineering	4.85						1.05	2.11	1.05							0.32	0.32				
O&M PROJECT																					
Over/Under Separation																					
Design	16.73	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	
Construction[1]	167.28		8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80
Total Annual Cost ($mil)	309.1	1.37	12.47	14.66	11.99	9.79	10.80	15.17	15.80	9.69	22.34	26.55	26.55	26.55	26.55	14.35	10.56	12.58	13.64	13.64	10.85

[1] Construction annualized based on 20-year @5% Escalation not considered
[2] Costs extend beyond 20-year capital schedule