Attachment 7: Economic Analysis – Flood Damage Reduction Costs and Benefits

Summary

The Downtown Sewer Upsizing Project is a portion of the City of Sacramento's Combined Sewer System Improvement Program (CSSIP). The City has completed similar improvements downstream, and in conjunction with them, the Downtown Combined Sewer Upsizing Project will reduce combined system overflows (CSOs) to the Sacramento River and reduce flooding of combined stormwater runoff and sewage (termed "CSS outflows") in the downtown area of Sacramento. Thus, the project will meet multiple planning objectives: improve water quality in the Sacramento River (the source of drinking water for millions of Californians), reduce flood damage in the economically vital downtown area of Sacramento, and protect public health by reducing the likelihood and volume of diluted sewage on streets and properties.

The Downtown Sewer Upsizing Project was first conceived by City hydrologists in the 1990's to address the ongoing flooding problems in the Downtown area. Previously completed portions of the project include the U and S Street Parallel Sewer (completed in 2007) and replacement of existing combined sewer trunk mains with larger pipelines (upsizing) and constructing parallel pipelines in S Street, 5th Street and in the alley between J and K Streets (completed in 2010). These projects served to both increase conveyance to the Sump 1/1A complex, which had been improved in 1997, and reduced the hydraulic grade line in the vicinity of the improvements, including a vulnerable flooding location at 5th and U Streets. It also provided hydraulic improvements to reduce odors and improve pumping efficiency at Sump 1 and Sump 2.

To complete the Downtown Sewer Upsizing Project, it is necessary to continue the "upsizing" in 7th Street to connect with a section upstream that was constructed out of sequence due to timing constraints, and to extend this network of upsized pipes in L, G, F, and 8th Street. For the project to function properly, it is necessary that it be continuous, without bottleneck sections like currently exist. Once completed, the network of upsized and parallel pipes will serve to lower the hydraulic grade line in this portion of the City with critical and high value real estate that has experienced flooding of combined sewer outflows in the past. The Downtown Sewer Upsizing Project will replace existing pipelines with larger pipes, by paralleling the existing pipeline or by connecting new pipes to upsized portions, whichever approach is determined to be most practical. Replacing the pipelines has the added benefit of renewing pipes that have long since exceeded their useful lives. For example, the pipes in 7th Street and S Street are mostly

constructed of clay bricks and were constructed in the 1890's. As such, they are not reliable and have been known to fail suddenly.

In addition to the benefits provided to the downtown Sacramento area due to reduced combined sewer overflows, the project will also benefit water suppliers utilizing Freeport Regional Water Authority's (FRWA) intake structure. As the FRWA intake facility is located three miles downstream of downtown Sacramento on the Sacramento River; any combined sewer overflows occurring in the City and entering the river has direct significant negative impacts on the river's water quality and therefore affects water entering the FRWA intake structure.

Costs

As documented in Attachment 4, the total capital cost for the Downtown Combined Sewer Upsizing Project is $13,109,359; however $6,776,064 of the total project costs occurred in previous years. Because these are "sunk costs," they are not used in calculating the net present value of all costs associated with this project. Table 1 augments the costs presented in Attachment 4, minus the sunk costs, with projected future operations, maintenance and replacement costs. The total present value of the project is $5,335,325 and is based on a 50-year project life cycle, which is consistent with the life cycle assumed in the flood damage reduction benefit analysis.

Table 1: Annual Cost of Project
(Referenced as Table 10 in Exhibit C of the Proposition 1E Grant PSP)

Table 2 - Annual Cost of Project
Project: Downtown Combined Sewer Upsizing Project

Year	Initial Costs	Operations and Maintenance Costs						Discounting Calculations	
	(a) Capital and Other Initial Costs	(b) Admin	(c) Operation	(d) Maintenance	(e) Replacement	(f) Other	(g) Total Costs (a)+…+(f)	(h) Discount Factor	(i) Discounted Costs (g) x (h)
2009	$0	$0	$0	$0	$0	$0	$0	1.00	$0
2010	$0	$0	$0	$0	$0	$0	$0	0.94	$0
2011	$2,154,031	$0	$0	$0	$0	$0	$2,154,031	0.89	$1,917,080
2012	$2,269,854	$0	$0	$0	$0	$0	$2,269,854	0.84	$1,905,813
2013	$1,909,410	$0	$0	$0	$0	$0	$1,909,410	0.79	$1,512,431
2014	$0	$0	$0	$0	$0	$0	$0	0.75	$0
2015	$0	$0	$0	$0	$0	$0	$0	0.70	$0
2016	$0	$0	$0	$0	$0	$0	$0	0.67	$0
2017	$0	$0	$0	$0	$0	$0	$0	0.63	$0
2018	$0	$0	$0	$0	$0	$0	$0	0.59	$0
2019	$0	$0	$0	$0	$0	$0	$0	0.56	$0
2020	$0	$0	$0	$0	$0	$0	$0	0.53	$0
2021	$0	$0	$0	$0	$0	$0	$0	0.50	$0
2022	$0	$0	$0	$0	$0	$0	$0	0.47	$0
2023	$0	$0	$0	$0	$0	$0	$0	0.44	$0
2024	$0	$0	$0	$0	$0	$0	$0	0.42	$0
2025	$0	$0	$0	$0	$0	$0	$0	0.39	$0
2026	$0	$0	$0	$0	$0	$0	$0	0.37	$0
2027	$0	$0	$0	$0	$0	$0	$0	0.35	$0
2028	$0	$0	$0	$0	$0	$0	$0	0.33	$0
2029	$0	$0	$0	$0	$0	$0	$0	0.31	$0

Table 2 - Annual Cost of Project Project: Downtown Combined Sewer Upsizing Project									
	Initial Costs	Operations and Maintenance Costs						Discounting Calculations	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Year	Capital and Other Initial Costs	Admin	Operation	Maintenance	Replacement	Other	Total Costs (a)+…+(f)	Discount Factor	Discounted Costs (g) x (h)
2030	$0	$0	$0	$0	$0	$0	$0	0.29	$0
2031	$0	$0	$0	$0	$0	$0	$0	0.28	$0
2032	$0	$0	$0	$0	$0	$0	$0	0.26	$0
2033	$0	$0	$0	$0	$0	$0	$0	0.25	$0
2034	$0	$0	$0	$0	$0	$0	$0	0.23	$0
2035	$0	$0	$0	$0	$0	$0	$0	0.22	$0
2036	$0	$0	$0	$0	$0	$0	$0	0.21	$0
2037	$0	$0	$0	$0	$0	$0	$0	0.20	$0
2038	$0	$0	$0	$0	$0	$0	$0	0.18	$0
2039	$0	$0	$0	$0	$0	$0	$0	0.17	$0
2040	$0	$0	$0	$0	$0	$0	$0	0.16	$0
2041	$0	$0	$0	$0	$0	$0	$0	0.15	$0
2042	$0	$0	$0	$0	$0	$0	$0	0.15	$0
2043	$0	$0	$0	$0	$0	$0	$0	0.14	$0
2044	$0	$0	$0	$0	$0	$0	$0	0.13	$0
2045	$0	$0	$0	$0	$0	$0	$0	0.12	$0
2046	$0	$0	$0	$0	$0	$0	$0	0.12	$0
2047	$0	$0	$0	$0	$0	$0	$0	0.11	$0
2048	$0	$0	$0	$0	$0	$0	$0	0.10	$0
2049	$0	$0	$0	$0	$0	$0	$0	0.10	$0
2050	$0	$0	$0	$0	$0	$0	$0	0.09	$0
2051	$0	$0	$0	$0	$0	$0	$0	0.09	$0
2052	$0	$0	$0	$0	$0	$0	$0	0.08	$0

Table 2 - Annual Cost of Project

Project: Downtown Combined Sewer Upsizing Project

	Initial Costs	**Operations and Maintenance Costs**						**Discounting Calculations**	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Year	Capital and Other Initial Costs	Admin	Operation	Maintenance	Replacement	Other	Total Costs (a)+…+(f)	Discount Factor	Discounted Costs (g) x (h)
2053	$0	$0	$0	$0	$0	$0	$0	0.08	$0
2054	$0	$0	$0	$0	$0	$0	$0	0.07	$0
2055	$0	$0	$0	$0	$0	$0	$0	0.07	$0
2056	$0	$0	$0	$0	$0	$0	$0	0.06	$0
2057	$0	$0	$0	$0	$0	$0	$0	0.06	$0
2058	$0	$0	$0	$0	$0	$0	$0	0.06	$0
2059	$0	$0	$0	$0	$0	$0	$0	0.05	$0
2060	$0	$0	$0	$0	$0	$0	$0	0.05	$0
2061	$0	$0	$0	$0	$0	$0	$0	0.05	$0
2062	$0	$0	$0	$0	$0	$0	$0	0.05	$0
2063	$0	$0	$0	$0	$0	$0	$0	0.04	$0
2064	$0	$0	$0	$0	$0	$0	$0	0.04	$0
2065	$0	$0	$0	$0	$0	$0	$0	0.04	$0
	Total Present Value of Discounted Costs (Sum of Column (i))								**$5,335,325**

Comments: This project does not include maintenance costs as the continued maintenance costs associated with sewer cleaning are not affected by the pipeline upsizing. Therefore, there is no incremental increase in the amount of sewer cleaning, repair, and inspection. Project life is considered to be 50 years, which is consistent with the life cycle assumed in the flood damage reduction benefit analysis.

The "Without Project" Baseline

The City's current combined sewer infrastructure is insufficient to handle large storms, resulting in raw sewage outflows onto streets in Downtown Sacramento and into the adjacent Sacramento River. As the downtown Sacramento area is highly populated, the sewage outflows present a public health risk in addition to associated flood damages and water quality impacts.

In 1990, the Central Valley Regional Water Quality Control Board served the City with a Cease and Desist Order that directed the City to devise a plan to reduce its CSO's and CSS outflows. The Downtown Combined Sewer Upsizing Project would increase the conveyance capacity and in-system storage of the combined sewer system, significantly reducing the frequency and volume of combined sewage spills and discharges. Without this project, alternative projects would need to be developed to meet the requirements in the Regional Board's Cease and Desist Order and/or sewer overflows would continue at the existing rate, posing public health, water quality and water supply impacts.

Flood Damage Reduction Benefits

This section describes the Flood Damage Reduction Analysis (FDRA) that was completed for the Project and presents the Expected Annual Damage (EAD) benefits that would result from the completion of the Project.

Hydrology and Hydraulic Analysis

For the hydrologic and hydraulic analysis, the City of Sacramento used their existing InfoWorks CS model. InfoWorks CS is a collection system model that can be used to simulate the effects that storm events have on collection systems. The City of Sacramento's Infoworks model was used for this analysis to determine the surcharge volume for different storm events.

The Sacramento InfoWorks CS model was developed for the City by AECOM as part of the Combined Sewer Improvement Plan (CSSIP) Update. The key objective of the CSSIP Update was to build upon the extensive modeling work conducted by the City over the last 20 years by revising, extending, updating, and refining the existing Sacramento CSS-SWMM model. The comprehensive effort included extending the physical network representation, updating dry- and wet-weather flow inputs, reviewing and refining model assumptions and techniques, and validating the model against existing data and those obtained as part of a flow monitoring program conducted over the period from January 9^{th} to March 10^{th} of 2009. The updated and extended model includes approximately three times as many nodes and conduits, precise representation of all special structures and facilities such as Sump 2/2A, 1/1A/1B, Pioneer Reservoir, and all diversions and sumps. Dry- and wet-weather flows are represented based on monitoring data. Hydraulic parameters that influence the simulation of level, velocity and flow have been adjusted in order to produce a calibrated and verified model.

The City's InfoWorks model was fine-tuned in order to be able to distinguish street flooding (surface runoff that cannot enter a surcharged system) from outflows (flows that come out of the system). An additional feature of the InfoWorks model was invoked such that, during a simulation ,the program keeps track of the composition of wastewater as a percentage of its two sources, namely the amount derived from base sanitary sewage and stormwater runoff sources.

The calibrated model was used to analyze seven planned CSSIP project alternatives. The goal of this modeling was to compare the results of the InfoWorks model to prior results obtained using the previous CSS-SWMM modeling in terms of outflow and flooding reduction. The InfoWorks CS model predicted larger outflow and flooding volumes compared to the previous CSS-SWMM modeling. However, the predicted percent reduction in outflow and flooding associated with the proposed projects is similar.

Using the calibrated model developed by AECOM, City staff simulated for pre- and post-project conditions for the Downtown Sewer Upsizing Project. The 2-year, 5-year, 10-year, 25-year, and 50-year storms were analyzed. The storms were nested 6-hour storms with 5 minute increments. The Infoworks CS model integrates GIS, aerial photos, and LIDAR data and is able to plot flooding for the various simulations over the aerial photo.

Flood Damage Analysis

Flood damage was determined by visual inspection of the pre- and post-aerial photos for each simulated storm event. For each simulated storm, City staff counted the number of structures that were shown as flooded in the pre-project aerial photo and no longer flooded in the post-project aerial photo at key locations. These locations were determined selected based on greatest amount of flooding depth reduction and past experience with the City's combined sewer system. The number of flooded structures was then determined by extrapolating the number structures counted over the entire systems' flood reduction. This effort was repeated for each of the return periods analyzed.

Only damage to properties was considered in this analysis. If the elevation of the flood or overflow water was greater than finished floor or lowest living area elevation, an average flood damage cost of $33,000 was assumed. This flood damage cost was taken from the average flood damage claim over the past 10 years (National Flood Insurance Program). Table 2 shows the number of properties damaged per each storm event and Table 3 shows the total damage for each storm event.

The expected damage without the project is $622,050, while there will be no damage once the project is implemented; therefore, the expected damage reduction benefit is $622,050. The present value of the project benefits, assuming a 50-year lifespan and a 6% discount rate, is $9,803,508 (Table 4).

Table 2: Properties Damaged by Storm Event

Hydrologic Event	Event Probability	Properties Damaged	Total Storm Damage
2-year	0.50	8	$264,000
5-year	0.20	44	$1,452,000
10-year	0.10	47	$1,551,000
25-year	0.04	58	$1,914,000
50-year	0.02	77	$2,541,000

Table 3: Event Damage
(Referenced as Table 11 in Exhibit C of the Proposition 1E Grant PSP)

Hydrologic Event	Event Probability	Event Damage Without Project	Event Damage With Project
2-year	0.50	$264,000	$0
5-year	0.20	$1,452,000	$0
10-year	0.10	$1,551,000	$0
25-year	0.04	$1,914,000	$0
50-year	0.02	$2,541,000	$0

Table 4: Present Value of Expected Annual Damage Benefits
(Referenced as Table 12 in Exhibit C of the Proposition 1E Grant PSP)

Expected Annual Damage Without Project	$622,050
Expected Annual Damage with Phase 1	$0
Expected Damage Benefit	$622,050
Present Value Coefficient	15.76
Present Value of Future Benefits	***$9,803,508***

Conclusion

The Downtown Sewer Upsizing Project will significantly reduce combined sewer overflows in the Downtown Sacramento area and provides a present value benefit of $9,803,508. The Project will remove 77 properties from the inundation area in the 50-year storm event. Aside from the damage to properties, the project will improve public health in the Downtown region by decreasing the amount of untreated wastewater that the public can come in contact with, as well as reducing debris cleanup costs. These other benefits have been monetized in Attachment 9 – Water Quality and Other Benefits.