

Appendix A Supporting Documentation for Cost Estimation

To understand the relative benefit of a mitigation activity with respect to its cost, this study developed planning level cost estimates. The mitigation activities identified through the study are conceptual and will undergo further refinement and development. At this stage of development, it is only possible to estimate rough order of magnitude costs for each of the mitigation projects. The team used the best available data and engineering judgment to quantify the costs. Unless specifically mentioned, all cost estimates provided in this study exclude the costs of real estate acquisition and operation/maintenance.

1.1 M1 Projects

M1 projects would benefit local drainage areas and are small-scale efforts.

1.1.1 Cost Estimation Methodology

The M1 projects provided the limited project information used in the cost estimates. Approximately 15% of the projects within the project list included cost estimates. Approximately 10% of the projects had construction plan sets. These plan sets allowed development of a general understanding of the type of projects being considered in the C-8 and C-9 Watersheds. The team applied this understanding and the project name/description to categorize most of the projects into one of the following categories:

- Drainage Improvements (typically exfiltration systems)
- Sluice Gate Construction (operational canal controls)
- Pump Station Construction (Levels 1 and 2)

Many of the M1 projects identified by partner communities address maintenance of systems. This study assumes systems are fully operational and maintained. Maintenance is critical to good flood control but is not “new” to the system and, therefore, was not included.

Applying the limited cost estimates provided, the team calculated an average project cost for the drainage improvements and sluice gate construction projects. There are several pump stations identified only by location as mitigation projects. Based on the locations of the pump station projects, the team assigned a reasonable pump station size of either 25 cfs or 100 cfs. With this size, this study assigned each a cost proportional to the SFWMD Coastal Resiliency Program (SFWMD, 2022) that applied a typical cost of \$55,000 per cfs. This rule of thumb cost gave the following unit costs for the two levels:

- Level 1-Neighborhood Pump Station-Level 1 \$1,375,000 Based on 25 CFS @ \$55,000/CFS
- Level 2-Tributary Canal Pump Station-Level 2 \$5,500,000 Based on 100 CFS @ \$55,000/CFS

These planning level costs apply appropriate assumptions and are in line with typical engineering projects of similar size and type **Table A- 1** presents the project costs for M1 projects. These costs can be updated as the M1 projects are refined and as unit costs for similar projects are developed.

Table A- 1: C-8 M1 Projects Cost Estimate

M1 Projects Cost Estimate - C-8 Basin		
Project Type	Unit Cost	Total Cost
Drainage Improvements	\$ 542,000	\$ 2,350,000
Pump Station - Level 1	\$ 1,375,000	\$ 1,375,000
Pump Station - Level 2	\$ 5,500,000	\$ 16,500,000
Total Projects Cost		\$ 20,225,000
M1 Projects Cost Estimate - C-9 Basin		
Project Type	Unit Cost	Total Cost
Drainage Improvements	\$ 542,000	\$ 7,948,000
Sluice Gate	\$ 108,000	\$ 1,080,000
Pump Station - Level 2	\$ 5,500,000	\$ 27,500,000
Total Projects Cost		\$ 36,528,000

1.2 M2 Projects (NGVD29 to NAVD88 Conversion = -1.57 ft)

1.2.1 Cost Estimation Methodology

Cost estimates for the M2 projects (M2A, M2B, and M2C) are based largely on prior cost estimates from SFWMD. SFWMD provided cost estimates from the Coastal Resiliency Program which were updated to represent the improvement strategies identified by the modeling team. This mainly involved modifying the pump and generator size, spillway elevation, tie-back levee elevation, and associated costs. Specifically, SFWMD provided the structure replacement costs with a 5 ft increase in spillway elevation.

Taylor developed all other pump station costs based on the cost estimates provided by SFWMD, as part of the Coastal Resiliency Program (SFWMD, 2022). Furthermore, Taylor proportionally modified (scaled up or down) the pump system items (pumps, generators, and associated control systems/structures) to develop the costs for the range of pump sizes used in the M2 projects. Based on the Coastal Resiliency Program cost estimates, Taylor used 15% of the construction costs for design and construction management. Please see **Table A- 14** through **Table A- 16** for the M2 projects cost estimates with references depicting the source of the item costs. In addition, Taylor developed the costs for expanding surface storage of floodwaters assuming a total of 500 acres of land is available across both watersheds combined, or 250 acres in each of the C—8 and C-9 Watersheds. Taylor also assumed each storage area would provide 1 ft of storage depth with the goal of providing 500 ac-ft of storage within the watersheds. This estimate excluded the real estate costs of these storage areas. While some of the areas identified are SFWMD or FDEP-owned, most would require purchasing the land or other intergovernmental agreements. These cost estimates are very general in nature and cannot increase in specificity until a

project location and size is determined. Each site will have its unique challenges that will greatly influence the construction costs.

To develop these general costs, the team used the FDOT Historical Costs Database and considered the following factors:

- Clearing
- Erosion Control
- Excavation
- Final Grade and Sod
- Bonds and Insurance 1.5%
- Profit 10%
- Overhead 6%
- Contingency 30%

Taylor also prepared costs for canal improvements including raising the canal banks to elevation 7.5 ft NGVD29 for M2B and M2C and widening the C-8 and C-9 Canals for M2C. **Table A- 2** through **Table A- 7** depict the overall cost estimates for the M2A, M2B, and M2C projects.

Table A- 2: Mitigation Project M2A Cost Estimate For C-8 Watershed

Pump Station	
Structure Replacement	\$ 19,057,000
Forward Pump (1550 cfs)	\$ 79,639,000
Forward Pump Backup Generator Facility	\$ 9,086,000
Structure Tie Back (Flood Barrier)	\$ 2,987,000
Design & Construction Management	\$ 16,615,000
Real Estate	\$ 7,000,000
Total Pump Station Cost	\$ 134,384,000
Storage	
Distributed Storage (~250 Ac-Ft)	\$ 38,860,000
Design & Construction Management	\$ 5,829,000
Total Storage Cost	\$ 44,689,000
Total Cost of Mitigation M2A for C-8 Watershed	\$ 179,073,000

Table A- 3: Mitigation Project M2A Cost Estimate For C-9 Watershed

Pump Station		
Structure Replacement	\$	19,057,000
Forward Pump (1550 cfs)	\$	84,291,000
Forward Pump Backup Generator Facility	\$	9,618,000
Structure Tie Back (Flood Barrier)	\$	2,769,000
Design & Construction Management	\$	17,360,000
Real Estate	\$	16,000,000
Total Pump Station Cost	\$	149,095,000
Storage		
Distributed Storage (~250 Ac-Ft)	\$	38,860,000
Design & Construction Management	\$	5,829,000
Total Storage Cost	\$	44,689,000
Total Cost of Mitigation M2A for C-9 Watershed	\$	193,784,000

Table A- 4: Mitigation Project M2B Cost Estimate For C-8 Watershed

Pump Station		
Structure Replacement	\$	19,057,000
Forward Pump (2550 cfs)	\$	107,002,000
Forward Pump Backup Generator Facility	\$	11,440,000
Structure Tie Back (Flood Barrier)	\$	2,987,000
Design & Construction Management	\$	21,073,000
Real Estate	\$	7,000,000
Total Pump Station Cost	\$	168,559,000
Storage		
Distributed Storage (~250 Ac-Ft)	\$	38,860,000
Design & Construction Management	\$	5,829,000
Total Storage Cost	\$	44,689,000
Canal Improvements		
Raise Canal Banks (to 7.5 ft NGVD29)	\$	12,413,000
Design & Construction Management	\$	1,862,000
Total Canal Improvements Cost	\$	14,274,000
Total Cost of Mitigation M2B for C-8 Watershed	\$	227,522,000

Table A- 5: Mitigation Project M2B Cost Estimate For C-9 Watershed

Pump Station		
Structure Replacement	\$	19,057,000
Forward Pump (2550 cfs)	\$	111,669,000
Forward Pump Backup Generator Facility	\$	11,919,000
Structure Tie Back (Flood Barrier)	\$	2,769,000
Design & Construction Management	\$	21,812,000
Real Estate	\$	16,000,000
Total Pump Station Cost	\$	183,226,000
Storage		
Distributed Storage (~250 Ac-Ft)	\$	38,860,000
Design & Construction Management	\$	5,829,000
Total Storage Cost	\$	44,689,000
Canal Improvements		
Raise Canal Banks (to 7.5 ft)	\$	7,119,000
Design & Construction Management	\$	1,068,000
Total Canal Improvements Cost	\$	8,186,000
Total Cost of Mitigation M2B for C-9 Watershed	\$	236,101,000

Table A- 6: Mitigation Project M2C Cost Estimate For C-8 Watershed

Pump Station		
Structure Replacement	\$	19,057,000
Forward Pump (3550 cfs)	\$	134,482,000
Forward Pump Backup Generator Facility	\$	13,792,000
Structure Tie Back (Flood Barrier)	\$	2,987,000
Design & Construction Management	\$	25,548,000
Real Estate	\$	7,000,000
Total Pump Station Cost	\$	202,866,000
Storage		
Distributed Storage (~250 Ac-Ft)	\$	38,860,000
Design & Construction Management	\$	5,829,000
Total Storage Cost	\$	44,689,000
Canal Improvements		
Raise Canal Banks (to 7.5 ft NGVD29)	\$	12,412,000
Widen Canal (approx. 20,000 linear ft by 100 ft)	\$	31,619,000
Design & Construction Management	\$	6,605,000
Total Canal Improvements Cost	\$	50,636,000
Total Cost of Mitigation M2C for C-8 Watershed	\$	298,191,000

Table A- 7: Mitigation Project M2C Cost Estimate For C-9 Watershed

Pump Station	
Structure Replacement	\$ 19,057,000
Forward Pump (3550 cfs)	\$ 139,006,000
Forward Pump Backup Generator Facility	\$ 14,217,000
Structure Tie Back (Flood Barrier)	\$ 2,769,000
Design & Construction Management	\$ 26,257,000
Real Estate	\$ 16,000,000
Total Pump Station Cost	\$ 217,306,000
Storage	
Distributed Storage (~250 Ac-Ft)	\$ 38,860,000
Design & Construction Management	\$ 5,829,000
Total Storage Cost	\$ 44,689,000
Canal Improvements	
Raise Canal Banks (to 7.5 ft NGVD29)	\$ 7,119,000
Widen Canal (approx. 79,000 linear ft by ~75 ft)	\$ 107,725,000
Design & Construction Management	\$ 17,227,000
Total Canal Improvements Cost	\$ 132,070,000
Total C-9 Cost	\$ 394,065,000

1.3 M3 Projects

1.3.1 Cost Estimation Methodology

This study followed the approach applied by Deltares (2018) to estimate the cost of raising buildings and roads. For buildings, Deltares used estimates by FEMA (2019) and Aerts et al (2013) to estimate a unit cost of raising a residential building by 2 to 6 ft. This unit cost is very general and only provides a gross estimate of what the possible costs could be. As communities work to mitigate buildings and roads on a basin-wide scale, these unit costs can be refined as the true cost of the activities are developed. To identify the number of buildings that need to be elevated, the team used MIKE SHE model results for existing conditions and added 1, 2, and 3 ft, and added the number of buildings in each flood layer.

Estimates to elevate roads follow a similar approach and use a unit cost per ft of road based on road costs values provided by Miami-Dade. The values provided by Miami-Dade included an average for elevating a 2-lane road in 50 ft of right-of-way. This study applies the average of elevating roads 1, 2, and 3 ft for a unit cost of \$673, \$892, and \$1,111 per linear foot, respectively. The M3 Cost Estimates are presented in

Table A- 8 through **Table A- 13**. Please note that the units EA and LF stand for “each” and “linear feet,” respectively.

Table A- 8: C-8 Watershed Cost Estimate of Mitigation M3 (1 ft)

Type	Unit Costs	Units	Value	Total Costs
Buildings	\$ 55,386	EA	1,648	\$ 91,300,000
Roads	\$ 673	LF	130,416	\$ 87,800,000
Total				\$ 179,100,000

Table A- 9: C-8 Watershed Cost Estimate of Mitigation M3 (2 ft)

Type	Unit Costs	Units	Value	Total Costs
Buildings	\$ 55,386	EA	2,255	\$ 124,900,000
Roads	\$ 892	LF	175,296	\$ 156,300,000
Total				\$ 281,200,000

Table A- 10: C-8 Watershed Cost Estimate of Mitigation M3 (3 ft)

Type	Unit Costs	Units	Value	Total Costs
Buildings	\$ 55,386	EA	3,193	\$ 176,800,000
Roads	\$ 1,111	LF	232,848	\$ 258,700,000
Total				\$ 435,500,000

Table A- 11: C-9 Watershed Cost Estimate of Mitigation M3 (1 ft)

Type	Unit Costs	Units	Value	Total Costs
Buildings	\$ 55,386	EA	1,064	\$ 58,900,000
Roads	\$ 673	LF	304,656	\$ 205,200,000
Total				\$ 264,100,000

Table A- 12: C-9 Watershed Cost Estimate of Mitigation M3 (2 ft)

Type	Unit Costs	Units	Value	Total Costs
Buildings	\$ 55,386	EA	1,225	\$ 67,800,000
Roads	\$ 892	LF	340,560	\$ 303,700,000
Total				\$ 371,500,000

Table A- 13: C-9 Watershed Cost Estimate of Mitigation M3 (3 ft)

Type	Unit Costs	Units	Value	Total Costs
Buildings	\$ 55,386	EA	1,616	\$ 89,500,000
Roads	\$ 1,111	LF	413,952	\$ 459,900,000
Total				\$ 549,400,000

Table A- 14: M2A Cost Estimation

M2A for 25-Year SLR1		
C-8/S-28 Cost Estimate		
Pump Station	Costs	References/Notes
Structure Replacement	\$19,056,898	S28 Costs from SFWMD PDF Costs (Assumed 250' DS; raise spillway by 5')
Forward Pump (1550 cfs)	\$79,639,466	S28 Costs from SFWMD's XLS Costs (S28:AN271)
Forward Pump Backup Generator Facility	\$9,085,601	S28 Costs from SFWMD's XLS Costs (S28:BH118)
Structure Tie Back (Flood Barrier)	\$2,987,463	S28 Costs from SFWMD's XLS Costs (raise berm by 3'x250') (S28:AX47)
Design & Construction Management	\$16,615,414	S28 Costs from SFWMD's XLS Costs (15% of costs excluding real estate)
Real Estate	\$7,000,000	S28 Costs from SFWMD's XLS Costs (S28:BR10)
Total Pump Station Cost	\$134,384,842	
Storage		
Distributed Storage (500 Ac-Ft)	\$38,859,600	Real estate costs excluded
Design & Construction Management	\$5,828,940	15% of costs excluding real estate
Total Storage Cost	\$44,688,540	
Total C-8 Cost	\$179,073,382	
C-9/S-29 Cost Estimate		
Pump Station		
Structure Replacement	\$19,056,898	S28 Costs from SFWMD's PDF Costs (raise spillway by 5') at minimum
Forward Pump (1550 cfs)	\$84,291,017	S29 Costs from SFWMD's XLS Costs Modified to 1500 CFS Pump (S29:J9)
Forward Pump Backup Generator Facility	\$9,618,145	S29 Costs from SFWMD's XLS Costs (S29:J10)
Structure Tie Back (Flood Barrier)	\$2,769,122	S29 Costs from SFWMD's XLS Costs (raise berm by 3') (S29:J11)
Design & Construction Management	\$17,360,277	S29 Costs from SFWMD's XLS Costs (15% of costs excluding real estate)
Real Estate	\$16,000,000	S29 Costs from SFWMD's XLS Costs (S29:J13)
Total Pump Station Cost	\$149,095,459	
Storage		
Distributed Storage (500 Ac-Ft)	\$38,859,600	Real estate costs excluded
Design & Construction Management	\$5,828,940	15% of costs excluding real estate
Total Storage Cost	\$44,688,540	
Total C-9 Cost	\$193,783,999	

Table A- 15: M2B Cost Estimation

M2B for 25-Year SLR1		
C-8/S-28 Cost Estimate		
Pump Station	Costs	References/Notes
Structure Replacement	\$19,056,898	S28 Costs from SFWMD's PDF Costs (Assumed 250' DS; raise spillway by 5')
Forward Pump (2550 cfs)	\$107,001,675	S28 Costs from SFWMD's XLS Costs scaled to 2500 CFS Pump (S28-M2B:AN271)
Forward Pump Backup Generator Facility	\$11,440,141	S28 Costs from SFWMD's XLS Costs, Scaled generator to match pump (S28:BH118)
Structure Tie Back (Flood Barrier)	\$2,987,463	S28 Costs from SFWMD's XLS Costs (raise berm by 3'x250') (S28:AX47)
Design & Construction Management	\$21,072,927	S28 Costs from SFWMD's XLS Costs (15% of costs excluding real estate)
Real Estate	\$7,000,000	S28 Costs from SFWMD's XLS Costs (S28:BR10)
Total Pump Station Cost	\$168,559,105	
Storage		
Distributed Storage (500 Ac-Ft)	\$38,859,600.00	Real estate costs excluded
Design & Construction Management	\$5,828,940.00	15% of costs excluding real estate
Total Storage Cost	\$44,688,540.00	
Canal Improvements		
Raise Canal Banks (to 7.5 ft)	\$12,412,542	Costs from SFWMD's email estimate (real estate costs excluded)
Design & Construction Management	\$1,861,881	15% of costs excluding real estate
Total Canal Improvements Cost	\$14,274,423	
Total C-8 Cost	\$227,522,068	
C-9/S-29 Cost Estimate		
Pump Station		
Structure Replacement	\$19,056,898	S28 Costs from SFWMD's PDF Costs (raise spillway by 5') at minimum
Forward Pump (2550 cfs)	\$111,668,639	S29 Costs from SFWMD's XLS Costs Scaled to 2500 CFS Pump (S29-M2B:J9)
Forward Pump Backup Generator Facility	\$11,918,924	S29 Costs from SFWMD's XLS Costs, Scaled generator to match pump (S29:J10)
Structure Tie Back (Flood Barrier)	\$2,769,122	S29 Costs from SFWMD's XLS Costs (raise berm by 3') (S29:J11)
Design & Construction Management	\$21,812,037	S29 Costs from SFWMD's XLS Costs (15% of costs excluding real estate)
Real Estate	\$16,000,000	S29 Costs from SFWMD's XLS Costs (S29:J13)
Total Pump Station Cost	\$183,225,620	
Storage		

M2B for 25-Year SLR1		
C-8/S-28 Cost Estimate		
Distributed Storage (500 Ac-Ft)	\$38,859,600	Real estate costs excluded
Design & Construction Management	\$5,828,940	15% of costs excluding real estate
Total Storage Cost	\$44,688,540	
Canal Improvements		
Raise Canal Banks (to 7.5 ft)	\$7,118,542	Costs from SFWMD's email estimate (real estate costs excluded)
Design & Construction Management	\$1,067,781	15% of costs excluding real estate
Total Canal Improvements Cost	\$8,186,323	
Total C-9 Cost	\$236,100,483	

Table A- 16: M2C Cost Estimation

M2C for 25-year SLR3		
C-8/S-28 Cost Estimate		
Pump Station	Costs	References/Notes
Structure Replacement	\$19,056,898	S28 Costs from SFWMD's PDF Costs (Assumed 250' DS; raise spillway by 5')
Forward Pump (3550 cfs)	\$134,481,716	S28 Costs from SFWMD's XLS Costs scaled to 3500 CFS Pump (S28-M2C:AN271)
Forward Pump Backup Generator Facility	\$13,791,922	S28 Costs from SFWMD's XLS Costs, Scaled generator to match pump (S28:BH118)
Structure Tie Back (Flood Barrier)	\$2,987,463	S28 Costs from SFWMD's XLS Costs (raise berm by 3'x250') (S28:AX47)
Design & Construction Management	\$25,547,700	S28 Costs from SFWMD's XLS Costs (15% of costs excluding real estate)
Real Estate	\$7,000,000	S28 Costs from SFWMD's XLS Costs (S28:BR10)
Total Pump Station Cost	\$202,865,699	
Storage		
Distributed Storage (500 Ac-Ft)	\$38,859,600	Real estate costs excluded
Design & Construction Management	\$5,828,940	15% of costs excluding real estate
Total Storage Cost	\$44,688,540	
Canal Improvements		
Raise Canal Banks (to 7.5 ft)	\$12,412,542	Raise Tab using SFWMD's email estimate (real estate costs excluded)
Widen Canal (by 100 ft)	\$31,618,782	Widen Tab using (real estate costs excluded)
Design & Construction Management	\$6,604,699	15% of costs excluding real estate
Total Canal Improvements Cost	\$50,636,022	
Total C-8 Cost	\$298,190,261	
C-9/S-29 Cost Estimate		
Pump Station		
Structure Replacement	\$19,056,898	S28 Costs from SFWMD's PDF Costs (raise spillway by 5') at minimum
Forward Pump (3550 cfs)	\$139,005,527	S29 Costs from SFWMD's XLS Costs Modified to 3500 CFS Pump (S29-M2C:J9)
Forward Pump Backup Generator Facility	\$14,217,365	S29 Costs from SFWMD's XLS Costs, Scaled generator to match pump (S29:J10)
Structure Tie Back (Flood Barrier)	\$2,769,122	S29 Costs from SFWMD's XLS Costs (raise berm by 3') (S29:J11)
Design & Construction Management	\$26,257,337	S29 Costs from SFWMD's XLS Costs (15% of costs excluding real estate)
Real Estate	\$16,000,000	S29 Costs from SFWMD's XLS Costs (S29:J13)
Total Pump Station Cost	\$217,306,249	

M2C for 25-year SLR3		
C-8/S-28 Cost Estimate		
Storage		
Distributed Storage (500 Ac-Ft)	\$38,859,600	Real estate costs excluded
Design & Construction Management	\$5,828,940	15% of costs excluding real estate
Total Storage Cost	\$44,688,540	
Canal Improvements		
Raise Canal Banks (to 7.5 ft)	\$7,118,542	Costs from SFWMD's email estimate (real estate costs excluded)
Widen Canal (by ~75 ft)	\$107,725,296	Widen Tab using (real estate costs excluded)
Design & Construction Management	\$17,226,576	15% of costs excluding real estate
Total Canal Improvements Cost	\$132,070,414	
Total C-9 Cost	\$394,065,203	