City of Bellaire
Public Works Department

MEMORANDUM

TO:	Paul A. Hofmann, City Manager
FROM:	Michael Leech, Public Work Director
DATE:	November 3, 2017
SUBJECT:	Flap Gate Project Update

At the March 20, 2017 City Council Meeting, Costello Engineering was awarded a contract to provide design services for the reconstruction of several street segments. The project also included the design of drainage system flap gates. The purpose of the proposed flap gates is to keep Brays Bayou storm water from entering the City's storm sewer system during high water surface elevation events along Brays. This memorandum will provide an update on the schedule of this work.

The street segments currently in design for reconstruction are listed below:

- 500 Block of Bolivar
- 4500 Block of Maple
- 5100 - 5200 Blocks of Spruce
- 700 Block of N Fifth Street

The flap gates, also currently in design, will be located at the following outfall locations:

- South Rice
- IH 610
- New Castle

Soon after the design of this project began, staff asked the Costello to explore the possibility of splitting the flap gate portion of the work from the roadway reconstruction portion. The logic behind the request was as follows:

- It may be possible to accelerate the schedule of the flap gate portion of the work.
- There may be savings in awarding two construction contracts rather than one as flap gate construction is relatively specialized when compared to roadway reconstruction.

City of Bellaire
Public Works Department

MEMORANDUM

Attached please find a letter from Costello supporting the installation of flap gates and explaining the results of their analysis relative to the flap gates. The letter generally states that the proposed flap gates would provide protection to the City during most high surface water events on Brays Bayou. It also states that there is no risk of a negative impact from the flap gates. However, during a record breaking event like Harvey, the flap gates would provide little benefit.

Also attached to this memorandum are revised project schedules for both the flap gate and roadway projects. By splitting the two projects the revised construction start date for the flap gates portion of the work is January 2019. This is approximately seven months sooner than the original schedule which combined both projects. The roadway portion of the project is scheduled to begin in August of 2019.

October 26, 2017

Ms. Cristin Emshoff
City of Bellaire
4440 Edith Street
Bellaire, Texas 77401

Re: Storm Sewer Outfall Flap Gate Hydraulic Analysis
City of Bellaire
CI Job No. 2017114-000-00-011

Dear Ms. Emshoff:

This purpose of this letter is to present the results of a preliminary analysis to install flap gates at three major storm sewer outfall locations within the City of Bellaire: South Rice Avenue, IH-610, and Newcastle Street. These three systems discharge into the Cypress Ditch that runs along the south boundary of the city, generally parallel to Beechnut Street, and ultimately discharges into Brays Bayou. The purpose of the flap gates would be to prevent floodwaters from Brays Bayou from backing-up the Cypress Ditch into the storm sewer systems, thus reducing the capacity of the storm sewers. This analysis quantifies the amount of the storm sewer systems affected by the Brays backwater for a range of storm events and identifies under which conditions the flap gates provide a hydraulic benefit.

The main trunks flowlines and top of pipe elevations along each storm sewer system were compared to the Brays Bayou effective FEMA HEC-RAS model water surface elevations for the 10, 50, and 100-year event. The geometric data for each storm sewer was taken from the report tables provided by the city. The vertical elevation information provided was stated to be on the NGVD 1929, 73 adjustment. The FEMA model is on NAVD 1988, 2001 adjustment. A datum adjustment was computed of -3.24 feet (29, 73 – 3.24 feet = 88,2001) from HCFCD monument B 1211.

The attached **Exhibit 1** shows a profile of the South Rice Avenue storm sewer which compares the storm sewer system to the FEMA water surface elevations from Brays Bayou at the outfall location. The Brays 50 and 100-year backwater elevation in the ditch completely fill up the storm sewer pipes. The Brays 10-year backwater elevation leaves very little storage available. Installing a flap gate at the storm sewer outfall would prevent the ditch floodwater from backing up into the Bellaire storm sewers. However, when the river floodwater overtops the banks of the ditch, flap gates will provide no benefit. This elevation is between the 10-year and 50-year elevation, as indicated on the profiles. Additionally, if a local intense rainfall event occurs over Bellaire simultaneously, the local rain will fill up the system and balance itself hydraulically, regardless of the flap gate. In these situations, the flap gate does not provide a negative impact, but also does not provide any hydraulic value to the system.

To better define the range of hydrologic conditions in which a flap gate would provide benefit to the storm sewer system, an XP-STORM 2-dimensional analysis (2D) was created that simulates the main trunk of the underground storm sewer with the overlaying topographic ground. This 2D analysis allows

for simulation of a range of dynamic tailwater conditions with varying levels of rainfall to determine what conditions a flap gate would be beneficial to the hydraulics of the system.

The storm sewer pipes and manholes have been modeled as 1D elements connected to a 2D grid of the city created using the HGAC 2008 LiDAR dataset. A variable tailwater curve was created that approximates a Brays Bayou flooding event that fills up the Cypress Ditch in three separate tailwater conditions: bank ½ fill, bank full, and overtopping. Runoff hydrographs for a range of local rainfall events were computed which include the 2, 5, 10, 25, 50, and 100-year events. Each condition was then simulated with and without a flap gate. The benefits of the flap gate were determined by comparing the resultant water surface elevations with and without the flap gate. **Exhibit 2** shows a table of each storm event versus tailwater conditions.

The models indicate that the flap gate provides the greatest benefit when the local rainfall event occurs after the peak of Brays Bayou begins to recede. Additionally, as underground detention is planned to be constructed to aid in reducing internal peak ponding levels within the city, the benefit of the flap gate would increase due to the additional volume that would be at risk of being lost due to backwater from Brays Bayou.

Based on the above analysis, the addition of a flap gate would provide a benefit only during a certain range of hydrologic conditions, but these hydrologic conditions are experienced on a more frequent basis. No condition was determined that would create an adverse impact due to the flap gate being in place. With the planned underground detention improvements, the utilization of a flap gate would provide a reduced risk of flooding within the City of Bellaire. If you have any questions or comments, please feel free to contact me at 713-783-7788 or by email at swilcox@costelloinc.com.

Sincerely,
Costello, Inc.

James S. Wilcox

J. Stephen Wilcox, P.E., CFM
Project Manager – Hydrology & Hydraulics

Attachments
Exhibit 1 – Storm Sewer Profile
Exhibit 2 – Benefit Summary Table

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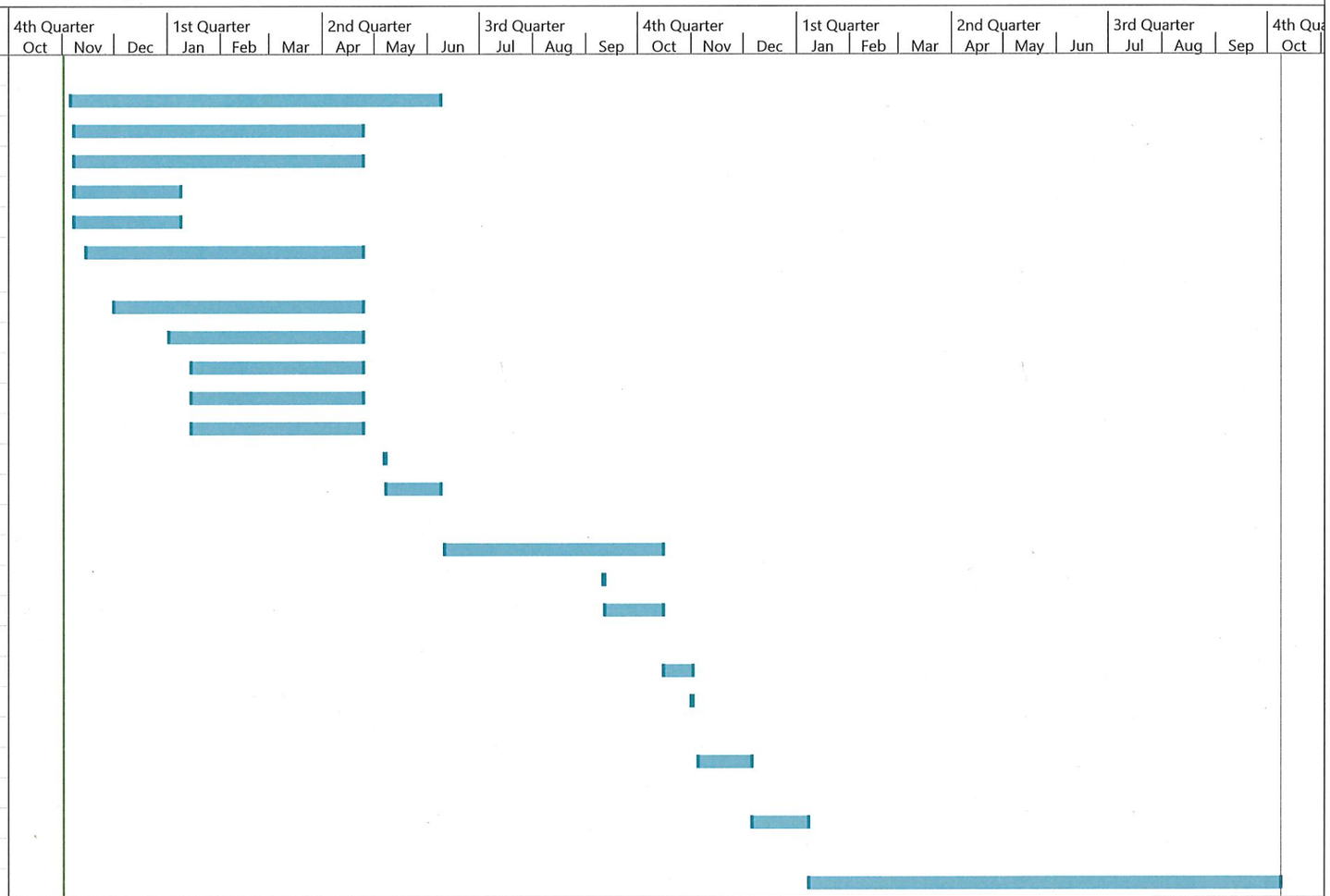
Schedule
City of Bellaire
Group C, Phase 2 Flap Gates

ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1						
2	60% Design	155 days	Mon 11/6/17	Fri 6/8/18		
3	Utility Coord	120 days	Wed 11/8/17	Tue 4/24/18		
4	Agency Coord	120 days	Wed 11/8/17	Tue 4/24/18		
5	Surveying	44 days	Wed 11/8/17	Mon 1/8/18		
6	Geotechnical	44 days	Wed 11/8/17	Mon 1/8/18		
7	Structural Design	115 days	Wed 11/15/17	Tue 4/24/18		
8	Details	103 days	Fri 12/1/17	Tue 4/24/18		
9	Traffic Control	81 days	Tue 1/2/18	Tue 4/24/18		
10	SW3P	72 days	Mon 1/15/18	Tue 4/24/18		
11	Project Manual	72 days	Mon 1/15/18	Tue 4/24/18		
12	Cost Estimate	72 days	Mon 1/15/18	Tue 4/24/18		
13	60% Submittal	1 day	Mon 5/7/18	Mon 5/7/18		
14	60% Reviews	24 days	Tue 5/8/18	Fri 6/8/18		
15						
16	90% Design	91 days	Mon 6/11/18	Mon 10/15/1		
17	90% Submittals	1 day	Tue 9/11/18	Tue 9/11/18		
18	Approvals	24 days	Wed 9/12/18	Mon 10/15/1		
19						
20	100% Design	13 days	Tue 10/16/18	Thu 11/1/18		
21	100% Submittal	1 day	Thu 11/1/18	Thu 11/1/18		
22						
23	Bid Process	23 days	Mon 11/5/18	Wed 12/5/18		
24						
25	Contracts Process	23 days	Thu 12/6/18	Mon 1/7/19		
26						
27	Construction	196 days	Tue 1/8/19	Tue 10/8/19		

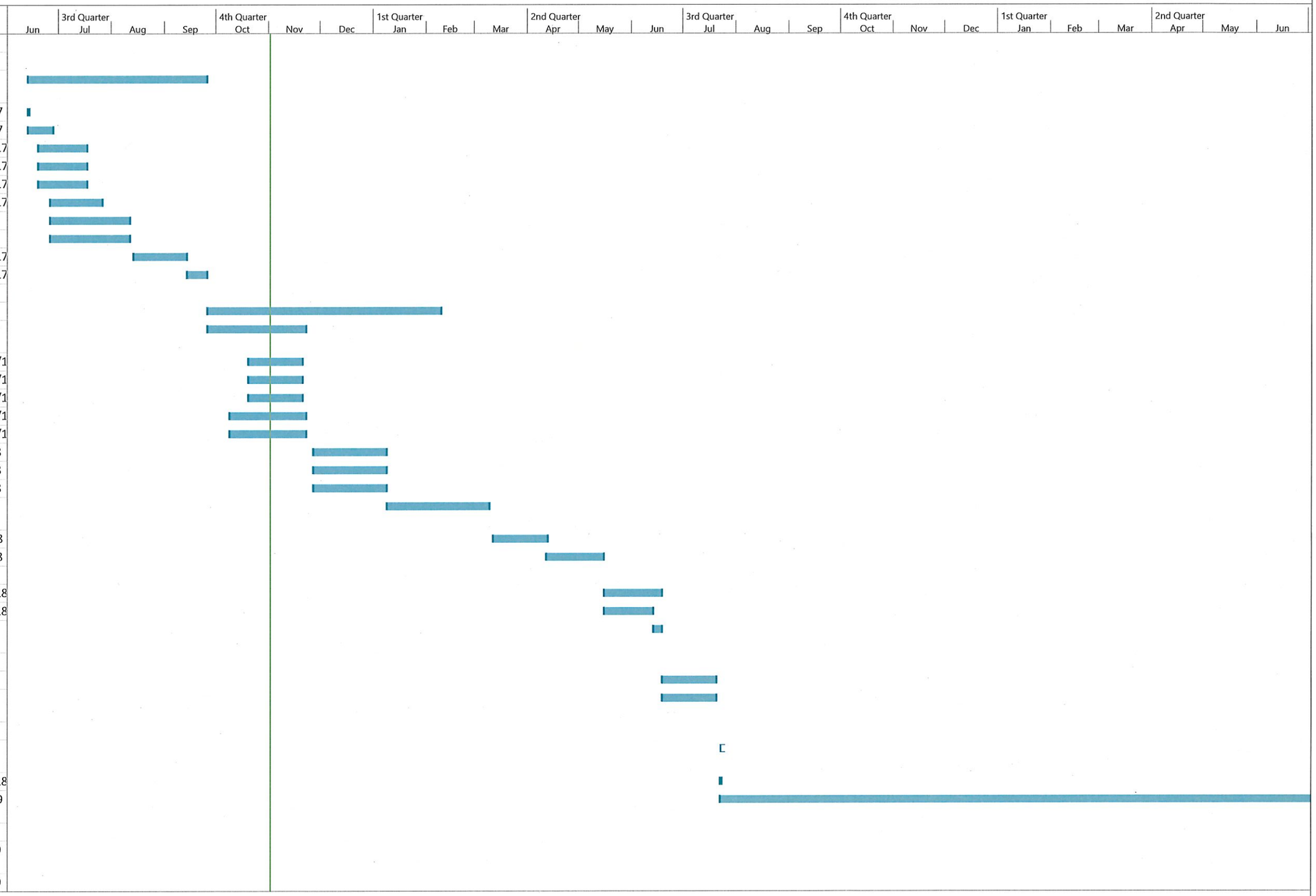


Project: Flap Gate schedule 110
Date: Thu 11/2/17

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

Preliminary Schedule
Bonds for Bellaire, Group C
Ph 2 Streets & Drainage*

ID	Task Name	Duration	Start	Finish
1				
2				
3	PRELIMINARY ENGR	75 days	Tue 6/13/17	Mon 9/25/17
4	Kickoff Mtg	1 day	Tue 6/13/17	Tue 6/13/17
5	Research	11 days	Tue 6/13/17	Tue 6/27/17
6	Survey	21 days	Mon 6/19/17	Mon 7/17/17
7	Utility Coord	21 days	Mon 6/19/17	Mon 7/17/17
8	Agency Coord	21 days	Mon 6/19/17	Mon 7/17/17
9	Geotechnical	23 days	Mon 6/26/17	Wed 7/26/17
10	30% PSE	35 days	Mon 6/26/17	Fri 8/11/17
11	Draft PER	35 days	Mon 6/26/17	Fri 8/11/17
12	City Comments	23 days	Mon 8/14/17	Wed 9/13/17
13	Final PER	8 days	Thu 9/14/17	Mon 9/25/17
14				
15	FINAL DESIGN	99 days	Tue 9/26/17	Fri 2/9/18
16	60% Constr Dwgs	42 days	Tue 9/26/17	Wed 11/22/17
17	TCP	22 days	Fri 10/20/17	Mon 11/20/1
18	SW3P	22 days	Fri 10/20/17	Mon 11/20/1
19	Tree Protection	22 days	Fri 10/20/17	Mon 11/20/1
20	Specifications	33 days	Mon 10/9/17	Wed 11/22/1
21	Project Manual	33 days	Mon 10/9/17	Wed 11/22/1
22	City Comments	31 days	Mon 11/27/1	Mon 1/8/18
23	Agency Reviews	31 days	Mon 11/27/1	Mon 1/8/18
24	Utility Reviews	31 days	Mon 11/27/1	Mon 1/8/18
25	90% Constr Dwgs	44 days	Tue 1/9/18	Fri 3/9/18
26	90% Reviews	24 days	Mon 3/12/18	Thu 4/12/18
27	100% PSE	24 days	Thu 4/12/18	Tue 5/15/18
28				
29	BID PHASE	24 days	Wed 5/16/18	Mon 6/18/18
30	Bidding Process	21 days	Wed 5/16/18	Wed 6/13/18
31	Bid Tab/Rec Award	3 days	Thu 6/14/18	Mon 6/18/18
32				
33	CONTRACT PHASE	24 days	Tue 6/19/18	Fri 7/20/18
34	Contract Execution	24 days	Tue 6/19/18	Fri 7/20/18
35				
36	CONSTRUCTION PHASE		Mon 7/23/18	
37	Pre Con Meeting	1 day	Mon 7/23/18	Mon 7/23/18
38	Construction	284 days	Mon 7/23/18	Thu 8/22/19
39	Inspections	7 days	Thu 8/22/19	Fri 8/30/19
40	Substancial Compl	1 day	Mon 9/2/19	Mon 9/2/19
41	Final Compl	1 day	Mon 9/9/19	Mon 9/9/19



Project: Group C Phase 2 Street
Date: 11/2/17

Task	Summary	Inactive Milestone	Duration-only	Start-only	External Milestone	Manual Progress
Split	Project Summary	Inactive Summary	Manual Summary Rollup	Finish-only	Deadline	
Milestone	Inactive Task	Manual Task	Manual Summary	External Tasks	Progress	

* - Flap Gate work in Separate Construction Contract