

AMORY ENGINEERS, P.C.

WATER WORKS • WATER RESOURCES • CIVIL WORKS

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June 1, 2020

Mr. Peter Buttkus, Director
Department of Public Works
878 Tremont Street
Duxbury, MA 02332

Subject: Duxbury Beach Seawall Assessment and Replacement Phasing Plan

Dear Mr. Buttkus:

In response to your request, we are pleased to submit this assessment report on the condition of the Duxbury Beach Seawall along with our recommendations for replacement phases of the wall. The purpose of this report is 1) to document the current condition of the $\pm 2,860$ linear feet of existing seawall that will not be replaced under the Phase I replacement project and 2) to prioritize and recommend the order in which sections of the seawall should be replaced.

The condition assessment is based on visual inspection conducted on March 27 and April 10, 2020 of the existing seawall. The condition of each individual section of seawall¹ was rated based on its position (i.e. leaning, settlement, etc.) and concrete condition. The ratings do not account for the presence of stone revetment fronting the wall. Condition was rated on a scale of 1 to 10, with 1 being the poorest and 10 being the best. For example, a rating of 1 would be a wall that would likely fail during a severe storm event and a rating of 10 would be a new wall with no deficiencies. The condition assessment and ratings are shown in Table 1, attached.

Ideally, the entire existing seawall would be replaced in one construction contract. However, funding will ultimately dictate the amount of seawall that may be replaced in any given contract and the number of phases will likely be required. Clearly, the sections of seawall that have the lowest rating should be replaced first. However, it is not practical nor economical to replace individual short sections of wall. Therefore, the recommendations and order of priority listed below are based on replacing numerous adjacent sections at a time.

Priority 1: Replace the north seawall, including the block wall adjacent to the south end. We note that the northern-most section (Section 18) is located in Marshfield and coordination with Marshfield will be required as this section should be replaced at the same time as the Duxbury sections. Total length of wall, including the block wall, is approximately 905 linear feet (l.f.) with approximately 850 l.f. in Duxbury and 55 l.f. in Marshfield.

Priority 2: Replace the south low wall, south of the stairs. Total length of this wall is approximately 575 l.f.

¹ Seawall sections are generally fifty feet in length. See attached Location Plan for reference.

Priority 3: Replace Section 32 of the south low wall and the leaning sections (Sections 33-40) of the south high wall. Total length is approximately 425 l.f. The leaning sections of wall are rated lower than the sections recommended under Priority 2 but the leaning sections have revetment in front which adds some stability to these sections and make them slightly less susceptible to storm damage than the sections of south low wall without revetment.

Priority 4: Replace the remainder of the south high wall (Sections 41-58). Total length is approximately 1,010 l.f.

We have prepared estimates of cost for replacing the seawall in three scenarios, first, the entire 2,860 l.f. at once, second, three phases with about 1,000 l.f. per phase and third, six phases with about 500 l.f. per phase. Our estimates of cost are included in Table 2, attached. Please note that the estimates do not include costs for beach nourishment, which will be required for any phases of wall replacement beyond the Phase 1 project, currently under construction. The estimates do include allowances for engineering and permitting.

We trust that the information included in this report is sufficient to suit your needs. Please call if you have any question.

Very truly yours,

AMORY ENGINEERS, P.C.

By:



A handwritten signature in blue ink, appearing to read "Patrick G. Brennan", written over a horizontal line.

Patrick G. Brennan, P.E.

PGB
enc.

TABLE 1

Duxbury Beach Seawalls - 2020 Condition Assessment

Condition rating is on a scale of 1 through 10, with 1 being the worst condition and 10 being the best.

Section Number	Condition Description	Condition Rating
South Low Wall		
1	Newer concrete (circa 2007), a couple of minor vertical cracks	8
2	Minor horizontal and vertical cracks and efflorescence	7
3	Minor horizontal and vertical cracks and efflorescence, one area with about a 5'-6' long larger horizontal crack	5
4	Minor horizontal and vertical cracks and efflorescence	7
5	Minor horizontal and vertical cracks and efflorescence	7
6	Large cracks in northern 10'-15' of section, adjacent to joint	3
7	Minor horizontal and vertical cracks and efflorescence	7
8	Major horizontal cracks throughout entire section	2
9	Minor and intermediate horizontal and vertical cracks and efflorescence	4
10	Major horizontal crack along north 2/3 of section. Joint between 10 & 11 moved in March 2018	3
11	Minor horizontal and vertical cracks and efflorescence, intermediate vertical crack at about mid-point	4
12	Minor horizontal and vertical cracks and efflorescence, major vertical crack and spall at about mid-point, minor settlement	5
13	To be replaced under Phase I	
14	To be replaced under Phase I	
15	To be replaced under Phase I	
16	To be replaced under Phase I	
17	To be replaced under Phase I	
18	To be replaced under Phase I	
19	To be replaced under Phase I	
20	To be replaced under Phase I	

TABLE 1

Duxbury Beach Seawalls - 2020 Condition Assessment

Condition rating is on a scale of 1 through 10, with 1 being the worst condition and 10 being the best.

Section Number	Condition Description	Condition Rating
21	To be replaced under Phase I	
22	To be replaced under Phase I	
23	To be replaced under Phase I	
24	To be replaced under Phase I	
25	To be replaced under Phase I	
26	To be replaced under Phase I	
27	To be replaced under Phase I	
28	To be replaced under Phase I	
29	To be replaced under Phase I	
30	To be replaced under Phase I	
31	To be replaced under Phase I	
32	Intermediate vertical cracks, minor horizontal cracks and efflorescence	4

South High Wall

33	Minor horizontal and vertical cracks and efflorescence, a couple of intermediate vertical cracks	6
34	Movement seaward at joint with 33; intermediate vertical cracks throughout, major crack & spalling at joint with 35	4
35	Significant seaward movement at joint with 34; section leaning seaward; revetment in front; major crack & spalling at joint with 36	3
36	Section leaning seaward; revetment in front; minor horizontal and vertical cracks and efflorescence	4
37	Section leaning seaward; revetment in front; minor horizontal and vertical cracks and efflorescence	4
38	Section leaning seaward; revetment in front; intermediate and major vertical cracks and efflorescence	3
39	Section leaning seaward; revetment in front; minor horizontal and vertical cracks and efflorescence	4
40	Section leaning seaward; revetment in front; intermediate and major vertical cracks and efflorescence, major movement at joint with 41	4

TABLE 1

Duxbury Beach Seawalls - 2020 Condition Assessment

Condition rating is on a scale of 1 through 10, with 1 being the worst condition and 10 being the best.

Section Number	Condition Description	Condition Rating
41	Minor horizontal and vertical cracks and efflorescence, intermediate vertical crack about mid-point	4
42	Minor & intermediate horizontal and vertical cracks and efflorescence	6
43	Minor horizontal and vertical cracks and efflorescence	7
44	Minor & intermediate horizontal and vertical cracks and efflorescence	6
45	Minor horizontal and vertical cracks and efflorescence	7
46	Minor & intermediate horizontal and vertical cracks and efflorescence	6
47	Minor & intermediate horizontal and vertical cracks and efflorescence	6
48	Minor horizontal and vertical cracks and efflorescence	7
49	Minor horizontal and vertical cracks and efflorescence	7
50	Minor & intermediate horizontal and vertical cracks and efflorescence	6
51	Minor & intermediate horizontal and vertical cracks and efflorescence	6
52	Minor & intermediate horizontal and vertical cracks and efflorescence	5
53	Minor horizontal and vertical cracks and efflorescence	7
54	Minor & intermediate horizontal and vertical cracks and efflorescence	5
55	Minor & intermediate horizontal and vertical cracks and efflorescence	5
56	Minor & intermediate horizontal and vertical cracks and efflorescence	4
57	Minor & intermediate horizontal and vertical cracks and efflorescence, some major cracks	4
58	Minor & intermediate horizontal and vertical cracks and efflorescence	5

TABLE 1

Duxbury Beach Seawalls - 2020 Condition Assessment

Condition rating is on a scale of 1 through 10, with 1 being the worst condition and 10 being the best.

Section Number	Condition Description	Condition Rating
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North Wall

Block Wall	This wall was constructed some time after the other portions of the seawall. This wall is in poor condition and should be replaced at the same time as the adjacent seawall.	1
1	South top corner of section has major cracks; minor & intermediate horizontal and vertical cracks and efflorescence	4
2	Minor & intermediate horizontal and vertical cracks and efflorescence	5
3	Minor & intermediate horizontal and vertical cracks and efflorescence	5
4	Intermediate horizontal and vertical cracks and efflorescence	4
5	Intermediate horizontal and vertical cracks and efflorescence, major vertical and horizontal cracks at north end	3
6	Major horizontal cracks throughout with a couple of vertical cracks; top section of wall broke off & repaired in 2018	2
7	Intermediate & major horizontal cracks throughout; top section of wall broke off & repaired in 2018; revetment in front	2
8	Intermediate vertical cracks, horizontal and vertical cracks and efflorescence; revetment in front	4
9	Major horizontal and vertical cracks throughout; revetment in front	2
10	Major vertical cracks; a portion of the top at south end broke off & repaired in 2018; revetment in front	2
11	Intermediate & major horizontal and vertical cracks throughout; revetment in front	2
12	Intermediate horizontal cracks, major vertical crack about 20 feet from south end; revetment in front	2
13	Minor and intermediate horizontal and vertical cracks; revetment in front	3
14	Minor and intermediate horizontal and vertical cracks; revetment in front	3
15	Minor and intermediate horizontal and vertical cracks; revetment in front	4
16	Minor and intermediate horizontal and vertical cracks; revetment in front	4
17	Minor and intermediate horizontal and vertical cracks, major vertical crack at mid-point; revetment in front	3
18	Minor horizontal and vertical cracks, major vertical crack about 15 feet from north end (section in Marshfield); revetment in front	3

Table 2**Cost Estimates**

Notes:

Inflation calculated at 2% yearly.

Estimates based on present day construction cost.

\$ 4,820 Present cost of seawall per linear foot.

Scenario 1, Replace entire Seawall:

2,860 Linear Feet:

\$ 13,785,200 Present-Day Construction Cost
 \$ 1,378,520 Engineering & Permitting (10%)
 \$ 15,163,720 Sub-Total

Scenario 1 Total: \$ 15,776,334 Year 2022 cost

Scenario 2, Replace in three phases:

Phase 1: North Seawall (Block wall plus Sections 1-17, does not include wall Section 18 in Marshfield).

850 Linear Feet:

\$ 4,097,000 Present-Day Construction Cost
 \$ 409,700 Engineering & Permitting (10%)
 \$ 4,506,700 Sub-Total
 \$ 4,688,771 Year 2022 cost

Phase 2: Ocean Road South (Sections 1-12), South Low Wall Section 32 & South High Wall Sections 33-40

1,000 Linear Feet:

\$ 4,820,000 Present-Day Construction Cost
 \$ 482,000 Engineering & Permitting (10%)
 \$ 5,302,000 Sub-Total
 \$ 5,739,055 Year 2024 cost

Phase 3: South High Wall (Sections 41-58)

1010 Linear Feet:

\$ 4,868,200 Present-Day Construction Cost
 \$ 486,820 Engineering & Permitting (10%)
 \$ 5,355,020 Sub-Total
 \$ 6,030,622 Year 2026 cost

Scenario 2 Total: \$ 16,458,448

Scenario 3, Replace in six phases:

Phase 1: South end of North Seawall (Block Wall plus Sections 1-8)

450 Linear Feet:

\$ 2,169,000 Present-Day Construction Cost
 \$ 216,900 Engineering & Permitting (10%)
 \$ 2,385,900 Sub-Total
 \$ 2,482,290 Year 2022 cost

Phase 2: North end of North Seawall (Sections 9-17)

400 Linear Feet:

\$ 1,928,000 Present-Day Construction Cost
 \$ 192,800 Engineering & Permitting (10%)
 \$ 2,120,800 Sub-Total
 \$ 2,295,622 Year 2024 cost

Phase 3: Ocean Road South (Sections 1-12)

575 Linear Feet:

\$ 2,771,500 Present-Day Construction Cost
 \$ 277,150 Engineering & Permitting (10%)
 \$ 3,048,650 Sub-Total
 \$ 3,433,275 Year 2026 cost

Phase 4: South Low Wall Section 32 & South High Wall Sections 33-40

425 Linear Feet:

\$ 2,048,500 Present-Day Construction Cost
 \$ 204,850 Engineering & Permitting (10%)
 \$ 2,253,350 Sub-Total
 \$ 2,640,159 Year 2028 cost

Phase 5: South High Wall next 500 l.f.

500 Linear Feet:

\$ 2,410,000 Present-Day Construction Cost
 \$ 241,000 Engineering & Permitting (10%)
 \$ 2,651,000 Sub-Total
 \$ 3,231,554 Year 2030 cost

Phase 6: South High wall remaining 510 l.f.)

510 Linear Feet:

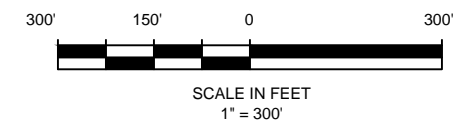
\$ 2,458,200 Present-Day Construction Cost
 \$ 245,820 Engineering & Permitting (10%)
 \$ 2,704,020 Sub-Total
 \$ 3,429,351 Year 2032 cost

Scenario 3 Total: \$ 17,512,252



NOTES:

1. BASE MAP IS MASSGIS 2019 ORTHOPHOTOS.



DEPARTMENT OF PUBLIC WORKS DUXBURY, MASSACHUSETTS	
DUXBURY BEACH SEAWALLS LOCATION PLAN	
DATE: 6/1/20	SCALE: 1" = 300'
AMORY ENGINEERS, P.C. DUXBURY, MASSACHUSETTS	

SOUTH LOW WALL



Section 1



Section 1

SOUTH LOW WALL



Section 2



Section 2

SOUTH LOW WALL



Section 2 – 3



Section 3

SOUTH LOW WALL



Section 3



Section 3 – 4

SOUTH LOW WALL



Section 4



Section 4

SOUTH LOW WALL



Section 4 – 5



Section 5

SOUTH LOW WALL



Section 5 – 6



Section 6

SOUTH LOW WALL



Section 6



Section 6 – 7

SOUTH LOW WALL



Top Section 6



Section 7

SOUTH LOW WALL



Section 7



Section 8

SOUTH LOW WALL



Close up of cracks in Section 8



Section 8

SOUTH LOW WALL



Section 8



Section 8 – 9

SOUTH LOW WALL



Section 9



Top Section 9

SOUTH LOW WALL



Section 9 – 10



Section 10

SOUTH LOW WALL



Section 10



Section 10 – 11

SOUTH LOW WALL



Top joint Section 10 – 11



Section 11

SOUTH LOW WALL



Section 11 – 12



Section 12

SOUTH LOW WALL



Crack in Section 12



Top of crack in Section 12

SOUTH LOW WALL



Section 31 – 32



Section 32

SOUTH HIGH WALL



Section 32 (low wall) 33 (high wall)



Section 33 – 34

SOUTH HIGH WALL



Section 34



Section 34 – 35

SOUTH HIGH WALL



Section 35



Joint between Section 35 – 36

SOUTH HIGH WALL



Section 36



Section 36 - 37

SOUTH HIGH WALL



Section 37



Section 37 – 38

SOUTH HIGH WALL



Section 38



Section 38 – 39

SOUTH HIGH WALL



Section 39



Section 39 – 40

SOUTH HIGH WALL



Section 40



Section 40 – 41

SOUTH HIGH WALL



Section 40 – 41



Section 41

SOUTH HIGH WALL



Section 41 – 42



Section 42

SOUTH HIGH WALL



Section 42



Section 42 - 43

SOUTH HIGH WALL



Section 43



Section 43 – 44

SOUTH HIGH WALL



Section 44



Section 44 – 45

SOUTH HIGH WALL



Section 45 – 46



Section 46

SOUTH HIGH WALL



Section 46 – 47



Section 47

SOUTH HIGH WALL



Section 47 – 48



Section 48

SOUTH HIGH WALL



Section 48 – 49



Section 49

SOUTH HIGH WALL



Section 49 – 50



Section 50

SOUTH HIGH WALL



Section 50 – 51



Section 51

SOUTH HIGH WALL



Section 51 – 52



Section 52

SOUTH HIGH WALL



Section 52 – 53



Section 53

SOUTH HIGH WALL



Section 53 – 54



Section 54

SOUTH HIGH WALL



Section 54 – 55



Section 55 – 56

SOUTH HIGH WALL



Section 56



Section 56 – 57

SOUTH HIGH WALL



Section 56 – 57



Section 57

SOUTH HIGH WALL



Section 57 – 58



Section 58

SOUTH HIGH WALL



Section 58

NORTH WALL



Block wall section



Block wall and Section 1

NORTH WALL



Section 1



Section 2

NORTH WALL



Section 2 – 3



Section 3

NORTH WALL



Section 3



Section 3 – 4

NORTH WALL



Section 4



Section 4 – 5

NORTH WALL



Section 5 – 6



Section 6

NORTH WALL



Section 6 – 7



Section 7

NORTH WALL



Section 7 – 8



Section 8

NORTH WALL



Section 8 – 9



Section 9

NORTH WALL



Section 9 – 10



Section 10

NORTH WALL



Section 10 – 11



Section 11

NORTH WALL



Section 11 – 12



Section 12

NORTH WALL



Section 12 – 13



Section 13 – 14

NORTH WALL



Section 14 – 15



Section 15

NORTH WALL



Section 15 – 16



Section 16

NORTH WALL



Section 16 – 17



Section 17

NORTH WALL



Section 17



Section 17 – 18 – Joint approximately at Town line.

NORTH WALL



Section 18 - Marshfield



Section 18 - Marshfield