WRIGHT-PIERCE
Engineering a Better Environment

Memorandum

Date: **11/30/2023**

Project No.: **21529 A.10**

To: **Daniel Marks, Wastewater Superintendent, Town of Falmouth**

From: **Rychel Gibson, PE & Jaime Wallace, PE, Wright-Pierce**

Subject: **Mackworth Interceptor Removal or Rehabilitation Feasibility**

The Falmouth Wastewater Department has hired Wright-Pierce to evaluate the feasibility of removing or rehabilitating the Mackworth interceptor from Brown Street to Route 1 in Falmouth (see Figure 1 in Appendix A). In 2010, Wright-Pierce completed an evaluation of the interceptor from Brown Street to Andrews Avenue. The study considered three alternatives:

- Option A – Re-location of the entire Mackworth interceptor within the ROW of Shoreline Drive, and Carroll Street between Brown Street and Andrews Avenue, installation of a new pump station at Andrews Avenue, and removal of the pump station located at the end of Brown Street.
- Option B – Re-location of the entire Mackworth interceptor, within the ROW of Shoreline Drive, and Carroll Street between Brown Street and Andrews Avenue, installation of a new pump station at Andrews Avenue, and maintaining the pump station located at the end of Brown Street with reduced flows.
- Option C – Re-location of half of the Mackworth interceptor within the ROW of Shoreline Drive from a new pump station on Andrews Avenue, to Hammond Road.

Based on preliminary discussions with the Wastewater Department, we have prepared this feasibility study to include only Option A and B from the 2010 study described above, inclusion of the segment of sewer between Route 1 and Andrews Avenue for both Option A and B, and evaluation of rehabilitation and reinforcing options for the entirety of the interceptor for a total of three options considered. In addition, the Department has asked for evaluation and comment on the feasibility of reusing the existing cross-country route from Carroll Street to Hammond Street.

Existing Conditions

Constructed around 1967, the Mackworth interceptor consists of 4,700 linear feet of 12-inch to 16-inch asbestos cement gravity sewer and 15 manholes located within the tidally influenced Casco Bay along Bay Shore Drive, Shoreline Drive, and up to Brown Street in Falmouth. A location map of the existing interceptor is included in Appendix A as Figure 1. The interceptor collects all flow on the end of the peninsula west of Carroll Street and conveys it to the Brown Street Pump Station, which pumps up to SMH-13 at the intersection of Route 1 and Brown Street. The existing manholes along the interceptor are located within a V2 flood zone (velocity hazard zone) below the 100-year flood elevation of 12’ while the Brown Street Pump Station is located within an A2 flood zone (1% annual chance of flooding) at the 100-year flood elevation of 12’ (see Appendix B). Highest astronomical tide (HAT) for this area is 6.9’. Table 1 shows the ground elevation, current rim elevation for the existing interceptor manholes, rim height above ground, rim height over HAT, and rim height over 100-year flood elevation.

Table 1: Interceptor Rim Heights

SMH ID	*Ground Elev. (ft)*	*Rim Elev. (ft)*	Manhole Height above grade (ft)	Manhole Height above HAT (ft)	Manhole Height above 100 yr Flood (ft)
14[1]	7	7.25	0.25	0.35	-4.75
15[1]	7.25	7.25	0	0.35	-4.75
16[1]	6	7.5	1.5	0.6	-4.5
17	2.798	7.862	5.064	0.962	-4.138
18	8.156	8.211	0.055	1.311	-3.789
19	4.79	8.099	3.309	1.199	-3.901
20	5.456	8.602	3.146	1.702	-3.398
21	4.783	8.58	3.797	1.68	-3.42
22	3.911	8.239	4.328	1.339	-3.761
23	5.713	9.045	3.332	2.145	-2.955
24	7.444	10.602	3.158	3.702	-1.398
25	5.784	8.115	2.331	1.215	-3.885
26	9.553	10.149	0.596	3.249	-1.851
27	7.66	9.073	1.413	2.173	-2.927
28	7.434	10.822	3.388	3.922	-1.178
29	11.114	11.058	-0.056	4.158	-0.942

Note 1: SMH 14, 15, and 16 were not surveyed as part of this effort. Ground elevations as stated are estimated based on State LiDAR data and rim elevations are pulled from as built drawings. Actual ground and rim elevations may vary.

Internal inspection via CCTV of the Mackworth interceptor from 2019 suggests the interceptor pipe is in good condition with some exceptions; various pipes showed sags, some surface spalling, and the segment between SMH 26 and SMH 25 had broken pipe. Comment by the operators suggests maintenance is an issue due to flat spots and debris buildup. Conductivity measurements collected by the Town during wet weather events suggest minimal inflow of salt water from the structures and pipe. However, the exposed manholes have varying levels of corrosion on the exterior and susceptible to damage from storm surge and ice buildup. Site access to the manholes is limited to existing easements and Town owned property and make maintenance of the system a challenge for the Town.

A site visit was conducted on August 22, 2023, to confirm rim elevations and depths, and to collect photos of the interior and exterior of subject manholes. These photographs are not considered formal inspections, nor do they meet the requirements of National Association of Sewer Service Companies (NASSCO) Manhole Assessment Certification Program (MACP) inspections. General findings from the site visit include bench deterioration from influent sewer lines, existing cementitious lining in various states of wear, existing chimney coatings in various

states of wear, and evidence of prior interior infiltration at possible failed joint seals. A sample of collected photos is included in Appendix C.

During the site visit, it was mentioned that a pump station on Mackworth Island terminates at the high point on the island and a 6" HDPE inverted siphon conveys wastewater from the island, under Casco Bay, and eventually discharges to SMH 25. This was not identified in the 2010 memo and was not considered for evaluation of options during the 2010 study. Based on historical drawings, the inverted siphon begins at a cleanout manhole on the island at approximately elevation 20' above sea level (ASL). The current discharge elevation is approximately 1.46' ASL. For the purposes of this evaluation, it is assumed the inverted siphon hydraulics allows for extension of the pipe to the nearest proposed gravity manhole for discharge. Detailed analysis of the pump station and inverted siphon should be completed during preliminary design.

During a review meeting on October 12, 2023, it was noted that two services on Carroll Street discharge directly to the Brown Street Pump Station and two services on Carroll Street discharge directly to the Mackworth Interceptor through the backside of the property. For the purposes of this report, it is assumed these services can be replumbed and discharge to the Carroll Street sewer. This effort is not included in any cost estimates.

Design Criteria and Assumptions

The following assumptions and design criteria were made while evaluating feasibility of alternatives:

- Assume little to no change in flow in the collection area.
- Pipe as proposed is 12" PVC
- All proposed pipe segments are proposed at or below existing collection system elevations to accommodate existing services. The proposed pipe is not necessarily below the existing Mackworth Interceptor elevation.
- New easement required between Reg Roc Drive and Andrews Avenue.
- New easement required between Carroll Street and Hammond Road.
- New easement required between Shoreline Drive and Andrews Avenue.

Alternatives Considered

Three alternatives were considered for feasibility as part of this study. Overall alternative plans and conceptual plans and profiles for alternative 1 and alternative 2 are included as Appendix D to this memo.

Alternative 1 – Relocation of the Entire Interceptor and Removal of the Brown Street Pump Station

Description

Alternative 1 corresponds to Option A from the 2010 Elimination Options Memo and includes relocation of the interceptor from Andrews Avenue to Route 1 within the Town's ROW along Bayshore Drive and through a proposed easement between Reg Roc Road and Andrews Avenue. Under this alternative, 5,080 linear feet of gravity sewer and 18 manholes would be constructed between Brown Street and Andrews Avenue, with 410 linear feet of cross-country sewer and one manhole between Carroll Street and Shoreline Drive, and 150 linear feet of cross-country sewer between Shoreline Drive and Andrews Avenue. An additional 1,170 linear feet of gravity sewer and five manholes would be constructed along Bay Shore Drive to Andrews Avenue with 260 linear feet of cross-country sewer between Bay Shore Drive and Andrews Avenue. A new pump station would be constructed on Andrews Avenue with a 4,020-foot, 6-inch HDPE force main that discharges at the top of Brown Street. The Mackworth Island Pump Station siphon would be extended 75' to SMH G on Shoreline Drive for discharge at elevation -5.19' ASL.

Impacts

Alternative 1 requires clearing of existing trees and shrubbery between Reg Roc Road and Andrews Avenue, and between Carroll Street and Hammond Road. Easements are proposed along existing property boundaries to minimize impact and the number of easements required.

Based on existing GIS invert information, 12 of the 23 proposed manholes would be between 15' and 20' deep, nine would be greater than 20' deep, and the proposed pump station on Andrews Avenue would be approximately 31' deep with operating space. Excavation for structure and pipe installation would likely require sheeting and dewatering and additional space for construction.

As proposed in 2010, the segment between Brown Street and Carroll Street traverses cross-country; however, there is insignificant difference between using a cross-country route versus rerunning the Brown Street Sewer to Carroll Street. Therefore, under this alternative, the proposed route is to re-pipe Brown Street to flow to the Carroll Street intersection, then down Carroll Street. This route would maintain the pipe within the Town's ROW and would allow for less challenging means of access for maintenance in the future.

The roadway between Hammond Road and Winslow Street has a 30" culvert at an approximate invert of 5' ASL. The approximate invert elevation of the proposed sewer at the crossing based on minimum slope is 5.07' ASL, in direct conflict with the culvert. To avoid conflict, the sewer line has been dropped an additional 2' which impacts the depth of the remainder of the sewer line to the Andrews Avenue pump station.

Abandonment of the existing manholes and interceptor pipe would require access through Town owned property or through construction easements. Impacts associated with access would involve temporary impacts to coastal wetlands for equipment and personnel access as well as impacts to private property.

Land Requirements

New 40' wide permanent easements would be required between Reg Roc Road and Andrews Avenue, between Shoreline Drive and Andrews Avenue, and between Carroll Street and Hammond Road. The total easement length is approximately 740 linear feet. The Town currently has an easement over the existing sewer line between SMH 199 and SMH 17 from Carroll Street to the interceptor. Portions of the proposed easement are located within the same property on Carroll Street.

Constructability

The depth of pipe for this alternative ranges from 6' to 26'. Range of pipe depth for each portion of the roadway is shown in the table below. Deep structure and pipe installation would likely require additional measures for installation including sheeting, shoring, and dewatering. Deep installation along roadways would yield a greater area of impact and would likely close segments of the road during installation. Ledge is expected along this segment of road as well, however actual quantity to be removed is unknown. Roadway edges may require additional stabilization following construction due to construction proximity to unstable embankments. Deep pipe installation along proposed easements may have a larger impact along the easement area.

Table 2: Pipe Depth Ranges for Alt.1

Road Segment	Pipe Depth Range (ft)
Bay Shore Drive (SMH A-D)	6-21
Reg Roc Road to Andrews Avenue Easement (SMH D-E)	21-22
Andrews Avenue (at Mackworth Island Bridge) (SMH F)	21.3
Shoreline Drive (SMH G-N)	17.4-26.0
Carroll Street to Hammond Rd Easement (SMH N-P)	17.4-18.7
Carroll Street (SMH P-W)	17.5-19.5
Brown Street (SMH W-SMH 189)	9.1-19.5

Alternative 2 – Relocation of the Entire Interceptor and Reduced Flows at Brown Street Pump Station

Description

Alternative 2 corresponds to Option B from the 2010 Elimination Options Memo and includes re-location of the interceptor from Andrews Avenue to Route 1 within the Town ROW along Bayshore Drive and through a proposed easement between Reg Roc Road and Andrews Avenue. Under this alternative, the existing Brown Street pump station would remain in service at reduced daily flow servicing only the homes on Brown Street. Flow from Carroll Street would be rerouted from existing SMH 199 and 3,100 linear feet of gravity sewer and 11 manholes would be constructed between Carroll Street and Andrews Avenue, with 410 linear feet of cross-country sewer and one manhole between Carroll Street and Hammond Road, and 150 linear feet of cross-country sewer between Shoreline Drive and Andrews Avenue. An additional 1,170 linear feet of gravity sewer and five manholes would be constructed along Bay Shore Drive to Andrews Avenue with 260 linear feet of cross-country sewer between Bay Shore Drive and Andrews Avenue. A new pump station would be constructed on Andrews Avenue with a force main that discharges at the top of Brown Street. The Mackworth Island Pump Station siphon would be extended 75’ to SMH G on Shoreline Drive for discharge at elevation 3.52’ ASL.

Impacts

Alternative 2 requires clearing of existing trees and shrubbery between Reg Roc Road and Andrews Avenue and between Carroll Street and Hammond Road. Easements are proposed along existing property boundaries to minimize impact and the number of easements required.

Based on existing GIS invert information, two of the 16 proposed manholes would be between 15’ and 20’ deep, two would be greater than 20’ deep, and the proposed pump station on Andrews Street would be approximately 24’ deep with operating space. Excavation for structure and pipe installation would likely require sheeting and dewatering and therefore additional space for construction.

The roadway between Hammond Road and Winslow Street has a 30” culvert at an approximate invert of 5’ ASL. The approximate invert elevation of the proposed sewer at the crossing is 11.88’. Ground elevation over the culvert is approximately 13’, leaving less than 6” cover over the proposed sewer. The ground elevation would need to be raised to provide cover over the proposed pipe which would also likely impact the adjacent driveway.

Abandonment of the existing manholes and interceptor pipe would require access through Town owned property or through construction easements. Impacts associated with access would involve temporary impacts to coastal wetlands for equipment and personnel access as well as impacts to private property.

Land Requirements

A new 40' wide permanent easement is required between Reg Roc Road and Andrews Avenue and new 30' permanent easement is required between Shoreline Drive and Andrews Avenue and between Carroll Street and Hammond Road. The total easement length is approximately 740 linear feet. The Town currently has an easement over the existing sewer line between SMH 199 and SMH 17 from Carroll Street to the interceptor. Portions of the proposed easement are potentially located within the same property on Carroll Street.

Constructability

The depth of pipe in this alternative ranges from 6' to 22', a range of pipe depth for each portion of the roadway is depicted in the table below. Deep structure and pipe installation would require additional measures for installation including sheeting and shoring. Deep installation along roadways would likely close segments of the road during installation. Ledge is expected along this segment of road as well, however actual quantity to be removed is unknown. Roadway edges may require additional stabilization following construction due to construction proximity to unstable embankments. Deep pipe installation along proposed easements may have a larger impact along the easement area.

Table 3: Pipe Depth Ranges for Alt. 2

Road Segment	Pipe Depth Range (ft)
Bay Shore Drive (SMH A-D)	5.9 – 19.4
Reg Roc Road to Andrews Avenue Easement (SMH D-E)	20.9 – 22
Andrews Avenue (at Mackworth Island Bridge) (SMH F)	12.6
Shoreline Drive (SMH G-N)	9.1-17.3
Carroll Street to Hammond Rd Easement (SMH N-P)	10.6-11.9
Carroll Street (SMH P-SMH 199)	10.7-12

Alternative 3 – Rehabilitation and Preventative Measures of Manholes In-Kind

Description

Alternative 3 corresponds to addressing current issues observed during the August 22, 2023 site visit and is considered the minimum requirement to maintain the existing alignment of the Mackworth Interceptor. Under this alternative, Level 2 NASSCO manhole inspections would need to be completed on all interceptor manholes; CCTV inspection would need to be completed on all interceptor pipe; existing frames and covers would be replaced with watertight frames and covers; risers and chimneys would be repaired; benches and channels would be repaired; and an interior epoxy or polyurea coating would be applied to all interceptor manholes.

Alternative 3 also involves providing resiliency to the existing manholes which are exposed to tidal and wave action. Based on discussions with the Town, we understand that in the past there have been attempts to armor the exposed manholes with riprap and gabion baskets which have since washed away. Under this alternative, additional reinforcement would be provided using a 6' minimum diameter 'doghouse' manhole barrel sections which would

be placed over the existing manhole structures in sections. The structure would be placed using a hydrovac and a hydraulic crane on a barge with guide pile(s) to maintain alignment. The void between the doghouse manhole and the existing manhole would be filled with flowable fill concrete placed by a pump truck either by barge or from land where able. An option to cast a structure in place is also an alternative option. However, costs associated with dewatering, sheeting, and temporary equipment access would need to be considered.

The stability of each structure would need to be further analyzed and detailed under preliminary design should this alternative be chosen. Subsurface geotechnical evaluation would be required at each manhole location to confirm subsurface conditions at each structure. A concept figure is included as Appendix E to this memo, however geotechnical recommendations may change or refine this concept.

This alternative does not remove any portion of the Mackworth Interceptor from the tidal zone or improve any flat spot or debris build-up issues within the collection system.

Impacts

Alternative 3 requires access to the existing interceptor manholes via existing easements and Town owned property. Access to some manholes may be limited and may require temporary construction easements. We also understand from our site visit with the Town that visual impacts may need to be considered for any exterior work proposed.

Land Requirements

None

Constructability

Access requirements for structural repair and coating may be limited for some manholes unless temporary construction easements are acquired. Equipment may need to reach manholes by boat or by ATV or similar in some cases. Additionally, work on the manholes would need to be timed with the tides to allow access to the sites. Construction contingency has been built into the cost estimate to address access and timing constraints for the interceptor.

For reinforcing of the structures, equipment would need to access the entirety of the interceptor which would likely require temporary construction easements and likely the use of a crane, a barge, and a concrete pump truck.

Permitting

All three alternatives would require permits from the Maine Department of Environmental Protection (Maine DEP), Army Corps of Engineers (Army Corp), and the Town of Falmouth. The coastal stretch adjacent to Shoreline Drive is mapped as an Estuarine and Marine Wetland by the U.S. Fish and Wildlife Service. Work completed in the mapped wetland to access the existing interceptor and manholes would require a Natural Resources Protection Act Individual Permit from Maine DEP and Army Corp. An Individual Permit application would be reviewed under both Maine DEP and Army Corp, however separate permits from the agencies would be issued. In an effort to mitigate impacts to wetlands, Maine DEP requires compensation for impacts to wetlands that result in a loss of function. Therefore, any permanent alterations to the coastal wetland that result from manhole rehabilitation or work on the interceptor may require compensation. The compensation must directly offset or exceed any loss of the wetland. Means of compensation are on-site or off-site permittee-responsible projects or an in-lieu fee. On- or off-site projects include restoring, enhancing, preserving, or creating a wetland to compensate for any lost function.

Alternatively, permittees can pay an in-lieu fee based on square footage of impact and compensation rates provided by Maine DEP. Compensation for coastal wetlands is not required if the impacts are less than 500 square feet.

Based on the Town of Falmouth's Shoreland Zoning Map (dated 5/26/09), the coastal area adjacent to Shoreline Drive is a Residential Shoreland Zoning District. Any work completed in this zoning district, including clearing and soil disturbance to access the interceptor and manholes, may require a Shoreland Zoning Permit by the Town of Falmouth, which may also require Planning Board approval. Planning Board approval from the Town of Falmouth would be required if more than 10 yards of fill are placed or removed from the site.

Additional Design Considerations

Under Alternative 2, invert elevation coming into the proposed Andrews Avenue Pump Station is currently dictated by the existing sewer elevation on the Route 1 end of the project area. Based on a minimum slope of 0.004 for 12" sewer, the invert into the pump station from the Route 1 end of the project area is 0.526'. If this section of project area were removed from the scope of work, the interceptor could be rerouted from SMH 26 and enter the pump station at invert 1.099'. While this does not significantly impact the overall depth of the pump station at Andrews Avenue, designing and constructing the pump station around the inclusion of a rerouted Route 1 end of the project area does mean installation of the Route 1 end of the project can be phased for minimal additional construction cost at the pump station.

The difference in overall wet well depth is approximately 6' between Alternatives 1 and 2. The pipe depth along Shoreline Drive is approximately 9' deeper under Alternative 1. While the depth is quantitatively accounted for in the cost estimate, additional depth would also have qualitative effects including longer install time, larger machinery onsite, greater impact on roadways and easements, and increased risk of destabilizing nearby embankments.

Easement Evaluation

Wright-Pierce was asked to review the feasibility of reusing the existing easement from Carroll Street to Hammond Street. The elevation of the pipe at SMH 17, which is located at the base of the easement within the tidal zone, is approximately -5' ASL with minimal cover. To maintain -5' elevation at SMH 17 requires the installation of 4 manholes along Shoreline Drive in excess of 30' deep. Given the likely presence of ledge and the proximity to potentially unstable embankments, this was not considered feasible. There is potential to move SMH 17 uphill within the easement, but to reach Shoreline Drive, two new waterfront easements would be required, the risk of destabilizing embankments remains high, and the overall elevation of the pipe would still be very deep for downstream installation.

Table 4, below, provides a summary of proposed easements, including lengths and affected properties.

Table 4: Easement Properties

Easement	Address	Length
Carroll-Hammond	40 Carroll Street/36 Carroll Street	270’
	22 Hammond Street	120’
Shoreline-Andrews	1 Shoreline Drive	150’
	34 Andrews Avenue	20’
Reg Roc-Andrews	16 Reg Roc Road/24 Bayshore Drive	100’
	39 Andrews Avenue/33 Andrews Avenue	100’
Modified Easement Reuse	36 Carroll Street	180’
	28 Hammond Street	115’

Estimate of Probable Construction Costs

Cost comparison for the three Alternatives is as shown below. A detailed breakdown of probable construction costs is included in Appendix F attached to this memo. These estimates are considered a class four estimate and are estimated using October 2023 dollars. These estimates are for conceptual feasibility planning only. Escalation of project costs should be revisited during preliminary design and again in final design.

Table 4: Cost Comparison

Alt. 1	Alt. 2	Alt. 3
$16,721,000	$12,363,000	$3,079,000

Alternative 3 is the least expensive alternative; however, it does not improve issues with flat spots or debris build-up or remove the sewer from the tidal zone. Additionally, this provides a structural repair for the manholes, but does not address the pipe that is 56 years into a typical design life of 50 years. Alternative 1 is the most expensive alternative and also poses the highest risk of bank destabilization due to deep sewers. Cost estimates as presented include construction, technical services, and legal and administration fees, but do not include easement acquisition fees. Cost estimates are projected out to 2025 construction year and are tied to the latest ENR Cost Index for use in future adjustments as needed. Cost estimates for pipe installation include ledge removal for all pipe greater than 10’ depth. Where the proposed pipe is replacing an existing pipe, ledge is only assumed beyond the depth of the existing pipe.

Recommendations

Wright-Pierce recommends Alternative 2 as proposed using a new easement between Carroll Street and Hammond Street. Due to the risks associated with deep excavation along Shoreline Drive, neither Alternative 1 nor reuse of the existing easement are recommended. Alternative 3, although the cheapest option, does not provide a long-term solution to removal of the interceptor from tidal waters, and will need to be monitored for further

rehabilitation periodically. Alternative 3 could be considered as a stopgap measure to provide structural protection against wave action and ice if funding cannot be acquired for Alternative 2.

We also recommend that a survey monitoring plan be developed for the interceptor in the interim. The monitoring plan would monitor elevations of the existing sewer manholes along the interceptor periodically and after storm events which cause significant wave runup. This would include surveying the manhole rims along with ground surface elevation immediately adjacent to the manhole structure. We would also recommend monitoring of saltwater intrusion along the interceptor during the same time as the survey monitoring. Samples could be taken from SMH-14 or the Brown Street pump station while surveying to test conductivity levels in the interceptor.

A phased approach can be taken with Alternative 2. See the potential phase breakdown below.

Table 5: Project Phasing

Alternative 2	Description	Cost
Phase 1	Andrews Avenue Pump Station & Force Main including SMH 26 Reroute to Andrews Avenue Pump Station.	$5,790,000
Phase 2	Hammond Road to Andrews Avenue Gravity Sewer including extension of Mackworth Island Force Main, abandonment of SMH 25-18.	$3,711,000
Phase 3	Carroll Street Gravity Sewer with Carroll-Hammond Cross-Country Sewer, abandonment of SMH 17-SMH 14	$900,000
Phase 4	Route 1 to Andrews Avenue Gravity Sewer, abandonment of SMH 29-26	$2,446,000

The above breakdown allows additional time for easement acquisition for Phase 3 and 4 portions of the project while providing near-term abandonment of significant portions of the interceptor with Phases 1 and 2. Phasing as shown can be completed as it fits into the Department's capital improvement plan or can be completed in rapid succession. Wright-Pierce is also assisting the Town with identifying and evaluating slope stability alternatives along Bay Shore Drive and Shoreline Drive. We recommend that selection of the preferred alternative consider locations where access to the interceptor can be created as part of a slope stability project as doing so would likely decrease the costs associated with challenging access to the interceptor.

It was noted during review that if the Town elects to keep the Brown Street Pump Station, an additional alternative for Carroll Street may be needed to reroute Carroll Street flow north from SMH 199 through SMH 200 and create a new easement that drops into Brown Street Pump Station between 12 and 18 Carroll Street. This alternative was identified, but not evaluated in this report.

Appendices

Appendix A – Existing Interceptor Location

Appendix B – FEMA Flood Zone Map

Appendix C – Inspection Photos

Appendix D – Alternative 1 and Alternative 2 Plan and Profile Sheets

Appendix E – Suggested Manhole Reinforcing Detail

Appendix F – Estimates of Probable Construction Costs

Appendix A
Existing Interceptor Location

Data credits.

Sewer Manhole
Pump Station
Stub
Force Main
Gravity Main by Diameter
8
10
12
16
Unknown
Parcel

Route 1
Old Route One
Carroll
Tidewater
Rosemary
Ivy
Fern
Webster
Kelley
Forestside
Just a Mere
Bayside
Aldrich
Willowbrook
McKinley
Phillips
Bryson
Vinalhaven
Hammond
Shoreline
Brown St Pump Station
SMH 28
SMH 27
SMH 26
SMH 25
SMH 24
SMH 23
SMH 22
SMH 21
SMH 20
SMH 20B
SMH 19
SMH 18
SMH 17
SMH 16
SMH 15
SMH 14

Existing Conditions
Sewer System
Falmouth, ME

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FIGURE: 1

Appendix B
FEMA Flood Zone Map

FEMA Flood Zone
Falmouth, ME

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FIGURE: 1

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Appendix C
Inspection Photos

Appendix C – Manhole Inspection Sample Photos

Appendix D
Alternative 1 and Alternative 2
Plan and Profile Sheets

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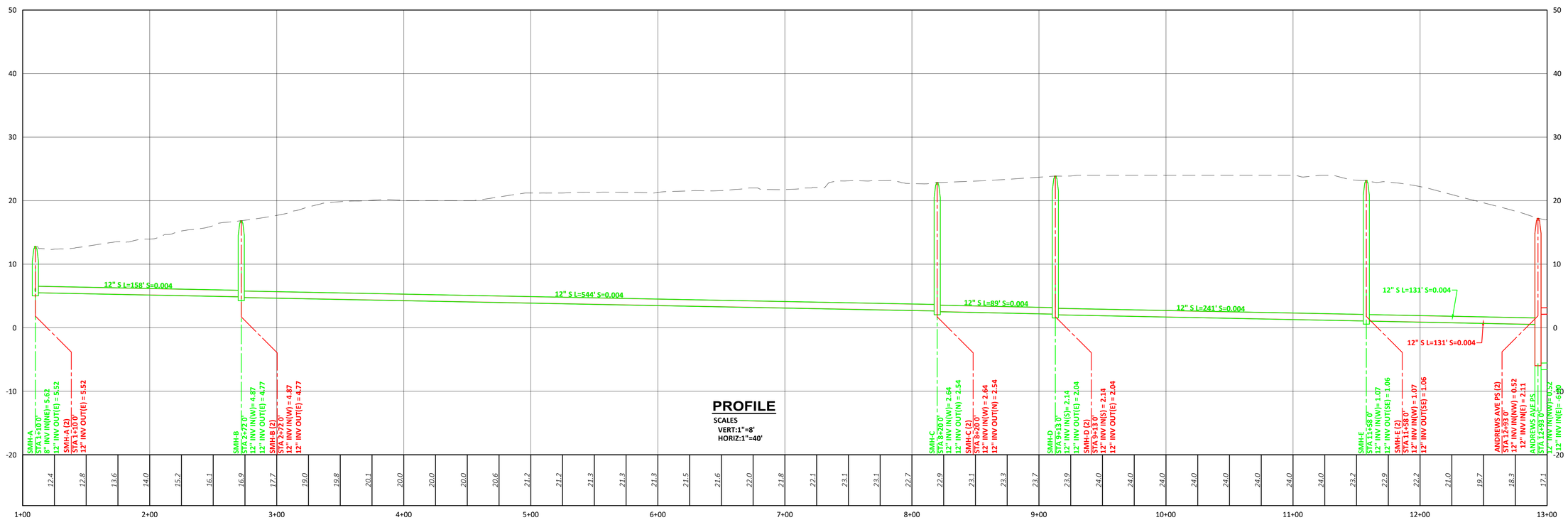

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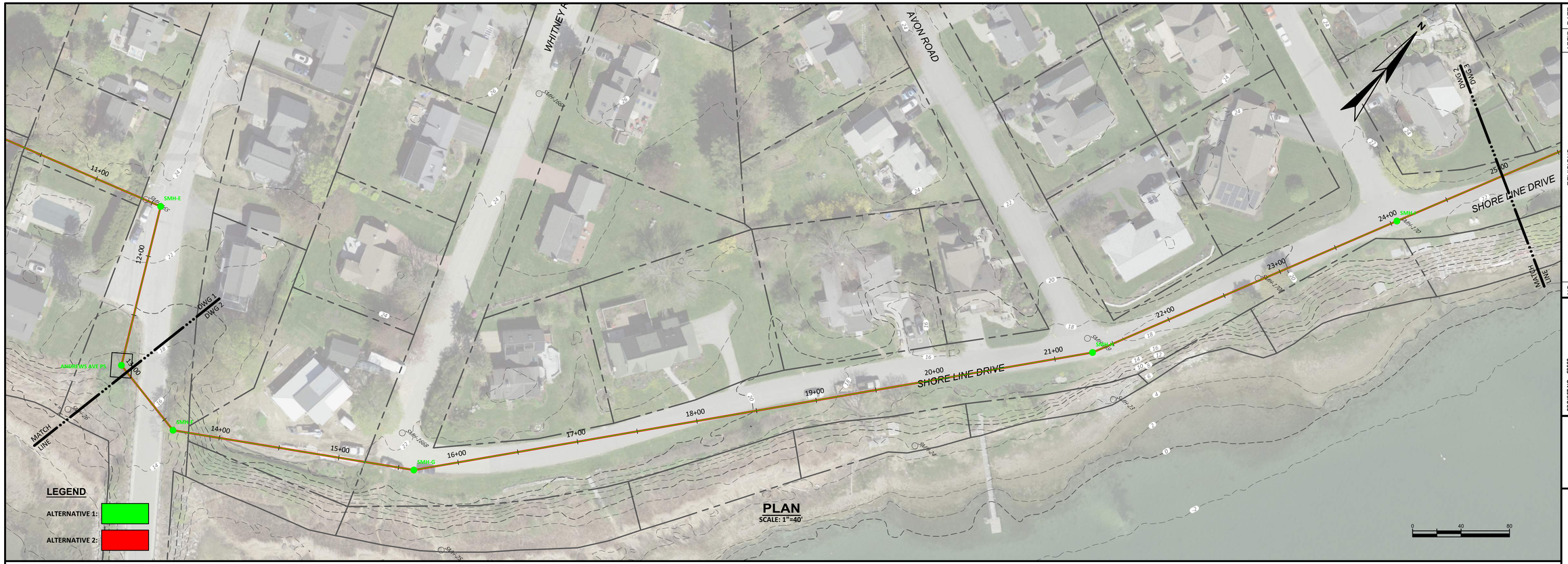

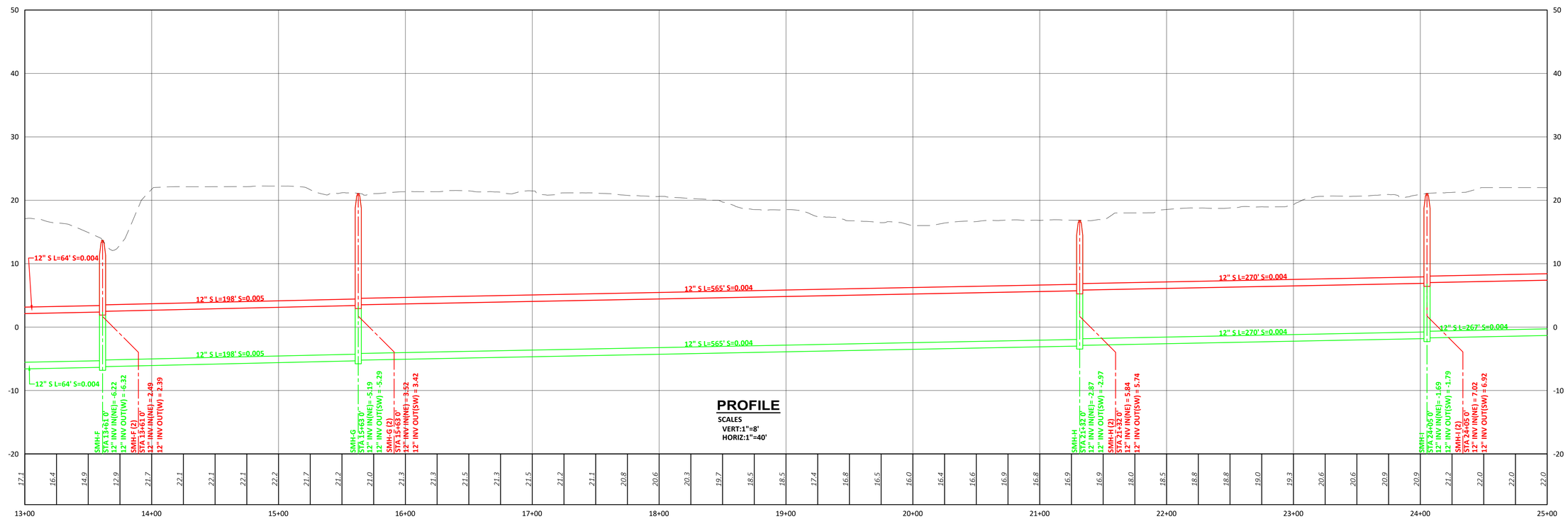

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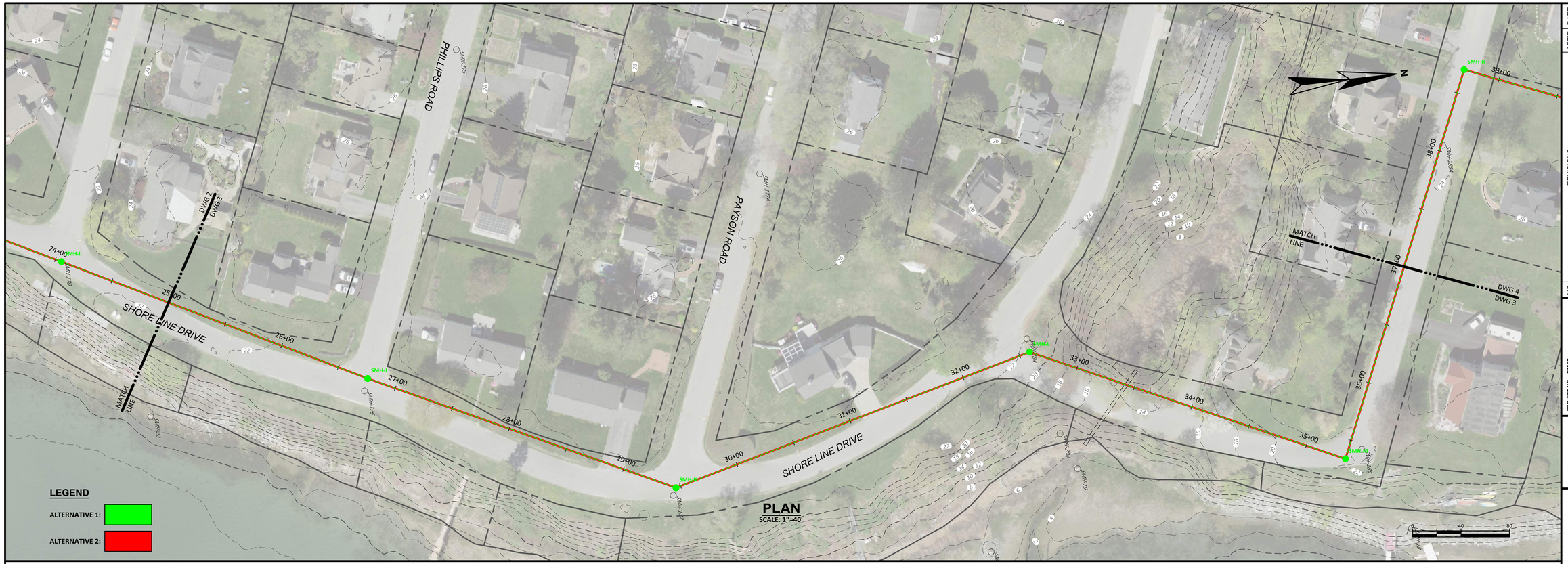
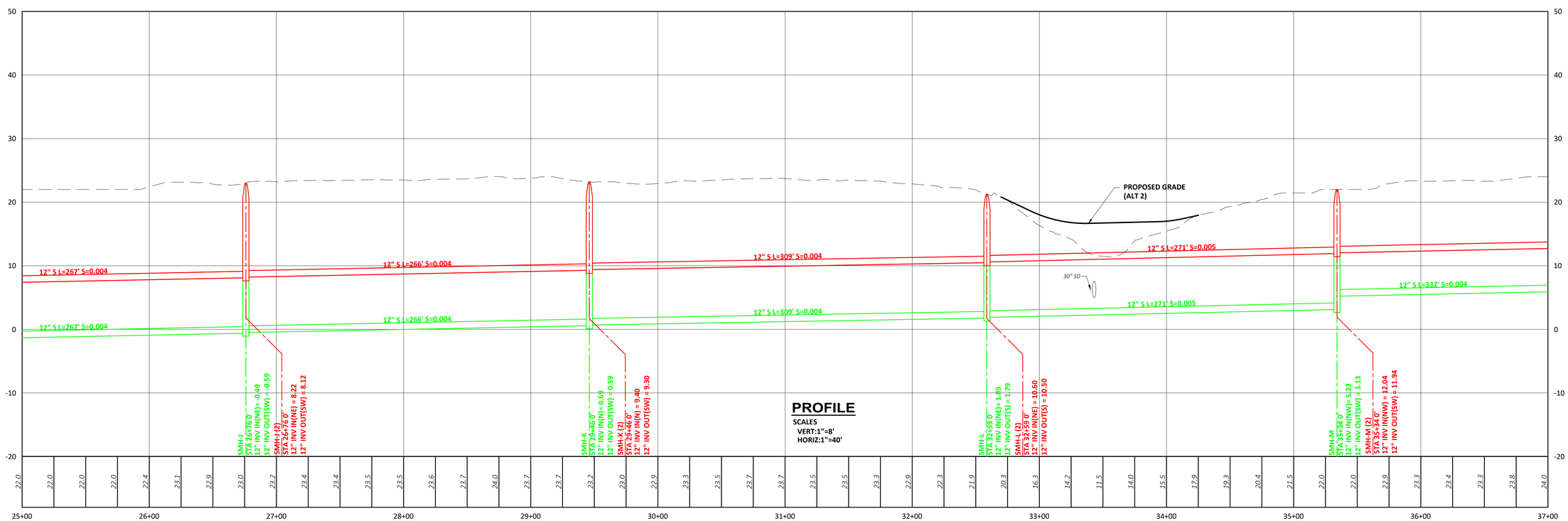


PLAN
SCALE: 1"=40'



PROFILE
SCALES
VERT:1"=8'
HORIZ:1"=40'

NO	REVISIONS	APP'D	DATE
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PROJECT NO: C3500
DESIGNED:
CAD COORD:
CAD:
CHECKED:
DATE:
APPROVED:
DATE:
SUBMISSION:

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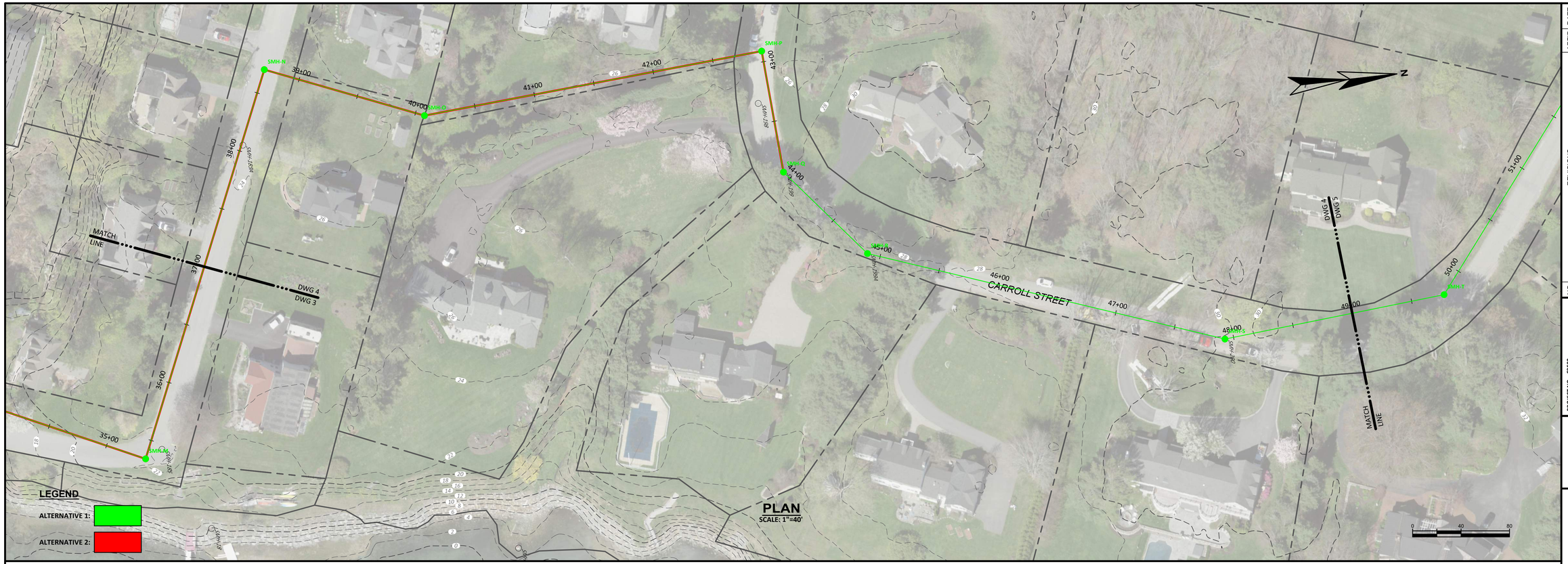
FALMOUTH, MAINE
MACKWORTH INTERCEPTOR STUDY

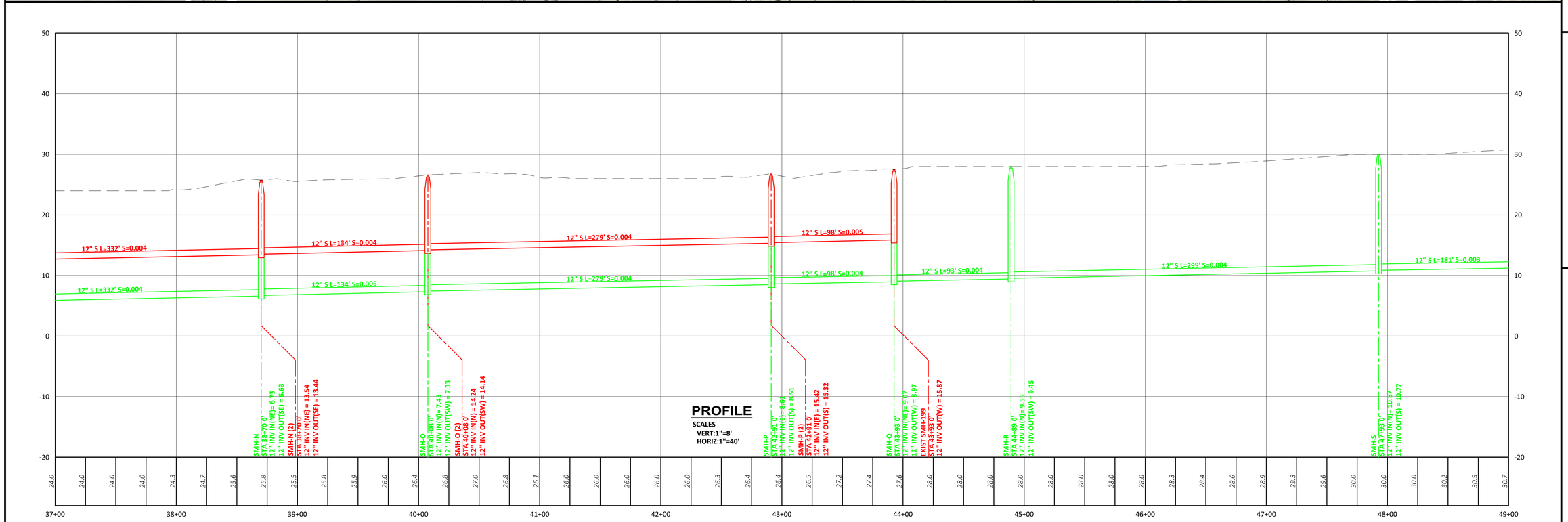
PLAN AND PROFILE
ALTERNATIVE 1 AND 2
STA 25+00 TO STA 37+00

DRAWING
3

J:\ENGWR\FALMOUTH\21529-MACKWORTHINTERCEPTOR\REHAB_DRAWINGS\CIV\MODEL\FOR\REF\21529-CM-RAS.DWG | Fig 3 | 1:2.5849 | ---- | 11/30/2023 7:33:52 AM | JAMES.MICHAUD

LAST SAVED BY: JAMES.MICHAUD 11/30/2023 7:30 AM





NO	REVISIONS	APP'D	DATE
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PROJECT NO: C3500
DESIGNED:
CAD COORD:
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CHECKED:
DATE:
APPROVED:
DATE:
SUBMISSION:

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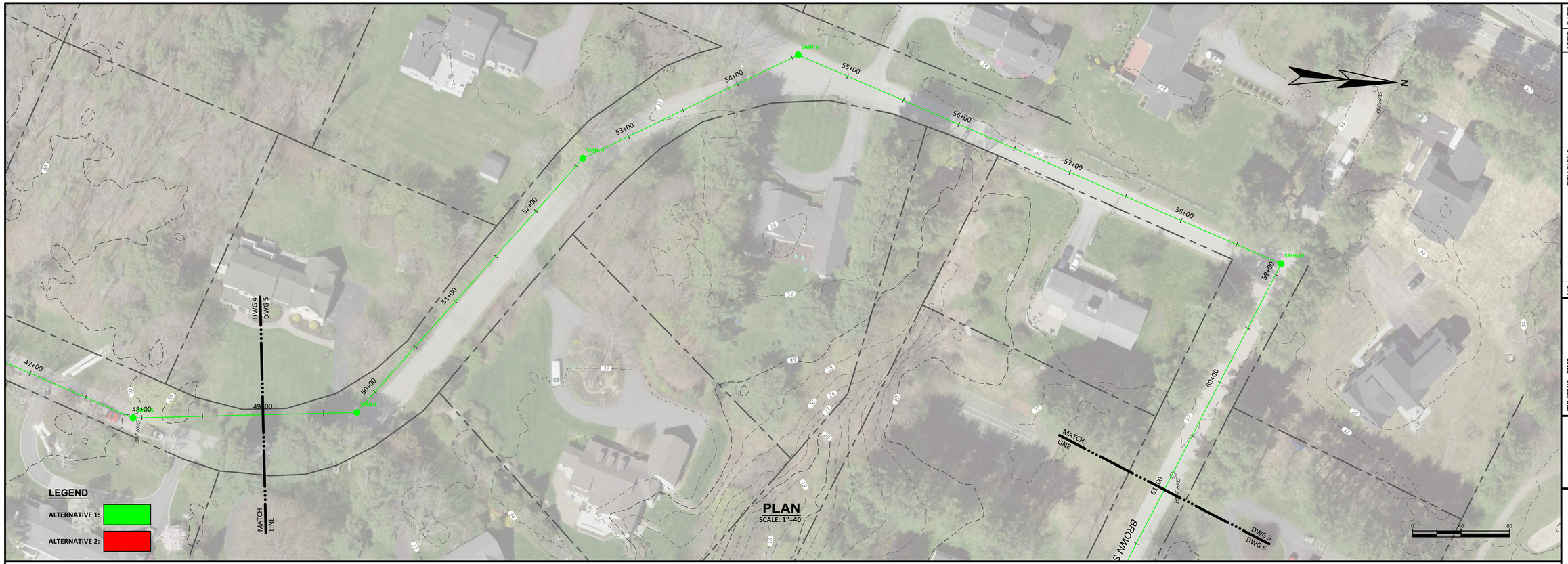
FALMOUTH, MAINE
MACKWORTH INTERCEPTOR STUDY

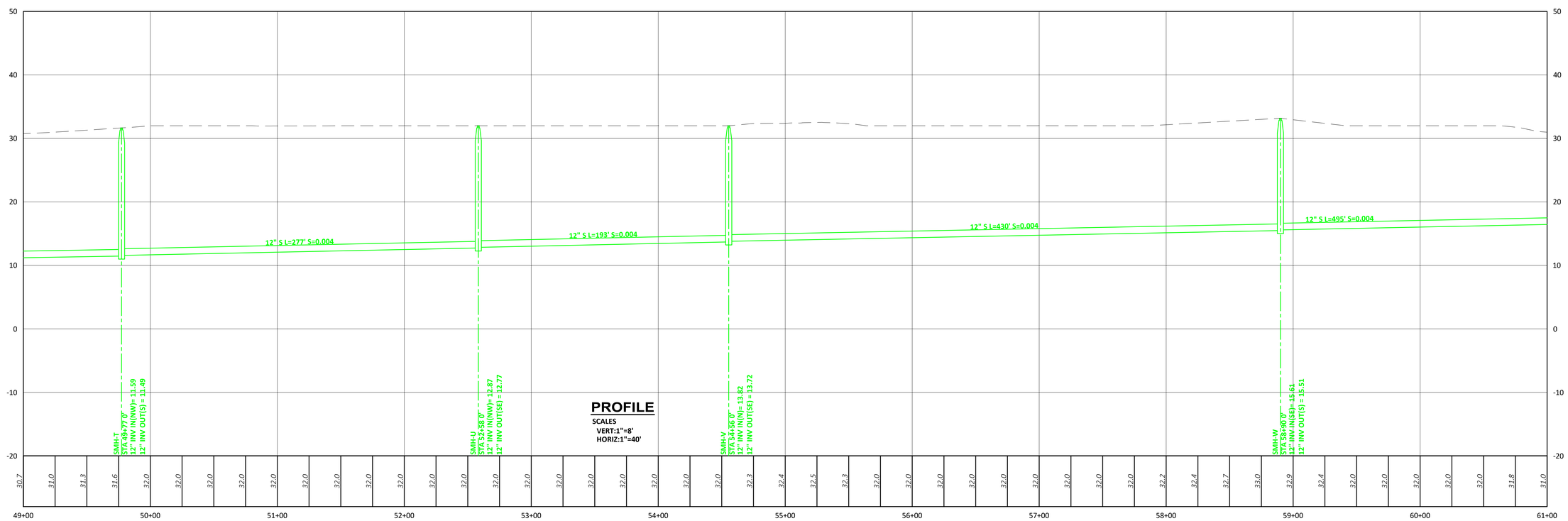
PLAN AND PROFILE
ALTERNATIVE 1 AND 2
STA 37+00 TO STA 49+00

DRAWING
4

I:\ENGWS\FALMOUTH\21529-MACKWORTHINTERCEPTOR\REHAB_DRAWINGS\CIV\MODEL\FOR\REF\21529-CM-RAS.DWG | Fig 4 | 1:2.5849 | ---- | 11/30/2023 7:34:02 AM | JAMES.MICHAUD

LAST SAVED BY: JAMES.MICHAUD 11/30/2023 7:30 AM





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PROJECT NO: C3500
DESIGNED:
CAD COORD:
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CHECKED:
DATE:
APPROVED:
DATE:
SUBMISSION:

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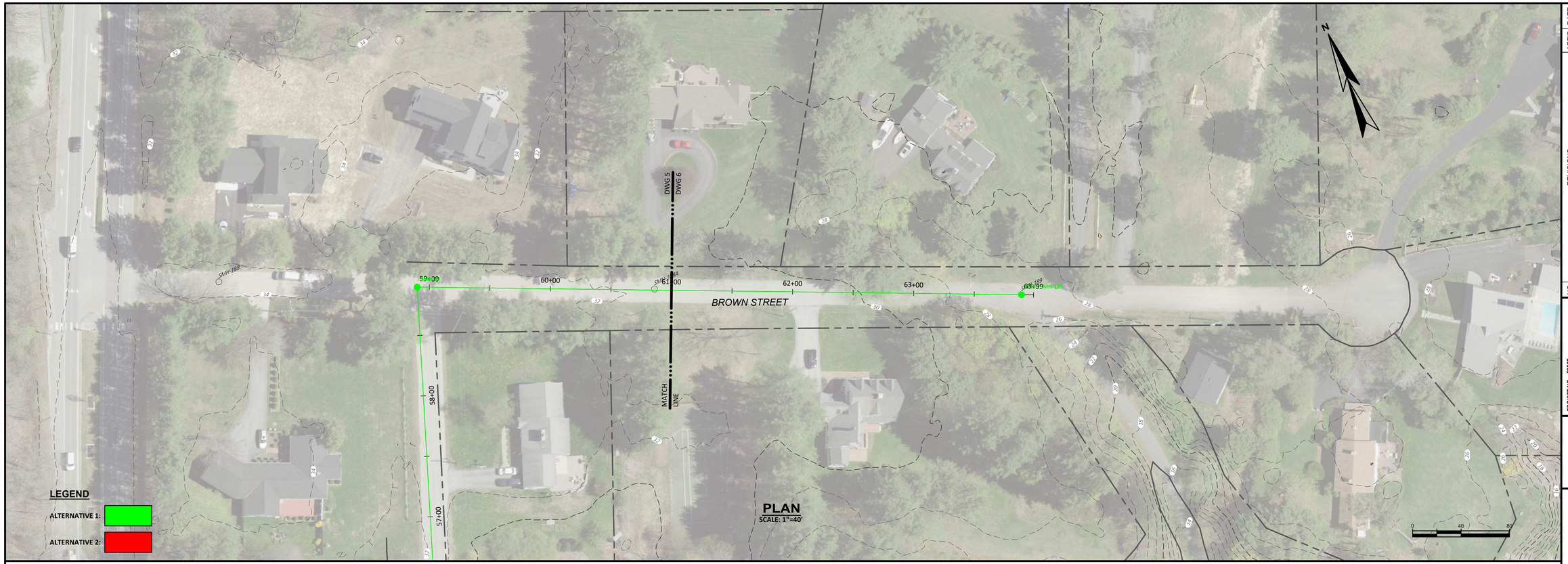
FALMOUTH, MAINE
MACKWORTH INTERCEPTOR STUDY

PLAN AND PROFILE
ALTERNATIVE 1 AND 2
STA 49+00 TO STA 61+00

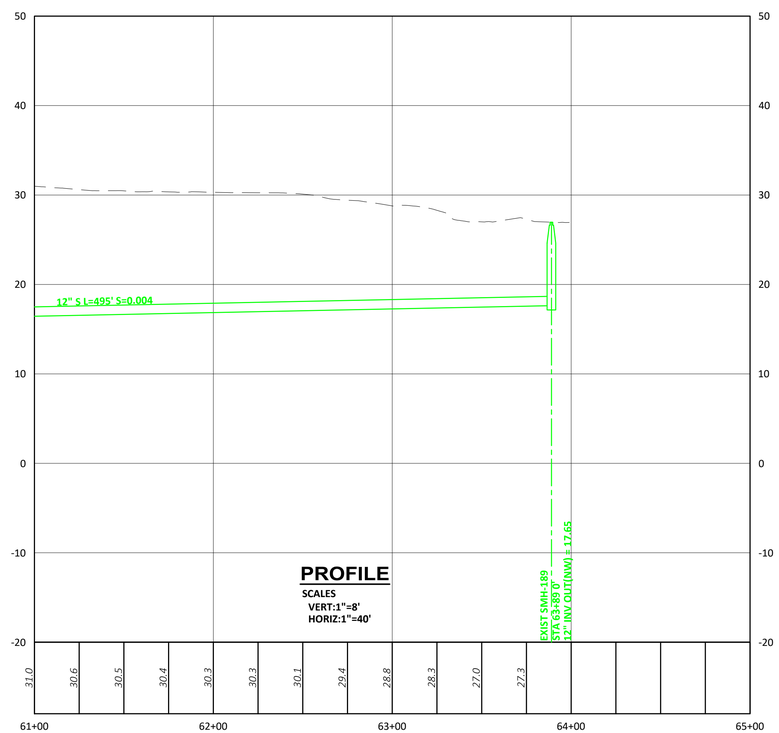
DRAWING
5

J:\ENGW\F\FALMOUTH\21529-MACKWORTHINTERCEPTOR\REHAB_DRAWINGS\CIV\MODELFORXREF\21529-CM-RAS.DWG | Fig 5 | 1:2.5849 | ---- | 11/30/2023 7:34:11 AM | JAMES.MICHAUD

LAST SAVED BY: JAMES.MICHAUD 11/30/2023 7:30 AM



PLAN
SCALE: 1"=40'



PROFILE
SCALES
VERT:1"=8'
HORIZ:1"=40'

NO	REVISIONS	APP'D	DATE
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6			

PROJECT NO: C3500
DESIGNED:
CAD COORD:
CAD:
CHECKED:
DATE:
APPROVED:
DATE:
SUBMISSION:

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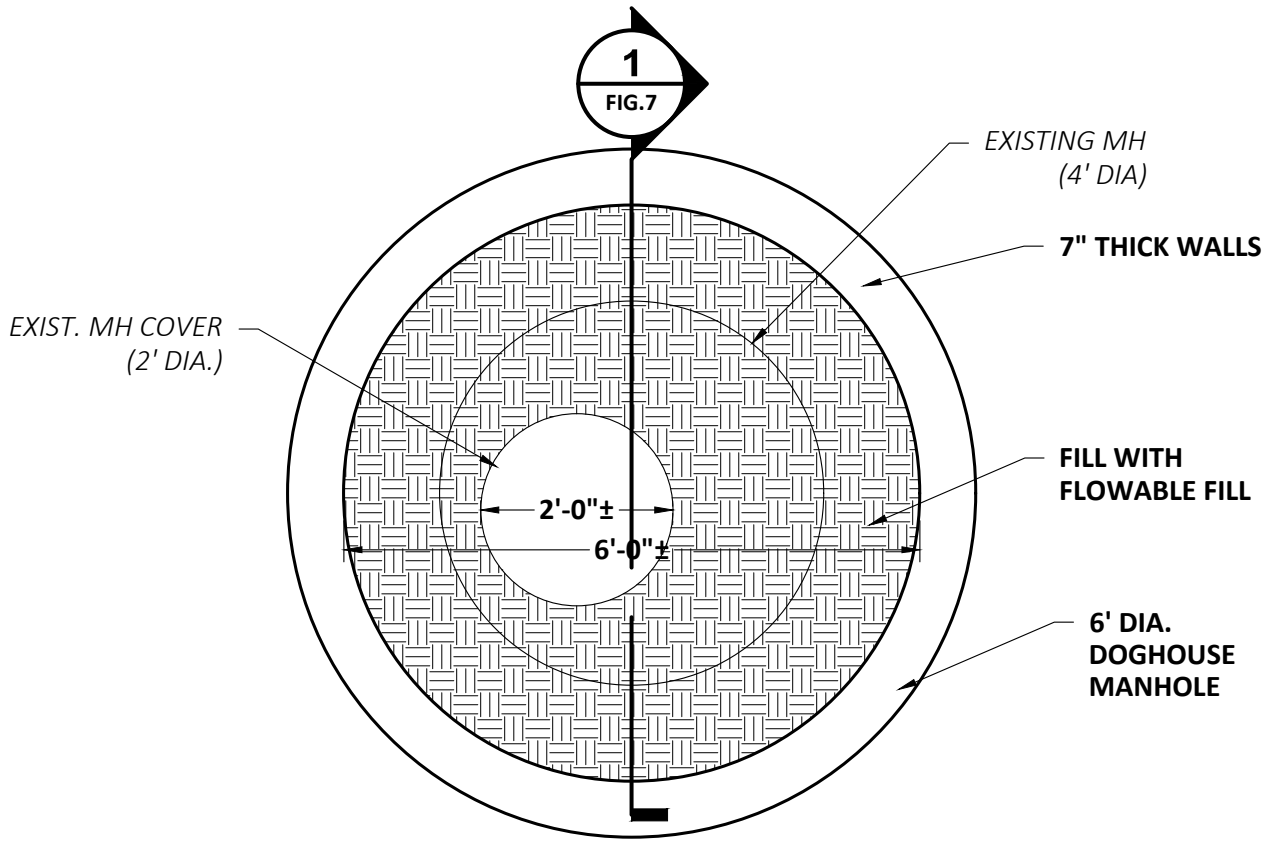
FALMOUTH, MAINE
MACKWORTH INTERCEPTOR STUDY

PLAN AND PROFILE
ALTERNATIVE 1 AND 2
STA 61+00 TO STA 65+00

DRAWING
6

J:\ENGWR\FALMOUTH\21529-MACKWORTHINTERCEPTORREHAB_DRAWINGS\CIV\MODELFORXREF\21529-CM-RAS.DWG | Fig 6 | 1:2.5840 | ---- | 11/30/2023 7:34:19 AM | JAMES.MICHAUD

Appendix E
Suggested Manhole Reinforcing Detail



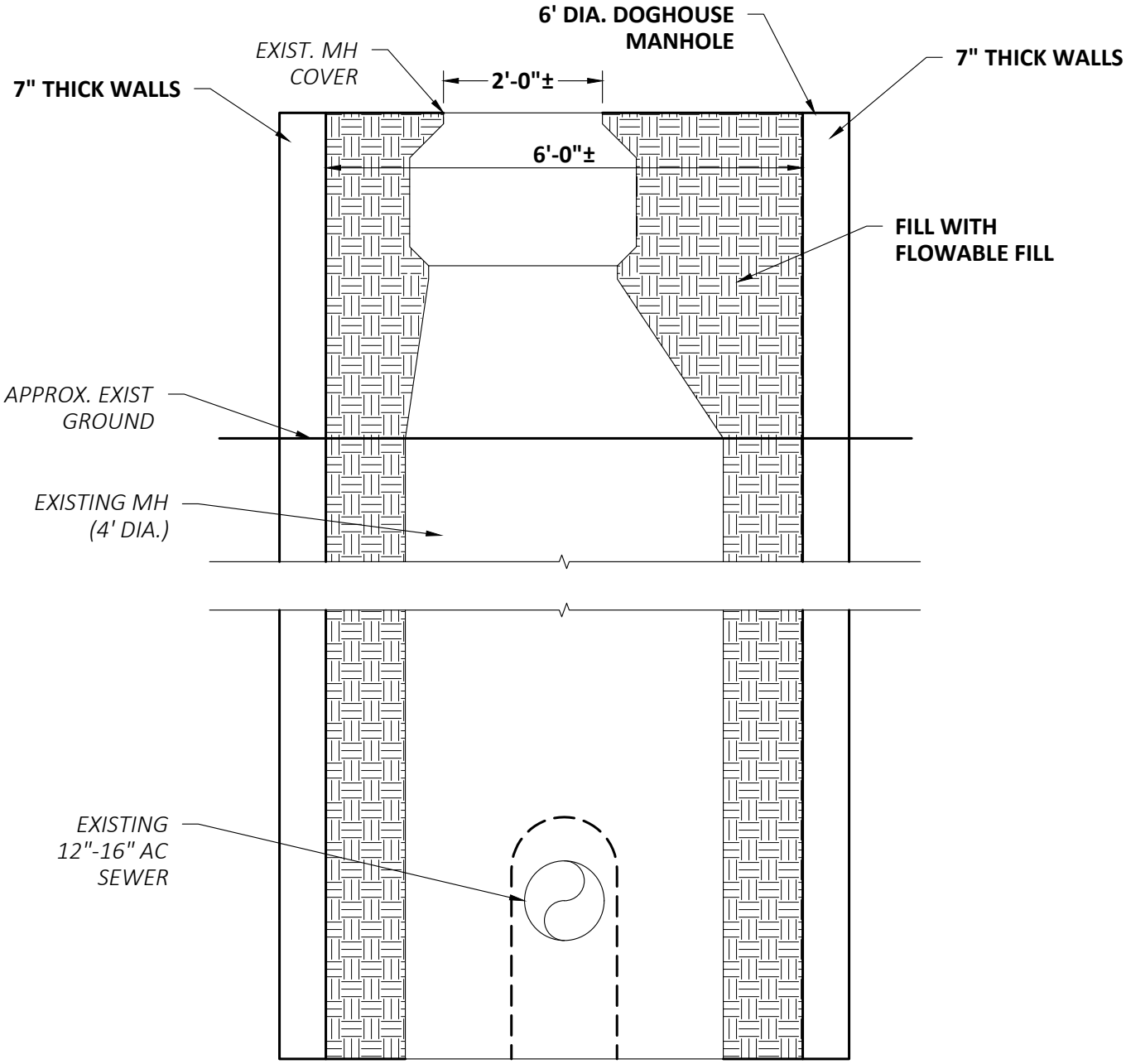
PLAN

SCALE: 1"=2'

PRELIMINARY NOT FOR CONSTRUCTION

FALMOUTH, MAINE MACKWORTH INTERCEPTOR STUDY	NO.	REVISIONS	
	1		
	DRAWN BY: J.MICHAUD	DATE: OCTOBER 2023	PROJ NO: 21529
WRIGHT-PIERCE	APPROVED BY: J.WALLACE	REFERENCE DWG:	FIGURE: 4
	SUGGESTED MH REINFORCING DETAIL		

J:\ENG\ME\FALMOUTH\21529-MACKWORTHINTERCEPTORREHAB_DRAWINGS\CIV\FIGURES\FIG7.DWG



SECTION

SCALE: 1"=2'

PRELIMINARY NOT FOR CONSTRUCTION

FALMOUTH, MAINE MACKWORTH INTERCEPTOR STUDY	NO.	REVISIONS	
	1		
	DRAWN BY: J.MICHAUD	DATE: OCTOBER 2023	PROJ NO: 21529
WRIGHT-PIERCE	APPROVED BY: J.WALLACE	REFERENCE DWG:	FIGURE: 5
	SUGGESTED MH REINFORCING DETAIL		

J:\ENG\ME\FALMOUTH\21529-MACKWORTHINTERCEPTORREHAB_DRAWINGS\CIV\FIGURES\FIG7.DWG

Appendix F
Estimates of Probable Construction Costs

TOWN OF FALMOUTH - WASTEWATER DEPARTMENT
MACKWORTH INTERCEPTOR REMOVAL OR REHABILITATION FEASIBILITY
W-P PROJECT NO. 21529
STUDY
(ENR INDEX 13511, 11/2023)
Alternative 1 Estimate of Probable Construction Costs

PROJECT COMPONENT		COST	
CONSTRUCTION		$11,000,000	Refer to Construction Summary
CONSTRUCTION CONTINGENCY	20.0%	$2,200,000	Allowance
TECHNICAL SERVICES	25.0%	$2,750,000	Allowance
MATERIALS TESTING	0.5%	$55,000	Allowance
LEGAL/ ADMINISTRATIVE	5.0%	$550,000	Allowance
SUBTOTAL		$16,555,000	
FINANCING	1.0%	$166,000	Estimated interim interest
ENGINEER'S ESTIMATE OF PROJECT COST		$16,721,000	

Notes:
1) Cost estimate is based on (ENR INDEX 13511, 11/2023).

TOWN OF FALMOUTH - WASTEWATER DEPARTMENT
CKWORTH INTERCEPTOR REMOVAL OR REHABILITATION FEASIBIL
W-P PROJECT NO. 21529
STUDY
(ENR INDEX 13511, 11/2023)
UNIT QUANTITIES AND PRICES ESTIMATE

NO.	DESCRIPTION	UNITS	Total Quantity	UNIT PRICE	TOTAL COST
1	Mobilization/Demobilization (10% of total cost)	LS	1	$784,000	$784,000
2	Traffic Control Plan	LS	1	$50,000	$50,000
3	Electronic Message Boards	LS	1	$25,000	$25,000
4	12" Sewer Pipe (0'-10')	LF	85	$200	$17,000
5	12" Sewer Pipe (10'-20')	LF	3,715	$220	$817,300
6	12" Sewer Pipe (>20')	LF	2,805	$250	$701,250
7	6" HDPE Force Main Pipe	LF	4,095	$200	$819,000
8	Sanitary Service Connections	LF	515	$125	$64,375
9	Sanitary Manholes (0'-10')	VF	230	$650	$149,500
10	Sanitary Manholes (10'-20')	VF	200	$750	$150,000
11	Sanitary Manholes (>20')	VF	20	$850	$17,000
12	Manhole Drop Connections (Inside Drop/Outside Drop)	VF	5	$200	$1,000
13	Trench Excavation – Ledge	CY	6,175	$300	$1,852,500
14	Replacement of Unsuitable Material Above Pipe Bedding and I	CY	6,175	$30	$185,250
15	Loaming and Seeding	LS	1	$50,000	$50,000
16	Dewatering	LS	1	$100,000	$100,000
17	Initial Pavement (Binder Course)	TON	1,240	$200	$248,000
18	Final Pavement (Surface Course)	TON	1,240	$250	$310,000
19	Test Pit Excavation and Backfill	EA	5	$1,500	$7,500
20	Existing Sewer Main and Manholes - Abandon	LS	1	$250,000	$250,000
21	Pump Station	LS	1	$1,825,000	$1,825,000
22	Shoreland Stabilization	LS	1	$150,000	$150,000
23	Excavation Support Engineering	LS	1	$25,000	$25,000
24	Groundwater Dewatering Engineering	LS	1	$25,000	$25,000
	Construction - Subtotal				$8,623,675
	Project Multiplier - Design Contingency (based on design submittal)			**1.20**	
	Project Multiplier - Inflation to MidPoint (see work sheet)			**1.063**	
	Construction - Total				$11,000,000

TOWN OF FALMOUTH - WASTEWATER DEPARTMENT
MACKWORTH INTERCEPTOR REMOVAL OR REHABILITATION FEASIBILITY
W-P PROJECT NO. 21529
STUDY
(ENR INDEX 13511, 11/2023)
Alternative 2 - Estimate of Probable Construction Costs

PROJECT COMPONENT		COST	
CONSTRUCTION		$8,130,000	Refer to Construction Summary
CONSTRUCTION CONTINGENCY	20.0%	$1,630,000	Allowance
TECHNICAL SERVICES	25.0%	$2,033,000	Allowance
MATERIALS TESTING	0.5%	$41,000	Allowance
LEGAL/ ADMINISTRATIVE	5.0%	$407,000	Allowance
SUBTOTAL		$12,241,000	
FINANCING	1.0%	$122,000	Estimated interim interest
ENGINEER'S ESTIMATE OF PROJECT COST		$12,363,000	

Notes:
1) Cost estimate is based on (ENR INDEX 13511, 11/2023).

TOWN OF FALMOUTH - WASTEWATER DEPARTMENT
MACKWORTH INTERCEPTOR REMOVAL OR REHABILITATION FEASIBILITY
W-P PROJECT NO. 21529
STUDY
(ENR INDEX 13511, 11/2023)
UNIT QUANTITIES AND PRICES ESTIMATE

NO.	DESCRIPTION	UNITS	Total Quantity	UNIT PRICE	TOTAL COST
1	Mobilization/Demobilization (10% of Total Cost)	LS	1	$580,000	$580,000
2	Traffic Control Plan	LS	1	$50,000	$50,000
3	Electronic Message Boards	LS	1	$25,000	$25,000
4	12" Sewer Pipe (0'-10')	LF	495	$200	$99,000
5	12" Sewer Pipe (10'-20')	LF	3,395	$220	$746,900
6	12" Sewer Pipe (>20')	LF	425	$250	$106,250
7	6" HDPE Force Main Pipe	LF	4,095	$200	$819,000
8	Sanitary Service Connections	LF	355	$125	$44,375
9	Sanitary Manholes (0'-10')	VF	155	$650	$100,750
10	Sanitary Manholes (10'-20')	VF	60	$750	$45,000
11	Sanitary Manholes (>20')	VF	3	$850	$2,550
12	Trench Excavation – Ledge	CY	3,465	$300	$1,039,500
13	Replacement of Unsuitable Material Above Pipe Bedding and Initial Backfill	CY	3,465	$30	$103,950
14	Loaming and Seeding	LS	1	$50,000	$50,000
15	Dewatering	LS	1	$100,000	$100,000
16	Initial Pavement (Binder Course)	TON	610	$200	$122,000
17	Final Pavement (Surface Course)	TON	610	$250	$152,500
18	Test Pit Excavation and Backfill	EA	5	$1,500	$7,500
19	Existing Sewer Main and Manholes - Abandon	LS	1	$250,000	$250,000
20	Pump Station	LS	1	$1,735,000	$1,735,000
21	Shoreland Stabilization	LS	1	$150,000	$150,000
22	Excavation Support Engineering	LS	1	$25,000	$25,000
23	Groundwater Dewatering Engineering	LS	1	$25,000	$25,000
	Construction - Subtotal				$6,379,275
	Project Multiplier - Design Contingency (based on design submittal)			**1.20**	
	Project Multiplier - Inflation to MidPoint (see work sheet)			**1.063**	
	Construction - Total				$8,130,000

TOWN OF FALMOUTH - WASTEWATER DEPARTMENT
MACKWORTH INTERCEPTOR REMOVAL OR REHABILITATION FEASIBILITY
W-P PROJECT NO. 21529
STUDY
(ENR INDEX 13511, 11/2023)
PROJECT COST ESTIMATE

PROJECT COMPONENT		COST	
CONSTRUCTION		$1,800,000	Refer to Construction Summary
CONSTRUCTION CONTINGENCY	20.0%	$360,000	Allowance
TECHNICAL SERVICES	30.0%	$540,000	Allowance
MATERIALS TESTING	0.50%	$9,000	Allowance
REPAIR/RECONSTRUCTION OF ASBESTOS CEMENT PIPE		$250,000	Allowance
LEGAL/ ADMINISTRATIVE	5.0%	$90,000	Allowance
SUBTOTAL		$3,049,000	
FINANCING	1.0%	$30,000	Estimated interim interest
ENGINEER'S ESTIMATE OF PROJECT COST		$3,079,000	

Notes:
1) Cost estimate is based on (ENR INDEX 13511, 11/2023).

TOWN OF FALMOUTH - WASTEWATER DEPARTMENT
CKWORTH INTERCEPTOR REMOVAL OR REHABILITATION FEASIBII
W-P PROJECT NO. 21529
STUDY
(ENR INDEX 13511, 11/2023)
UNIT QUANTITIES AND PRICES ESTIMATE

NO.	DESCRIPTION	UNITS	Total Quantity	UNIT PRICE	TOTAL COST
1	Mobilization/Demobilization (10% of Total Cost)	LS	1	$130,000	$130,000
2	Barge Rental	DAY	32	$10,000	$320,000
3	Hydrovac Rental	DAY	32	$3,000	$96,000
4	6' Dia. Doghouse Manhole	VF	145	$1,000	$145,000
5	Flowable Fill	CY	150	$250	$37,500
6	Pump Truck Rental	DAY	16	$3,000	$48,000
7	Dewatering	HR	16	$500	$8,000
8	Crane Rental	DAY	32	$10,000	$320,000
9	Permitting (In-Lieu Fee) - $6/SF MEDEP, $13/SF ACOE	SF	500	$19	$9,500
10	Replace Frame and Cover (watertight)	EA	16	$4,000	$64,000
11	Epoxy Interior Lining	EA	16	$7,000	$112,000
12	Repair Bench and Channel	EA	16	$2,000	$32,000
13	Temporary Access Causeway	FT	80	$1,250	$100,000
	Construction - Subtotal				$1,422,000
	Project Multiplier - Design Contingency (based on design submittal)			**1.20**	
	Project Multiplier - Inflation to MidPoint (see work sheet)			**1.053**	
	Construction - Total				$1,800,000