WELLS HARBOR PEDESTRIAN CROSSING FEASIBILITY STUDY

Prepared For:
The Town of Wells, Maine
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Acknowledgements

As a group, Dirigo Student Engineering would like to thank a number of individuals for their generous help and support that allowed us to undertake this project. This project has given us an opportunity to grow as students and apply our training we have learned at the University of Maine.

We would like to thank our contacts from the Town of Wells, Maine, specifically Wells Town Manager Jon Carter for his enthusiastic support of not only the project but of us as students. Also, Harbormaster Chris Mayo for sharing his extensive knowledge of the harbor and providing us with a wealth of information.

We would like to extend a special thank you to our consultants, Jonathan Edgerton of Wright-Pierce and Norm Baker of T.Y. Lin. Mr. Edgerton gave us overall project guidance while Mr. Baker pointed us in the correct direction with regard to our conceptual structural design.

We also owe thanks to Mr. Chad Michaud of S.W. Cole for his guidance with the geotechnical aspect of the project. Doug Dow of Cianbro Corporation supported us when estimating the project.

Finally we would like to thank the UMaine faculty, Edwin Nagy, Aria Amirbahaman, Will Manion, Thomas Sandford and Judy Hakola, for their time and suggestions.

Executive Summary

The Town of Wells requested a feasibility study of connecting the eastern and western shores of Wells Harbor with a pedestrian crossing. Wells Harbor consists of two distinct shores with municipal waterfront facilities and attractions located on both sides. The Wells Harbor area attracts thousands of tourists each year with its beaches and environmental programs associated with the surrounding estuary. In order to reach the eastern shore facilities and beach from the main harbor facilities on the western shore, a five mile automobile trip is required that can take upwards of 40 minutes during peak tourism season.

To increase connectivity throughout the Wells Harbor area Dirigo Student Engineering designed a pedestrian crossing connecting the harbor's eastern and western shores. This project involved conducting a site analysis, determining options for routing, designing superstructure and foundations for bridge and boardwalk structures, looking into regulatory considerations and determining a final cost estimate.

The site analysis involved researching and compiling data relative to the project site. Areas of research included: land use characteristics, zoning districts, harbor schematics, wetlands, dredging, topography, hydraulic conditions, soil conditions and an environmental assessment.

Three routing options for the crossing were considered. Option One spans straight across the harbor. Option Two connects the harbors western shore beach to the eastern shore parking lot. Option Three connects the western shore beach to the docks as well as the eastern shore parking lot.

The crossing had to utilize bridge as well as boardwalk structures due to the presence of a deep channel in the harbor. The boardwalk consists of a timber frame and decking resting on top of wooden piles. A 300-foot long bridge structure was designed using four spans of NEXT beams resting on top of reinforced concrete piles.

The federally managed harbor surrounded by protected wetlands required considering a multitude of regulatory considerations. The project required coordination with the Department of Environmental Protection, Army Corps of Engineers, Coast Guard, Department of Transportation and local agencies.

Option Two is recommended at an estimated cost of about $2,500,000. The estimate was based on materials, labor, and installation costs for each item of the superstructure and foundation for the bridge and boardwalk.

The pedestrian crossing detailed in this report would be a great benefit to the Town of Wells by improving access in Wells Harbor and the Webhannet Estuary.

1.0 Project Overview

1.1 Introduction

This document is an engineering report prepared for the Town of Wells by Dirigo Student Engineering (DSE) regarding the research, analysis and design of a pedestrian crossing in Wells Harbor. This report includes information on a site analysis, routing, conceptual bridge design, applicable regulatory considerations and a cost estimation. The body of this report describes in general terms the problems identified, solutions developed, methods used, and recommendations made while the appendices contain supporting technical detail.

DSE is a group of senior students in the Civil and Environmental Engineering Department at the University of Maine, Orono. Specifically we are Christopher Marchetti (Project Manager), Jonathan Englehardt, Cullen Finn, Ernest Kilbride, Imre Kormendy and Jack Miniutti. Our team name stems from the State of Maine's motto "Dirigo," which is Latin for "I lead" or "I direct." In engineering, leadership is an essential attribute when dealing with problems that need to be solved. DSE takes pride in our leadership abilities and strong initiative in developing solutions for the Wells Harbor pedestrian crossing.

Our work on this project is part of our required capstone design course, a real-world "service learning" experience for students to transition from academic coursework to the professional workplace. However, because we are students, our recommendations cannot be used as a substitute for professional engineering services. For additional information, please refer to the Disclaimer section at the end of this report.

1.2 Project Background

In 2012 The Town of Wells received a grant from the Maine Coastal Program to undertake a feasibility analysis of connecting the eastern and western shores of Wells Harbor with a pedestrian crossing. Jon Carter, Wells Town Manager, contacted the University of Maine Department of Civil and Environmental Engineering in regard to having a senior capstone group complete this study. The work is a goal set in the 2012 Update of the Wells Harbor Plan developed for the Town of Wells by Wright-Pierce. Through the town, DSE has been paired with Jonathan Edgerton of Wright-Pierce, who acted as program manager, and Norman Baker of T.Y. Lin International, who assisted us with bridge design.

1.2.2 Description of Wells Harbor

Our study focuses on Wells Harbor, a protected cove located on the coast of southern Maine, seen in Figure 1. Wells Harbor is a federally designated harbor and channel originally built in the 1950's. The harbor lies within the Webhannet River and is surrounded by the Webhannet Estuary. The harbor is permitted 150 moorings that are accessed from each side of the Webhannet River. The harbor's shallow waters are subject to sedimentation and require periodic dredging by the United States Army Corps of Engineers (USACE) to maintain navigability. Municipal waterfront facilities are located on both shores of the harbor and are labeled in Figure 1.

Western Shore

The main harbor facilities are located on the harbor's western shore. They include the Harbormaster's office, a pier with floating docks, restrooms and a boat launch ramp. Lords Harbor Side Restaurant attracts patrons who arrive by both land and sea. The Webhannet River Boatyard is a privately owned business that provides supplies, repairs, storage and launching/haul-out services for boaters. The boatyard includes a bait and tackle shop and kayak rental service. Harbor Park attracts visitors with its gazebo, pavilion and playground. The western shore is served by 205 parking spaces accessed from Route 1 by Harbor Road.

Eastern Shore

Eastern shore attractions include a public marina and Wells Beach. This area is served by a 250-space parking lot and accessed via Atlantic Ave, a narrow barrier road passing through dense residential housing development, with extensive seasonal foot traffic.

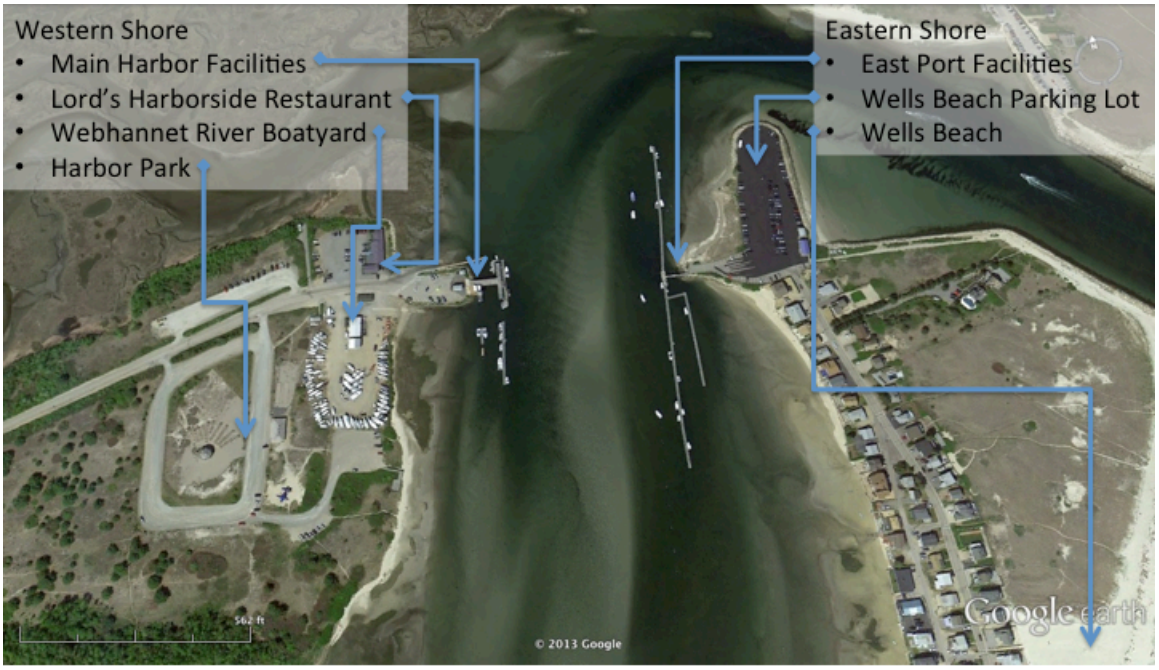


Figure 1- Wells Harbor Aerial View (Google Maps website, 3/25/2013, Edited by CMM on 3/25/2013)

1.2.3 Need for a Crossing

No convenient connection between the eastern and western shores of Wells Harbor currently exists. The five-mile trip required to travel between the shores limits coastal accessibility and can take upwards of 40 minutes during the height of tourism season. On December 7, 2012, Kristen Grant of the Wells Reserve wrote an email to Jon Carter in support of the grant stating “summer traffic congestion along US 1 is a deterrent to prospective recreational beach users in the region and likely has a negative impact on the coastal economy of the town.” The Rachel Carson National Wildlife Refuge (Rachel Carson NWR) and Wells National Estuarine Research Reserve (Wells NERR) could benefit from greater estuary access and eco-tourism promotion with the implementation of a pedestrian crossing. The crossing would also support the Wells Harbor Management Plan’s goal of promoting carless daytrips by improved pedestrian access throughout the harbor. For all these reasons, providing a connection between the eastern and western shores of the harbor has been a dream of the community for many years.

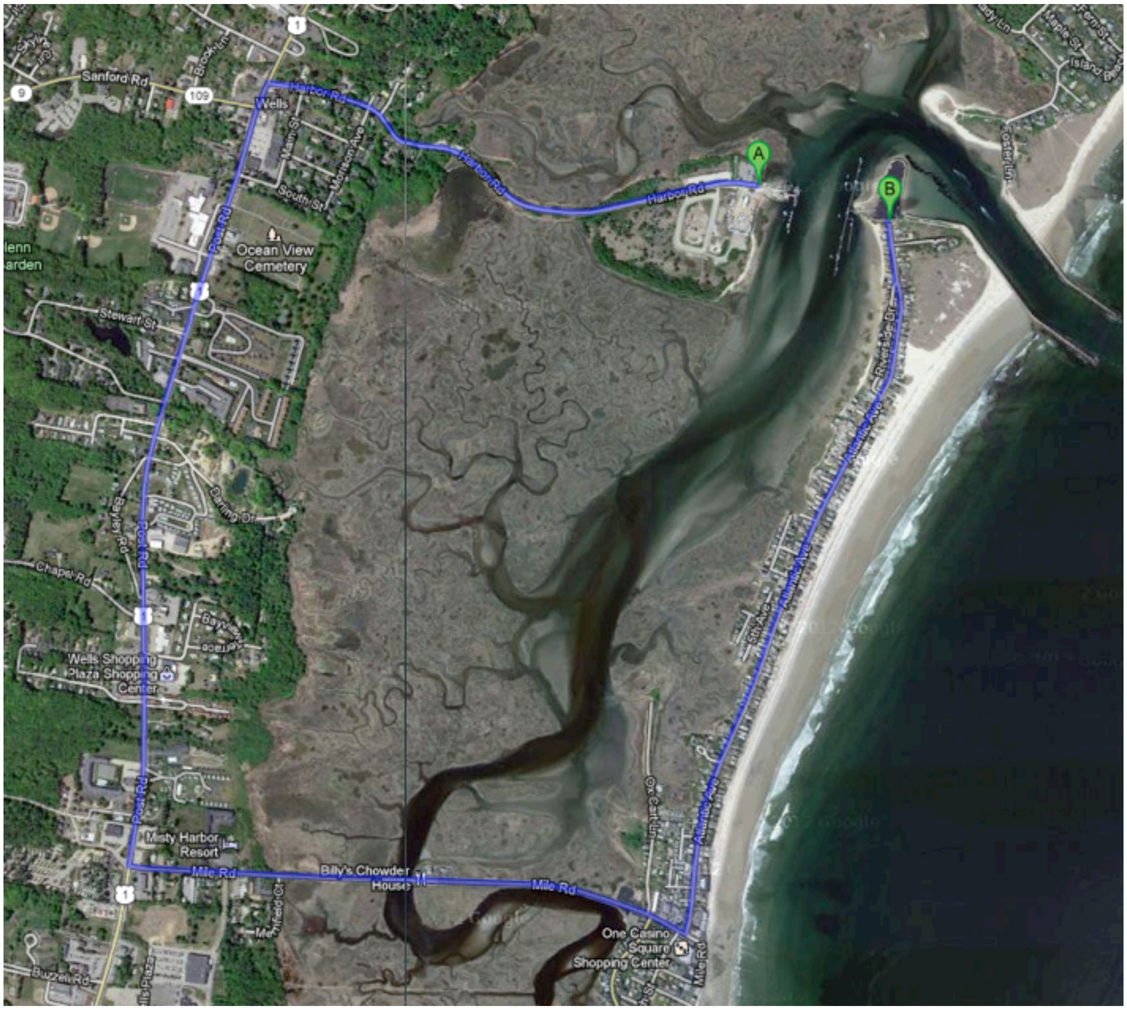


Figure 2- Existing Route between Western and Eastern Shores of Wells Harbor (Google Maps website, 3/25/2013)

1.3 Scope

To fulfill the needs of the Town of Wells DSE has broken the project into five sections.

- Site Analysis
- Routing
- Design
- Regulatory Considerations
- Cost Analysis

A final recommendation based on this work is given at the end of the report.

1.4 Criteria

The following is a list of requirements that must be met and/or researched in order to ensure a structure is built that meets the needs of all users.

- Determine options for routing
- Understand and incorporate design constraints associated with construction in sensitive ecological areas
- Design crossing structure for pedestrians and maintenance vehicles
- Design foundations to meet requirements for area soil characteristics
- Include 10 feet of clearance from high high Tide for navigational channel
- Meet AASHTO bridge requirements
- Meet ADA design standards

2.0 Site Analysis

This section details the site analysis and provides information necessary to understand the subsequent sections of this report. All figures referred to in this section can be found in Appendix A.

2.1 Land Use Characteristics

Land use characteristics such as existing parcel information and location of public land can be seen in Figure A1. This information was necessary to research because the crossing must be located on public land and not infringe on abutting property owners' land.

2.2 Zoning Districts

Figure A2 shows the existing zoning districts for the proposed site. The following zoning districts were considered for the proposed crossing:

- Harbor
- Residential B
- Resource Protection
- 250’ Shoreland Overlay

The crossing must abide by the town regulations for these zoning districts discussed further in Section 8: Regulatory Considerations.

2.3 Mooring Field Location

Figure A3 shows the harbor schematic and mooring plan for Wells Harbor. The location of the crossing must not infringe on the mooring field or docks. Wells Harbormaster Chris Mayo indicated that a 50-foot buffer must exist between the docks and the crossing for navigational purposes.

2.4 Wetlands

A National Wetlands Inventory map produced by the U.S. Fish and Wildlife Service can be seen in Figure A4. The wetlands in this project site include:

- Estuarine and Marine
- Estuarine and Marine Deepwater

This image also shows the location of the Rachel Carson NWR, which the crossing must avoid.

2.5 Dredging and Conservation Easement

An after dredging/condition survey of Wells Harbor conducted by the USACE can be seen in Figure A5. The figure shows the location of dredging, conservation easement and depths of the harbor. The USACE requires no structure be located within a horizontal buffer zone that is equal to three times the authorized depth of the Federal Navigation Project (FNP). The depth of the Wells Harbor FNP is 6 feet and requires a buffer of 18 feet for the proposed structure.

2.6 Topography and Bathymetry

In addition to the USACE survey data, the Wells National Estuarine Research Reserve recorded topographic profiles at a number of locations in the harbor for the report titled: *Salt marsh response to harbor dredging in the Webhannet River estuary, Maine: a tutorial.* The map showing the location of the profiles can be seen in Figure A6. The relevant profiles can be seen in Figures A7 and A8. This information was necessary to determine navigable clearance heights and pile lengths.

2.7 Hydraulic Conditions

A map indicating the 100-year floodplain can be seen in Figure A9. The portion of the Webhannet River where our project site is located is considered a Zone AE flood region. The significance of this designation will be discussed further in the Section 8: Regulatory Considerations.

Chris Mayo was consulted for information relative to the harbor's tides. He suggested we design for a change in tide elevation of 13 feet. The tide chart as seen in Figure A10 shows a typical extreme tide event with a high tide elevation of 11.4 feet and a low tide elevation of -2 feet. The tidal information was necessary to determine navigable clearance heights and pile lengths.

2.8 Soil Conditions

Two split spoon boring investigations were conducted on either side of the harbor by East Coast Explorations on October 11 and 12, 2012. The boring logs can be seen in Figures A11 and A12. From these logs it was found that that blue marine clay exists from a depth of 30 feet to the bottom of the boring at 50 feet.

A soil profile of the Mile Road Bridge seen in Figure A13 was also obtained through the Maine Department of Transportation (MDOT) to give us a better understanding of the subsurface conditions. The bridge is located just over mile upstream from the project site.

2.9 Environmental Assessment

In 2004 the U.S. Army Corps of Engineers conducted "an assessment of the potential environmental effects of dredging the entrance channel and portions of the settling basin of the Federal navigation project at Wells Harbor, Maine." The result of the environmental assessment was that "the proposed project is not expected to result in significant adverse impacts to the project area" (USACE, 2004). Because of the close proximity of the dredging area to the proposed crossing site, the report is used to support the likely insignificant impact of the pedestrian crossing project.

The different areas assessed in the report include:

1. Physical Setting
2. Sediment Quality
3. Water Quality
4. Aquatic Resources
5. Wildlife Resources
6. Essential Fish Habitat
7. Threatened and Endangered Species
8. Historical and Archaeological Resources
9. Environmental Justice
10. Cumulative Impact

Relevant excerpts from the report are shown in Appendix B.

3.0 Routing

3.1 Routes Considered

Two initial routing options for the crossing were provided by Wright-Pierce and can be seen in Figures C1 and C2 of Appendix C. The route for Option One is straight across the harbor connecting the western beach to the eastern shore. The route for Option Two is a dogleg connecting the western beach to the parking lot on the eastern shore. A third option was suggested when DSE met with the Wells Harbor Advisory Committee on April 3rd, 2013. This option involves running the dogleg flush with the easternmost dock with its approach connecting to the east shore pier. The three routing options can be seen in Figure 3. Graphics of each individual route can be seen in Appendix C. The figure shows both bridge and boardwalk sections for the crossing. The need for both bridge and boardwalk sections was due to the presence of a deep channel and is discussed in further detail in Section's 4 and 5.

Figure 3- Routing Options (Google Maps website, 3/25/2013, Edited by CMM on 4/8/2013)

3.2 Routing Criteria

A number of constraints were imposed due to the site's characteristics:

- Avoid the area designated conservation easement, Rachel Carson National Wildlife Refuge, mooring field and abutting property owner's parcels.
- Provide a minimum horizontal buffer of 18 feet from the dredge zone.
- Include a 50-foot buffer from floating docks.
- Make approach easily accessible and located on public land.

3.3 Route Locations and Discussion

All three routing options share the same western boardwalk and bridge spans with the approach located at the end of the west shore beach. It is located on public land and is easily accessible by footpaths from Harbor Park.

3.3.1 East Shore Boardwalk Span: Option One

Option One involves a boardwalk spanning 415 feet from the edge of the bridge straight to the east shore. Its approach is located on an extension of a narrow side street between two residential houses seen in Figures C3 and C4 of Appendix C. This approach location is not inviting as a public access point and would likely see opposition from the abutting property owners. This approach also sacrifices pedestrian safety by requiring users to walk about a quarter of a mile from the beach parking lot along Atlantic Ave. and Riverside Dr. to access the crossing.

3.3.2 East Shore Boardwalk Span: Option Two

Option Two involves a boardwalk spanning 160 feet straight from the bridge and continuing at a right angle 830 feet to an easily accessible approach at the public parking lot. It includes approximately 150 feet of horizontal clearance from the eastern most floating docks and satisfies the Harbor Master's request.

3.3.3 East Shore Boardwalk Span: Option Three

Option Three includes an 870-foot boardwalk span from the end of the bridge section to the beach parking lot by the east shore pier. The idea behind this option is to provide greater connectivity to the easternmost docks. The floating docks would be anchored to the boardwalk with chains and posts or a product called "Tide-Slide." The connection would entail an ADA compliant gangway that would require the installation of wider floats. The use of 13 floating docks would be lost with this option but loss of docking space could be partially overcome by extending the floats along the boardwalk. It is believed that approximately 11 additional floats could be extended along the boardwalk structure.

4.0 Superstructure Design

This section details the design and analysis of the boardwalk and bridge superstructure. From the topographic investigation we found that the harbor consists of a deep channel surrounded by relatively shallow waters on either side. The location of the crossing matches that of the topographic profile seen in Figure A7. It was determined that a boardwalk would be used to traverse the shallow waters while a multiple span bridge structure would have to be used to traverse the deep channel.

4.1 Criteria

The superstructure was designed following the criteria and constraints imposed by the client, Maine DOT, ASCE 7, and AASHTO LRFD Bridge Design Specifications as well as the supplemental AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges.

4.1.1 Loading Requirements

The superstructure had to be designed according to the anticipated loadings and subsequent deflections it could possibly experience throughout its lifetime. The design criteria for the bridge had to meet AASHTO design recommendations and were designed to structurally support the weight of a small truck or a light-weight maintenance vehicle (H5) in addition to the pedestrian load. AASHTO LRFD Articles 3.4, 3.5 and 3.6 describes the required loading and load combinations. The deflection of the bridge due to the unfactored pedestrian live loading shall not exceed 1/360 of the span length.

4.1.2 Width Requirements

The bridge width had to meet the AASHTO minimum width of 10 feet and the ADA minimum clear width of 8 feet. The minimum width required for shared pathway designation by AASHTO is 12 feet.

4.1.3 Clearance Requirements

As requested by the Harbor Advisory Committee to meet navigational requirements, the superstructure had to allow for 10 feet of clearance from high high tide.

4.1.4 Railing Requirements

The railing designs had to meet the AASHTO Bridge Design Specifications for both pedestrian and bicycle railings. Both AASHTO Article 13.8.1 and 13.9.1 state that the height of a pedestrian/bicycle railing shall not be less than 42 inches measured from the top to the walkway or riding surface. The railings are designed to be 52 inches in height with a grab bar at 42 inches for pedestrians.

Pedestrian railing openings between horizontal or vertical members must be small enough that a 6-inch sphere cannot pass through them in the lower 27 inches. For the portion of pedestrian railing that is higher than 27 inches, openings may be spaced such that an 8-inch sphere cannot pass through them.

4.2 Design Methods

The precast concrete bridge portion was designed using the loadings described in section 4.1.1 as well as AASHTO LRFD Bridge Design Section 5.2. The beam sizing was calculated utilizing PGSuper, a comprehensive AASHTO LRFD precast prestressed bridge girder design software. The precast concrete beam calculations are available in Appendix D.

In order to design a timber boardwalk structure the loadings described in section 4.1.1 above and the methods described in AASHTO LRFD Bridge Design Section 8 were applied. The formulas and subsequent calculations can be seen in Appendix E and F.

4.3 Bridge Recommendations

The bridge was designed to span 300 feet across the channel reaching depths of 23 feet. The bridge structure consists of four 75-foot spans of two adjacent precast concrete 36F NEXT beams. The NEXT beam is capable of spans of up to 85 feet, making it ideal for the span lengths necessary for the bridge. The bridge deck is a composite cast-in-place concrete deck with a gross depth of eight inches. The base of the bridge structure is elevated to provide 10 feet of clearance from high high tide and allow for vessel navigation. A section view of the proposed design can be seen in Figure 4.

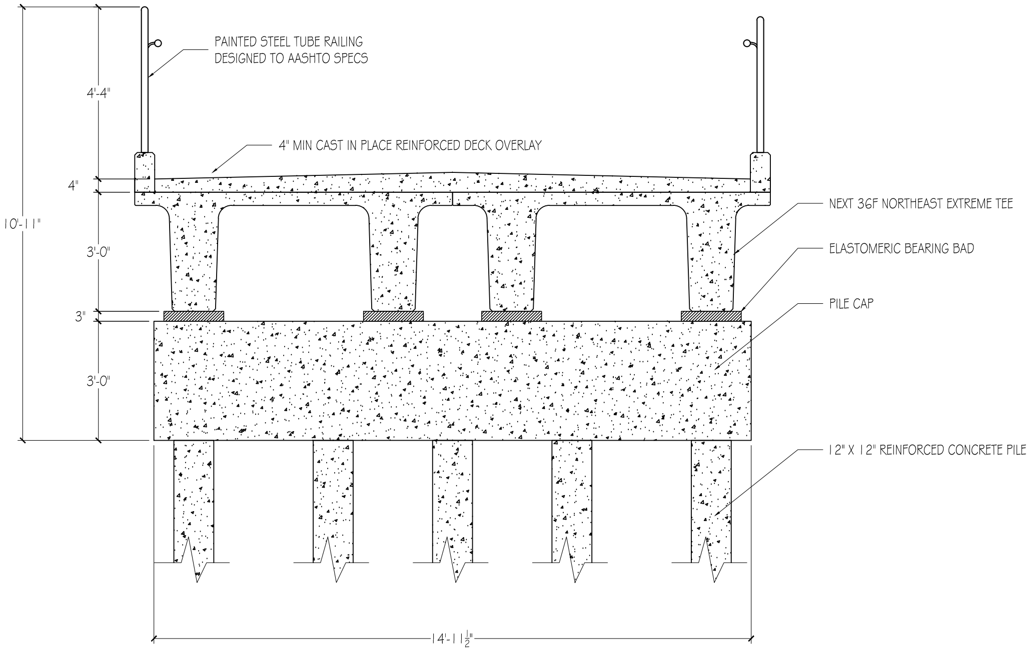


Figure 4- Bridge Section View

Due to the size of the NEXT beam, the minimum bridge width is 16 feet, which exceeds the ADA minimum clear width of 8 feet and meets the 12-foot required shared use pathway. The wider bridge section can become the focal point of the bridge offering additional space for pedestrian recreation. This area of the crossing will be used to promote environmental education with info-graphics from the Rachel Carson NWR and Wells NERR. This area will also contain benches and provide users space to fish.

4.4 Boardwalk Recommendations

A boardwalk that meets the established standards by AASHTO was designed to traverse the harbor's shallow water depths of up to 14 feet. The boardwalk consists of a timber frame and decking. The selected 12-foot width exceeds the requirements for a pedestrian bridge and satisfies the minimum requirement for a shared use pathway. The standard practice in Maine when building pier and boardwalk structures is three feet of free board. Our structure follows standard practice and provides three feet of vertical clearance from high high tide. The boardwalk spans approaching the bridge section are raised at a 5% grade for 180 feet and meet ADA slope requirements.

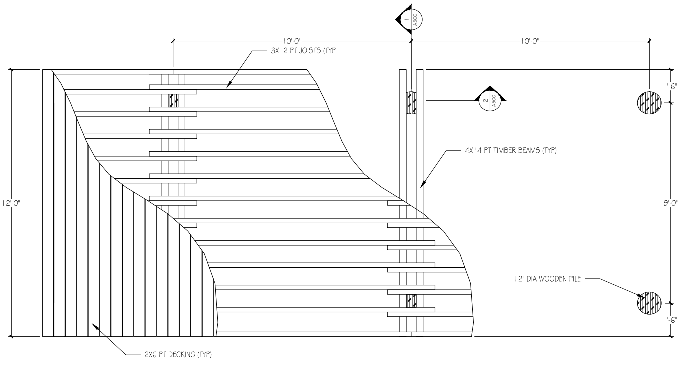


Figure 5- Boardwalk Plan View

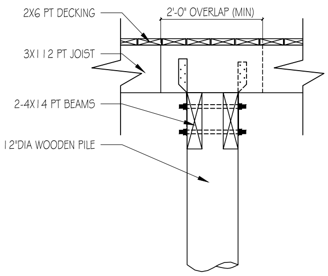


Figure 6- Pile Connection Detail

A plan view of the boardwalk can be seen above in Figure 5 while a cross section can be seen on the next page in Figure 7. The boardwalk is supported by two transverse 4-inch by 14-inch timber beams. The pile is notched on both sides to receive the 4-inch by 14-inch beams and the beams are fastened using two 7/8-inch through bolts at each pile. A detail of the pile connection can be seen in Figure 5. The deck consists of 2-inch by 6-inch decking material and is supported by 3-inch by 12-inch timber joists that are secured to the transverse beam with stainless steel twist straps. Because untreated wood is not recommended in a coastal zone, the timber elements should be constructed with pressure treated wood.

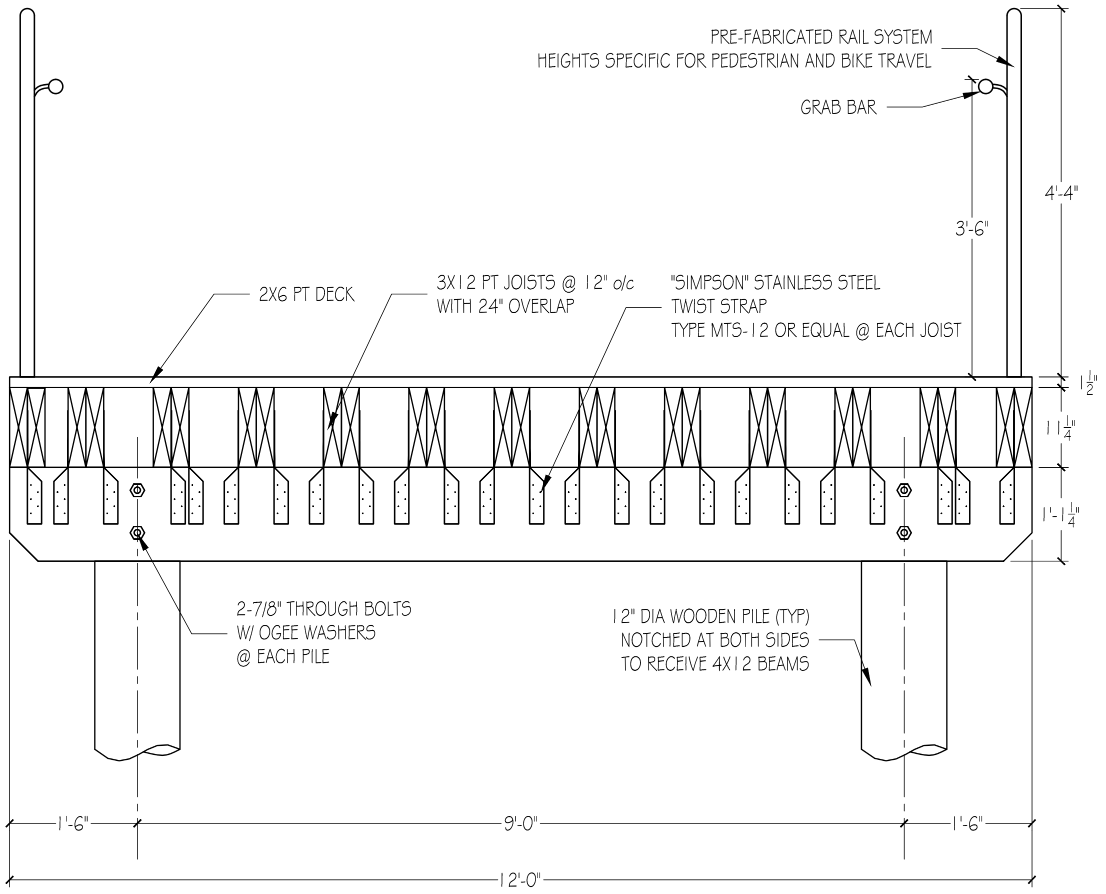


Figure 7- Boardwalk Cross Section

5.0 Substructure Design

The feasibility of this crossing relies on piles to support the superstructure. Line 2 in figure A7 shows the first leg of the alignment and the depth of the channel. The shallower portions of the crossing can utilize a boardwalk design, supported by timber piles that are driven into the blue marine clay. There is a 300-foot span towards the center of the channel where the distance to the subsurface becomes too great for timber piles. Because of the increase in channel depth, the piles must be longer and support a higher static load due to the precast concrete beams. For the bridge portion of the crossing, concrete piles are used.

5.1 Criteria

The major criterion that the foundation needed to meet was being a wood structure for the majority of the crossing. This material allows for a more aesthetically pleasing look; however, it makes the number of piles needed to support the superstructure much greater. Since there are only so many available lengths for timber piles, only a certain loading can be applied to each pile.

The bridge and boardwalk soil profile's, as shown in Appendix G, were assumed from the two split spoon boring samples we received as well information obtained from the Mile Road Bridge soil profile.

To successfully support each section of the crossing, two separate pile designs were needed. The design for the boardwalk portion specifies the use of timber piles spaced nine feet on center laterally, and 10 feet on center longitudinally. Each pile bent must support 16 kips (or 1.6 kips/lf), therefore every pile must have an allowable capacity of 16 kips/pile. With a factor of safety of three, this design met traditional standards.

For greater depths, concrete piles become more economical and provide a greater loading capacity. The concrete piles specified in the design are 1-foot by 1-foot and reinforced with steel rebar. The four bridge spans are spaced 75 feet apart. Since these piles are end bearing on rock, the allowable capacity is much greater compared to the timber piles.

The piles for the crossing were designed following the criteria and constraints outlined in the Naval Facilities Engineering Command Design Manual, Section 7.2 (NAVFAC-DM 7.2). This manual was followed for both the granular and cohesive soil layers.

5.3 Pile Design

Soil properties are the most important aspect to design pile capacity using frictional forces; therefore, a soil investigation was performed at each landing and properties from that were used for the main design of both the wooden and concrete piles. Blue marine clay was found at a depth of 50 feet, and no deeper investigations were implemented.

The next step was to review the collected information and determine the best type of foundation to use. For the boardwalk portion of the crossing, piles need to be driven to a depth of 35-45 feet to support the superstructure. Timber piles are only available in certain lengths; therefore, 45-foot piles were chosen to design for the longest pile. The section where a bridge is needed requires deep driven piles and will be significantly longer than those of the boardwalk. For the shorter piles, timber will be used but the longer piles will have to be reinforced concrete. It becomes more economically desirable to use concrete for these longer piles because timber piles are limited in lengths and have low capacities.

The most challenging research that we had to do was estimating the pile length for each section. It takes an experienced geotechnical engineer with a thorough understanding of the soil-pile interaction to accurately estimate these numbers. Chad Michaud, a senior geotechnical engineer for S.W. Cole, provided assistance with this aspect of the project. He does his company's work at sites located in York County and is familiar with the soil conditions that this crossing faces.

Once soil profiles are developed a conceptual foundation design is possible. The piles for the bridge crossing were assumed to hit bedrock after driving through 20 feet of clay. This assumption was based off the soil profile of Mile Road Bridge, located approximately 1.2 miles upstream. The final design will require a more accurate soil investigation to select lengths for each pile according to the layout of the subsurface profile.

The next step in the design process was to take into account the driveability of the selected pile, to assure that the required capacity and penetration depth can be reached at a practical driving resistance.

5.3 Recommendations

The piles for the bridge must range from 35-45 feet long to penetrate the subsurface enough to provide an allowable loading capacity with frictional resistance. These piles are designed to support 22 kips each in compression. Wooden 1-foot diameter circular piles are chosen to stay economically friendly. We used 450 piles in groups of two piles spaced every 10 feet on center longitudinally and 9 feet on center laterally.

For the bridge, the piles must be 75 feet long to penetrate the subsurface enough to provide an allowable loading capacity. These piles are designed to support 210 kips each in compression and 27 kips each in tension. Precast 1-foot by 1-foot square reinforced concrete piles are chosen for the bridge structure. This area of concrete can support the load that must be supported since our piles are end bearing for this portion of the crossing. For the four spans a total of 25 of these piles are needed. They are grouped in bents of 5 piles spaced 3.75 feet apart center to center

The contractor selected to perform this task will need to select a pile hammer before a driveability analysis can be completed. This part of the design process was excluded from our work due to the time constraints we faced. It is something that will need to be completed before final designs can be reviewed and approved.

6.0 Regulatory Considerations and Permitting

This section covers the research about federal, state, and local agencies that could be involved with the project. We found a number of regulations that factored into the bridge design criteria. Some challenges we faced were that the project is located in the vicinities of a federal harbor, local ordinances, conservation easement, high risk floodplain, and a sensitive wetland environment. The priority agency list is as follows:

- Maine Department of Environmental Protection (MDEP)
- United States Army Corps of Engineers (ACOE)
- United States Coast Guard (USCG)
- Maine Department of Transportation (MDOT)
- Local Ordinances

We followed the advice of our contacts and were able to obtain sufficient correspondence to proceed with alignments and design criteria. This section includes details regarding the Natural Resource Protection Act permit, Land Use Regulation Commission permit, and federal and local jurisdictions. Plans for moving forward include mitigation planning and compensation concerns.

6.1 Natural Resources Protection Act (NRPA) Permit

The Maine Department of Environmental Protection (MDEP) is an agency responsible for the enforcement of the NRPA Permit. This legislature declares that:

> The State's rivers and streams, great ponds, fragile mountain areas, freshwater wetlands, significant wildlife habitat, coastal wetlands and coastal sand dunes systems are resources of state significance. These resources have great scenic beauty and unique characteristics, unsurpassed recreational, cultural, historical and environmental value of present and future benefit to the citizens of the State and that uses are causing the rapid degradation and, in some cases, the destruction of these critical resources, producing significant adverse economic and environmental impacts and threatening the health, safety and general welfare of the citizens of the State.

Even though this project is less than 45,000 square feet, due to the coastal wetland location it will require a full tier III NRPA permit. After meeting with Robert Green of the MDEP, it became apparent that there are two main areas that need to be addressed in the application.

1. "Existing uses. The activity will not unreasonably interfere with existing scenic, aesthetic, recreational or navigational uses." (Natural Resources Protection Act, 480D Standards1, p.10.)

   The key points here are to make the bridge as aesthetically appealing as possible. While site lines will be lost from the mile bridge, the public will gain many site lines via the bridge that are not currently available. The pedestrian crossing would actually increase the recreational use of the harbor. The waters on the other side of the bridge have very limited navigational use, only high tide fishing. This bridge would create a further barrier to protect the Rachel Carson preserve shores. Most of the residential housing located on the eastern shore is on an elevated sea wall. This is significant as most of the dog leg boardwalk structure will still be below the property site lines.

2. "Harm to habitats, fisheries. The activity will not unreasonably harm any significant wildlife habitat, freshwater wetland plant habitat, threatened or endangered plant habitat, aquatic or adjacent upland habitat, travel corridor, freshwater, estuarine or marine fisheries or other aquatic life." (Natural Resources Protection Act, 480D Standards 3, p. 11.)

The degree of habitat fracturing is to be determined by the Department of Marine Resources, Maine Fisheries and Wildlife in conjunction with the Maine DEP. During the meeting with Robert Green, we were informed that the degree of fracturing could trigger compensation fees reaching $40-50 per square foot of the entire structure. These fees pose a significant threat to the feasibility of this project.

We feel that there are two key methods to address the harm to habitats and fisheries and the accompanying compensation fees. First, the number of piles going into the water will be the most crucial item in determining the fracturing of the habitat. A more in-depth soil profile to more accurately determine the pile spans will be crucial. The current ten-foot span totals nearly 365 piles for the dogleg option. The current eastern shore pier is constructed with piles 18 feet on center without any settling over the last 75 years. We feel that the boardwalk span length can be further optimized to reduce the total pile count. Reducing the pile count will also reduce the construction cost dramatically.

The second method will be to work in conjunction with the Maine Fisheries and Wildlife, Maine Audubon Society, Rachel Carson NWR, Wells National Estuarine Research Reserve (NERR) and Laudholm Trust, Maine Department of Marine Resources and National Marine Fisheries Service prior to submitting the NRPA application. The reason is to make all parties aware of the project and that the impacts on the environment are important to the project management team. Any mitigation strategies proposed by the agencies should be adopted within reason to make as many agencies as happy as possible.

Table 1 shows the cost of applicable fees as well as the expected processing times obtained from the MDEP. Effective: November 1, 2012 to October 31, 2013.

NRPA Licensing Fees & Schedule

Permit Type	Processing Fee	Licensing Fee	Processing Time
TW: tidal waterfowl area	$210	$74	90 Days
4C: structure >1000 sq.ft. over water	$361	$90	90 Days
4E: other activity on a coastal wetland	$361	$90	90 Days

Table 1 - NRPA Licensing Fees & Schedule by permit type

Table 2 shows the alteration fees triggered by having more than 500 square feet of fill. The fill for this project will primarily be the piles penetrating the submerged lands. The processing fee is calculated as $0.0219 per total project square footage. The Licensing fee is calculated as $0.0073 per total project square footage. The Potential Compensation fees are calculated as $40-50 per total project square footage.

Alteration Fee				
		Processing	Licensing	Potential Compensation Fees: ($40-$50 per square foot)
Option #1	$16,980 sq.ft.	$373	$124	$679,200 - $849,000
Option #2	$23,880 sq.ft.	$523	$175	$955,200 - $1,194,000
Option #3	$22,440 sq.ft.	$492	$164	$897,600 -$1,122,000

Table 2 – NRPA Alteration Fee & Potential Compensation Fee

We have also fulfilled the requirement of Attachment 11 of the NRPA tier III permit in obtaining a letter from the Maine Historic Preservation Commission stating that this project will have no significant historical impact on the site (see Appendix K).

6.2 Maine Submerged Lands Program

After the NRPA permit application has been negotiated with the agencies named above, the project will then be reviewed by the Maine Submerged Lands Program (SLP). We collaborated with Carol DiBello from the Department of Agriculture, Conservation and Forestry, Division of Parks and Public Lands, Maine Submerged Lands. The State of Maine defines the publicly owned submerged lands in our project location as tidal rivers and all land below mean low water mark. This project should not require a bridge permit as the height clearance is sufficient for navigation under the structure. However, the project will require a submerged lands conveyance for the substructure penetrated the submerged lands. This process can take up to 90 days to review.

6.3 Army Corps of Engineers

The Army Corps of Engineers (ACOE) is a federal agency that manages the Wells Harbor Federal Navigation Project. They will negotiate the terms of the permitting application in conjunction with the Natural Resource Protection Act permit. They review permit applications to protect aquatic ecosystems, property rights of neighboring land users, and the general public. Jay Clement of the ACOE has advised us to remain outside the designated dredging zone and its accompanying buffer.

All agencies involved must validate the construction of the bridge before consideration is taken by the Army Corps jurisdiction, including the Federal Emergency Management Agency (FEMA) and the National Environmental Protection Agency (NEPA).

6.4 United States Coast Guard and Department of Transportation

The United States Coast Guard sets clearance guidelines for navigable waters. The navigable portion is defined as territorial seas and internal waters of the United States subject to tidal influence. Chris Bisigano of the USCG recommended we remain outside the navigable portion of the river. There is currently no bridge clearance guidelines specified for the Webhannet River, so we have been advised to use the clearance of the Mile Road Bridge (Island Ledge Road Bridge).

According to Christopher Bisignano of the USCG, if we assume federal funding, the project could be administered by the United States Coast Guard (USCG) or Federal Highway Administration. The bridge divisions regulate and uphold bridge codes, environmental laws, and other general policies for federal waterways. Additional items required with an application include a design package, dimensions, surveys and assessments, plan sheets, and environmental documents. After submission of the application the initial review period duration is 30 days.

6.5 Local

In collaboration with Mike Livingston, Town Engineer, the contents of this project suggest that it would be declared as “municipal use.” He has also referenced Chapter 145, Land Use Regulations, as the primary ordinances. This section includes the laws and regulations associated with the zoning maps in Figure A2. The specific districts include Residential B, Harbor, Resource Protection, and Shoreland Overlay. We have also been advised to remain on public land.

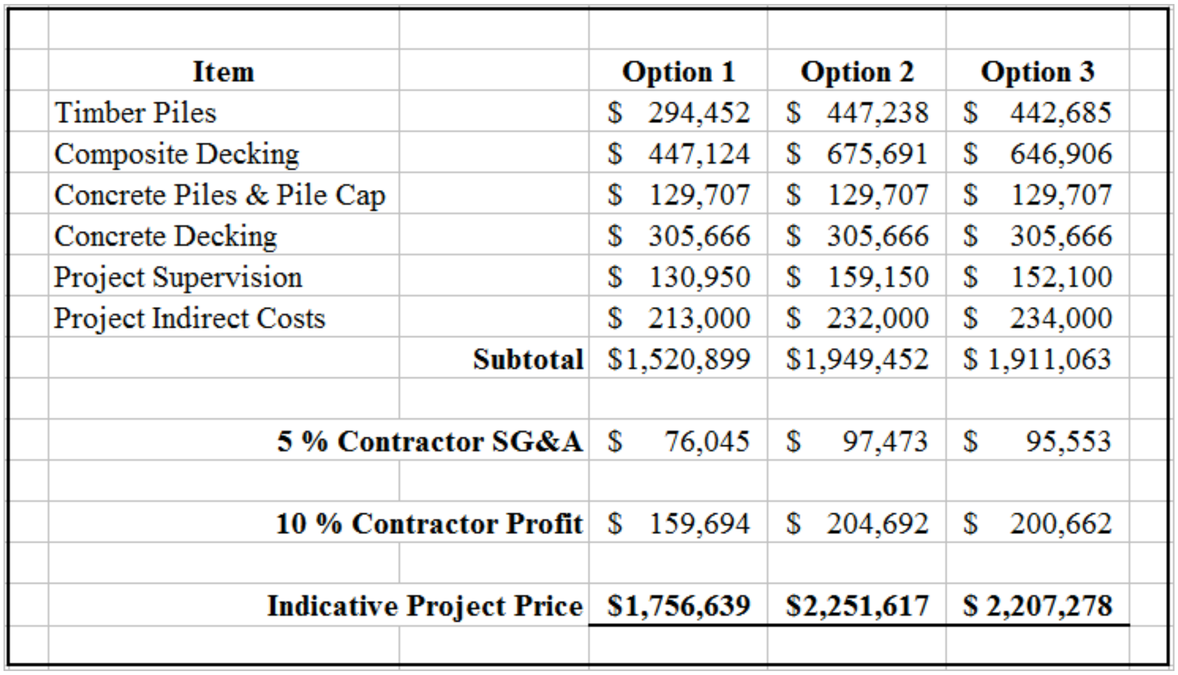
As mentioned in section 2.9, Hydraulic Assessment, the project location is located in a high-risk flood plain zone, also known as a Special Flood Hazard Area (SFHA). The town participates in the National Flood Insurance Program (NFIP) in accordance with The Federal Emergency Management Agency (FEMA). The purpose of the management plan is to ensure no significant backwater will be generated that could flood the upstream conditions. Details of the mission are included in Chapter 116, Floodplain Management, which include a permitting process.

7.0 Cost Evaluation

Dirigo Student Engineering evaluated the cost associated with all three options of the aforementioned bridge designs. This analysis was based on the total cost of the project, including materials, labor, and installation costs for all items excluding the boardwalk abutments. Included are the components of both the boardwalk section of the crossing and the four individual spans over the deepest part of the channel. Doug Dow, Estimating Manager for Cianbro Corporation, aided in the cost estimates by providing insight into our equipment and supervision needs, as well as production quantities.

7.1 Summary of Project Costs

A summary of estimated costs can be seen below in Table 3. All dollar amounts are in 2013 dollars with no escalation included in the price. All costs are specific to the Southern Maine area. The exclusions from this cost estimate are given in Section 7.2 of this report. All assumptions that were made are described in Section 7.3. Refer to Appendix H, I, and J for a more detailed breakdown of all costs associated with the project that lie within our scope.



Item		**Option 1**	**Option 2**	**Option 3**
Timber Piles		$ 294,452	$ 447,238	$ 442,685
Composite Decking		$ 447,124	$ 675,691	$ 646,906
Concrete Piles & Pile Cap		$ 129,707	$ 129,707	$ 129,707
Concrete Decking		$ 305,666	$ 305,666	$ 305,666
Project Supervision		$ 130,950	$ 159,150	$ 152,100
Project Indirect Costs		$ 213,000	$ 232,000	$ 234,000
	Subtotal	$1,520,899	$1,949,452	$ 1,911,063
	5 % Contractor SG&A	$ 76,045	$ 97,473	$ 95,553
	10 % Contractor Profit	$ 159,694	$ 204,692	$ 200,662
	Indicative Project Price	**$1,756,639**	**$2,251,617**	**$ 2,207,278**

Table 3 – Summary of Estimated Project Costs

7.2 Cost Exclusions

It is important to take into consideration that the above estimate does not include a price to furnish materials nor labor to install the landings/abutments that would be needed to connect the boardwalk to the mainland. The cost of the site work necessary to establish a walking path between the boardwalk and the nearby parking lots has also been excluded. Signage that would be used to instruct pedestrians about bridge use has been excluded. Specific to Option Three, the interface between the boardwalk structure and the dock has not been included in the price. There is no contingency included in the above prices. The owner is advised to include an Owner Contingency of 15%.

Option Three is unique in the fact that it connects the western and eastern shores by way of the docks on the eastern shore. If this option is considered, the boardwalk would run parallel to the docks on eastern side and eliminate 13 boat slips on the eastern side of the dock. It is estimated that 11 slips could be added to the existing dock if the Town of Wells chooses to add more dock space. Each dock section costs approximately $5,000 delivered, for a total cost of $55,000; which is not included in the estimate for Option Three.

7.3 Estimate Assumptions

The estimate for all three routing options was made with the following assumptions: The first being that there is no bedrock in the soil. If future borings indicate that bedrock is located at a usable depth, the project cost may decrease because the pile lengths could be shortened, thus decreasing material costs. It was assumed that all permits associated with this project will be obtained by others and are therefore the face value of the permits not the indirect costs associated with obtaining them are included in the estimate. All costs associated with the permitting process are outlined in Section 6.1 of this report. Another assumption with regard the project price was whether or not the entire structure is accessible by water during construction. The project estimates in Table 3 assume that 100% of the structure would be able to be built by use of barge. Due to the insufficient data regarding channel depth, it is difficult to estimate whether a barge is feasible. If a barge is not allowed in the channel because of too much draft or environmental concerns, an alternative method of construction such as a trestle may have to be considered. This will add significantly to the costs of the project and may prove to be too costly.

7.4 Bridge Materials

Due to the location of the bridge, all materials will need to withstand a naturally corrosive environment. All wood materials, excluding the deck, have been priced with pressure treated (PT) southern yellow pine lumber. Pressure treated wood has been chemically treated to ensure a longer lifespan when exposed to a damp and corrosive environment. Per the American Wood Protection Association (AWPM) Specifications for Treated Wood, U1-12 Section 2, timber piles exposed to saltwater and/or brackish water should be type UC5A. These southern yellow pine timber piles are treated with 2.5 pounds of Chromated Copper Arsenate (CCA) per cubic foot. The estimate for all three options in Table 4 below includes a composite decking such as CorrectDeck or a similar product. All fasteners on the structure must be treated with a hot dip galvanic coating or be of a stainless steel material. In order to minimize costs to the client, the cost estimates for the three crossing options have been calculated with the use of galvanized fasteners.

7.5 Alternative Bridge Materials

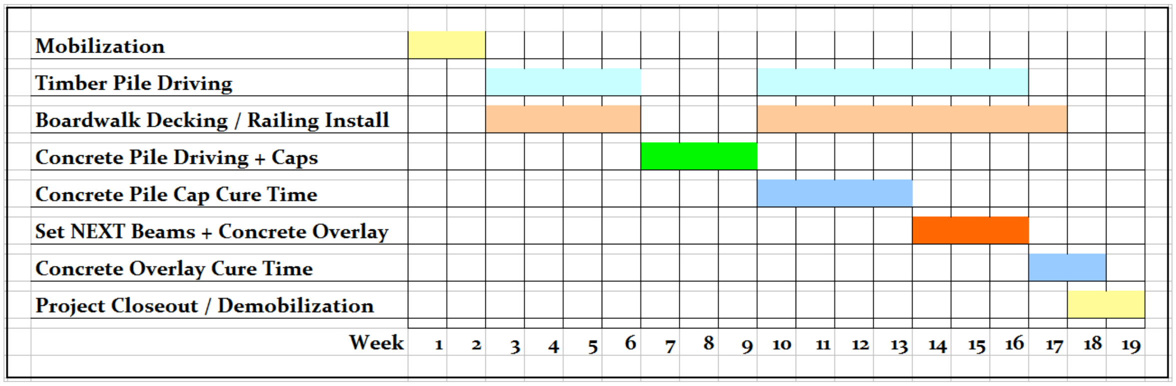
Due to the nature of the design we have provided, we do not feel that the design allows for much flexibility with regards to materials other than the decking materials. Currently, the boardwalk is priced with a commercial grade composite decking which would cost about $8.00 per square foot. Pressure treated 2-inch by 6-inch lumber is also a viable option at about $2.00 per square foot. Even though PT 2-inch by 6-inch would save about 75% (as seen in Table 4 below) when compared with composite decking, it has a typical lifespan of 15-20 years, less than half of what composite decking would be. Also periodic maintenance such as cleaning and staining is required with PT decking in order to increase life span and pedestrian safety. The costs shown in Table 4 are material costs only and do not include labor to reinstall materials.

Material Options	Life Span	Unit Price	1	2	3
PT Southern Yellow Pine	15-20 years	$2.00 / sf	$26,280.00	$40,080.00	$37,200.00
Composite Lumber	>40 years	$8.00 / sf	$105,120.00	$160,320.00	$148,800.00

Table 4 – Summary of Estimated Cost Differences between PT and Composite Decking. 2013 Dollars

8.0 Construction

According to the Maine Department of Environmental Protection, the entire structure would have to be constructed during the winter months in order to minimize the impact on migratory water fowl. This would prove to be beneficial for the Town of Wells as the construction schedule would take advantage of the quiet season and create less disruption to tourists, business owners and those who enjoy the river during the summer months. Table 5 shows a construction schedule that would be representative of Option Two and Option Three. It is estimated that from start to finish the entire project would take approximately 19 weeks. Option One would consist of a shorter construction schedule (15 weeks) as it involves less boardwalk installation. A contractor would have to determine the construction methods, but we feel that a crane mounted barge with appropriate pile driving equipment would be most economical, and as such, the project is priced that way.



Mobilization	■	■																	
Timber Pile Driving			■	■	■	■				■	■	■	■	■	■	■			
Boardwalk Decking / Railing Install			■	■	■	■				■	■	■	■	■	■	■	■		
Concrete Pile Driving + Caps							■	■	■										
Concrete Pile Cap Cure Time										■	■	■	■						
Set NEXT Beams + Concrete Overlay														■	■	■			
Concrete Overlay Cure Time																	■	■	
Project Closeout / Demobilization																		■	■
Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

Table 5 – Summary of typical construction schedule

9.0 Additional Recommendations

9.1 Lighting

DSE recommends using solar lighting to avoid the need of wiring the entire bridge structure. It is recommended that pairs of a product known as the DOCK LITE be installed at 12 foot spacing along the structure.

9.2 Alternative Option: Water Taxi

It is possible to increase connectivity in the harbor utilizing a water taxi service. Although this was outside of our scope of work, it was discussed with Chris Mayo. It is believed that a water taxi service is not commercially viable as a private enterprise. Although a municipally funded operation would not hold profit margins it would need to be economically viable to be implemented. The problem that arises is that demand for such a service is unknown. Correspondence regarding the water taxi alternative can be seen in Appendix K. DSE recommends the town look further into this alternative.

10.0 Final Recommendation

In conclusion, DSE found that it is feasible to connect the east and west shores of Wells Harbor with a pedestrian crossing. We have provided three possible routing options. Option Two, connecting the west shore beach to the east shore parking lot proves most feasible because it aligns itself best with the needs of the town and the constraints of the site.

We recommend the crossing consist of a boardwalk to traverse the shallow portions of the harbor and a bridge to traverse the deep channel. The boardwalk will consist of a timber frame and decking using wooden piles. We recommend the bridge structure be constructed with NEXT beams and reinforced concrete piles.

11.0 Qualifications

All Dirigo Student Engineering team members will earn B.S. degrees in Civil and Environmental Engineering in either May or December of 2013. Below are the specific qualifications of each person who worked on this project

Christopher Marchetti, Project Manager
Concentration: Environmental Engineering
Primary Responsibilities: Team leader and primary contact for client; will complete site analysis and routing
Relevant Courses: Engineering Leadership and Management, Project Management
Relevant Experience: Project Manager Assistant, Student Laboratory Technician

Jonathan Englehart
Concentration: Structural Engineering
Primary Responsibilities: Superstructure Design
Relevant Courses: Structural analysis, Geotechnical Engineering, Soil Mechanics
Relevant Experience: Intern with the Lane Construction Corporation, bridge division

Cullen Finn
Concentration: Structural Engineering
Primary Responsibilities: Foundation Design
Relevant Courses: Geotechnical Engineering, Soil Mechanics, Concrete Design

Ernest Kilbride
Concentration: Structural Engineering
Primary Responsibilities: Cost Estimate
Relevant Courses: Structural Analysis, Engineering Decisions, Economics
Relevant Experience: Intern with Shaw Brothers Construction, Cianbro Corporation

Imre Kormendy
Concentration: Environmental Engineering
Primary Responsibilities: Regulatory Considerations
Relevant Courses: Hydrology, Groundwater Hydraulics, Fluid Mechanics
Relevant Experience: Intern with GZA Geo-Environmental

Jack Miniutti
Concentration: Environmental Engineering
Primary Responsibilities: Regulatory Considerations
Relevant Courses: Structural analysis, Soil Mechanics, Fluid Mechanics
Relevant Experience: Intern with PC Construction

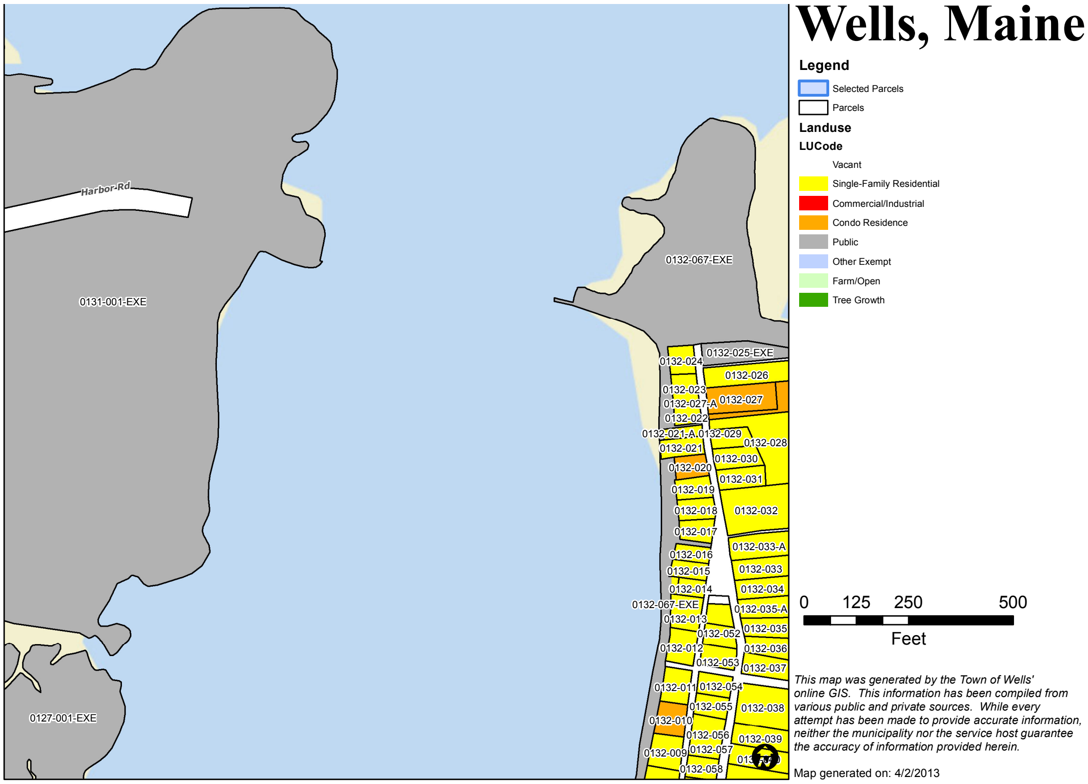
11.0 Disclaimer

The materials contained in this document and any supporting documentation were developed by us as students as part of our education in the College of Engineering in order to gain supervised engineering problem-solving experience. Therefore, information and recommendations, while useful for understanding a particular project's scope and possibilities for implementing solutions, should not be relied upon solely for the purposes of advancing a project beyond conceptual levels.

Furthermore, such material should not substitute for or replace the services of a design professional practicing in the areas of engineering or architecture, particularly for projects whose direct or indirect impact may affect the safety, health, or welfare of the public.

We students who prepared this information look forward to the opportunity to serve with fidelity the public, our future employers, and clients. In providing you with this information, our intention is to uphold and enhance the honor, integrity, and dignity of the engineering profession. We thank you for the opportunity to develop our skills through our work on this project.

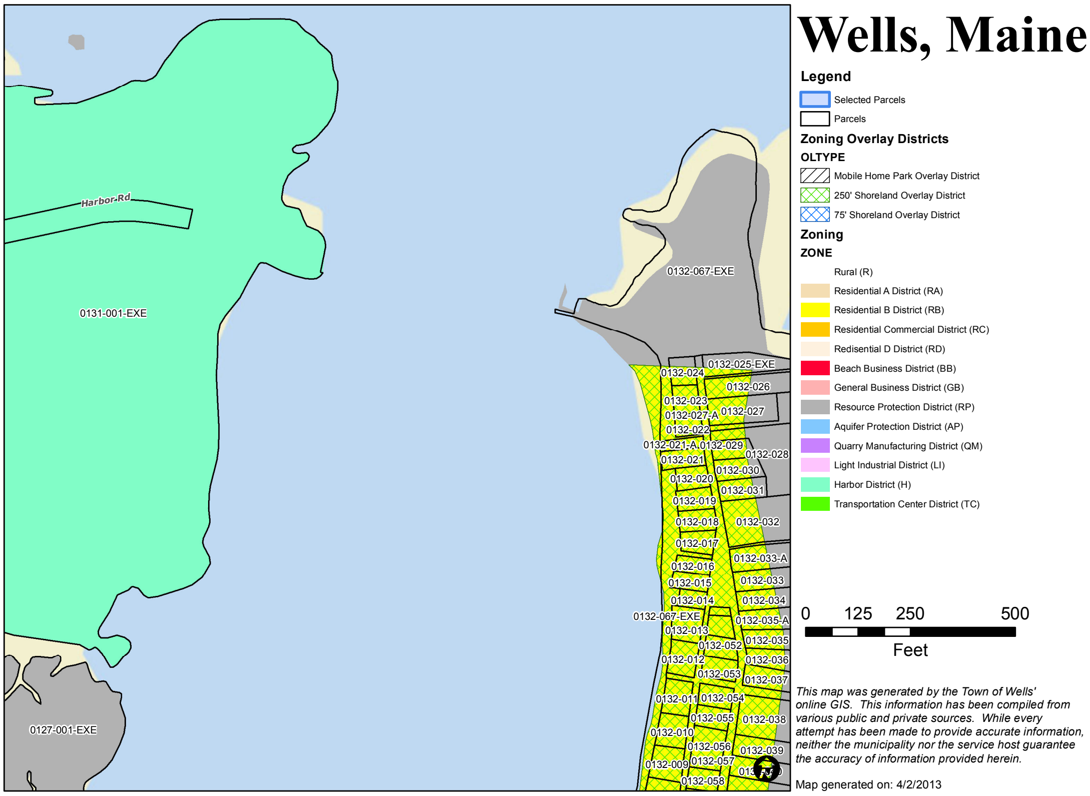
APPENDIX A: SITE ANALYSIS



This map was generated by the Town of Wells' online GIS. This information has been compiled from various public and private sources. While every attempt has been made to provide accurate information, neither the municipality nor the service host guarantee the accuracy of information provided herein.

Map generated on: 4/2/2013

Figure A1- Land Use Characteristics (Woodard & Curran, 4/12/2013)



This map was generated by the Town of Wells' online GIS. This information has been compiled from various public and private sources. While every attempt has been made to provide accurate information, neither the municipality nor the service host guarantee the accuracy of information provided herein.

Map generated on: 4/2/2013

Figure A2- Zoning (Woodard & Curran, 4/12/2013)

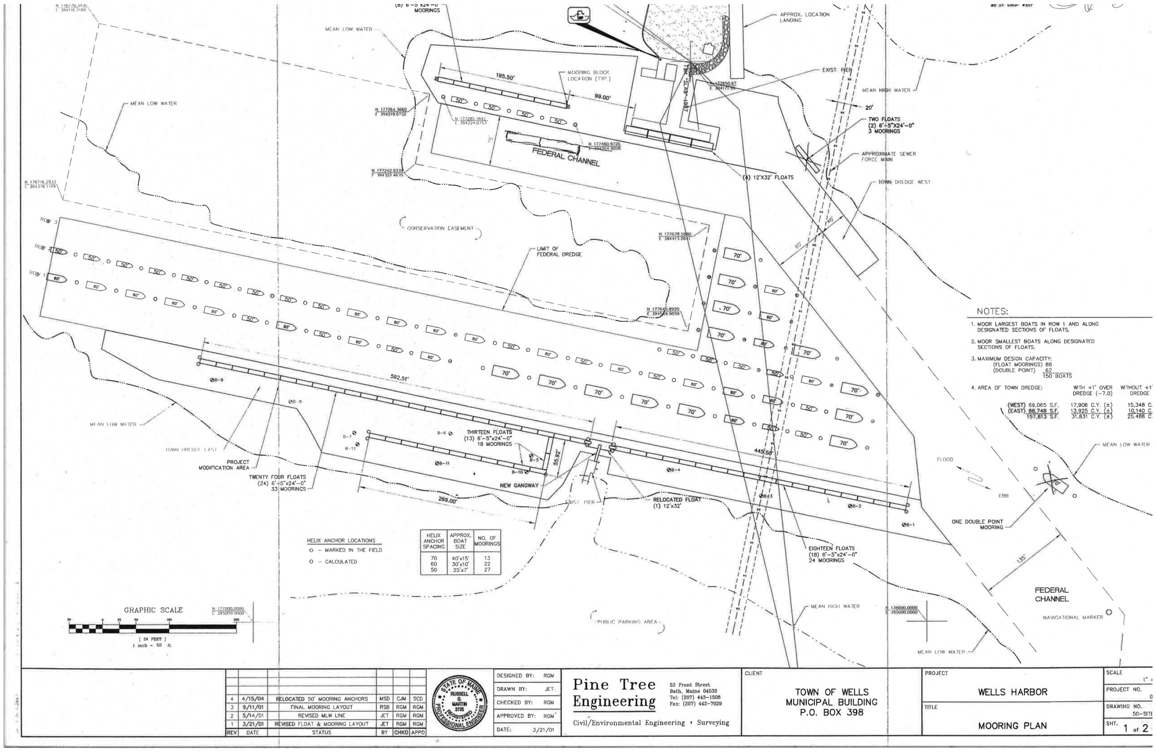
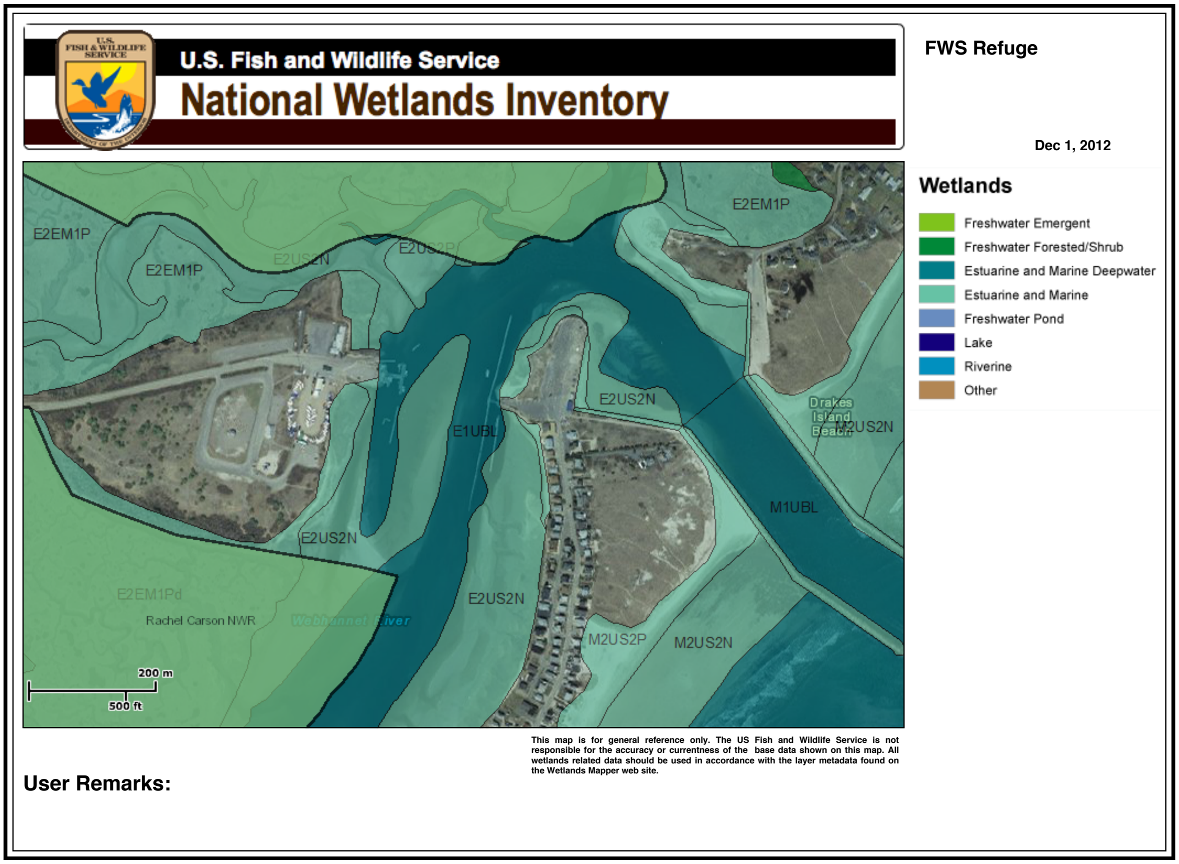


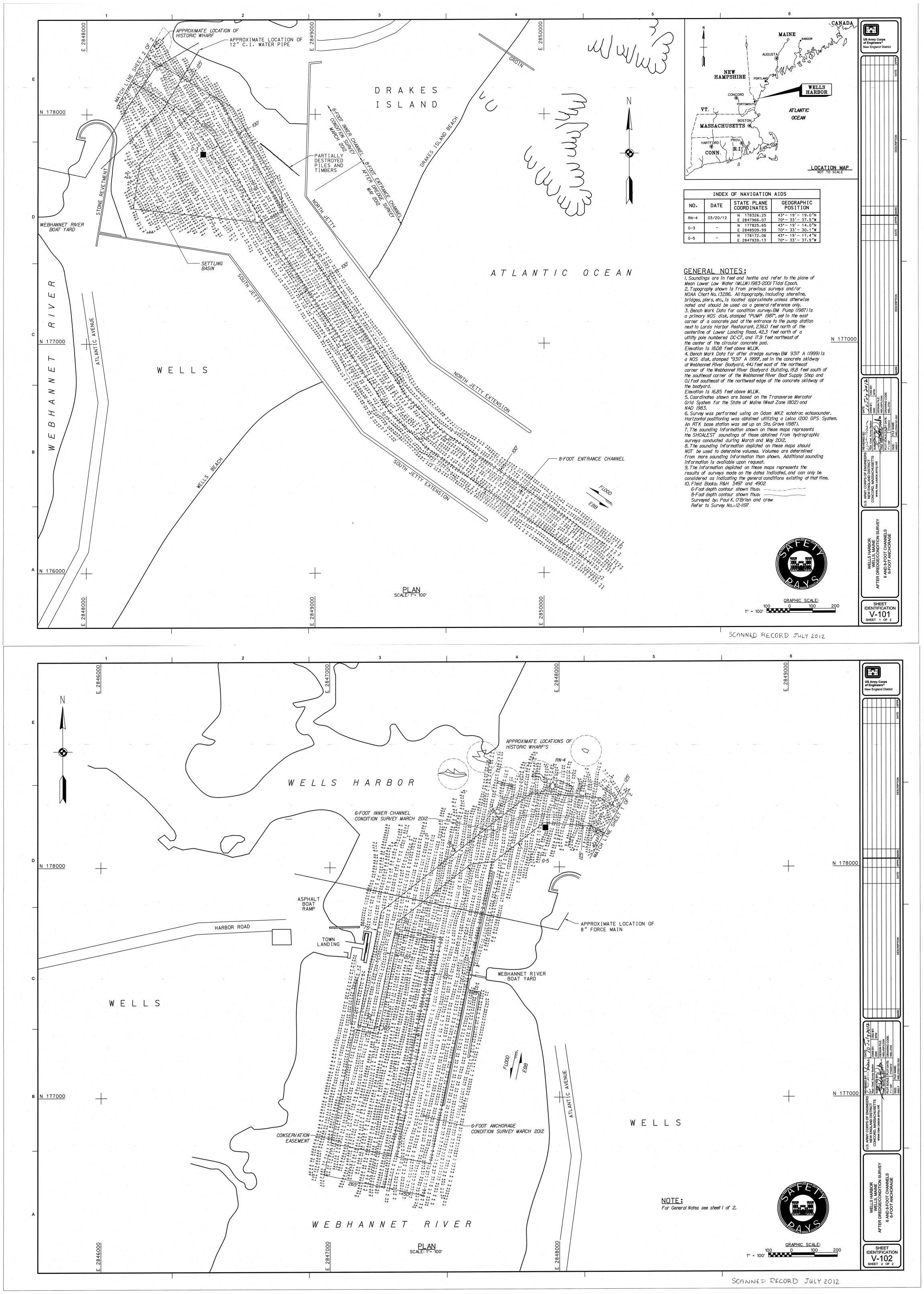
Figure A3- Wells Harbor Mooring Plan



This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

User Remarks:

Figure A4- Wetlands (U.S. Fish and Wildlife Service website, 12/1/2012)



INDEX OF NAVIGATION AIDS			
NO.	DATE	STATE PLANE COORDINATES	GEOGRAPHIC POSITION
RN-4	03/20/12	N 178326.25 E 2847966.07	43° - 19' - 19.0"N 70° - 33' - 37.5"W
G-3	-	N 177825.65 E 2848509.99	43° - 19' - 14.0"N 70° - 33' - 30.1"W
G-5	-	N 178172.06 E 2847939.13	43° - 19' - 17.4"N 70° - 33' - 37.9"W

GENERAL NOTES:

1. Soundings are in feet and tenths and refer to the plane of Mean Lower Low Water (MLLW) 1983-2001 Tidal Epoch.
2. Topography shown is from previous surveys and/or NOAA Chart No. 13286. All topography, including shoreline, bridges, piers, etc., is located approximate unless otherwise noted and should be used as a general reference only.
3. Bench Mark Data for condition survey: BM Pump (1987) is a primary NOS disk, stamped "PUMP 1987", set in the east corner of a concrete pad at the entrance to the pump station next to Lords Harbor Restaurant, 236.0 feet north of the centerline of Lower Landing Road, 42.3 feet north of a utility pole numbered DC-C7, and 17.9 feet northeast of the center of the circular concrete pad.
Elevation is 18.08 feet above MLLW.
4. Bench Mark Data for after dredge survey: BM 9317 A (1999) is a NOS disk, stamped "9317 A 1999", set in the concrete skidway at Webhannet River Boatyard, 44.1 feet east of the northeast corner of the Webhannet River Boatyard Building, 18.8 feet south of the southeast corner of the Webhannet River Boat Supply Shop and 0.1 foot southeast of the northwest edge of the concrete skidway at the boatyard.
Elevation is 16.85 feet above MLLW.
5. Coordinates shown are based on the Transverse Mercator Grid System for the State of Maine (West Zone 1802) and NAD 1983.
6. Survey was performed using an Odom MK2 echotrac echosounder. Horizontal positioning was obtained utilizing a Leica 1200 GPS System. An RTK base station was set up on Sta. Grove (1987).
7. The sounding information shown on these maps represents the SHOALEST soundings of those obtained from hydrographic surveys conducted during March and May 2012.
8. The sounding information depicted on these maps should NOT be used to determine volumes. Volumes are determined from more sounding information than shown. Additional sounding information is available upon request.
9. The information depicted on these maps represents the results of surveys made on the dates indicated, and can only be considered as indicating the general conditions existing at that time.
10. Field Books: R&H 3497 and 4902

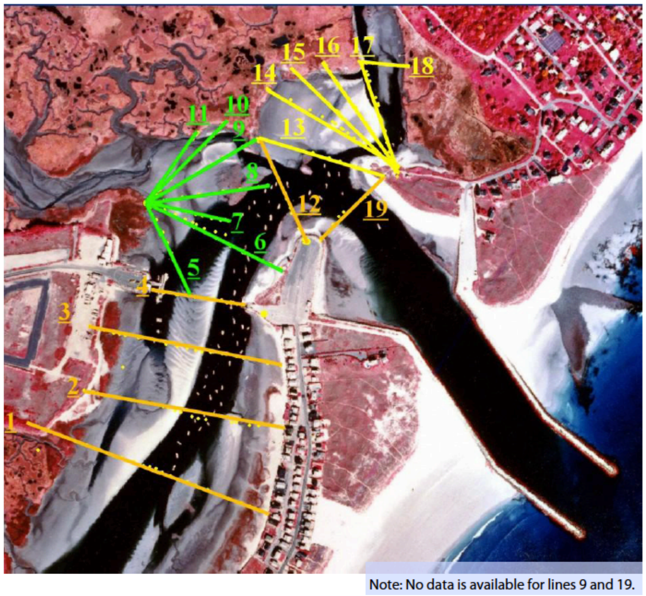
6-Foot depth contour shown thus:
8-Foot depth contour shown thus:
Surveyed by: Paul K. O'Brien and crew
Refer to Survey No.: 12-1197

NOTE:
For General Notes see sheet 1 of 2.

SCANNED RECORD JULY 2012

SCANNED RECORD JULY 2012

Figure A5- Dredging and Conservation Easement



Note: No data is available for lines 9 and 19.

The map at left shows the locations where topographic profiles were taken before and after the dredging. Click on a number to view a graph showing how the sediment profile changed at that transect. The legend indicates the cross-sectional area of the channel through which water can flow, measured on several dates. A reduced cross-sectional area indicates sediment gain, an increased area indicates sediment loss.

Figure A6- Topographic Map Locations (Wells NERR)

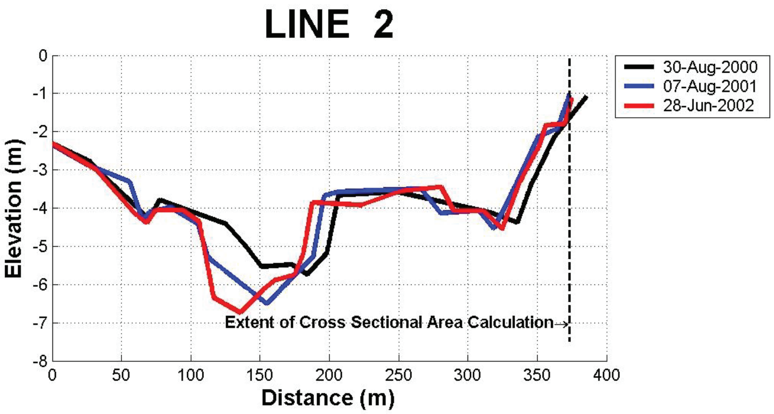


Figure A7- Line 2 Topographic Profile (Wells NERR)

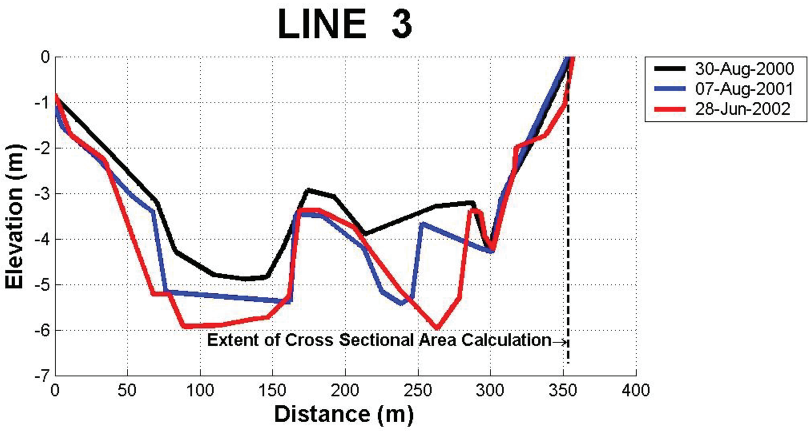


Figure A8- Line 3 Topographic Profile (Wells NERR)

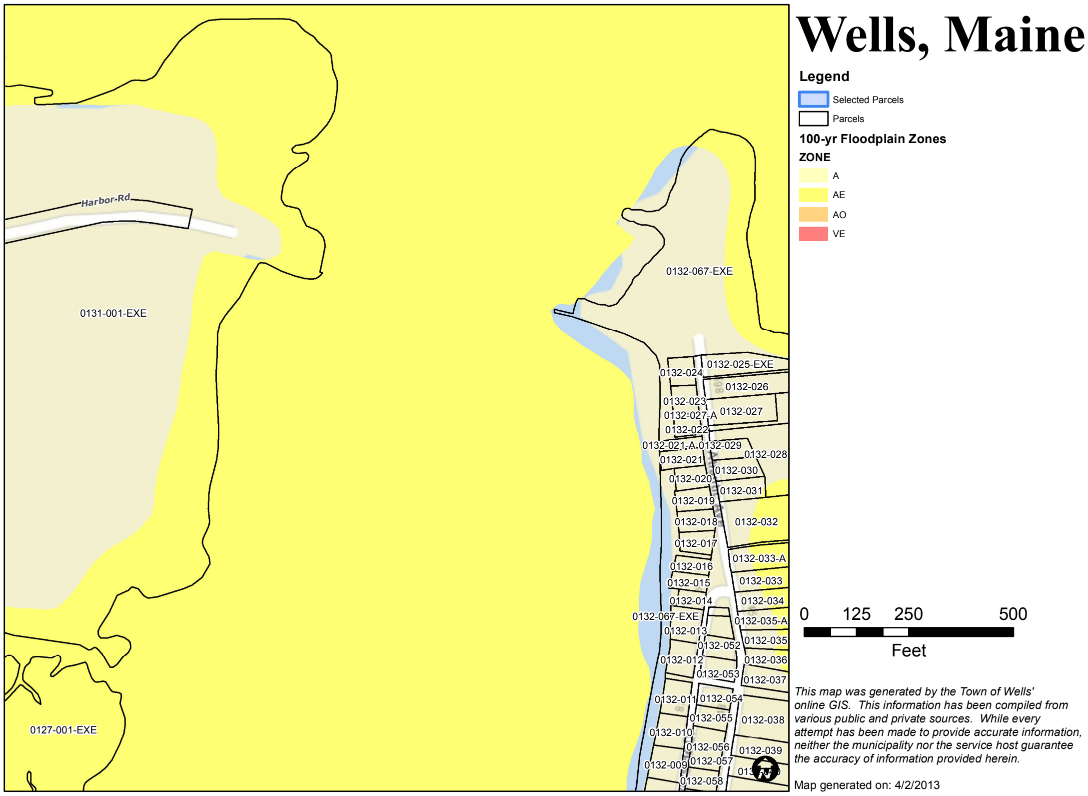
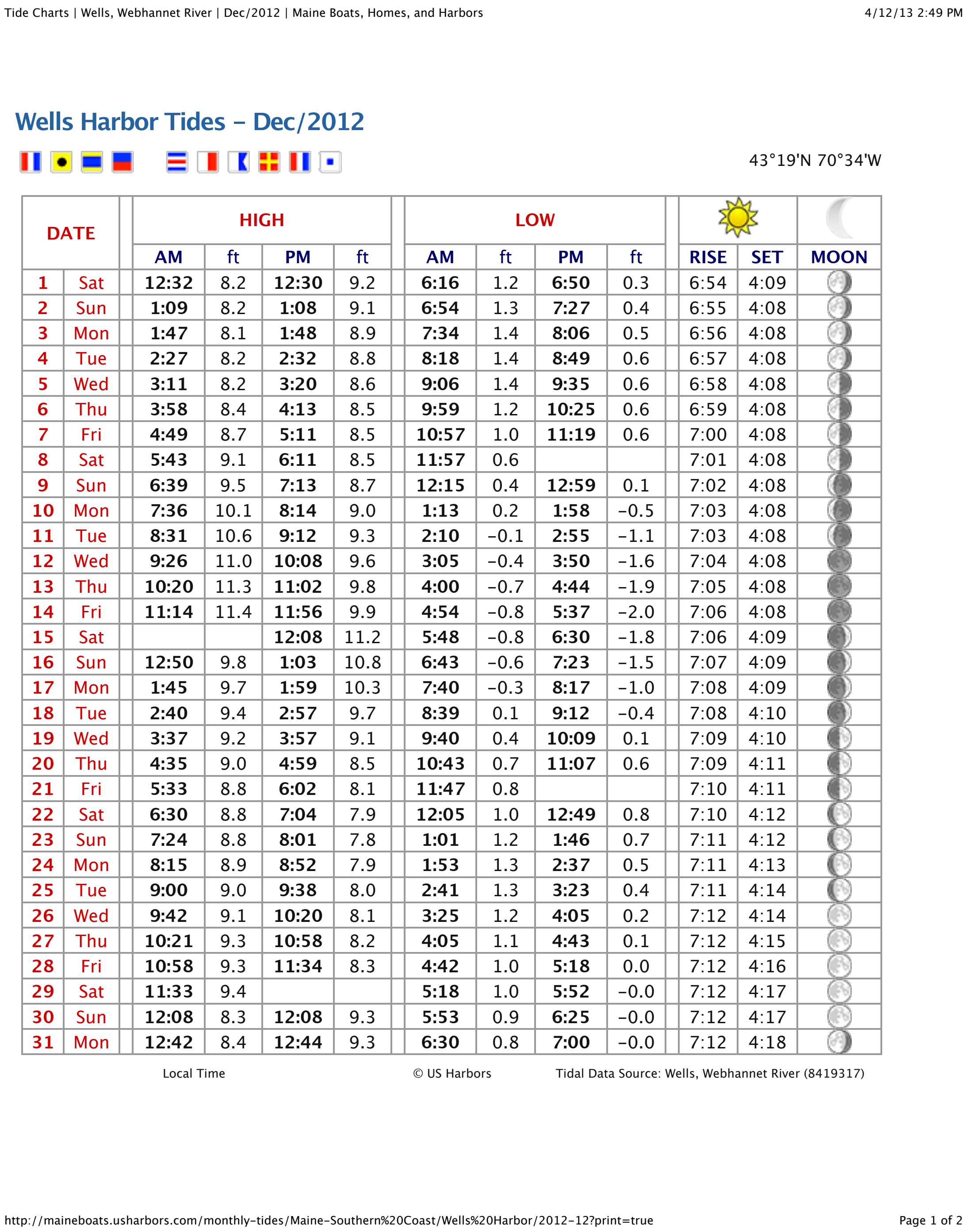


Figure A9- Floodplain (Woodard & Curran, 4/2/2013)



Tide Charts | Wells, Webhannet River | Dec/2012 | Maine Boats, Homes, and Harbors 4/12/13 2:49 PM

Wells Harbor Tides – Dec/2012

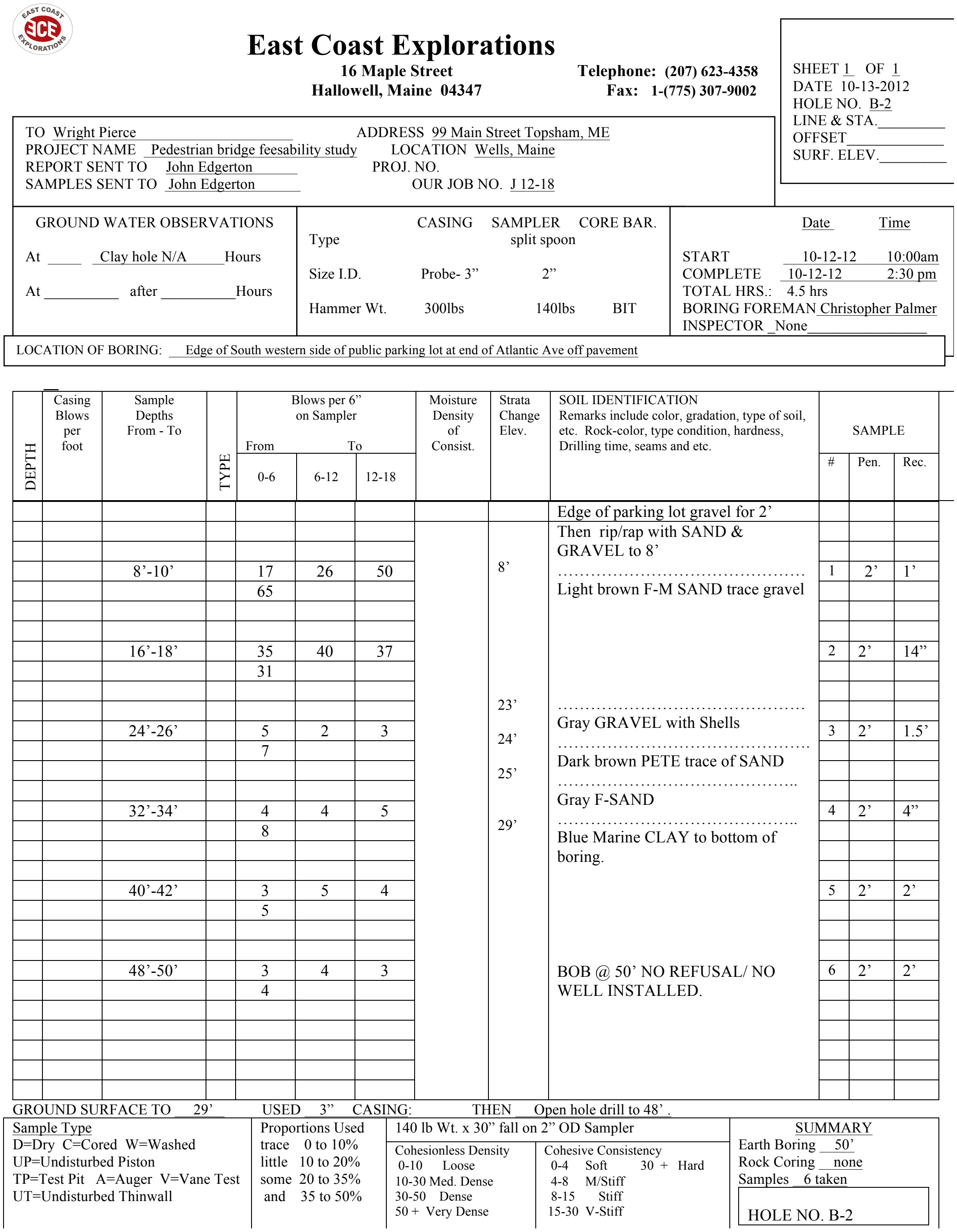
43°19'N 70°34'W

DATE		HIGH				LOW				☀		☾
		AM	ft	PM	ft	AM	ft	PM	ft	RISE	SET	MOON
1	Sat	12:32	8.2	12:30	9.2	6:16	1.2	6:50	0.3	6:54	4:09	🌖
2	Sun	1:09	8.2	1:08	9.1	6:54	1.3	7:27	0.4	6:55	4:08	🌖
3	Mon	1:47	8.1	1:48	8.9	7:34	1.4	8:06	0.5	6:56	4:08	🌖
4	Tue	2:27	8.2	2:32	8.8	8:18	1.4	8:49	0.6	6:57	4:08	🌖
5	Wed	3:11	8.2	3:20	8.6	9:06	1.4	9:35	0.6	6:58	4:08	🌗
6	Thu	3:58	8.4	4:13	8.5	9:59	1.2	10:25	0.6	6:59	4:08	🌗
7	Fri	4:49	8.7	5:11	8.5	10:57	1.0	11:19	0.6	7:00	4:08	🌗
8	Sat	5:43	9.1	6:11	8.5	11:57	0.6			7:01	4:08	🌘
9	Sun	6:39	9.5	7:13	8.7	12:15	0.4	12:59	0.1	7:02	4:08	🌘
10	Mon	7:36	10.1	8:14	9.0	1:13	0.2	1:58	−0.5	7:03	4:08	🌘
11	Tue	8:31	10.6	9:12	9.3	2:10	−0.1	2:55	−1.1	7:03	4:08	🌘
12	Wed	9:26	11.0	10:08	9.6	3:05	−0.4	3:50	−1.6	7:04	4:08	🌑
13	Thu	10:20	11.3	11:02	9.8	4:00	−0.7	4:44	−1.9	7:05	4:08	🌑
14	Fri	11:14	11.4	11:56	9.9	4:54	−0.8	5:37	−2.0	7:06	4:08	🌑
15	Sat			12:08	11.2	5:48	−0.8	6:30	−1.8	7:06	4:09	🌒
16	Sun	12:50	9.8	1:03	10.8	6:43	−0.6	7:23	−1.5	7:07	4:09	🌒
17	Mon	1:45	9.7	1:59	10.3	7:40	−0.3	8:17	−1.0	7:08	4:09	🌒
18	Tue	2:40	9.4	2:57	9.7	8:39	0.1	9:12	−0.4	7:08	4:10	🌒
19	Wed	3:37	9.2	3:57	9.1	9:40	0.4	10:09	0.1	7:09	4:10	🌓
20	Thu	4:35	9.0	4:59	8.5	10:43	0.7	11:07	0.6	7:09	4:11	🌓
21	Fri	5:33	8.8	6:02	8.1	11:47	0.8			7:10	4:11	🌓
22	Sat	6:30	8.8	7:04	7.9	12:05	1.0	12:49	0.8	7:10	4:12	🌔
23	Sun	7:24	8.8	8:01	7.8	1:01	1.2	1:46	0.7	7:11	4:12	🌔
24	Mon	8:15	8.9	8:52	7.9	1:53	1.3	2:37	0.5	7:11	4:13	🌔
25	Tue	9:00	9.0	9:38	8.0	2:41	1.3	3:23	0.4	7:11	4:14	🌔
26	Wed	9:42	9.1	10:20	8.1	3:25	1.2	4:05	0.2	7:12	4:14	🌕
27	Thu	10:21	9.3	10:58	8.2	4:05	1.1	4:43	0.1	7:12	4:15	🌕
28	Fri	10:58	9.3	11:34	8.3	4:42	1.0	5:18	0.0	7:12	4:16	🌕
29	Sat	11:33	9.4			5:18	1.0	5:52	−0.0	7:12	4:17	🌕
30	Sun	12:08	8.3	12:08	9.3	5:53	0.9	6:25	−0.0	7:12	4:17	🌕
31	Mon	12:42	8.4	12:44	9.3	6:30	0.8	7:00	−0.0	7:12	4:18	🌖

Local Time © US Harbors Tidal Data Source: Wells, Webhannet River (8419317)

http://maineboats.usharbors.com/monthly-tides/Maine-Southern%20Coast/Wells%20Harbor/2012-12?print=true Page 1 of 2

Figure A10- Wells Harbor Tides (U.S. Harbors website, 4/12/2013)



East Coast Explorations
16 Maple Street
Hallowell, Maine 04347
Telephone: (207) 623-4358
Fax: 1-(775) 307-9002

SHEET 1 OF 1
DATE 10-13-2012
HOLE NO. B-2
LINE & STA.________
OFFSET____________
SURF. ELEV.________

TO Wright Pierce
ADDRESS 99 Main Street Topsham, ME
PROJECT NAME Pedestrian bridge feesability study
LOCATION Wells, Maine
REPORT SENT TO John Edgerton
PROJ. NO.
SAMPLES SENT TO John Edgerton
OUR JOB NO. J 12-18

GROUND WATER OBSERVATIONS
At ____ Clay hole N/A ____Hours
At _________ after _________Hours

	CASING	SAMPLER	CORE BAR.
Type		split spoon	
Size I.D.	Probe- 3”	2”	
Hammer Wt.	300lbs	140lbs	BIT

	Date	Time
START	10-12-12	10:00am
COMPLETE	10-12-12	2:30 pm

TOTAL HRS.: 4.5 hrs
BORING FOREMAN Christopher Palmer
INSPECTOR None______________

LOCATION OF BORING: Edge of South western side of public parking lot at end of Atlantic Ave off pavement

DEPTH	Casing Blows per foot	Sample Depths From - To	TYPE	Blows per 6” on Sampler From 0-6	6-12	To 12-18	Moisture Density of Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, type of soil, etc. Rock-color, type condition, hardness, Drilling time, seams and etc.	SAMPLE #	Pen.	Rec.
									Edge of parking lot gravel for 2’			
									Then rip/rap with SAND &			
									GRAVEL to 8’			
		8’-10’		17	26	50		8’	……	1	2’	1’
				65					Light brown F-M SAND trace gravel			
		16’-18’		35	40	37				2	2’	14”
				31								
								23’	……			
		24’-26’		5	2	3		24’	Gray GRAVEL with Shells	3	2’	1.5’
				7					……			
								25’	Dark brown PETE trace of SAND			
									……			
		32’-34’		4	4	5			Gray F-SAND	4	2’	4”
				8				29’	……			
									Blue Marine CLAY to bottom of			
									boring.			
		40’-42’		3	5	4				5	2’	2’
				5								
		48’-50’		3	4	3			BOB @ 50’ NO REFUSAL/ NO	6	2’	2’
				4					WELL INSTALLED.			

GROUND SURFACE TO 29’ USED 3” CASING: THEN Open hole drill to 48’ .

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

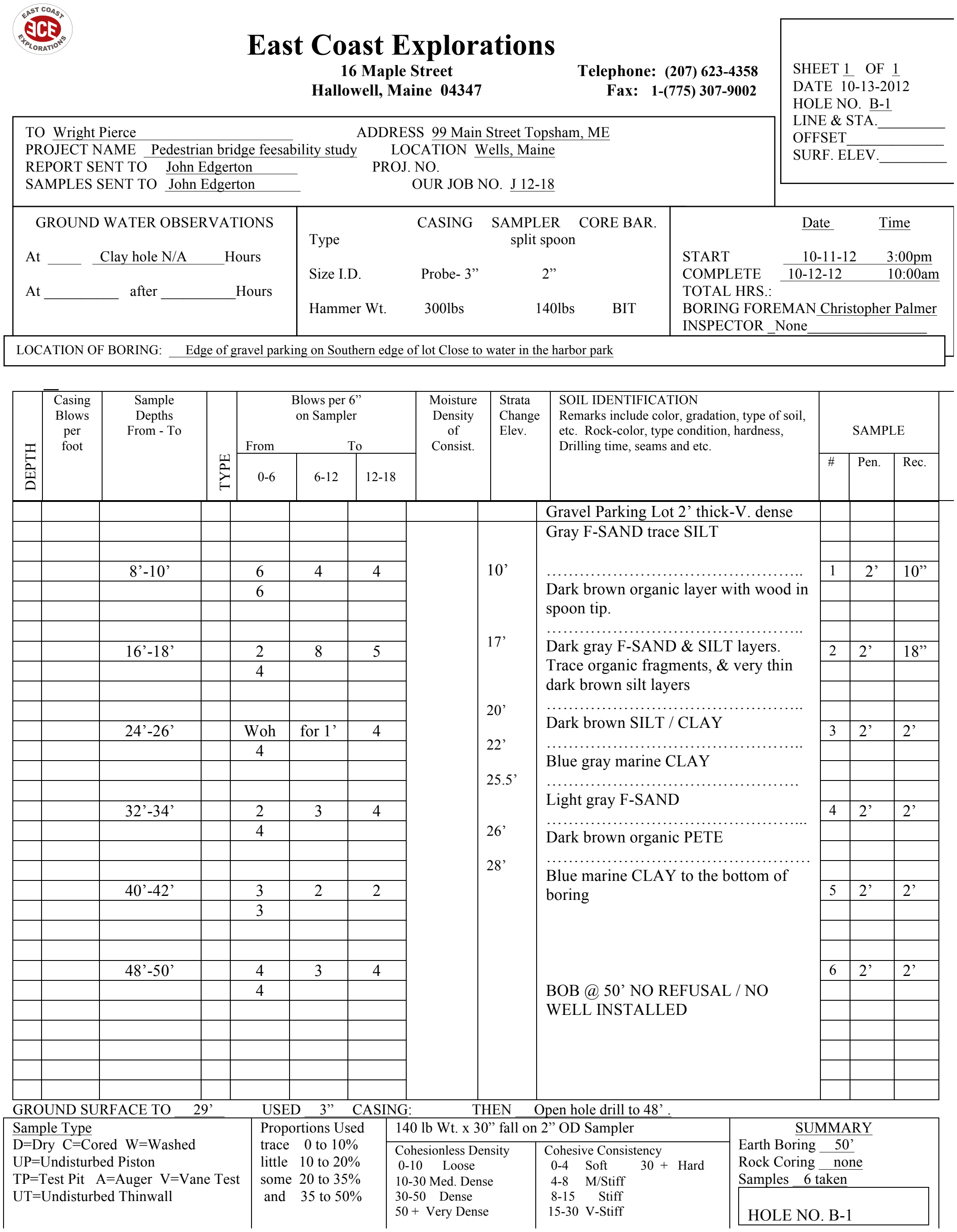
140 lb Wt. x 30” fall on 2” OD Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4	Soft
10-30	Med. Dense	4-8	M/Stiff
30-50	Dense	8-15	Stiff
50 +	Very Dense	15-30	V-Stiff
		30 +	Hard

SUMMARY
Earth Boring 50’
Rock Coring none
Samples 6 taken

HOLE NO. B-2

Figure A11-Boring Log 1



East Coast Explorations
16 Maple Street
Hallowell, Maine 04347
Telephone: (207) 623-4358
Fax: 1-(775) 307-9002

SHEET 1 OF 1
DATE 10-13-2012
HOLE NO. B-1
LINE & STA.________
OFFSET____________
SURF. ELEV.________

TO Wright Pierce
ADDRESS 99 Main Street Topsham, ME
PROJECT NAME Pedestrian bridge feesability study
LOCATION Wells, Maine
REPORT SENT TO John Edgerton
PROJ. NO.
SAMPLES SENT TO John Edgerton
OUR JOB NO. J 12-18

GROUND WATER OBSERVATIONS
At _____ Clay hole N/A _____Hours
At __________ after __________Hours

	CASING	SAMPLER	CORE BAR.
Type		split spoon	
Size I.D.	Probe- 3”	2”	
Hammer Wt.	300lbs	140lbs	BIT

	Date	Time
START	10-11-12	3:00pm
COMPLETE	10-12-12	10:00am
TOTAL HRS.:		

BORING FOREMAN Christopher Palmer
INSPECTOR None________________

LOCATION OF BORING: Edge of gravel parking on Southern edge of lot Close to water in the harbor park

DEPTH	Casing Blows per foot	Sample Depths From - To	TYPE	Blows per 6” on Sampler From 0-6	6-12	To 12-18	Moisture Density of Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, type of soil, etc. Rock-color, type condition, hardness, Drilling time, seams and etc.	SAMPLE #	Pen.	Rec.
									Gravel Parking Lot 2’ thick-V. dense			
									Gray F-SAND trace SILT			
		8’-10’		6	4	4		10’	……………………………………….	1	2’	10”
				6					Dark brown organic layer with wood in spoon tip.			
								17’	……………………………………….			
		16’-18’		2	8	5			Dark gray F-SAND & SILT layers. Trace organic fragments, & very thin dark brown silt layers	2	2’	18”
				4								
								20’	……………………………………….			
		24’-26’		Woh	for 1’	4			Dark brown SILT / CLAY	3	2’	2’
				4				22’	……………………………………….			
									Blue gray marine CLAY			
								25.5’	……………………………………….			
									Light gray F-SAND			
		32’-34’		2	3	4			……………………………………….	4	2’	2’
				4				26’	Dark brown organic PETE			
								28’	……………………………………….			
		40’-42’		3	2	2			Blue marine CLAY to the bottom of boring	5	2’	2’
				3								
		48’-50’		4	3	4				6	2’	2’
				4					BOB @ 50’ NO REFUSAL / NO WELL INSTALLED			

GROUND SURFACE TO 29’ USED 3” CASING: THEN Open hole drill to 48’ .

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb Wt. x 30” fall on 2” OD Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4	Soft
10-30	Med. Dense	4-8	M/Stiff
30-50	Dense	8-15	Stiff
50 +	Very Dense	15-30	V-Stiff
		30 +	Hard

SUMMARY
Earth Boring 50’
Rock Coring none
Samples 6 taken

HOLE NO. B-1

Figure A12- Boring Log 2

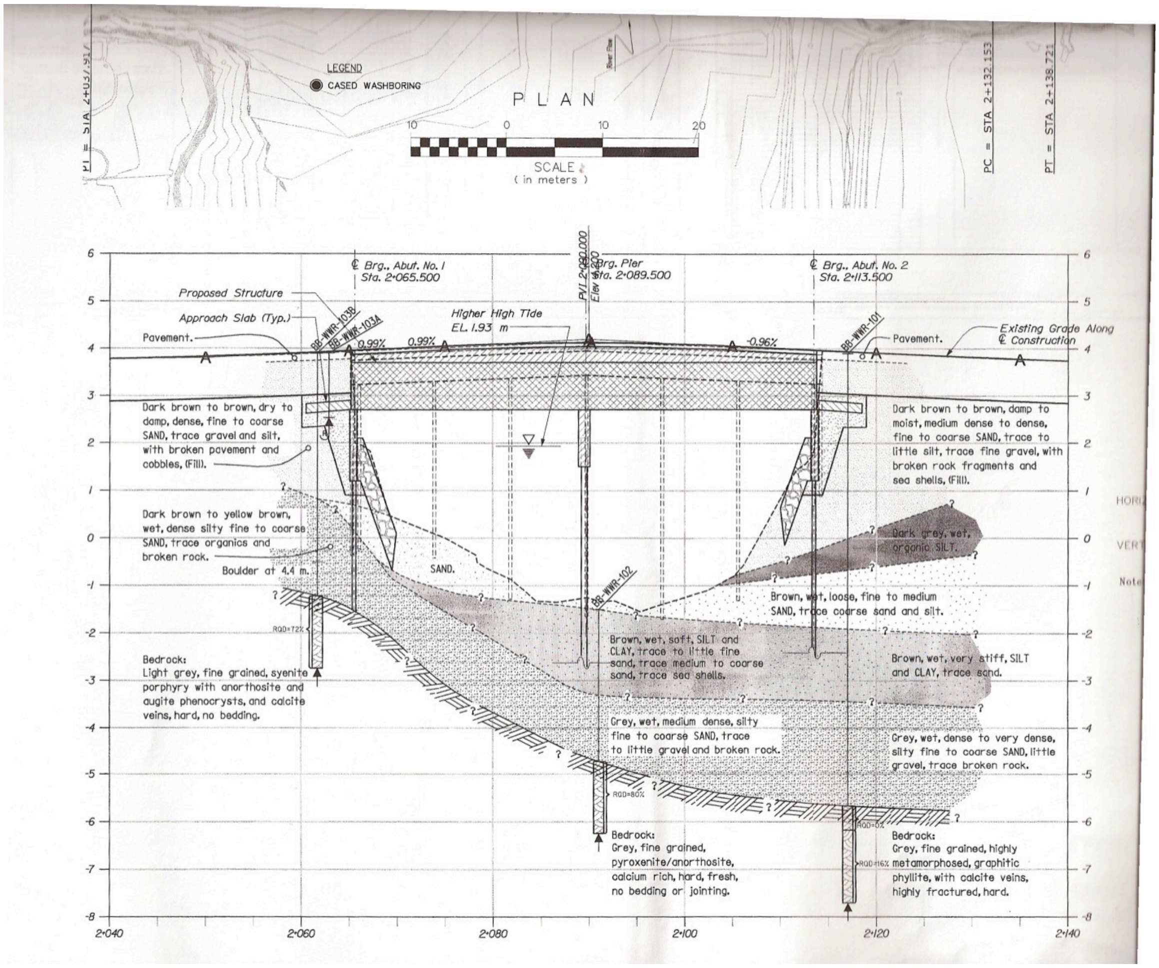


Figure A13- Soil Profile Mile Rd Bridge

United States Army Corps of Engineers Environmental Assessment

V. AFFECTED ENVIRONMENT

A. Physical Setting

"Tidal wetlands located adjacent to the lower portion of the river form part of the Rachel Carson Natural Wildlife Refuge, a Federal management area under the jurisdiction of the U.S. Fish & Wildlife Service, which extends along the southern coast of Maine. Portions of the estuary are also included in the Wells National Estuarine Research Reserve, managed jointly by the Town, State and NOAA"

B. Sediment Quality

"Sediments from the Wells Harbor entrance channel are well-sorted fine sands consisting of mostly fine sand and some medium sand. Coarse sand and gravel were a minor component."

C. Water Quality

"Water quality in the Wells Harbor area is Class SB. Class SB waters are suitable for recreation in and on the water, fishing, aquaculture, propagation and harvesting of shellfish, navigation and as habitat suitable for fish and other estuarine and marine life (Maine's Water Classification Program)."

D. Aquatic Resources

"Wells Harbor entrance channel is a nearshore environment that supports typical sandy habitat benthic communities. The infaunal communities are generally sparse because these areas are subject to the continual movement of sand and the epifauna tend to be highly mobile."

"No significant lobster or shellfish habitat is present in the entrance channel. Additionally, no submerged aquatic vegetation (i.e., eelgrass) is present."

E. Wildlife Resources

"Wells Harbor supports a large diversity of wildlife. A wide variety of bird species can be found in the vicinity of Wells Harbor due to the large diversity of habitats in the area. Habitat types include tidal sand and mudflat; low and high salt marsh, upland, dune and beach, pannes, freshwater and brackish ponds. The high-energy entrance channel and nearshore disposal area, however, do not contain the wildlife diversity that is seen in the other habitats."

F. Essential Fish Habitat

"The 1996 amendments to the Magnuson-Stevens Fishery Conservation Management Act strengthen the ability of the National Marine Fisheries Service and the New England Fishery Management Council to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is termed "essential fish habitat", and is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Managed species listed for the 10' x 10' square of latitude and longitude which includes Wells Harbor and the disposal area are: Atlantic cod Gadus morhua (adult), whiting Merluccius bilinearis (adult), white hake Urophycis tenuis (juvenile, adult), winter flounder Pleuronectes americanus (eggs, larvae, juveniles, adults), yellowtail flounder Pleuronectes ferrugineus (larvae, adults), windowpane flounder Scophthalmus aquosus (eggs, larvae, juveniles, adults), American plaice Hippoglossoides platessoides (juveniles, adults), Atlantic halibut Hippoglossus hippoglossus (eggs, larvae, juveniles, adults), Atlantic sea scallop Placopecten magellanicus (eggs, larvae, juveniles, adults), Atlantic sea herring Clupea harengus (larvae, juveniles, adults), bluefish Pomatomus saltatrix (juveniles, adults), and bluefin tuna Thunnus thynnus (adults). The only managed species listed above which use the mixing waterlbrackish salinity zone (0.5 to 25 ppt) and seawater (> 25 ppt) for Wells Harbor include white hake (juveniles, adults), winter flounder (eggs, larvae, juveniles, adults, spawning adults), yellowtail flounder (larvae-seawater only), windowpane flounder (eggs, larvae, juveniles, adults, spawning adults), Atlantic halibut (eggs, larvae, juveniles, adults, spawning adults), Atlantic herring (larvae, juveniles, adults-seawater only), and bluefish (adults)."

G. Threatened and Endangered Species
"The Federally threatened piping plover uses both Wells Beach and Drakes Island Beach (and adjacent Laudholm Beach) for nesting. In 2003, five pairs of plovers nested on Wells Beach, with 12 young fledged. In 2003, one pair nested on Drakes Island Beach, and one young fledged from that nest. In addition, six pairs nested on Laudholm beach and fledged 10 young. Plovers have successfully fledged young on Wells Beach since 1995 and on Laudholm Beach since 1991. Use of Drakes Island Beach has been sporadic since 1996. Preliminary indications are that Wells and Drakes Island Beach may be one of Maine's most important plover nesting areas for 2004."

H. Historic and Archeological Resources
"The Maine Historic Preservation Office has determined that the project would have no impact on cultural or historic resources."

VI. ENVIRONMENTAL CONSEQUENCES

A. Physical Setting
"There should be no significant impacts from the temporary increases in turbidity."

C. Water Quality
"No significant adverse water quality impacts are anticipated from the dredging and disposal operations."

D. Aquatic Resources
"Dredging operations would have no significant adverse impact on aquatic resources in Wells Harbor."
"Most motile organisms, such as crabs and finfish, would probably be able to avoid the dredge. Recolonization of the dredged areas would be rapid. The post-dredging community should closely resemble the existing community." "Because the material to be dredged is sand, with low silt content, only a small area in the vicinity of the dredging

site is likely to be impacted by elevated concentrations of suspended sediments, or sedimentation. Most fish are quite tolerant of short-term exposure to elevated suspended sediment levels (see Stem and Stickle, 1978), and those in the dredging area are unlikely to be significantly impacted by this project (see also Barr, 1987). Finfish can also leave the area of disturbance, thus further reducing the area of impact. Adult lobsters are also tolerant of exposure to elevated suspended sediment concentrations (Stem and Stickle1978), and those inhabiting channel jetties should not be significantly impacted by the project. Impacts to shellfish resources in the vicinity of the dredging operation would be minimal as the channel sediments are coarse sands, making the impact area high localized."

"In a report by the Wells Harbor Monitoring Scientific Review Panel, which reviewed the monitoring data between July 1998 and August 2002, they found "no convincing evidence of any effects directly related to dredging that took place in November-December of 2000.""

E. Wildlife

"The project should have no significant adverse impact on waterfowl or other wildlife occurring in the vicinity of Wells Harbor. Some individuals may be displaced during dredging activities, but recolonization should occur rapidly after completion of the project."

F. Essential Fish Habitat

"There is negligible potential for adverse effects, including cumulative effects, of the proposed action on Essential Fish Habitat for any of the managed species in the area."

"Schooling life stages are not expected to be affected by the proposed project. Spawning habitat and nursery habitat for the managed species listed in section V.F. are not expected to be adversely affected by the proposed project. Winter flounder spawning, eggs and larvae will not be affected, as dredging will occur during a one to two week period during the late spring or summer. This follows the National Marine Fisheries Service recommendation that dredging occurs between June 1st and February 15th to avoid adverse impacts to EFH for spawning adult and juvenile flounder."

G. Threatened and Endangered Species

"This project is anticipated to have no significant impact on any Federally listed threatened or endangered species. No threatened or endangered species under the jurisdiction of the National Marine Fisheries Service is known to exist in the project area (see letter dated June 10,2004), therefore no further consultation pursuant to Section 7 of the Endangered Species Act is required."

H. Historic and Archaeological Resources

"Since both the dredge and disposal sites have been previously disturbed, the US ACE believes that the proposed maintenance dredging and disposal is unlikely to have an effect upon any structure or site of historic, architectural or archaeological significance as defined by the National Historic Preservation Act of 1966, as amended."

I. Environmental Justice

“No significant adverse impacts to children, minority or low income populations are anticipated as a result of this project. Less than three percent of the population is considered a minority and less than six percent of the population is below the poverty level in Wells, Maine (U.S. Census Bureau, 2000). Therefore, any potential environmental effects of this project on this portion of the population are very small.”

J. Cumulative Impact

Cumulative impact is the impact on the environment that results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or persons undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. No significant cumulative impacts is expected from this proposed dredging or other dredging activities in the project area.” “Overall, the proposed project is not expected to result in significant adverse impacts to the project area.”

APPENDIX C: ROUTING

Figure C1- Initial Route Option One (Wright-Pierce)

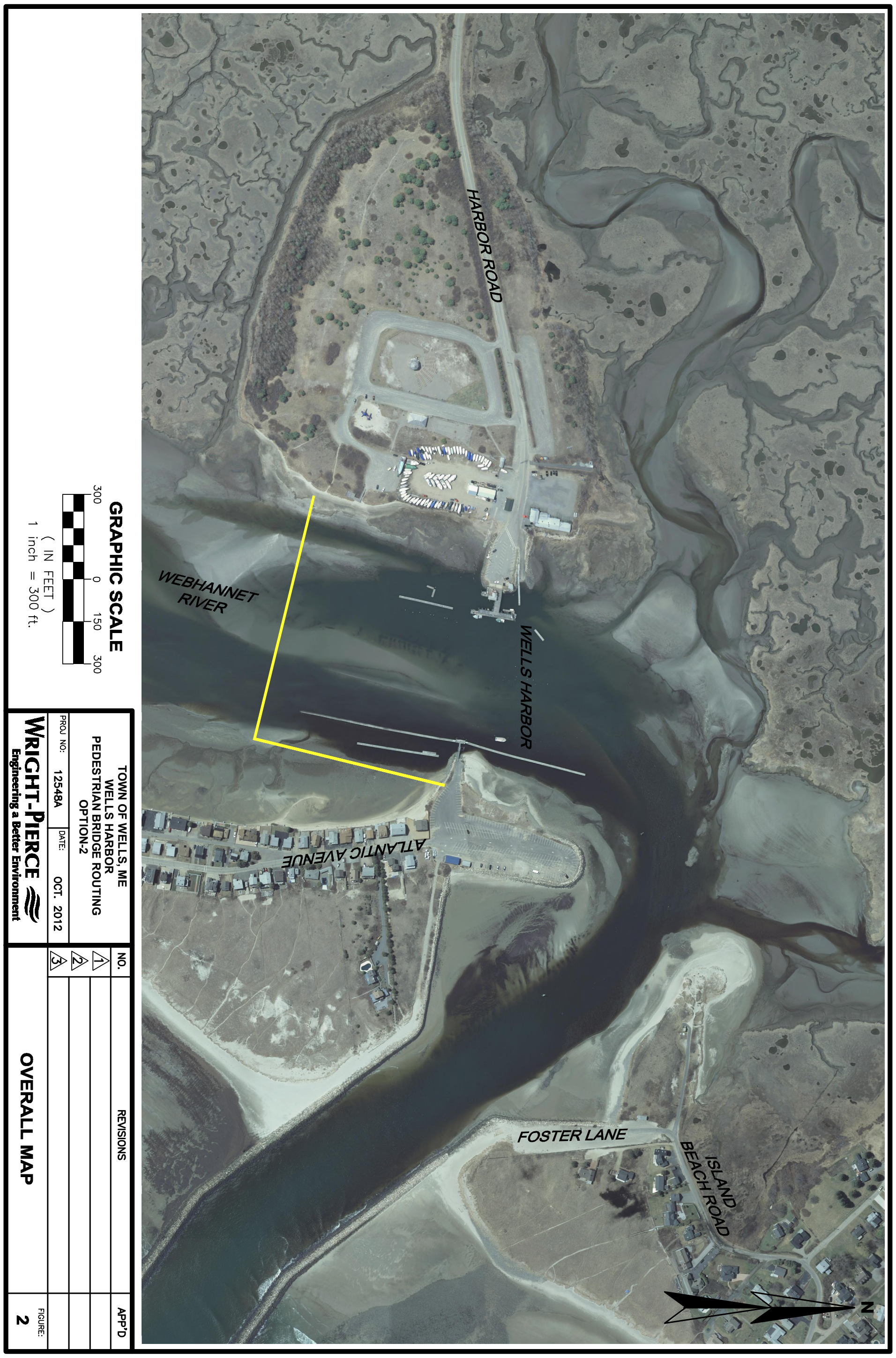


Figure C2- Initial Route Option Two (Wright-Pierce)

Figure C3- Final Route Option 1 (Google Maps website, 3/25/2013, Edited by CMM on 4/8/2013)

Figure C4- Route Option One Land Use (Woodard & Curran, 4/2/2013, Edited by CMM on 4/8/2013)

Figure C5- Route Option 1 East Landing (Google Maps website, 3/25/2013)

Figure C6- Final Route Option Two (Google Maps website, 3/25/2013, Edited by CMM on 4/8/2013)

Figure C7- Final Route Option Three (Google Maps website, 3/25/2013, Edited by CMM on 4/8/2013)

APPENDIX D: Bridge Calculations

TxDOT Summary Report (Long Form)

For

Span 1 Girder A

April 29, 2013 7:23:35 pm

PGSuper™

Version 2.7.2 - Built on Nov 9 2012

Washington State
Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

AD ASTRA PER ASPERA
Kansas
Department of Transportation

Project Properties	
Bridge Name	Wells Pedestrian Bridge
Bridge ID	0002
Company	Dirigo Student Engineering
Engineer	Jonathan Englehart
Job Number	0002
Comments	NEXT 36F
File	C:\Users\JON\Dropbox\Coursework\PGSuper (NEXT).pgs

Library Usage

Master Library Publisher: Default libraries installed with PGSuper
Master Library File: C:\Program Files\WSDOT\PGSuper\WSDOT.lbr
Master Library Date Stamp: November 9, 2012 12:42:59 pm

Library	**Entry**	**Source**
Connections	Typical	Project Library
Girders	NEXT 36 F	Project Library
Traffic Barriers	PA Typical 10M Bridge Barrier	Project Library
Project Criteria	AASHTO LRFD Bridge Design Specifications - NEXT Beams	Project Library
Vehicular Live Load	H5	Master Library
Vehicular Live Load	PL	Project Library
Load Rating Criteria	2	Project Library

Notes

Symbol	**Definition**
L_g	Length of Girder
L_s	Length of Span
FoS	Face of Support
Debond	Point where bond begins for a debonded strand
PSXFR	Point of prestress transfer
CS	Critical Section for Shear
H	H from end of girder or face of support
1.5H	1.5H from end of girder or face of support
HP	Harp Point
Pick Point	Support point where girder is lifted from form
Bunk Point	Point where girder is supported during transportation

APPENDIX D: Bridge Calculations

Specification Check Summary

The Specification Check was Successful

Girder Summary

TxDOT Girder Schedule

Span	**1**
Girder	**A**
Girder Type	NEXT 36 F
Prestressing Strands	**Total**
NO. ($N_h + N_s$)	38
Size	0.600 in Dia.
Strength	Grade 270 Low Relaxation
Eccentricity @ CL	13.080 in
Eccentricity @ End	11.985 in
Prestressing Strands	**Debonded**
NO. (# of Debonded Strands)	8
Concrete	
Release Strength f'_{ci}	4.600 KSI
Minimum 28 day compressive strength f'_{c}	5.000 KSI
Optional Design	
Design Load Compressive Stress (Top CL)	2.552 KSI
Design Load Tensile Stress (Bottom CL)	-3.683 KSI
Required minimum ultimate moment capacity	3583.29 kip-ft
Live Load Distribution Factor for Moment (Strength and Service Limit States)	1.00000
Live Load Distribution Factor for Shear (Strength and Service Limit States)	1.00000
Live Load Distribution Factor for Moment (Fatigue Limit States)	1.00000

NOTE: Stresses show in the above table reflect the following sign convention:
Compressive Stress is positive. Tensile Stress is negative

Debonded Strand Pattern for Span 1 Girder A

Dist from Bottom	No. Strands		Number of Strands Debonded To									
	Total	Debonded	3 ft	6 ft	9 ft	12 ft	15 ft	18 ft	21 ft	24 ft	27 ft	30 ft
2.500 in	6	2	0	0	0	0	0	2	0	0	0	0
4.500 in	10	4	0	0	2	2	0	0	0	0	0	0
6.500 in	10	2	2	0	0	0	0	0	0	0	0	0

Girder Line Geometry

Girder Type	NEXT 36 F
Span Length, CL Bearing to CL Bearing	72.333 ft
Girder Length	73.333 ft
Number of Girders	2
Girder Spacing Datum Start of Span	Measured normal to alignment at centerline pier
Right Girder Spacing Start of Span	8.000 ft
Girder Spacing Datum End of Span	Measured normal to alignment at centerline pier
Right Girder Spacing End of Span	8.000 ft
Slab Thickness for Design	3.500 in
Slab Thickness for Construction	4.000 in
Slab Offset at Start ("A" Dimension)	8.000 in
Slab Offset at End ("A" Dimension)	8.000 in
Overlay	30.000 PSF
Left Traffic Barrier	PA Typical 10M Bridge Barrier
Right Traffic Barrier	PA Typical 10M Bridge Barrier
Traffic Barrier Weight (per girder)	0.300 kip/ft
Connection type at Pier 1	Typical
Connection type at Pier 2	Typical

Loading Details

Uniform Loads Applied Along the Entire Girder

Load Type	w (kip/ft)
Girder	1.377

Slab Load Applied Between Bearings

Slab Load is uniform along entire girder length.
Haunch weight includes effects of roadway geometry but does not include a reduction for camber

Load Type	w (kip/ft)
Main Slab Weight	0.400
Haunch Weight	0.400
Total Slab Weight	0.800

Live Load Details

Live Loads used for Design

The following live loads were applied to the design (Service and Strength I) limit states:

User-defined vehicular live load: PL (150 psf)
Configuration: Lane load applied only (no truck)
Usage: Use for all actions at all locations
Lane Load Value: 1.200 kip/ft
Lane Load is applied for span length greater than 0.000 ft

Live Loads Used for Fatigue Limit States

The following live loads were applied to the Fatigue I limit state:

AASHTO LRFD 3.6.1.4: Fatigue Vehicular Live Load

Live Loads Used for Design Permit Limit State

The following live loads were applied to the design permit (Strength II) limit state:

User-defined vehicular live load: H5
Configuration: Truck applied only (no lane)
Usage: Use for all actions at all locations

Axle	Weight (kip)	Spacing (ft)
1	2.00	
2	8.00	14.000

Camber and Deflections

Camber and Deflection for Span 1 Girder A

Estimated camber at 40 days, D	2.301 in	0.192 ft
Estimated camber at 120 days, D	2.832 in	0.236 ft
Deflection (Prestressing)	2.582 in	0.215 ft
Deflection (Girder)	-1.229 in	-0.102 ft
Deflection (Slab and Diaphragms)	-0.685 in	-0.057 ft
Deflection (Traffic Barrier)	-0.186 in	-0.016 ft
Deflection (Overlay)	0.000 in	0.000 ft
Deflection (User Defined DC)	0.000 in	0.000 ft
Deflection (User Defined DW)	0.000 in	0.000 ft
Screed Camber, C	0.871 in	0.073 ft
Excess Camber (Based on Design Camber)	1.961 in	0.163 ft
Live Load Deflection (HL93 - Per Lane)	-0.741 in	-0.062 ft
Optional Live Load Deflection (LRFD 3.6.1.3.2)	-0.716 in	-0.060 ft

Prestress Force and Strand Stresses

Effective Prestress at Mid-Span

Loss Stage	**Permanent Strand**		
	Force (kip)	**Eff. Loss (KSI)**	**f_{pe} (KSI)**
At Jacking	1669.82	0.000	202.500
Before Prestress Transfer	1669.82	0.000	202.500
After Prestress Transfer	1561.84	13.094	189.406
At Lifting	1561.84	13.094	189.406
At Shipping	1512.34	19.097	183.403
After Deck Placement	1412.64	31.188	171.312
After Superimposed Dead Loads	1421.57	30.105	172.395
Final	1402.28	32.444	170.056
Final with Live Load	1402.28	32.444	170.056

Stress Checks

Specification = AASHTO LRFD Bridge Design Specifications - NEXT Beams

Stress Check for Service I for Casting Yard Stage (At Release) [5.9.4.1.2]

For temporary stresses before losses in pretensioned components
Allowable tensile stress = $0.0948\sqrt{f'_{ci}}$ but not more than 0.200 KSI = 0.200 KSI
Allowable tensile stress = $0.2400\sqrt{f'_{ci}}$ = 0.515 KSI if at least 0.783 in^2 of mild reinforcement is provided
Allowable compressive stress = $-0.6f'_{ci}$ = -2.760 KSI
f'_{ci} required to satisfy this stress check = 4.568 KSI

Location from End of Girder (ft)	**Prestress**		**Service I**		**Demand**		**Tension Status w/o rebar (C/D)**	**Tension Status w/ rebar (C/D)**	**Compression Status (C/D)**
	f_t (KSI)	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**			
($0.0L_g$) 0.000	0.000	0.000	0.000	0.000	0.000	0.000	Pass (∞)	Pass (∞)	Pass (∞)
0.500	0.059	-0.485	-0.027	0.041	0.032	-0.444	Pass (6.28)	Pass (10+)	Pass (6.21)
(H, PSXFR, Debond) 3.000	0.354	-2.921	-0.156	0.237	0.198	-2.685	Pass (1.01)	Pass (2.60)	Pass (1.03)
3.750	0.366	-2.981	-0.193	0.293	0.173	-2.688	Pass (1.16)	Pass (2.98)	Pass (1.03)
(PSXFR) 6.000	0.402	-3.159	-0.299	0.453	0.103	-2.706	Pass (1.94)	Pass (5.00)	Pass (1.02)
($0.1L_g$) 7.333	0.403	-3.164	-0.358	0.543	0.044	-2.622	Pass (4.51)	Pass (10+)	Pass (1.05)
7.733	0.403	-3.166	-0.375	0.569	0.027	-2.597	Pass (7.32)	Pass (10+)	Pass (1.06)
(Debond) 9.000	0.403	-3.170	-0.429	0.649	-0.025	-2.521	Pass (-)	Pass (-)	Pass (1.09)
(PSXFR, Debond) 12.000	0.466	-3.428	-0.545	0.825	-0.079	-2.603	Pass (-)	Pass (-)	Pass (1.06)
($0.2L_g$) 14.667	0.521	-3.658	-0.637	0.965	-0.116	-2.693	Pass (-)	Pass (-)	Pass (1.02)
14.967	0.527	-3.683	-0.646	0.979	-0.119	-2.704	Pass (-)	Pass (-)	Pass (1.02)
(PSXFR) 15.000	0.528	-3.686	-0.648	0.981	-0.120	-2.705	Pass (-)	Pass (-)	Pass (1.02)
(Debond) 18.000	0.529	-3.696	-0.737	1.117	-0.208	-2.579	Pass (-)	Pass (-)	Pass (1.07)
(PSXFR) 21.000	0.606	-3.973	-0.813	1.232	-0.207	-2.741	Pass (-)	Pass (-)	Pass (1.01)
($0.3L_g$) 22.000	0.606	-3.975	-0.836	1.266	-0.229	-2.709	Pass (-)	Pass (-)	Pass (1.02)
22.200	0.606	-3.976	-0.840	1.273	-0.234	-2.703	Pass (-)	Pass (-)	Pass (1.02)
($0.4L_g$) 29.333	0.608	-	-	1.447	-	-	Pass	Pass	Pass

Location from End of Girder (ft)	Prestress		Service I		Demand		Tension Status w/o rebar (C/D)	Tension Status w/ rebar (C/D)	Compression Status (C/D)
	f_t (KSI)	f_b (KSI)	f_t (KSI)	f_b (KSI)	f_t (KSI)	f_b (KSI)			
		3.989	0.955		0.347	2.542	(-)	(-)	(1.09)
29.433	0.608	-3.989	-0.956	1.449	-0.348	-2.541	Pass (-)	Pass (-)	Pass (1.09)
(0.5L_g) 36.667	0.609	-3.994	-0.995	1.507	-0.386	-2.486	Pass (-)	Pass (-)	Pass (1.11)
43.900	0.608	-3.989	-0.956	1.449	-0.348	-2.541	Pass (-)	Pass (-)	Pass (1.09)
(0.6L_g) 44.000	0.608	-3.989	-0.955	1.447	-0.347	-2.542	Pass (-)	Pass (-)	Pass (1.09)
51.133	0.606	-3.976	-0.840	1.273	-0.234	-2.703	Pass (-)	Pass (-)	Pass (1.02)
(0.7L_g) 51.333	0.606	-3.975	-0.836	1.266	-0.229	-2.709	Pass (-)	Pass (-)	Pass (1.02)
(PSXFR) 52.333	0.606	-3.973	-0.813	1.232	-0.207	-2.741	Pass (-)	Pass (-)	Pass (1.01)
(Debond) 55.333	0.529	-3.696	-0.737	1.117	-0.208	-2.579	Pass (-)	Pass (-)	Pass (1.07)
(PSXFR) 58.333	0.528	-3.686	-0.648	0.981	-0.120	-2.705	Pass (-)	Pass (-)	Pass (1.02)
58.367	0.527	-3.683	-0.646	0.979	-0.119	-2.704	Pass (-)	Pass (-)	Pass (1.02)
(0.8L_g) 58.667	0.521	-3.658	-0.637	0.965	-0.116	-2.693	Pass (-)	Pass (-)	Pass (1.02)
(PSXFR, Debond) 61.333	0.466	-3.428	-0.545	0.825	-0.079	-2.603	Pass (-)	Pass (-)	Pass (1.06)
(Debond) 64.333	0.403	-3.170	-0.429	0.649	-0.025	-2.521	Pass (-)	Pass (-)	Pass (1.09)
65.600	0.403	-3.166	-0.375	0.569	0.027	-2.597	Pass (7.32)	Pass (10+)	Pass (1.06)
(0.9L_g) 66.000	0.403	-3.164	-0.358	0.543	0.044	-2.622	Pass (4.51)	Pass (10+)	Pass (1.05)
(PSXFR) 67.333	0.402	-3.159	-0.299	0.453	0.103	-2.706	Pass (1.94)	Pass (5.00)	Pass (1.02)
69.583	0.366	-2.981	-0.193	0.293	0.173	-2.688	Pass (1.16)	Pass (2.98)	Pass (1.03)
(H, PSXFR, Debond) 70.333	0.354	-2.921	-0.156	0.237	0.198	-2.685	Pass (1.01)	Pass (2.60)	Pass (1.03)
72.833	0.059	-0.485	-0.027	0.041	0.032	-0.444	Pass (6.28)	Pass (10+)	Pass (6.21)
(1.0L_g) 73.333	0.000	0.000	0.000	0.000	0.000	0.000	Pass (∞)	Pass (∞)	Pass (∞)

Stress Check for Service I for Deck and Diaphragm Placement (Bridge Site 1) [5.9.4.2.2]

For stresses at service limit state after losses for components with bonded prestressing tendons other than piles
Allowable tensile stress = 0.0948√f'_c but not more than 0.200 KSI = 0.200 KSI
Allowable compressive stress = -0.45f'_c = -2.250 KSI
f'_c required to satisfy this stress check = 4.961 KSI

Location from Left Support (ft)	**Prestress**		**Service I**		**Demand**		**Tension Status (C/D)**	**Compression Status (C/D)**
	f_t (KSI)	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**		
(0.0L_s) 0.000	0.051	-0.419	0.000	0.000	0.051	-0.419	Pass (3.93)	Pass (5.37)
(PSXFR, Debond) 2.500	0.308	-2.542	-0.204	0.309	0.104	-2.233	Pass (1.93)	Pass (1.01)
(H) 3.250	0.319	-2.598	-0.263	0.398	0.056	-2.200	Pass (3.55)	Pass (1.02)
(PSXFR) 5.500	0.352	-2.766	-0.430	0.652	-0.078	-2.115	Pass (-)	Pass (1.06)
6.833	0.354	-2.779	-0.524	0.793	-0.170	-1.986	Pass (-)	Pass (1.13)
(0.1L_s) 7.233	0.354	-2.783	-0.551	0.835	-0.197	-1.948	Pass (-)	Pass (1.15)
(Debond) 8.500	0.356	-2.795	-0.635	0.962	-0.279	-1.833	Pass (-)	Pass (1.23)
(PSXFR, Debond) 11.500	0.412	-3.036	-0.819	1.240	-0.406	-1.796	Pass (-)	Pass (1.25)
14.167	0.463	-3.251	-0.964	1.461	-0.501	-1.791	Pass (-)	Pass (1.26)
(0.2L_s) 14.467	0.469	-3.275	-0.980	1.484	-0.511	-1.792	Pass (-)	Pass (1.26)
(PSXFR) 14.500	0.470	-3.278	-0.981	1.486	-0.512	-1.792	Pass (-)	Pass (1.26)
(Debond) 17.500	0.473	-3.302	-1.123	1.701	-0.650	-1.601	Pass (-)	Pass (1.41)
(PSXFR) 20.500	0.543	-3.559	-1.243	1.884	-0.700	-1.675	Pass (-)	Pass (1.34)
21.500	0.544	-3.566	-1.279	1.937	-0.735	-1.628	Pass (-)	Pass (1.38)
(0.3L_s) 21.700	0.544	-3.567	-1.286	1.948	-0.742	-1.619	Pass (-)	Pass (1.39)
28.833	0.549	-3.601	-1.468	2.223	-0.918	-1.377	Pass (-)	Pass (1.63)
(0.4L_s) 28.933	0.549	-3.601	-1.469	2.226	-0.920	-1.375	Pass (-)	Pass (1.64)
(0.5L_s) 36.167	0.551	-3.612	-1.531	2.319	-0.980	-1.294	Pass (-)	Pass (1.74)

Location from Left Support (ft)	Prestress		Service I		Demand		Tension Status (C/D)	Compression Status (C/D)
	f_t (KSI)	f_b (KSI)	f_t (KSI)	f_b (KSI)	f_t (KSI)	f_b (KSI)		
(0.6L_s) 43.400	0.549	-3.601	-1.469	2.226	-0.920	-1.375	Pass (-)	Pass (1.64)
43.500	0.549	-3.601	-1.468	2.223	-0.918	-1.377	Pass (-)	Pass (1.63)
(0.7L_s) 50.633	0.544	-3.567	-1.286	1.948	-0.742	-1.619	Pass (-)	Pass (1.39)
50.833	0.544	-3.566	-1.279	1.937	-0.735	-1.628	Pass (-)	Pass (1.38)
(PSXFR) 51.833	0.543	-3.559	-1.243	1.884	-0.700	-1.675	Pass (-)	Pass (1.34)
(Debond) 54.833	0.473	-3.302	-1.123	1.701	-0.650	-1.601	Pass (-)	Pass (1.41)
(PSXFR) 57.833	0.470	-3.278	-0.981	1.486	-0.512	-1.792	Pass (-)	Pass (1.26)
(0.8L_s) 57.867	0.469	-3.275	-0.980	1.484	-0.511	-1.792	Pass (-)	Pass (1.26)
58.167	0.463	-3.251	-0.964	1.461	-0.501	-1.791	Pass (-)	Pass (1.26)
(PSXFR, Debond) 60.833	0.412	-3.036	-0.819	1.240	-0.406	-1.796	Pass (-)	Pass (1.25)
(Debond) 63.833	0.356	-2.795	-0.635	0.962	-0.279	-1.833	Pass (-)	Pass (1.23)
(0.9L_s) 65.100	0.354	-2.783	-0.551	0.835	-0.197	-1.948	Pass (-)	Pass (1.15)
65.500	0.354	-2.779	-0.524	0.793	-0.170	-1.986	Pass (-)	Pass (1.13)
(PSXFR) 66.833	0.352	-2.766	-0.430	0.652	-0.078	-2.115	Pass (-)	Pass (1.06)
(H) 69.083	0.319	-2.598	-0.263	0.398	0.056	-2.200	Pass (3.55)	Pass (1.02)
(PSXFR, Debond) 69.833	0.308	-2.542	-0.204	0.309	0.104	-2.233	Pass (1.93)	Pass (1.01)
(1.0L_s) 72.333	0.051	-0.419	0.000	0.000	0.051	-0.419	Pass (3.93)	Pass (5.37)

Stress Check for Service I for Superimposed Dead Loads (Bridge Site 2) [5.9.4.2.1]

For stresses at service limit state after losses in other than segmentally constructed bridges due to permanent loads
Allowable compressive stress = -0.45f'_c = -2.250 KSI
f'_c required to satisfy this stress check = 4.888 KSI

Location from Left Support (ft)	**Prestress**		**Service I**		**Demand**		**Compression Status (C/D)**
	f_t (KSI)	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	
(0.0L_s) 0.000	0.051	-0.419	0.000	0.000	0.051	-0.419	Pass (5.37)
(PSXFR, Debond) 2.500	0.308	-2.544	-0.221	0.345	0.088	-2.200	Pass (1.02)
(H) 3.250	0.319	-2.601	-0.284	0.443	0.036	-2.158	Pass (1.04)
(PSXFR) 5.500	0.353	-2.771	-0.464	0.725	-0.112	-2.046	Pass (1.10)
6.833	0.354	-2.785	-0.565	0.883	-0.211	-1.902	Pass (1.18)
(0.1L_s) 7.233	0.355	-2.789	-0.595	0.929	-0.240	-1.860	Pass (1.21)
(Debond) 8.500	0.356	-2.802	-0.685	1.071	-0.329	-1.731	Pass (1.30)
(PSXFR, Debond) 11.500	0.414	-3.046	-0.884	1.381	-0.470	-1.665	Pass (1.35)
14.167	0.465	-3.264	-1.041	1.626	-0.576	-1.638	Pass (1.37)
(0.2L_s) 14.467	0.471	-3.289	-1.057	1.652	-0.587	-1.637	Pass (1.37)
(PSXFR) 14.500	0.471	-3.292	-1.059	1.655	-0.588	-1.636	Pass (1.37)
(Debond) 17.500	0.475	-3.317	-1.212	1.894	-0.737	-1.423	Pass (1.58)
(PSXFR) 20.500	0.546	-3.578	-1.342	2.097	-0.796	-1.480	Pass (1.52)
21.500	0.547	-3.585	-1.380	2.157	-0.834	-1.428	Pass (1.58)
(0.3L_s) 21.700	0.547	-3.586	-1.388	2.169	-0.841	-1.417	Pass (1.59)
28.833	0.553	-3.622	-1.584	2.475	-1.032	-1.147	Pass (1.96)
(0.4L_s) 28.933	0.553	-3.623	-1.586	2.478	-1.033	-1.144	Pass (1.97)
(0.5L_s) 36.167	0.554	-3.635	-1.652	2.582	-1.098	-1.053	Pass (2.05)
(0.6L_s) 43.400	0.553	-3.623	-1.586	2.478	-1.033	-1.144	Pass

Location from Left Support (ft)	**Prestress**		**Service I**		**Demand**		**Compression Status (C/D)**
	f_t (KSI)	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	
							(1.97)
43.500	0.553	-3.622	-1.584	2.475	-1.032	-1.147	Pass (1.96)
(0.7L_s) 50.633	0.547	-3.586	-1.388	2.169	-0.841	-1.417	Pass (1.59)
50.833	0.547	-3.585	-1.380	2.157	-0.834	-1.428	Pass (1.58)
(PSXFR) 51.833	0.546	-3.578	-1.342	2.097	-0.796	-1.480	Pass (1.52)
(Debond) 54.833	0.475	-3.317	-1.212	1.894	-0.737	-1.423	Pass (1.58)
(PSXFR) 57.833	0.471	-3.292	-1.059	1.655	-0.588	-1.636	Pass (1.37)
(0.8L_s) 57.867	0.471	-3.289	-1.057	1.652	-0.587	-1.637	Pass (1.37)
58.167	0.465	-3.264	-1.041	1.626	-0.576	-1.638	Pass (1.37)
(PSXFR, Debond) 60.833	0.414	-3.046	-0.884	1.381	-0.470	-1.665	Pass (1.35)
(Debond) 63.833	0.356	-2.802	-0.685	1.071	-0.329	-1.731	Pass (1.30)
(0.9L_s) 65.100	0.355	-2.789	-0.595	0.929	-0.240	-1.860	Pass (1.21)
65.500	0.354	-2.785	-0.565	0.883	-0.211	-1.902	Pass (1.18)
(PSXFR) 66.833	0.353	-2.771	-0.464	0.725	-0.112	-2.046	Pass (1.10)
(H) 69.083	0.319	-2.601	-0.284	0.443	0.036	-2.158	Pass (1.04)
(PSXFR, Debond) 69.833	0.308	-2.544	-0.221	0.345	0.088	-2.200	Pass (1.02)
(1.0L_s) 72.333	0.051	-0.419	0.000	0.000	0.051	-0.419	Pass (5.37)

Stress Check for Compressive Stresses for Service I for Final with Live Load (Bridge Site 3) [5.5.3.1]

For stresses at service limit state after losses in other than segmentally constructed bridges due to permanent and transient loads
Allowable compressive stress = $-0.6f'_c$ = -3.000 KSI
f'_c required to satisfy this stress check = 3.341 KSI

Location from Left Support (ft)	**Prestress**		**Service I**		**Demand**		**Compression Status (C/D)**
	f_t (KSI)	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	
($0.0L_s$) 0.000	0.049	-0.402	-0.413	0.260	-0.365	-0.142	Pass (8.23)
(PSXFR, Debond) 2.500	0.297	-2.447	-0.699	0.604	-0.402	-1.843	Pass (1.63)
(H) 3.250	0.308	-2.504	-0.780	0.703	-0.473	-1.801	Pass (1.67)
(PSXFR) 5.500	0.341	-2.677	-1.014	0.985	-0.674	-1.692	Pass (1.77)
6.833	0.343	-2.695	-1.145	1.143	-0.802	-1.552	Pass (1.93)
($0.1L_s$) 7.233	0.344	-2.701	-1.183	1.189	-0.840	-1.512	Pass (1.98)
(Debond) 8.500	0.346	-2.717	-1.300	1.331	-0.955	-1.387	Pass (2.16)
(PSXFR, Debond) 11.500	0.403	-2.965	-1.557	1.641	-1.154	-1.324	Pass (2.27)
14.167	0.454	-3.186	-1.760	1.886	-1.307	-1.300	Pass (2.30)
($0.2L_s$) 14.467	0.460	-3.211	-1.782	1.912	-1.322	-1.299	Pass (2.27)
(PSXFR) 14.500	0.460	-3.214	-1.784	1.915	-1.324	-1.299	Pass (2.27)
(Debond) 17.500	0.465	-3.247	-1.982	2.154	-1.517	-1.094	Pass (1.98)
(PSXFR) 20.500	0.536	-3.511	-2.150	2.357	-1.615	-1.154	Pass (1.86)
21.500	0.537	-3.520	-2.200	2.417	-1.663	-1.104	Pass (1.80)
($0.3L_s$) 21.700	0.537	-3.522	-2.210	2.428	-1.672	-1.094	Pass (1.79)
28.833	0.544	-3.569	-2.464	2.735	-1.919	-0.834	Pass (1.56)
($0.4L_s$) 28.933	0.545	-3.570	-2.466	2.738	-1.922	-0.832	Pass (1.56)
($0.5L_s$) 36.167	0.547	-3.586	-2.552	2.841	-2.005	-0.744	Pass

Location from Left Support (ft)	**Prestress**		**Service I**		**Demand**		**Compression Status (C/D)**
	f_t (KSI)	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	
							(1.50)
($0.6L_s$) 43.400	0.545	-3.570	-2.466	2.738	-1.922	-0.832	Pass (1.56)
43.500	0.544	-3.569	-2.464	2.735	-1.919	-0.834	Pass (1.56)
($0.7L_s$) 50.633	0.537	-3.522	-2.210	2.428	-1.672	-1.094	Pass (1.79)
50.833	0.537	-3.520	-2.200	2.417	-1.663	-1.104	Pass (1.80)
(PSXFR) 51.833	0.536	-3.511	-2.150	2.357	-1.615	-1.154	Pass (1.86)
(Debond) 54.833	0.465	-3.247	-1.982	2.154	-1.517	-1.094	Pass (1.98)
(PSXFR) 57.833	0.460	-3.214	-1.784	1.915	-1.324	-1.299	Pass (2.27)
($0.8L_s$) 57.867	0.460	-3.211	-1.782	1.912	-1.322	-1.299	Pass (2.27)
58.167	0.454	-3.186	-1.760	1.886	-1.307	-1.300	Pass (2.30)
(PSXFR, Debond) 60.833	0.403	-2.965	-1.557	1.641	-1.154	-1.324	Pass (2.27)
(Debond) 63.833	0.346	-2.717	-1.300	1.331	-0.955	-1.387	Pass (2.16)
($0.9L_s$) 65.100	0.344	-2.701	-1.183	1.189	-0.840	-1.512	Pass (1.98)
65.500	0.343	-2.695	-1.145	1.143	-0.802	-1.552	Pass (1.93)
(PSXFR) 66.833	0.341	-2.677	-1.014	0.985	-0.674	-1.692	Pass (1.77)
(H) 69.083	0.308	-2.504	-0.780	0.703	-0.473	-1.801	Pass (1.67)
(PSXFR, Debond) 69.833	0.297	-2.447	-0.699	0.604	-0.402	-1.843	Pass (1.63)
($1.0L_s$) 72.333	0.049	-0.402	-0.413	0.260	-0.365	-0.142	Pass (8.23)

Stress Check for Tensile Stresses for Service III for Final with Live Load (Bridge Site 3) [5.9.4.2.2]

For stresses at service limit state after losses which involve traffic loading in members with bonded prestressing tendons other than piles
Allowable tensile stress in the precompressed tensile zone = $0.0948\sqrt{f'_c}$ = 0.212 KSI
f'_c required to satisfy this stress check = 1.056 KSI

Location from Left Support (ft)	**Prestress f_b (KSI)**	**Service III f_b (KSI)**	**Demand f_b (KSI)**	**Tension Status (C/D)**
($0.0L_s$) 0.000	-0.402	0.260	-0.142	Pass (-)
(PSXFR, Debond) 2.500	-2.447	0.717	-1.730	Pass (-)
(H) 3.250	-2.504	0.847	-1.657	Pass (-)
(PSXFR) 5.500	-2.677	1.222	-1.455	Pass (-)
6.833	-2.695	1.431	-1.264	Pass (-)
($0.1L_s$) 7.233	-2.701	1.492	-1.209	Pass (-)
(Debond) 8.500	-2.717	1.680	-1.037	Pass (-)
(PSXFR, Debond) 11.500	-2.965	2.091	-0.874	Pass (-)
14.167	-3.186	2.416	-0.770	Pass (-)
($0.2L_s$) 14.467	-3.211	2.451	-0.760	Pass (-)
(PSXFR) 14.500	-3.214	2.455	-0.759	Pass (-)
(Debond) 17.500	-3.247	2.771	-0.476	Pass (-)
(PSXFR) 20.500	-3.511	3.041	-0.470	Pass (-)
21.500	-3.520	3.120	-0.400	Pass (-)
($0.3L_s$) 21.700	-3.522	3.135	-0.387	Pass (-)
28.833	-3.569	3.542	-0.027	Pass (-)
($0.4L_s$) 28.933	-3.570	3.546	-0.024	Pass (-)
($0.5L_s$) 36.167	-3.586	3.683	0.097	Pass

Location from Left Support (ft)	**Prestress f_b (KSI)**	**Service III f_b (KSI)**	**Demand f_b (KSI)**	**Tension Status (C/D)**
				(2.18)
(0.6L_s) 43.400	-3.570	3.546	-0.024	Pass (-)
43.500	-3.569	3.542	-0.027	Pass (-)
(0.7L_s) 50.633	-3.522	3.135	-0.387	Pass (-)
50.833	-3.520	3.120	-0.400	Pass (-)
(PSXFR) 51.833	-3.511	3.041	-0.470	Pass (-)
(Debond) 54.833	-3.247	2.771	-0.476	Pass (-)
(PSXFR) 57.833	-3.214	2.455	-0.759	Pass (-)
(0.8L_s) 57.867	-3.211	2.451	-0.760	Pass (-)
58.167	-3.186	2.416	-0.770	Pass (-)
(PSXFR, Debond) 60.833	-2.965	2.091	-0.874	Pass (-)
(Debond) 63.833	-2.717	1.680	-1.037	Pass (-)
(0.9L_s) 65.100	-2.701	1.492	-1.209	Pass (-)
65.500	-2.695	1.431	-1.264	Pass (-)
(PSXFR) 66.833	-2.677	1.222	-1.455	Pass (-)
(H) 69.083	-2.504	0.847	-1.657	Pass (-)
(PSXFR, Debond) 69.833	-2.447	0.717	-1.730	Pass (-)
(1.0L_s) 72.333	-0.402	0.260	-0.142	Pass (-)

Stress Check for Compressive Stresses for Fatigue I for Final with Live Load (Bridge Site 3) [5.5.3.1]

For stresses at service limit state after losses in other than segmentally constructed bridges due to the Fatigue I load combination and one-half the sum of effective prestress and permanent loads
Allowable compressive stress = -0.4f'_c = -2.000 KSI
f'_c required to satisfy this stress check = 4.469 KSI

Location from Left Support (ft)	**Prestress**		**Fatigue I**		**Demand**		**Compression Status (C/D)**
	f_t (KSI)	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	**f_t (KSI)**	**f_b (KSI)**	
(0.0L$_s$) 0.000	0.049	-0.402	-0.413	0.260	-0.389	0.059	Pass (5.14)
(PSXFR, Debond) 2.500	0.297	-2.447	-0.661	0.432	-0.513	-0.791	Pass (2.53)
(H) 3.250	0.308	-2.504	-0.731	0.481	-0.577	-0.771	Pass (2.59)
(PSXFR) 5.500	0.341	-2.677	-0.930	0.623	-0.760	-0.716	Pass (2.63)
6.833	0.343	-2.695	-1.040	0.702	-0.868	-0.646	Pass (2.30)
(0.1L$_s$) 7.233	0.344	-2.701	-1.071	0.725	-0.900	-0.626	Pass (2.22)
(Debond) 8.500	0.346	-2.717	-1.168	0.795	-0.996	-0.563	Pass (2.01)
(PSXFR, Debond) 11.500	0.403	-2.965	-1.376	0.950	-1.175	-0.532	Pass (1.70)
14.167	0.454	-3.186	-1.536	1.073	-1.309	-0.520	Pass (1.53)
(0.2L$_s$) 14.467	0.460	-3.211	-1.552	1.086	-1.322	-0.520	Pass (1.51)
(PSXFR) 14.500	0.460	-3.214	-1.554	1.087	-1.324	-0.520	Pass (1.51)
(Debond) 17.500	0.465	-3.247	-1.701	1.207	-1.469	-0.417	Pass (1.36)
(PSXFR) 20.500	0.536	-3.511	-1.838	1.308	-1.570	-0.447	Pass (1.27)
21.500	0.537	-3.520	-1.877	1.338	-1.609	-0.422	Pass (1.24)
(0.3L$_s$) 21.700	0.537	-3.522	-1.884	1.344	-1.616	-0.417	Pass (1.24)
28.833	0.544	-3.569	-2.059	1.498	-1.786	-0.287	Pass (1.12)
(0.4L$_s$) 28.933	0.545	-3.570	-2.060	1.499	-1.788	-0.286	Pass (1.12)
(0.5L$_s$) 36.167	0.547	-3.586	-2.058	1.551	-1.784	-0.242	Pass

Location from Left Support (ft)	Prestress		Fatigue I		Demand		Compression Status (C/D)
	f_t (KSI)	f_b (KSI)	f_t (KSI)	f_b (KSI)	f_t (KSI)	f_b (KSI)	
							(1.12)
(0.6L_s) 43.400	0.545	-3.570	-2.060	1.499	-1.788	-0.286	Pass (1.12)
43.500	0.544	-3.569	-2.059	1.498	-1.786	-0.287	Pass (1.12)
(0.7L_s) 50.633	0.537	-3.522	-1.884	1.344	-1.616	-0.417	Pass (1.24)
50.833	0.537	-3.520	-1.877	1.338	-1.609	-0.422	Pass (1.24)
(PSXFR) 51.833	0.536	-3.511	-1.838	1.308	-1.570	-0.447	Pass (1.27)
(Debond) 54.833	0.465	-3.247	-1.701	1.207	-1.469	-0.417	Pass (1.36)
(PSXFR) 57.833	0.460	-3.214	-1.554	1.087	-1.324	-0.520	Pass (1.51)
(0.8L_s) 57.867	0.460	-3.211	-1.552	1.086	-1.322	-0.520	Pass (1.51)
58.167	0.454	-3.186	-1.536	1.073	-1.309	-0.520	Pass (1.53)
(PSXFR, Debond) 60.833	0.403	-2.965	-1.376	0.950	-1.175	-0.532	Pass (1.70)
(Debond) 63.833	0.346	-2.717	-1.168	0.795	-0.996	-0.563	Pass (2.01)
(0.9L_s) 65.100	0.344	-2.701	-1.071	0.725	-0.900	-0.626	Pass (2.22)
65.500	0.343	-2.695	-1.040	0.702	-0.868	-0.646	Pass (2.30)
(PSXFR) 66.833	0.341	-2.677	-0.930	0.623	-0.760	-0.716	Pass (2.63)
(H) 69.083	0.308	-2.504	-0.731	0.481	-0.577	-0.771	Pass (2.59)
(PSXFR, Debond) 69.833	0.297	-2.447	-0.661	0.432	-0.513	-0.791	Pass (2.53)
(1.0L_s) 72.333	0.049	-0.402	-0.413	0.260	-0.389	0.059	Pass (5.14)

Moment Capacity

Positive Moment Capacity for Strength I Limit State for Final with Live Load Stage (Bridge Site 3) [5.7]

Location from Left Support (ft)	**M_u (kip-ft)**	**ϕM_n (kip-ft)**	**ϕM_n Min (kip-ft)**	**Status**	
				ϕM_n Min ≤ ϕM_n ($\phi M_n/\phi M_n$ Min)	**$M_u \le \phi M_n$ ($\phi M_n/M_u$)**
($0.0L_s$) 0.000	0.00	488.79	0.00	Pass (∞)	Pass (∞)
(FoS) 0.250	46.82	729.43	62.27	Pass (10+)	Pass (10+)
2.250	409.67	2559.42	544.86	Pass (4.70)	Pass (6.25)
(PSXFR, Debond) 2.500	453.57	2775.40	603.24	Pass (4.60)	Pass (6.12)
(CS) 2.760	498.83	2830.64	663.45	Pass (4.27)	Pass (5.67)
(H) 3.250	583.30	2933.46	775.79	Pass (3.78)	Pass (5.03)
4.500	793.04	3188.33	1054.74	Pass (3.02)	Pass (4.02)
(1.5H) 4.750	834.01	3238.56	1109.23	Pass (2.92)	Pass (3.88)
(PSXFR) 5.500	954.98	3389.00	1270.12	Pass (2.67)	Pass (3.55)
6.833	1162.82	3585.17	1546.55	Pass (2.32)	Pass (3.08)
($0.1L_s$) 7.233	1223.37	3643.68	1627.08	Pass (2.24)	Pass (2.98)
(Debond) 8.500	1409.63	3827.89	1874.80	Pass (2.04)	Pass (2.72)
(PSXFR, Debond) 11.500	1817.51	4310.32	2417.29	Pass (1.78)	Pass (2.37)
14.167	2140.82	4518.29	2847.29	Pass (1.59)	Pass (2.11)
($0.2L_s$) 14.467	2174.88	4541.58	2892.59	Pass (1.57)	Pass (2.09)
(PSXFR) 14.500	2178.63	4544.17	2897.58	Pass (1.57)	Pass (2.09)
(Debond) 17.500	2492.99	4606.02	3315.68	Pass (1.39)	Pass (1.85)
(PSXFR) 20.500	2760.58	4995.08	3585.55	Pass (1.39)	Pass (1.81)
21.500	2839.39	4995.28	3585.27	Pass (1.39)	Pass (1.76)

Positive Moment Capacity for Strength I Limit State for Final with Live Load Stage (Bridge Site 3) [5.7]

Location from Left Support (ft)	**M_u (kip-ft)**	**ϕM_n (kip-ft)**	**ϕM_n Min (kip-ft)**	**Status**	
				ϕM_n Min ≤ ϕM_n ($\phi M_n/\phi M_n$ Min)	**$M_u \le \phi M_n$ ($\phi M_n/M_u$)**
(0.3L_s) 21.700	2854.53	4995.32	3585.22	Pass (1.39)	Pass (1.75)
28.833	3258.53	4996.38	3583.79	Pass (1.39)	Pass (1.53)
(0.4L_s) 28.933	3262.32	4996.39	3583.77	Pass (1.39)	Pass (1.53)
(0.5L_s) 36.167	3398.25	4996.74	3583.29	Pass (1.39)	Pass (1.47)
(0.6L_s) 43.400	3262.32	4996.39	3583.77	Pass (1.39)	Pass (1.53)
43.500	3258.53	4996.38	3583.79	Pass (1.39)	Pass (1.53)
(0.7L_s) 50.633	2854.53	4995.32	3585.22	Pass (1.39)	Pass (1.75)
50.833	2839.39	4995.28	3585.27	Pass (1.39)	Pass (1.76)
(PSXFR) 51.833	2760.58	4995.08	3585.55	Pass (1.39)	Pass (1.81)
(Debond) 54.833	2492.99	4606.02	3315.68	Pass (1.39)	Pass (1.85)
(PSXFR) 57.833	2178.63	4544.17	2897.58	Pass (1.57)	Pass (2.09)
(0.8L_s) 57.867	2174.88	4541.58	2892.59	Pass (1.57)	Pass (2.09)
58.167	2140.82	4518.29	2847.29	Pass (1.59)	Pass (2.11)
(PSXFR, Debond) 60.833	1817.51	4310.32	2417.29	Pass (1.78)	Pass (2.37)
(Debond) 63.833	1409.63	3827.89	1874.80	Pass (2.04)	Pass (2.72)
(0.9L_s) 65.100	1223.37	3643.68	1627.08	Pass (2.24)	Pass (2.98)
65.500	1162.82	3585.17	1546.55	Pass (2.32)	Pass (3.08)
(PSXFR) 66.833	954.98	3389.00	1270.12	Pass (2.67)	Pass (3.55)
(1.5H) 67.583	834.01	3238.56	1109.23	Pass (2.92)	Pass (3.88)
67.833	793.04	3188.33	1054.74	Pass (3.02)	Pass (4.02)
(H) 69.083	583.30	2933.46	775.79	Pass (3.78)	Pass (5.03)
(CS) 69.574	498.83	2830.64	663.45	Pass	Pass

Positive Moment Capacity for Strength I Limit State for Final with Live Load Stage (Bridge Site 3) [5.7]

Location from Left Support (ft)	**M_u (kip-ft)**	**ϕM_n (kip-ft)**	**ϕM_n Min (kip-ft)**	**Status**	
				ϕM_n Min ≤ ϕM_n ($\phi M_n/\phi M_n$ Min)	**$M_u \le \phi M_n$ ($\phi M_n/M_u$)**
				(4.27)	(5.67)
(PSXFR, Debond) 69.833	453.57	2775.40	603.24	Pass (4.60)	Pass (6.12)
70.083	409.67	2559.42	544.86	Pass (4.70)	Pass (6.25)
(FoS) 72.083	46.82	729.43	62.27	Pass (10+)	Pass (10+)
(1.0L_s) 72.333	0.00	488.79	0.00	Pass (∞)	Pass (∞)

Shear

Ultimate Shears for Strength I Limit State for Bridge Site Stage 3 [5.8]

Location from Left Support (ft)	**Stirrups Required**	**Stirrups Provided**	**$\lvert V_u \rvert$ (kip)**	**ϕV_n (kip)**	**Status ($\phi V_n/V_u$)**
(CS) 2.760	Yes	Yes	173.69	929.38	Pass (5.35)
(H) 3.250	Yes	Yes	171.19	928.76	Pass (5.43)
(1.5H) 4.750	Yes	Yes	163.57	520.68	Pass (3.18)
(PSXFR) 5.500	Yes	Yes	159.78	519.47	Pass (3.25)
6.833	No	Yes	153.09	513.25	Pass (3.35)
(0.1L_s) 7.233	No	Yes	151.10	510.66	Pass (3.38)
(Debond) 8.500	No	Yes	144.80	502.92	Pass (3.47)
(PSXFR, Debond) 11.500	No	Yes	130.09	494.70	Pass (3.80)
14.167	No	Yes	117.22	490.65	Pass (4.19)
(0.2L_s) 14.467	No	Yes	115.79	490.29	Pass (4.23)
(PSXFR) 14.500	No	Yes	115.63	490.25	Pass (4.24)
(Debond) 17.500	No	Yes	101.44	481.08	Pass (4.74)
(PSXFR) 20.500	No	Yes	87.50	482.86	Pass (5.52)

Ultimate Shears for Strength I Limit State for Bridge Site Stage 3 [5.8]

Location from Left Support (ft)	**Stirrups Required**	**Stirrups Provided**	**$\|V_u\|$ (kip)**	**ϕV_n (kip)**	**Status ($\phi V_n/V_u$)**
21.500	No	Yes	82.92	481.08	Pass (5.80)
($0.3L_s$) 21.700	No	Yes	82.00	480.74	Pass (5.86)
28.833	No	Yes	50.17	471.61	Pass (9.40)
($0.4L_s$) 28.933	No	Yes	49.74	471.54	Pass (9.48)
($0.5L_s$) 36.167	No	Yes	18.99	470.01	Pass (10+)
($0.6L_s$) 43.400	No	Yes	49.74	471.54	Pass (9.48)
43.500	No	Yes	50.17	471.61	Pass (9.40)
($0.7L_s$) 50.633	No	Yes	82.00	480.74	Pass (5.86)
50.833	No	Yes	82.92	481.08	Pass (5.80)
(PSXFR) 51.833	No	Yes	87.50	482.86	Pass (5.52)
(Debond) 54.833	No	Yes	101.44	481.08	Pass (4.74)
(PSXFR) 57.833	No	Yes	115.63	490.25	Pass (4.24)
($0.8L_s$) 57.867	No	Yes	115.79	490.29	Pass (4.23)
58.167	No	Yes	117.22	490.65	Pass (4.19)
(PSXFR, Debond) 60.833	No	Yes	130.09	494.70	Pass (3.80)
(Debond) 63.833	No	Yes	144.80	502.92	Pass (3.47)
($0.9L_s$) 65.100	No	Yes	151.10	510.66	Pass (3.38)
65.500	No	Yes	153.09	513.25	Pass (3.35)
(PSXFR) 66.833	Yes	Yes	159.78	519.47	Pass (3.25)
(1.5H) 67.583	Yes	Yes	163.57	520.68	Pass (3.18)
(H) 69.083	Yes	Yes	171.19	928.76	Pass (5.43)
(CS) 69.574	Yes	Yes	173.69	929.38	Pass (5.35)

[LRFD 5.8.3.2] The reaction introduces compression into the end of the girder. Load between the CSS and the support is transferred directly to the support by compressive arching action without causing additional stresses in the stirrups. Hence, A_v/S in this region must be equal or greater than A_v/S at the critical section.

Ultimate Shears for Strength II Limit State for Bridge Site Stage 3 [5.8]

Location from Left Support (ft)	**Stirrups Required**	**Stirrups Provided**	**$\|V_u\|$ (kip)**	**ϕV_n (kip)**	**Status ($\phi V_n/V_u$)**
(CS) 2.760	No	Yes	115.89	948.90	Pass (8.19)
(H) 3.250	No	Yes	114.28	948.82	Pass (8.30)
(1.5H) 4.750	No	Yes	109.36	542.71	Pass (4.96)
(PSXFR) 5.500	No	Yes	106.89	543.41	Pass (5.08)
6.833	No	Yes	102.52	539.85	Pass (5.27)
($0.1L_s$) 7.233	No	Yes	101.20	537.88	Pass (5.31)
(Debond) 8.500	No	Yes	97.05	531.99	Pass (5.48)
(PSXFR, Debond) 11.500	No	Yes	87.20	528.49	Pass (6.06)
14.167	No	Yes	78.45	528.30	Pass (6.73)
($0.2L_s$) 14.467	No	Yes	77.46	528.34	Pass (6.82)
(PSXFR) 14.500	No	Yes	77.35	528.35	Pass (6.83)
(Debond) 17.500	No	Yes	67.50	521.66	Pass (7.73)
(PSXFR) 20.500	No	Yes	57.66	526.81	Pass (9.14)
21.500	No	Yes	54.37	525.66	Pass (9.67)
($0.3L_s$) 21.700	No	Yes	53.72	525.45	Pass (9.78)
28.833	No	Yes	30.30	519.21	Pass (10+)
($0.4L_s$) 28.933	No	Yes	29.97	519.17	Pass (10+)
($0.5L_s$) 36.167	No	Yes	6.23	518.62	Pass (10+)
($0.6L_s$) 43.400	No	Yes	29.97	519.17	Pass (10+)
43.500	No	Yes	30.30	519.21	Pass

Ultimate Shears for Strength II Limit State for Bridge Site Stage 3 [5.8]

Location from Left Support (ft)	**Stirrups Required**	**Stirrups Provided**	**$\lvert V_u \rvert$ (kip)**	**ϕV_n (kip)**	**Status ($\phi V_n/V_u$)**
					(10+)
($0.7L_s$) 50.633	No	Yes	53.72	525.45	Pass (9.78)
50.833	No	Yes	54.37	525.66	Pass (9.67)
(PSXFR) 51.833	No	Yes	57.66	526.81	Pass (9.14)
(Debond) 54.833	No	Yes	67.50	521.66	Pass (7.73)
(PSXFR) 57.833	No	Yes	77.35	528.35	Pass (6.83)
($0.8L_s$) 57.867	No	Yes	77.46	528.34	Pass (6.82)
58.167	No	Yes	78.45	528.30	Pass (6.73)
(PSXFR, Debond) 60.833	No	Yes	87.20	528.49	Pass (6.06)
(Debond) 63.833	No	Yes	97.05	531.99	Pass (5.48)
($0.9L_s$) 65.100	No	Yes	101.20	537.88	Pass (5.31)
65.500	No	Yes	102.52	539.85	Pass (5.27)
(PSXFR) 66.833	No	Yes	106.89	543.41	Pass (5.08)
(1.5H) 67.583	No	Yes	109.36	542.71	Pass (4.96)
(H) 69.083	No	Yes	114.28	948.82	Pass (8.30)
(CS) 69.574	No	Yes	115.89	948.90	Pass (8.19)

[LRFD 5.8.3.2] The reaction introduces compression into the end of the girder. Load between the CSS and the support is transferred directly to the support by compressive arching action without causing additional stresses in the stirrups. Hence, A_v/S in this region must be equal or greater than A_v/S at the critical section.

Horizontal Interface Shears/Length for Strength I Limit State [5.8.4]

Location from Left Support (ft)	**5.8.4.2**			**5.8.4.4**			**5.8.4.1**		
	s (in)	**s_{max} (in)**	**Status**	**a_{vf} (in^2/ft)**	**$a_{vf\ min}$ (in^2/ft)**	**Status**	**$\lvert v_{ui}\rvert$ (kip/ft)**	**ϕv_{ni} (kip/ft)**	**Status ($\phi v_{ni}/\lvert v_{ui}\rvert$)**
(CS) 2.760	6.000	24.000	Pass	2.400	N/A	N/A	74.258	420.048	Pass (5.66)
(H) 3.250	6.000	24.000	Pass	2.400	N/A	N/A	73.099	420.048	Pass (5.75)
(1.5H) 4.750	18.000	24.000	Pass	0.800	N/A	N/A	69.598	333.648	Pass (4.79)
(PSXFR) 5.500	18.000	24.000	Pass	0.800	N/A	N/A	67.872	333.648	Pass (4.92)
6.833	18.000	24.000	Pass	0.800	N/A	N/A	65.031	333.648	Pass (5.13)
(0.1L_s) 7.233	18.000	24.000	Pass	0.800	N/A	N/A	64.183	333.648	Pass (5.20)
(Debond) 8.500	18.000	24.000	Pass	0.800	N/A	N/A	61.510	333.648	Pass (5.42)
(PSXFR, Debond) 11.500	18.000	24.000	Pass	0.800	N/A	N/A	54.689	333.648	Pass (6.10)
14.167	18.000	24.000	Pass	0.800	N/A	N/A	48.881	333.648	Pass (6.83)
(0.2L_s) 14.467	18.000	24.000	Pass	0.800	N/A	N/A	48.241	333.648	Pass (6.92)
(PSXFR) 14.500	18.000	24.000	Pass	0.800	N/A	N/A	48.171	333.648	Pass (6.93)
(Debond) 17.500	18.000	24.000	Pass	0.800	N/A	N/A	42.257	333.648	Pass (7.90)
(PSXFR) 20.500	18.000	24.000	Pass	0.800	N/A	N/A	36.029	333.648	Pass (9.26)
21.500	18.000	24.000	Pass	0.800	N/A	N/A	34.140	333.648	Pass (9.77)
(0.3L_s) 21.700	18.000	24.000	Pass	0.800	N/A	N/A	33.764	333.648	Pass (9.88)
28.833	18.000	24.000	Pass	0.800	N/A	N/A	20.658	333.648	Pass (10+)
(0.4L_s) 28.933	18.000	24.000	Pass	0.800	N/A	N/A	20.478	333.648	Pass (10+)
(0.5L_s) 36.167	18.000	24.000	Pass	0.800	N/A	N/A	7.818	333.648	Pass (10+)
(0.6L_s) 43.400	18.000	24.000	Pass	0.800	N/A	N/A	20.478	333.648	Pass (10+)

Location from Left Support (ft)	**5.8.4.2**			**5.8.4.4**			**5.8.4.1**		
	s (in)	**s_{max} (in)**	**Status**	**a_{vf} (in^2/ft)**	**$a_{vf\ min}$ (in^2/ft)**	**Status**	**$\|v_{ui}\|$ (kip/ft)**	**ϕv_{ni} (kip/ft)**	**Status ($\phi v_{ni}/\|v_{ui}\|$)**
43.500	18.000	24.000	Pass	0.800	N/A	N/A	20.658	333.648	Pass (10+)
($0.7L_s$) 50.633	18.000	24.000	Pass	0.800	N/A	N/A	33.764	333.648	Pass (9.88)
50.833	18.000	24.000	Pass	0.800	N/A	N/A	34.140	333.648	Pass (9.77)
(PSXFR) 51.833	18.000	24.000	Pass	0.800	N/A	N/A	36.029	333.648	Pass (9.26)
(Debond) 54.833	18.000	24.000	Pass	0.800	N/A	N/A	42.257	333.648	Pass (7.90)
(PSXFR) 57.833	18.000	24.000	Pass	0.800	N/A	N/A	48.171	333.648	Pass (6.93)
($0.8L_s$) 57.867	18.000	24.000	Pass	0.800	N/A	N/A	48.241	333.648	Pass (6.92)
58.167	18.000	24.000	Pass	0.800	N/A	N/A	48.881	333.648	Pass (6.83)
(PSXFR, Debond) 60.833	18.000	24.000	Pass	0.800	N/A	N/A	54.689	333.648	Pass (6.10)
(Debond) 63.833	18.000	24.000	Pass	0.800	N/A	N/A	61.510	333.648	Pass (5.42)
($0.9L_s$) 65.100	18.000	24.000	Pass	0.800	N/A	N/A	64.183	333.648	Pass (5.20)
65.500	18.000	24.000	Pass	0.800	N/A	N/A	65.031	333.648	Pass (5.13)
(PSXFR) 66.833	18.000	24.000	Pass	0.800	N/A	N/A	67.872	333.648	Pass (4.92)
(1.5H) 67.583	18.000	24.000	Pass	0.800	N/A	N/A	69.598	333.648	Pass (4.79)
(H) 69.083	6.000	24.000	Pass	2.400	N/A	N/A	73.099	420.048	Pass (5.75)
(CS) 69.574	6.000	24.000	Pass	2.400	N/A	N/A	74.258	420.048	Pass (5.66)

Horizontal Interface Shears/Length for Strength II Limit State [5.8.4]

Location from Left Support (ft)	**5.8.4.2**			**5.8.4.4**			**5.8.4.1**		
	s (in)	**s_{max} (in)**	**Status**	**a_{vf} (in^2/ft)**	**$a_{vf\ min}$ (in^2/ft)**	**Status**	**$\lvert v_{ui}\rvert$ (kip/ft)**	**ϕv_{ni} (kip/ft)**	**Status ($\phi v_{ni}/\lvert v_{ui}\rvert$)**
(CS) 2.760	6.000	24.000	Pass	2.400	N/A	N/A	49.546	420.048	Pass (8.48)
(H) 3.250	6.000	24.000	Pass	2.400	N/A	N/A	48.799	420.048	Pass (8.61)
(1.5H) 4.750	18.000	24.000	Pass	0.800	N/A	N/A	46.531	333.648	Pass (7.17)
(PSXFR) 5.500	18.000	24.000	Pass	0.800	N/A	N/A	45.406	333.648	Pass (7.35)
6.833	18.000	24.000	Pass	0.800	N/A	N/A	43.547	333.648	Pass (7.66)
(0.1L_s) 7.233	18.000	24.000	Pass	0.800	N/A	N/A	42.990	333.648	Pass (7.76)
(Debond) 8.500	18.000	24.000	Pass	0.800	N/A	N/A	41.223	333.648	Pass (8.09)
(PSXFR, Debond) 11.500	18.000	24.000	Pass	0.800	N/A	N/A	36.659	333.648	Pass (9.10)
14.167	18.000	24.000	Pass	0.800	N/A	N/A	32.710	333.648	Pass (10+)
(0.2L_s) 14.467	18.000	24.000	Pass	0.800	N/A	N/A	32.272	333.648	Pass (10+)
(PSXFR) 14.500	18.000	24.000	Pass	0.800	N/A	N/A	32.223	333.648	Pass (10+)
(Debond) 17.500	18.000	24.000	Pass	0.800	N/A	N/A	28.121	333.648	Pass (10+)
(PSXFR) 20.500	18.000	24.000	Pass	0.800	N/A	N/A	23.739	333.648	Pass (10+)
21.500	18.000	24.000	Pass	0.800	N/A	N/A	22.387	333.648	Pass (10+)
(0.3L_s) 21.700	18.000	24.000	Pass	0.800	N/A	N/A	22.117	333.648	Pass (10+)
28.833	18.000	24.000	Pass	0.800	N/A	N/A	12.476	333.648	Pass (10+)
(0.4L_s) 28.933	18.000	24.000	Pass	0.800	N/A	N/A	12.340	333.648	Pass (10+)
(0.5L_s) 36.167	18.000	24.000	Pass	0.800	N/A	N/A	2.564	333.648	Pass (10+)
(0.6L_s) 43.400	18.000	24.000	Pass	0.800	N/A	N/A	12.340	333.648	Pass (10+)
43.500	18.000	24.000	Pass	0.800	N/A	N/A	12.476	333.648	Pass (10+)
(0.7L_s) 50.633	18.000	24.000	Pass	0.800	N/A	N/A	22.117	333.648	Pass (10+)
50.833	18.000	24.000	Pass	0.800	N/A	N/A	22.387	333.648	Pass

Location from Left Support (ft)	5.8.4.2			5.8.4.4			5.8.4.1		
	s (in)	s_{max} (in)	Status	a_{vf} (in^2/ft)	$a_{vf\ min}$ (in^2/ft)	Status	$\lvert v_{ui} \rvert$ (kip/ft)	ϕv_{ni} (kip/ft)	Status ($\phi v_{ni}/\lvert v_{ui} \rvert$)
									(10+)
(PSXFR) 51.833	18.000	24.000	Pass	0.800	N/A	N/A	23.739	333.648	Pass (10+)
(Debond) 54.833	18.000	24.000	Pass	0.800	N/A	N/A	28.121	333.648	Pass (10+)
(PSXFR) 57.833	18.000	24.000	Pass	0.800	N/A	N/A	32.223	333.648	Pass (10+)
($0.8L_s$) 57.867	18.000	24.000	Pass	0.800	N/A	N/A	32.272	333.648	Pass (10+)
58.167	18.000	24.000	Pass	0.800	N/A	N/A	32.710	333.648	Pass (10+)
(PSXFR, Debond) 60.833	18.000	24.000	Pass	0.800	N/A	N/A	36.659	333.648	Pass (9.10)
(Debond) 63.833	18.000	24.000	Pass	0.800	N/A	N/A	41.223	333.648	Pass (8.09)
($0.9L_s$) 65.100	18.000	24.000	Pass	0.800	N/A	N/A	42.990	333.648	Pass (7.76)
65.500	18.000	24.000	Pass	0.800	N/A	N/A	43.547	333.648	Pass (7.66)
(PSXFR) 66.833	18.000	24.000	Pass	0.800	N/A	N/A	45.406	333.648	Pass (7.35)
(1.5H) 67.583	18.000	24.000	Pass	0.800	N/A	N/A	46.531	333.648	Pass (7.17)
(H) 69.083	6.000	24.000	Pass	2.400	N/A	N/A	48.799	420.048	Pass (8.61)
(CS) 69.574	6.000	24.000	Pass	2.400	N/A	N/A	49.546	420.048	Pass (8.48)

Longitudinal Reinforcement for Shear Check - Strength I [5.8.3.5]

$$A_s f_y + A_{ps} f_{ps} \geq \left[\frac{M_u}{d_v \varphi_f} + 0.5\frac{N_u}{\varphi_a} + \left(\left|\frac{V_u}{\varphi_v} - V_p\right| - 0.5V_s\right)\cot\theta\right] \quad 5.8.3.5-1$$

$$A_s f_y + A_{ps} f_{ps} \geq \left(\frac{V_u}{\varphi_v} - V_p - 0.5V_s\right)\cot\theta \quad 5.8.3.5-2$$

Location from Left Support (ft)	Capacity (kip)	Demand (kip)	Equation	Status (C/D)
(FoS) 0.250	265.75	180.80	5.8.3.5-2	Pass (1.47)
(PSXFR, Debond) 2.500	1013.85	180.80	5.8.3.5-2	Pass (5.61)
(CS) 2.760	1033.83	180.80	5.8.3.5-2	Pass (5.72)
(H) 3.250	1071.31	410.60	5.8.3.5-1	Pass (2.61)
(1.5H) 4.750	1184.73	502.55	5.8.3.5-1	Pass (2.36)
(PSXFR) 5.500	1241.43	546.83	5.8.3.5-1	Pass (2.27)
6.833	1316.10	622.28	5.8.3.5-1	Pass (2.11)
(0.1L_s) 7.233	1338.51	644.16	5.8.3.5-1	Pass (2.08)
(Debond) 8.500	1409.55	711.35	5.8.3.5-1	Pass (1.98)
(PSXFR, Debond) 11.500	1595.36	856.62	5.8.3.5-1	Pass (1.86)
14.167	1674.87	970.12	5.8.3.5-1	Pass (1.73)
(0.2L_s) 14.467	1683.84	981.97	5.8.3.5-1	Pass (1.71)
(PSXFR) 14.500	1684.84	983.28	5.8.3.5-1	Pass (1.71)
(Debond) 17.500	1708.15	1092.60	5.8.3.5-1	Pass (1.56)
(PSXFR) 20.500	1847.23	1177.02	5.8.3.5-1	Pass (1.57)
21.500	1847.62	1203.33	5.8.3.5-1	Pass (1.54)
(0.3L_s) 21.700	1847.70	1208.35	5.8.3.5-1	Pass (1.53)
28.833	1849.73	1334.97	5.8.3.5-1	Pass (1.39)
(0.4L_s) 28.933	1849.75	1336.02	5.8.3.5-1	Pass (1.38)

Location from Left Support (ft)	**Capacity (kip)**	**Demand (kip)**	**Equation**	**Status (C/D)**
($0.5L_s$) 36.167	1850.44	1358.49	5.8.3.5-1	Pass (1.36)
($0.6L_s$) 43.400	1849.75	1336.02	5.8.3.5-1	Pass (1.38)
43.500	1849.73	1334.97	5.8.3.5-1	Pass (1.39)
($0.7L_s$) 50.633	1847.70	1208.35	5.8.3.5-1	Pass (1.53)
50.833	1847.62	1203.33	5.8.3.5-1	Pass (1.54)
(PSXFR) 51.833	1847.23	1177.02	5.8.3.5-1	Pass (1.57)
(Debond) 54.833	1708.15	1092.60	5.8.3.5-1	Pass (1.56)
(PSXFR) 57.833	1684.84	983.28	5.8.3.5-1	Pass (1.71)
($0.8L_s$) 57.867	1683.84	981.97	5.8.3.5-1	Pass (1.71)
58.167	1674.87	970.12	5.8.3.5-1	Pass (1.73)
(PSXFR, Debond) 60.833	1595.36	856.62	5.8.3.5-1	Pass (1.86)
(Debond) 63.833	1409.55	711.35	5.8.3.5-1	Pass (1.98)
($0.9L_s$) 65.100	1338.51	644.16	5.8.3.5-1	Pass (2.08)
65.500	1316.10	622.28	5.8.3.5-1	Pass (2.11)
(PSXFR) 66.833	1241.43	546.83	5.8.3.5-1	Pass (2.27)
(1.5H) 67.583	1184.73	502.55	5.8.3.5-1	Pass (2.36)
(H) 69.083	1071.31	410.60	5.8.3.5-1	Pass (2.61)
(CS) 69.574	1033.83	379.56	5.8.3.5-1	Pass (2.72)
(PSXFR, Debond) 69.833	1013.85	361.52	5.8.3.5-1	Pass (2.80)
(FoS) 72.083	265.75	199.46	5.8.3.5-1	Pass (1.33)

Longitudinal Reinforcement for Shear Check - Strength II [5.8.3.5]

$$A_s f_y + A_{ps} f_{ps} \ge \left[\frac{M_u}{d_v \varphi_f} + 0.5\frac{N_u}{\varphi_a} + \left(\left|\frac{V_u}{\varphi_v} - V_p\right| - 0.5V_s\right)\cot\theta\right] \qquad 5.8.3.5-1$$

$$A_s f_y + A_{ps} f_{ps} \ge \left(\frac{V_u}{\varphi_v} - V_p - 0.5V_s\right)\cot\theta \qquad 5.8.3.5-2$$

Location from Left Support (ft)	Capacity (kip)	Demand (kip)	Equation	Status (C/D)
(FoS) 0.250	265.75	121.50	5.8.3.5-2	Pass (2.19)
(PSXFR, Debond) 2.500	1013.85	121.50	5.8.3.5-2	Pass (8.34)
(CS) 2.760	1033.83	121.50	5.8.3.5-2	Pass (8.51)
(H) 3.250	1071.31	274.37	5.8.3.5-1	Pass (3.90)
(1.5H) 4.750	1184.73	335.79	5.8.3.5-1	Pass (3.53)
(PSXFR) 5.500	1241.43	365.33	5.8.3.5-1	Pass (3.40)
6.833	1316.10	415.63	5.8.3.5-1	Pass (3.17)
(0.1L_s) 7.233	1338.51	430.20	5.8.3.5-1	Pass (3.11)
(Debond) 8.500	1409.55	474.91	5.8.3.5-1	Pass (2.97)
(PSXFR, Debond) 11.500	1595.36	571.36	5.8.3.5-1	Pass (2.79)
14.167	1674.87	646.45	5.8.3.5-1	Pass (2.59)
(0.2L_s) 14.467	1683.84	654.27	5.8.3.5-1	Pass (2.57)
(PSXFR) 14.500	1684.84	655.13	5.8.3.5-1	Pass (2.57)
(Debond) 17.500	1708.15	727.07	5.8.3.5-1	Pass (2.35)
(PSXFR) 20.500	1847.23	782.18	5.8.3.5-1	Pass (2.36)
21.500	1847.62	799.27	5.8.3.5-1	Pass (2.31)
(0.3L_s) 21.700	1847.70	802.52	5.8.3.5-1	Pass (2.30)
28.833	1849.73	882.94	5.8.3.5-1	Pass (2.09)
(0.4L_s) 28.933	1849.75	883.57	5.8.3.5-1	Pass (2.09)

Location from Left Support (ft)	**Capacity (kip)**	**Demand (kip)**	**Equation**	**Status (C/D)**
(0.5L_s) 36.167	1850.44	893.24	5.8.3.5-1	Pass (2.07)
(0.6L_s) 43.400	1849.75	883.57	5.8.3.5-1	Pass (2.09)
43.500	1849.73	882.94	5.8.3.5-1	Pass (2.09)
(0.7L_s) 50.633	1847.70	802.52	5.8.3.5-1	Pass (2.30)
50.833	1847.62	799.27	5.8.3.5-1	Pass (2.31)
(PSXFR) 51.833	1847.23	782.18	5.8.3.5-1	Pass (2.36)
(Debond) 54.833	1708.15	727.07	5.8.3.5-1	Pass (2.35)
(PSXFR) 57.833	1684.84	655.13	5.8.3.5-1	Pass (2.57)
(0.8L_s) 57.867	1683.84	654.27	5.8.3.5-1	Pass (2.57)
58.167	1674.87	646.45	5.8.3.5-1	Pass (2.59)
(PSXFR, Debond) 60.833	1595.36	571.36	5.8.3.5-1	Pass (2.79)
(Debond) 63.833	1409.55	474.91	5.8.3.5-1	Pass (2.97)
(0.9L_s) 65.100	1338.51	430.20	5.8.3.5-1	Pass (3.11)
65.500	1316.10	415.63	5.8.3.5-1	Pass (3.17)
(PSXFR) 66.833	1241.43	365.33	5.8.3.5-1	Pass (3.40)
(1.5H) 67.583	1184.73	335.79	5.8.3.5-1	Pass (3.53)
(H) 69.083	1071.31	274.37	5.8.3.5-1	Pass (3.90)
(CS) 69.574	1033.83	253.63	5.8.3.5-1	Pass (4.08)
(PSXFR, Debond) 69.833	1013.85	241.64	5.8.3.5-1	Pass (4.20)
(FoS) 72.083	265.75	133.90	5.8.3.5-1	Pass (1.98)

Stirrup Detailing Check [5.8.2.5, 5.8.2.7, 5.10.3.1.2]

Location from Left Support (ft)	**Bar Size**	**S (in)**	**S_{max} (in)**	**S_{min} (in)**	**A_v/S (in^2/ft)**	**A_v/S_{min} (in^2/ft)***	**Status**
(0.0L_s) 0.000	#4	3.000	24.000	1.500	4.800	0.396	Pass

Stirrup Detailing Check [5.8.2.5, 5.8.2.7, 5.10.3.1.2]

Location from Left Support (ft)	**Bar Size**	**S (in)**	**S_{max} (in)**	**S_{min} (in)**	**A_v/S (in^2/ft)**	**A_v/S_{min} (in^2/ft)***	**Status**
(FoS) 0.250	#4	3.000	24.000	1.500	4.800	0.396	Pass
(PSXFR, Debond) 2.500	#4	6.000	24.000	1.500	2.400	0.396	Pass
(CS) 2.760	#4	6.000	24.000	1.500	2.400	0.396	Pass
(H) 3.250	#4	6.000	24.000	1.500	2.400	0.396	Pass
(1.5H) 4.750	#4	18.000	24.000	1.500	0.800	0.396	Pass
(PSXFR) 5.500	#4	18.000	24.000	1.500	0.800	0.396	Pass
6.833	#4	18.000	24.000	1.500	0.800	0.000	Pass
(0.1L_s) 7.233	#4	18.000	24.000	1.500	0.800	0.000	Pass
(Debond) 8.500	#4	18.000	24.000	1.500	0.800	0.000	Pass
(PSXFR, Debond) 11.500	#4	18.000	24.000	1.500	0.800	0.000	Pass
14.167	#4	18.000	24.000	1.500	0.800	0.000	Pass
(0.2L_s) 14.467	#4	18.000	24.000	1.500	0.800	0.000	Pass
(PSXFR) 14.500	#4	18.000	24.000	1.500	0.800	0.000	Pass
(Debond) 17.500	#4	18.000	24.000	1.500	0.800	0.000	Pass
(PSXFR) 20.500	#4	18.000	24.000	1.500	0.800	0.000	Pass
21.500	#4	18.000	24.000	1.500	0.800	0.000	Pass
(0.3L_s) 21.700	#4	18.000	24.000	1.500	0.800	0.000	Pass
28.833	#4	18.000	24.000	1.500	0.800	0.000	Pass
(0.4L_s) 28.933	#4	18.000	24.000	1.500	0.800	0.000	Pass
(0.5L_s) 36.167	#4	18.000	24.000	1.500	0.800	0.000	Pass
(0.6L_s) 43.400	#4	18.000	24.000	1.500	0.800	0.000	Pass
43.500	#4	18.000	24.000	1.500	0.800	0.000	Pass
(0.7L_s) 50.633	#4	18.000	24.000	1.500	0.800	0.000	Pass
50.833	#4	18.000	24.000	1.500	0.800	0.000	Pass
(PSXFR) 51.833	#4	18.000	24.000	1.500	0.800	0.000	Pass
(Debond) 54.833	#4	18.000	24.000	1.500	0.800	0.000	Pass
(PSXFR) 57.833	#4	18.000	24.000	1.500	0.800	0.000	Pass
(0.8L_s) 57.867	#4	18.000	24.000	1.500	0.800	0.000	Pass
58.167	#4	18.000	24.000	1.500	0.800	0.000	Pass
(PSXFR, Debond) 60.833	#4	18.000	24.000	1.500	0.800	0.000	Pass
(Debond) 63.833	#4	18.000	24.000	1.500	0.800	0.000	Pass
(0.9L_s) 65.100	#4	18.000	24.000	1.500	0.800	0.000	Pass
65.500	#4	18.000	24.000	1.500	0.800	0.000	Pass
(PSXFR) 66.833	#4	18.000	24.000	1.500	0.800	0.396	Pass
(1.5H) 67.583	#4	18.000	24.000	1.500	0.800	0.396	Pass
(H) 69.083	#4	6.000	24.000	1.500	2.400	0.396	Pass

Stirrup Detailing Check [5.8.2.5, 5.8.2.7, 5.10.3.1.2]							
Location from Left Support (ft)	**Bar Size**	**S (in)**	**S_{max} (in)**	**S_{min} (in)**	**A_v/S (in^2/ft)**	**A_v/S_{min} (in^2/ft)***	**Status**
(CS) 69.574	#4	6.000	24.000	1.500	2.400	0.396	Pass
(PSXFR, Debond) 69.833	#4	6.000	24.000	1.500	2.400	0.396	Pass
(FoS) 72.083	#4	3.000	24.000	1.500	4.800	0.396	Pass
(1.0L_s) 72.333	#4	3.000	24.000	1.500	4.800	0.396	Pass

* - Transverse reinforcement not required if $V_u < 0.5\phi(V_c + V_p)$ [Eqn 5.8.2.4-1]

APPENDIX E: Boardwalk Calculations- Joists

Pedestrian Load (lb/ft):	850	Cd	1	
Dead Load (lb/ft):	100	CF	1.00	
L(ft)	10	Fb	2050	
F'b (psi)	4026.75	Cr	1.15	
		CM	0.85	
		Ct	1	
		CKf	2.94	
		Φb	0.85	
		λ	0.8	
Pedestrian Load:		Section Properties:		3 x 12
w (lb/ft)	162.5	b (in)	2.5	
Mmax (lb-ft)	3554.69	d (in)	11.5	
Sx (in^3)	10.59	A (in^2)	28.13	
		Sx (in^3)	52.73	
Truck Load:		Ix (in^4)	296.6	
w (lb/ft)	12.5	E	1800000	
P (lb)	4000			
Mmax w:(lb-ft)	156.25			
Mmax P:(lb-ft)	17500			
Mmax total (lb-ft)	17656.25			
Sx req'd (in^3)	52.62			
fb	4018.11			
Check fb<F'b	OK			
Shear Check: AASHTO LRFD 8.7: When caculating maximum design shear, the live load shall be placed so as to produce the maximum shear at a distance from the support equal to the lesser of 3d or L/4.				
3d (ft)	414			
L/4 (ft)	2.5			
Pedestrian Load:				
Vmax	812.5	λ	0.8	

F'v (psi)	297.5	CKv	3.33
fv	43.33	Φv	0.75
Check fv<F'v	OK	Fv	175
		CM	0.85
Truck Load:		Ct	1
Vmax (lb)	3076	Ci	1
F'v	297.5		
fv	164.02		
Check fv<F'v	OK		
Deflection Check:			
L/360 (in)	0.33		
Δmax Truck (in)	0.27		
Δmax Pedestrian (in)	0.08		
Check TL Δmax<L/360	OK		
Check PL Δmax<L/360	OK		
3x12 Southern Pine (Select Structural) spaced at 1ft OC			

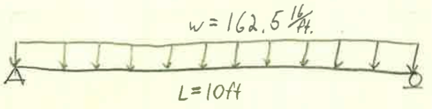
APPENDIX E: Boardwalk Calculations- Joists

Pedestrian Load: $1.75(0.85) + 1.25(0.100\,\#/ft) = 1.6125$

$1.25 \cdot 10\,psf \cdot 1'\,width = 12.5\,\#/ft$

$1.75\;\; 85\,psf \cdot 1'\,width = 150\,\#/ft$

Pedestrian:



Tributary width = 1 ft.

$W = 150\,\frac{lb}{ft^2}(1ft) + 12.5\,\frac{lb}{ft^2}(1ft)$

$= \underline{162.5\,lb/ft}$

$M_{max} = \frac{wL^2}{8} = \frac{(162.5)(10)^2}{8} = 2031.25\,lb\cdot ft$

$C_t = 1.0$ $\qquad \lambda = 0.8$

$F_b' = C_D C_F F_b C_r C_M C_t \cdot k_F\, \phi_b\, \lambda$ $\qquad C_D = 1.0$ for live load

$C_F = 1.1$

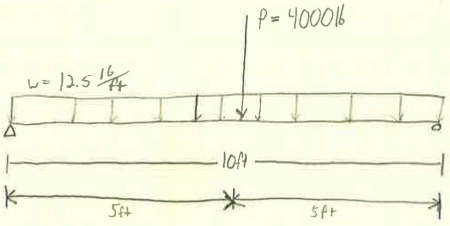
$F_b' = (1)(1.1)(2050)(1.15)(0.85)(1)(2.94)(0.85)(0.8)$ $\qquad F_b = 2050$ (select structural) $\quad C_M = 0.85$

$C_r = 1.15$ (repetitive member)

$F_b' = 4406.76\,\frac{lb}{in.^2}$ (psi) $\qquad k_F = \frac{2.5}{\phi_b}$ $\qquad \phi_b = 0.85$ $\qquad k_F = 2.94$

$S_x = \frac{M}{F_b'} = \frac{2031.25\,lb\cdot ft\,(12\frac{in}{ft})}{4406.76} = 5.53\,in.^3$

Truck:



$w = 12.5\,\frac{lb}{ft^2}(1ft)$

$= 12.5\,lb/ft$

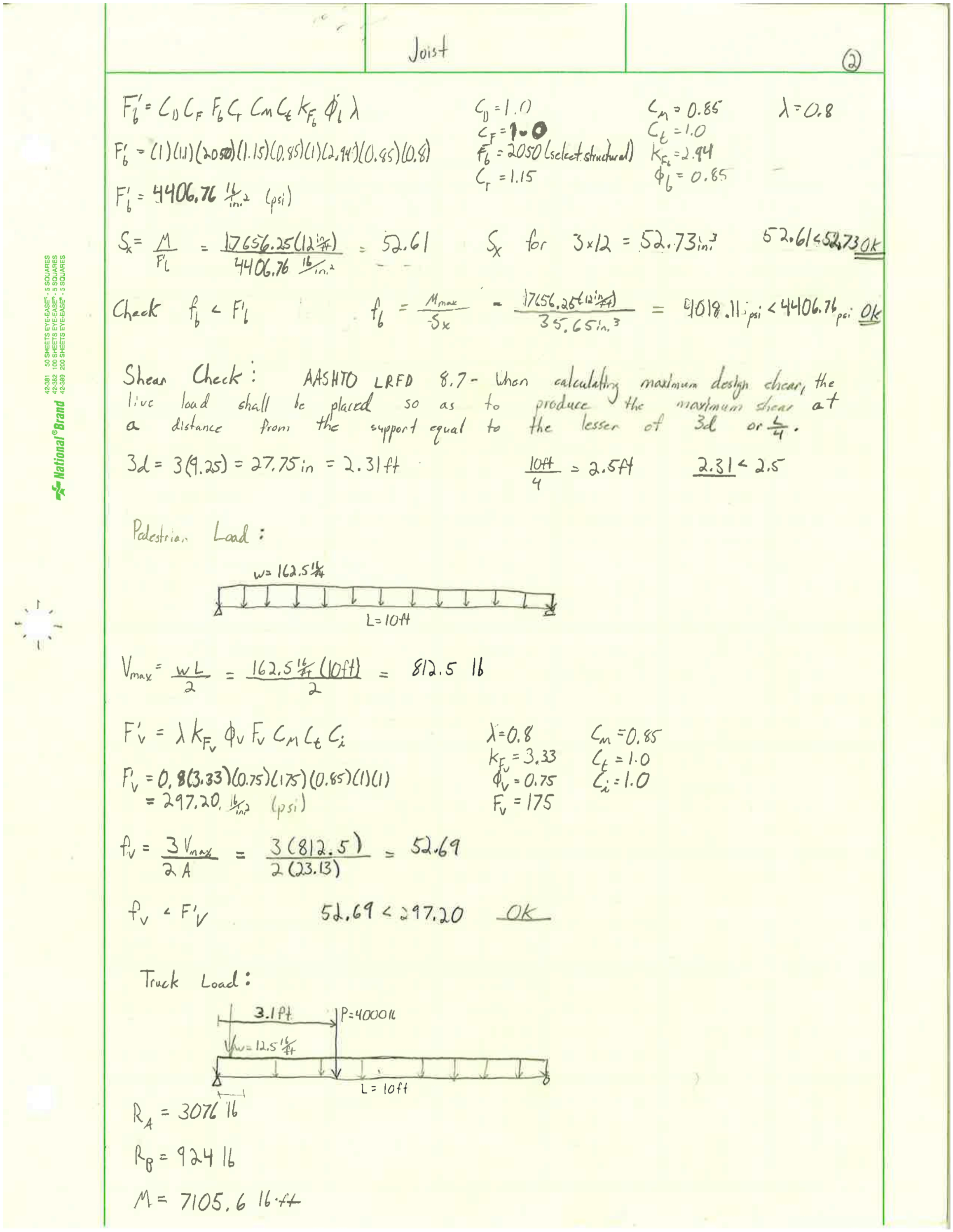
w: $M_{max} = \frac{12.5(10)^2}{8} = 156.25\,lb\cdot ft$

P: $M_{max} = \frac{PL}{4} = \frac{4000lb(10ft)}{4} = 10{,}000\,lb\cdot ft$

$M_{max} = 156.25 + 10{,}000 = 10{,}156.25\,lb\cdot ft$

$1.75(M_{max}) = 17656.25\,lb\cdot ft$

APPENDIX E: Boardwalk Calculations- Joists



Joist

②

$F_b' = C_D C_F F_b C_r C_m C_t k_{F_b} \phi_b \lambda$

$C_D = 1.0$

$C_F = 1.0$

$F_b = 2050$ (select structural)

$C_r = 1.15$

$C_m = 0.85$

$C_t = 1.0$

$k_{F_b} = 2.94$

$\phi_b = 0.85$

$\lambda = 0.8$

$F_b' = (1)(1.1)(2050)(1.15)(0.85)(1)(2.94)(0.85)(0.8)$

$F_b' = 4406.76 \ \frac{lb}{in.^2}$ (psi)

$S_x = \frac{M}{F_b'} = \frac{17656.25(12\frac{in}{ft})}{4406.76 \ \frac{lb}{in.^2}} = 52.61$ S_x for $3 \times 12 = 52.73 \ in.^3$ $52.61 < 52.73$ $\underline{\underline{Ok}}$

Check $f_b < F_b'$ $f_b = \frac{M_{max}}{S_x} = \frac{17656.25(12\frac{in}{ft})}{35.65 \ in.^3} = 4018.11 \ psi < 4406.76 \ psi$ $\underline{\underline{Ok}}$

Shear Check: AASHTO LRFD 8.7 - When calculating maximum design shear, the live load shall be placed so as to produce the maximum shear at a distance from the support equal to the lesser of 3d or $\frac{L}{4}$.

$3d = 3(9.25) = 27.75 \ in = 2.31 \ ft$ $\frac{10ft}{4} = 2.5 \ ft$ $\underline{2.31} < 2.5$

Pedestrian Load:

$V_{max} = \frac{wL}{2} = \frac{162.5\frac{lb}{ft}(10ft)}{2} = 812.5 \ lb$

$F_v' = \lambda k_{F_v} \phi_v F_v C_M C_t C_i$

$\lambda = 0.8$

$k_{F_v} = 3.33$

$\phi_v = 0.75$

$F_v = 175$

$C_m = 0.85$

$C_t = 1.0$

$C_i = 1.0$

$F_v' = 0.8(3.33)(0.75)(175)(0.85)(1)(1)$
$= 297.20 \ \frac{lb}{in^2}$ (psi)

$f_v = \frac{3V_{max}}{2A} = \frac{3(812.5)}{2(23.13)} = 52.69$

$f_v < F_v'$ $52.69 < 297.20$ $\underline{Ok}$

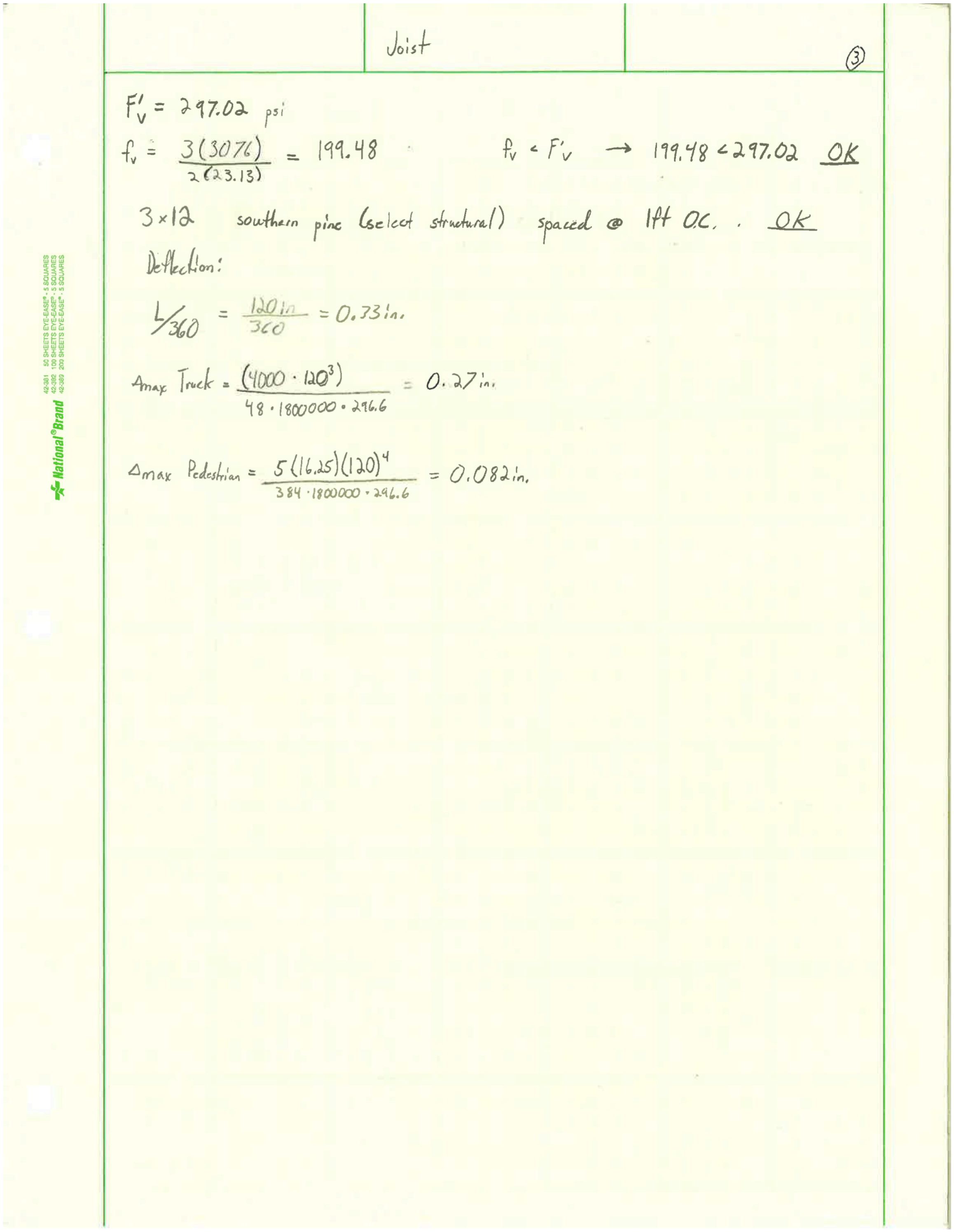
Truck Load:

$R_A = 3076 \ lb$

$R_B = 924 \ lb$

$M = 7105.6 \ lb \cdot ft$

APPENDIX E: Boardwalk Calculations- Joists



Joist

③

$F'_v = 297.02$ psi

$f_v = \frac{3(3076)}{2(23.13)} = 199.48$ $f_v < F'_v \rightarrow 199.48 < 297.02$ <u>OK</u>

3×12 southern pine (select structural) spaced @ 1ft O.C. . <u>OK</u>

Deflection:

$L/360 = \frac{120\text{ in}}{360} = 0.33\text{ in.}$

Δ_{max} Truck $= \frac{(4000 \cdot 120^3)}{48 \cdot 1800000 \cdot 296.6} = 0.27\text{ in.}$

Δ_{max} Pedestrian $= \frac{5(16.25)(120)^4}{384 \cdot 1800000 \cdot 296.6} = 0.082\text{ in.}$

APPENDIX F: Boardwalk Calculations- Beam

Pedestrian Load (lb/ft):	850	Cd	1	
Dead Load (lb/ft):	100	CF	0.99	
L(ft)	9	Fb	2050	
F'b (psi)	3446.84	Cr	1	
		CM	0.85	
		Ct	1	
		CKf	2.94	
		Φb	0.85	
		λ	0.8	
Pedestrian Load:		Section Properties:		4 x 12
w (lb/ft)	1625	b (in)	3.5	
Mmax (lb-ft)	14625	d (in)	13.25	
Sx req'd(in^3)	50.92	A (in^2)	46.38	
		Sx (in^3)	102.4	
Truck Load:		Ix (in^4)	678.5	
w (lb/ft)	125	E	1800000	
P (lb)	4000			
Mmax w:(lb-ft)	1265.63			
Mmax P:(lb-ft)	9000			
Mmax total (lb-ft)	17964.84			
Sx req'd (in^3)	62.54			
fb	2105.26			
Check fb<F'b	OK			

Shear Check: AASHTO LRFD 8.7: When caculating maximum design shear, the live load shall be placed so as to produce the maximum shear at a distance from the support equal to the lesser of 3d or L/4

3d (ft)	477	λ	0.8
L/4 (ft)	2.25	CKv	3.33
		Φv	0.75
Pedestrian Load:		Fv	175
Vmax (lb)	7312.5	CM	0.85
F'v (psi)	297.5	Ct	1
fv	236.50	Ci	1
Check fv<F'v	OK		

Truck Load: Vmax (lb)	3076	
F'v	297.5	
fv	99.48	
Check fv<F'v	OK	
Deflection Check:		
L/360 (in)	0.3	
Δmax Truck (in)	0.09	
Δmax Pedestrian (in)	0.26	
Check PL Δmax<L/360	OK	
Check TL Δmax<L/360	OK	

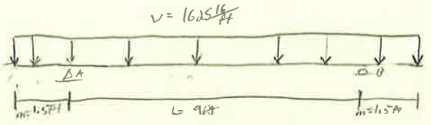
4x14 Southern Pine (Select Structural) OK

APPENDIX F: Boardwalk Calculations- Beam

Transverse Beam ④

T_{width} = 10ft $w = 150(10ft) + 12.5(10ft)$
$= 1625\ lb/ft$

Pedestrian:



$$M_{max} = \frac{wL^2}{8} - \frac{wm^2}{2} = \frac{1625(9)^2}{8} - \frac{1625(1.5)^2}{2} = 14625\ lb\,ft$$

$$F_b' = C_d C_f F_b C_m C_t k_{F_b} \phi_b' \lambda$$

$$F_b' = 3832\ psi$$

$$S_x = \frac{M}{F_b'} = \frac{14625}{3832} = 45.8\ in.^3$$

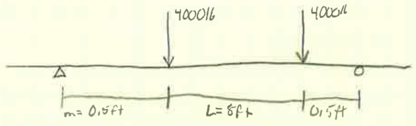
$$V_{max} = wm = 1625(1.5) = 2437.5\ lb$$

$$V_{max} = \tfrac{1}{2}wL = 0.5(1625)(9) = 7312.5\ lb$$

$$F_v' = 297.2\ psi$$

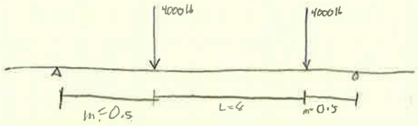
Truck:

Moment:

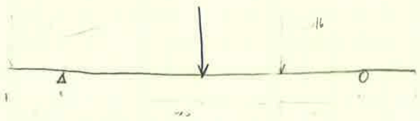


$$M_{max} = Pm = 4000(0.5) = 2000\ lb\cdot ft.$$

Shear: $3d =$ $L/4 = 27in. = 2.25ft.$

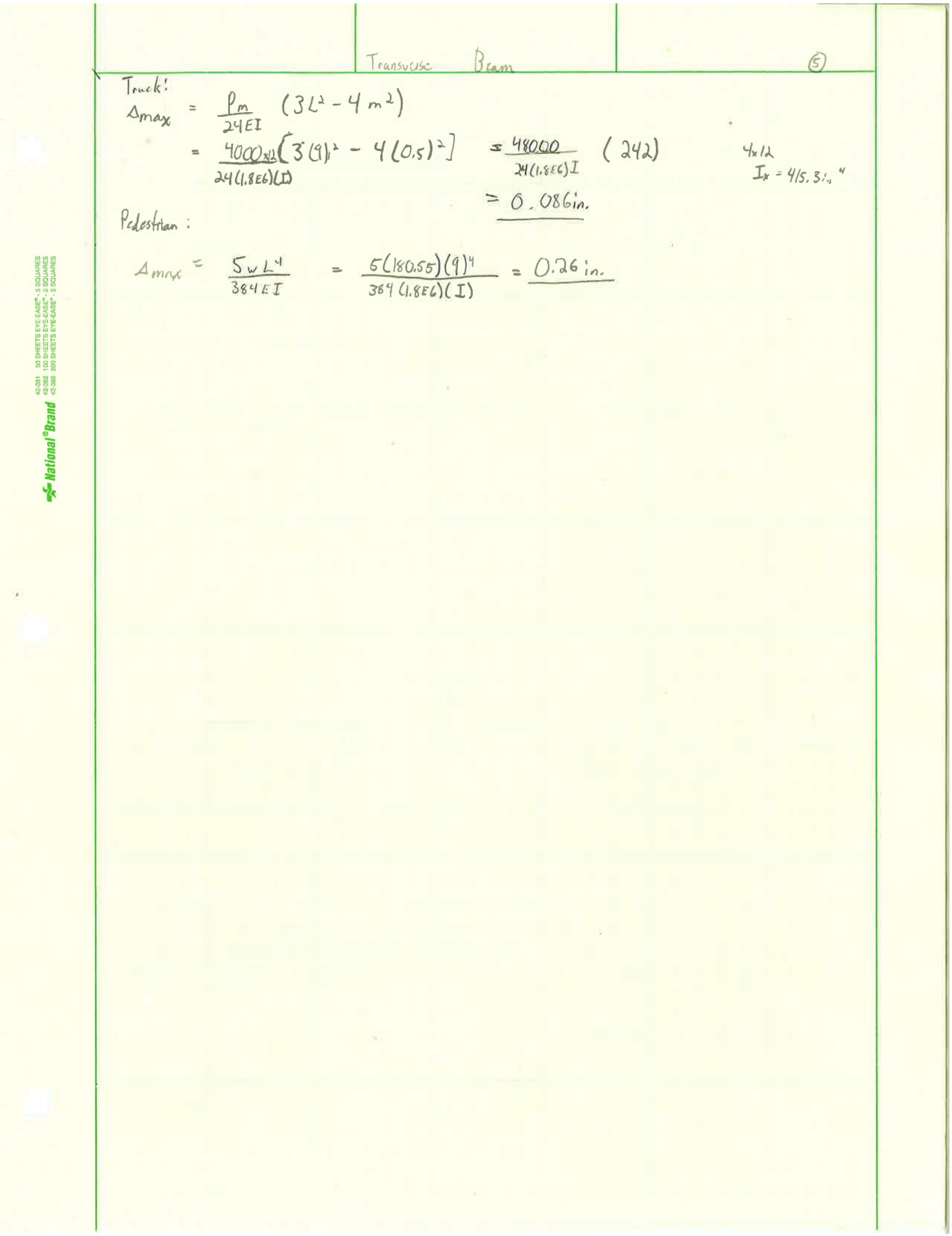


$$V_{max} = P = 4000\ lb$$



$$M_{max} = \frac{PL}{4} = 9000 + 1265.625 = 1265.625(1.25) = 17964.84\ lb\,ft.$$

APPENDIX F: Boardwalk Calculations- Beam



Transverse Beam ⑤

Truck:

$$\Delta_{max} = \frac{Pm}{24EI}(3L^2 - 4m^2)$$

$$= \frac{4000 \times 12}{24(1.8E6)(I)}\left[3(9)^2 - 4(0.5)^2\right] = \frac{48000}{24(1.8E6)I}(242)$$

$$= \underline{0.086\text{in.}}$$

4x12

$I_x = 415.3\text{ in}^4$

Pedestrian:

$$\Delta_{max} = \frac{5wL^4}{384EI} = \frac{5(180.55)(9)^4}{384(1.8E6)(I)} = \underline{0.26\text{ in.}}$$

Granular Soil

Ultimate & Allowable Load Capacity in Compression

- **Ultimate Capacity**

$$Q_{ULT} = P_T N_q A_T + \sum_{H=H_0}^{H=H_0+D} (K_{HC})(P_o)(\tan\partial)(S)\,H$$

Q_{ULT} = Ultimate Load Capacity in Compression
P_T = Effective Vertical Stress at Pile Tip (Note 1)
N_q = Bearing Capacity Factor (see Table)
A_T = Area of Pile Tip
K_{HC} = Ratio of Horizontal to Vertical Effective Stress on Side of Element when in Compression
P_o = Effective Vertical Stress over Length of Embedment, D
∂ = Friction Angle between Pile and Soil
S = Surface Area of Pile per unit length
H= Height

- **Allowable Capacity**

$$Q_{ALL} = \frac{Q_{ULT}}{FS}$$

Q_{ALL} = Allowable Load Capacity in Compression
FS = Factor of Safety (Using the standard value of 3 for this. Can be decreased if the Engineer feels the building loads and subsurface conditions are well documented.)

Boardwalk

Allowable Capacity Calculations		
Granular Soil-Ultimate Capacity (Compression)		
Variables		
Effective Verticle Stress at Pile Tip	0.75	
Bearing Capacity Factor (See Table)	62	
Area of Pile Tip	0.785	sq ft
Ratio of Horizontal to Vertical Effective Stress on Side of Element when in Compression	1.25	
Effective Vertical Stress over Length of Embedment, D	0.095	ksf
Friction Angle between Pile and Soil	27	degrees
Surface Area of Pile per unit length	3.14	sq ft
Ultimate Load Capacity in Compression=Qult	48	kips
Allowable Capacity		

Qall=Qult/FS	16	kips

Bridge

End Bearing
75' spans
14 kip/lf required for superstructure
14 kip/lf*75'=1050 kip/pile bent
5 piles/bent=210 kip/pile
End Bearing=210 kips/1.5k/in^2
Needed Area of Concrete=140in^2
Needed Dimensions=1'x1' pile
Each pile holds 210 kips per pile
5 piles/bent=1050 kip/pile

Ultimate & Allowable Load Capacity in Tension

- **Ultimate Capacity**

$$T_{ULT} = \sum_{H=H_o}^{H=H_o+D} (K_{HT})(P_o)(\tan \partial)(S)(H)$$

T_{ULT} = Ultimate Load Capacity in Tension
K_{HT} = Ratio of Horizontal to Vertical Effective Stress on Side of Element when in Tension
P_o = Effective Vertical Stress over Length of Embedment, D
∂ = Friction Angle between Pile and Soil
S = Surface Area of Pile per unit length
H = Circumference Area per Linear Foot

- **Allowable Capacity**

$$T_{ALL} = \frac{T_{ULT}}{FS} + W_p$$

T_{ALL} = Allowable Load Capacity in Tension
FS = Factor of Safety (Using the standard value of 3. Value can be decreased if the Engineer feels the building loads and subsurface conditions are well documented.)
W_p = Weight of Pile

Allowable Capacity Calculations		
Granular Soil-Ultimate Capacity (Tension)		
Variables		
Ratio of Horizontal to Vertical Effective Stress on Side of Element when in Tension	0.75	

Effective Vertical Stress over Length of Embedment, D	0.75	
Friction Angle between Pile and Soil	27	degrees
Surface Area of Pile per unit length	3.14	sf/LF
Circumference Area per Linear Foot, D1	1	ft
Circumference Area per Linear Foot, D2	2	ft
Weight of Pile	2.25	kips
Ultimate Load Capacity in Tension=Tult	2.7	kips
Allowable Load Capacity in Tension		
Tall=Tult/FS+Wp	1.7	kips

Cohesive Soil

Ultimate & Allowable Loading Capacity in Compression

- **Ultimate Capacity**

$$Q_{ULT} = C(N_{CS})\pi R^2 + (C_A)2\pi RZ$$

Q_{ULT} = Ultimate Load Capacity in Compression
C = Cohesion Factor
N_{CS} = Bearing Capacity Factor
R = Radius of Pile
C_A = Adhesion Factor
Z = Depth of Pile in Soil

- **Allowable Capacity**

$$Q_{ALL} = \frac{Q_{ULT}}{FS}$$

Q_{ALL} = Allowable Load Capacity in Compression
FS = Factor of Safety (Using the standard value of 3. Value can be decreased if the Engineer feels the building loads and subsurface conditions are well documented.)

Allowable Capacity Calculations		
Cohesive Soil-Ultimate Capacity (Compression)		
Variables		
Cohesion Factor	800	psf
Bearing Capacity Factor	9	
Radius of Pile	0.5	ft
Adhesion Factor	600	psf
Depth of Pile in Soil	33	ft
Ultimate Load Capacity in Compression=Qult	62.2	kips

Allowable Capacity	20.72	kips

Ultimate & Allowable Loading Capacity in Tension

- **Ultimate Capacity**

$$T_{ULT} = (C_A)2\pi RZ$$

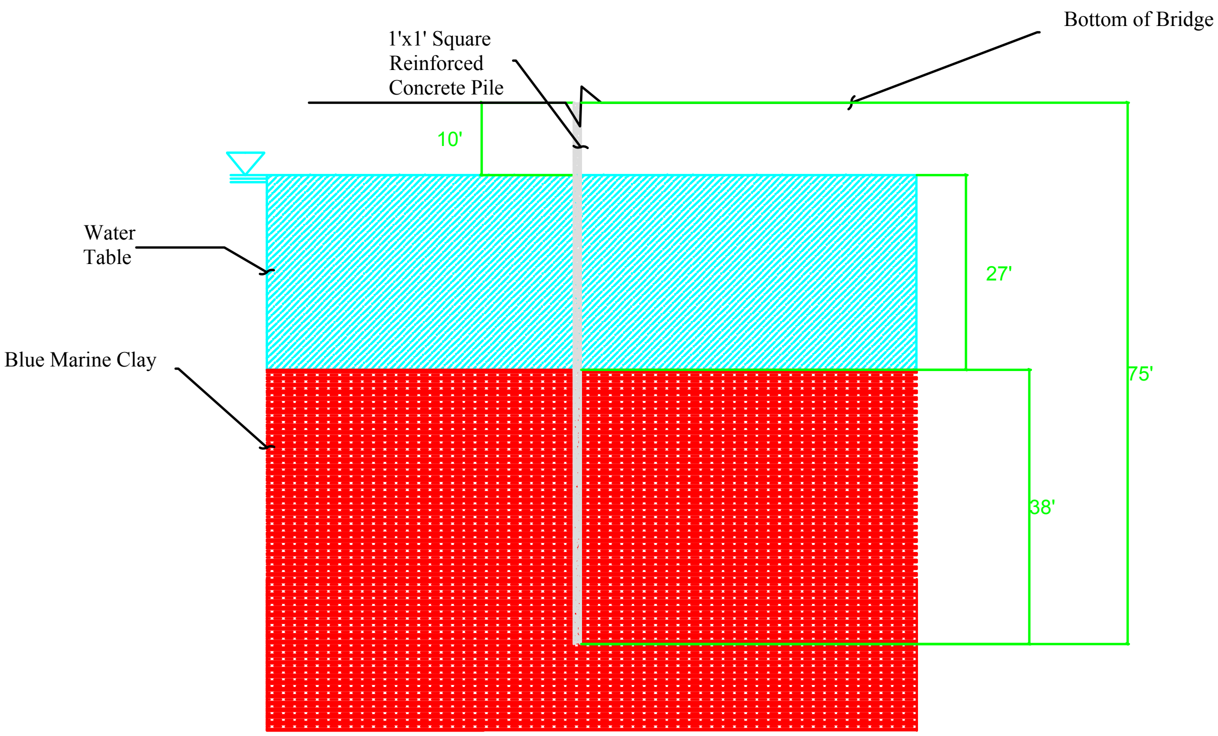
T_{ULT} = Ultimate Load Capacity in Tension
C_A = Adhesion Factor
R = Radius of Pile
Z = Depth of Pile in Soil

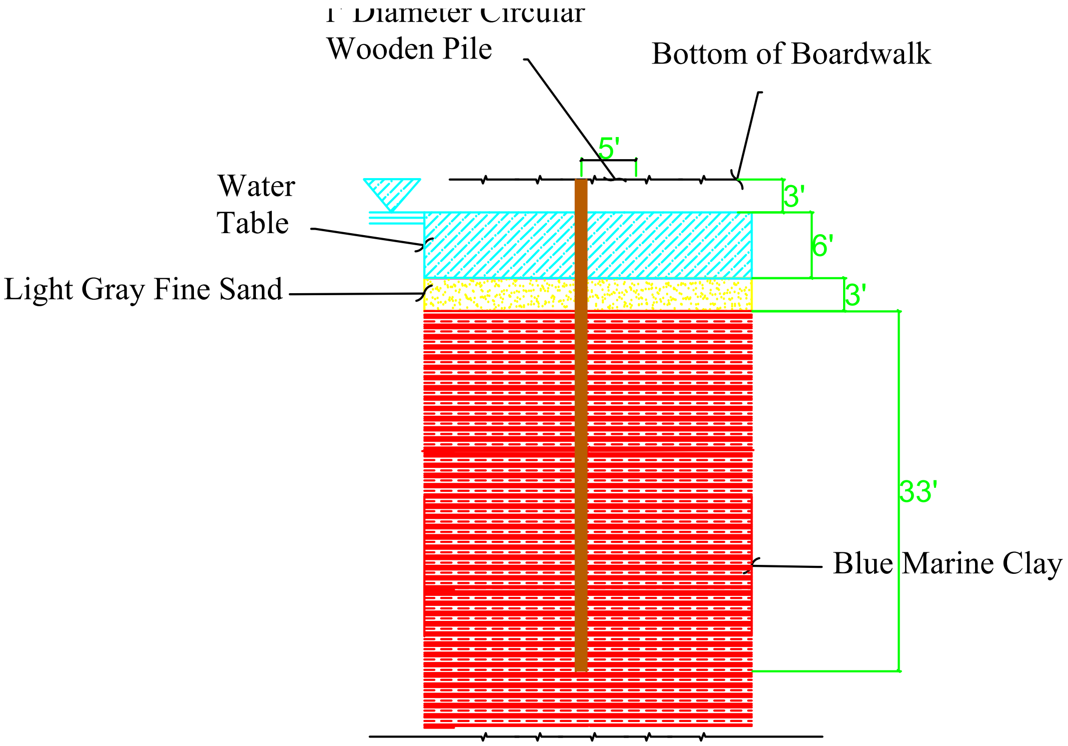
- **Allowable Capacity**

$$T_{ALL} = \frac{T_{ULT}}{FS} + W_p$$

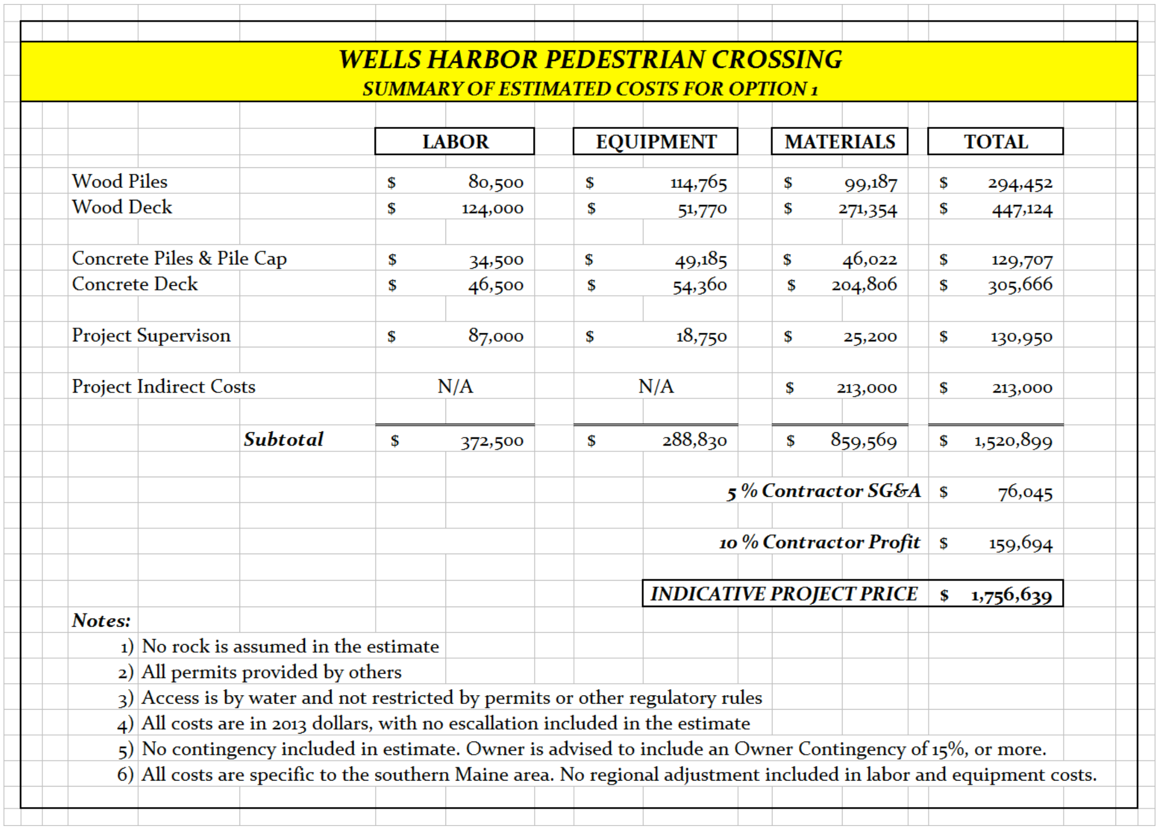
T_{ALL} = Allowable Load Capacity in Tension
FS = Factor of Safety (Using the standard value of 3. Value can be decreased if the Engineer feels the building loads and subsurface conditions are well documented.)
W_p = Weight of Pile

Allowable Capacity Calculations		
Cohesive Soil-Ultimate Capacity (Tension)		
Variables		
Adhesion Factor	600	psf
Radius of Pile	1	ft
Depth of Pile in Soil	16	ft
Ultimate Load Capacity in Tension=Tult	60.3	kips
Allowable Load Capacity in Tension		
Tall=Tult/FS+Wp	20.9	kips


Bottom of Bridge
1'x1' Square
Reinforced
Concrete Pile
10'
Water
Table
27'
Blue Marine Clay
75'
38'


1' Diameter Circular
Wooden Pile
Bottom of Boardwalk
5'
Water
Table
3'
6'
Light Gray Fine Sand
3'
33'
Blue Marine Clay

APPENDIX H: Cost Estimate Option One



WELLS HARBOR PEDESTRIAN CROSSING

SUMMARY OF ESTIMATED COSTS FOR OPTION 1

	LABOR	EQUIPMENT	MATERIALS	TOTAL
Wood Piles	$ 80,500	$ 114,765	$ 99,187	$ 294,452
Wood Deck	$ 124,000	$ 51,770	$ 271,354	$ 447,124
Concrete Piles & Pile Cap	$ 34,500	$ 49,185	$ 46,022	$ 129,707
Concrete Deck	$ 46,500	$ 54,360	$ 204,806	$ 305,666
Project Supervison	$ 87,000	$ 18,750	$ 25,200	$ 130,950
Project Indirect Costs	N/A	N/A	$ 213,000	$ 213,000
Subtotal	$ 372,500	$ 288,830	$ 859,569	$ 1,520,899
			5 % Contractor SG&A	$ 76,045
			10 % Contractor Profit	$ 159,694
			INDICATIVE PROJECT PRICE	**$ 1,756,639**

Notes:

1) No rock is assumed in the estimate
2) All permits provided by others
3) Access is by water and not restricted by permits or other regulatory rules
4) All costs are in 2013 dollars, with no escallation included in the estimate
5) No contingency included in estimate. Owner is advised to include an Owner Contingency of 15%, or more.
6) All costs are specific to the southern Maine area. No regional adjustment included in labor and equipment costs.

APPENDIX H: Cost Estimate Option One

12" Diameter Wood Piling

PART A - LABOR COSTS

	LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1)	Crane Operators	2	$ 3,600	7	$ 25,200
2)	Pile Driver Foreman	1	$ 2,000	7	$ 14,000
3)	Pile Drivers	2	$ 3,200	7	$ 22,400
4)	Construction Worker	2	$ 2,700	7	$ 18,900
					$ 80,500

PART B - EQUIPMENT COSTS

	EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1)	16' Aluminum Crew Work Boats	2	$ 425	7	$ 2,975
2)	Steel work Boat with Motor	1	$ 575	7	$ 4,025
3)	Manitowoc 4000 - 150 Ton Crane	1	$ 4,100	7	$ 28,700
4)	Air Compressor - 150 CFM	1	$ 400	7	$ 2,800
5)	20 Kw Portable power Unit	1	$ 325	7	$ 2,275
6)	Delmag 16G Diesel Pile Driving Hammer	1	$ 1,800	7	$ 12,600
7)	ICE 440 Hydrostatic Vibratory Pile Driving Hammer	1	$ 2,500	7	$ 17,500
8)	Timber Pile Clamp	1	$ 275	7	$ 1,925
9)	20 Foot Storage Containers	1	$ 30	7	$ 210
10)	Office Trailer	1	$ 65	7	$ 455
11)	400 Amp Diesel Welder	1	$ 300	7	$ 2,100
12)	15 Section Flexi-Float Barge with Crane Mats	1	$ 2,000	7	$ 14,000
13)	Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	7	$ 11,200
14)	Small Push Boat	1	$ 900	7	$ 6,300
15)	4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	7	$ 7,700
					$ 114,765

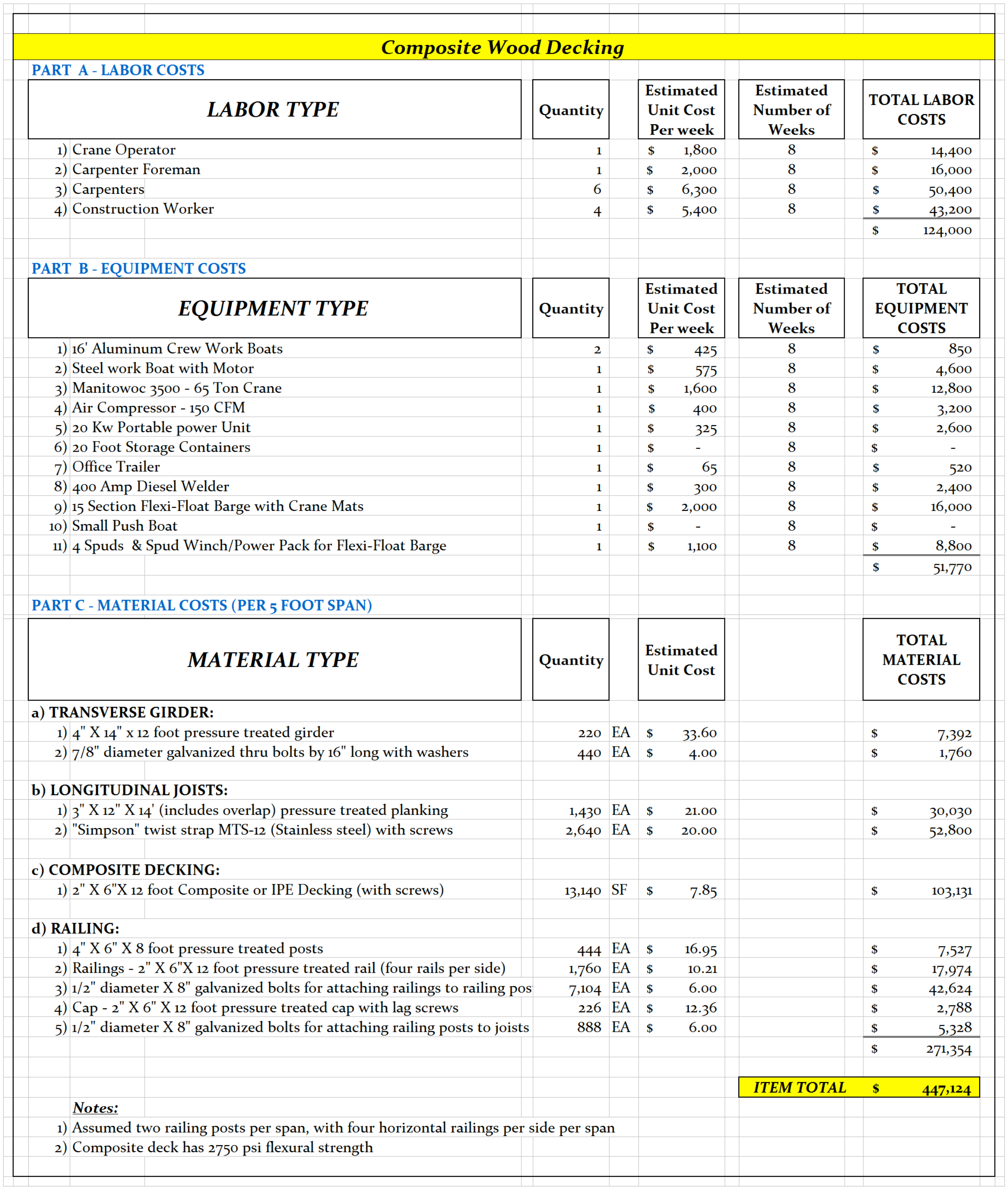
PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

	MATERIAL TYPE	Quantity		Estimated Unit Cost		TOTAL MATERIAL COSTS
	PILE:					
1)	12" diameter pressure treated wood pile by 35 foot (assumed) long	221	EA	$ 358		$ 79,187
2)	Pile Driving Frame	1	EA	$ 20,000		$ 20,000
						$ 99,187
					ITEM TOTAL	**$ 294,452**

Notes:

1) Wood piles are assumed to be 2.5 CCA pressure treated, 12" diameter by 35 feet long
2) Pile bents are 10 foot center to center

APPENDIX H: Cost Estimate Option One



Composite Wood Decking

PART A - LABOR COSTS

LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1) Crane Operator	1	$ 1,800	8	$ 14,400
2) Carpenter Foreman	1	$ 2,000	8	$ 16,000
3) Carpenters	6	$ 6,300	8	$ 50,400
4) Construction Worker	4	$ 5,400	8	$ 43,200
				$ 124,000

PART B - EQUIPMENT COSTS

EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1) 16' Aluminum Crew Work Boats	2	$ 425	8	$ 850
2) Steel work Boat with Motor	1	$ 575	8	$ 4,600
3) Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	8	$ 12,800
4) Air Compressor - 150 CFM	1	$ 400	8	$ 3,200
5) 20 Kw Portable power Unit	1	$ 325	8	$ 2,600
6) 20 Foot Storage Containers	1	$ -	8	$ -
7) Office Trailer	1	$ 65	8	$ 520
8) 400 Amp Diesel Welder	1	$ 300	8	$ 2,400
9) 15 Section Flexi-Float Barge with Crane Mats	1	$ 2,000	8	$ 16,000
10) Small Push Boat	1	$ -	8	$ -
11) 4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	8	$ 8,800
				$ 51,770

PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

MATERIAL TYPE	Quantity		Estimated Unit Cost	TOTAL MATERIAL COSTS
a) TRANSVERSE GIRDER:				
1) 4" X 14" x 12 foot pressure treated girder	220	EA	$ 33.60	$ 7,392
2) 7/8" diameter galvanized thru bolts by 16" long with washers	440	EA	$ 4.00	$ 1,760
b) LONGITUDINAL JOISTS:				
1) 3" X 12" X 14' (includes overlap) pressure treated planking	1,430	EA	$ 21.00	$ 30,030
2) "Simpson" twist strap MTS-12 (Stainless steel) with screws	2,640	EA	$ 20.00	$ 52,800
c) COMPOSITE DECKING:				
1) 2" X 6"X 12 foot Composite or IPE Decking (with screws)	13,140	SF	$ 7.85	$ 103,131
d) RAILING:				
1) 4" X 6" X 8 foot pressure treated posts	444	EA	$ 16.95	$ 7,527
2) Railings - 2" X 6"X 12 foot pressure treated rail (four rails per side)	1,760	EA	$ 10.21	$ 17,974
3) 1/2" diameter X 8" galvanized bolts for attaching railings to railing pos	7,104	EA	$ 6.00	$ 42,624
4) Cap - 2" X 6" X 12 foot pressure treated cap with lag screws	226	EA	$ 12.36	$ 2,788
5) 1/2" diameter X 8" galvanized bolts for attaching railing posts to joists	888	EA	$ 6.00	$ 5,328
				$ 271,354
			ITEM TOTAL	$ 447,124

Notes:

1) Assumed two railing posts per span, with four horizontal railings per side per span
2) Composite deck has 2750 psi flexural strength

APPENDIX H: Cost Estimate Option One

12" Square Concrete Piling & Concrete Pile Cap

PART A - LABOR COSTS

	LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1)	Crane Operators	2	$ 3,600	3	$ 10,800
2)	Pile Driver Foreman	1	$ 2,000	3	$ 6,000
3)	Pile Drivers	2	$ 3,200	3	$ 9,600
4)	Construction Worker	2	$ 2,700	3	$ 8,100
					$ 34,500

PART B - EQUIPMENT COSTS

	EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1)	16' Aluminum Crew Work Boats	2	$ 425	3	$ 1,275
2)	Steel work Boat with Motor	1	$ 575	3	$ 1,725
3)	Manitowoc 4000 - 150 Ton Crane	1	$ 4,100	3	$ 12,300
4)	Air Compressor - 150 CFM	1	$ 400	3	$ 1,200
5)	20 Kw Portable power Unit	1	$ 325	3	$ 975
6)	Delmag 16G Diesel Pile Driving Hammer	1	$ 1,800	3	$ 5,400
7)	ICE 440 Hydrostatic Vibratory Pile Driving Hammer	1	$ 2,500	3	$ 7,500
8)	Timber Pile Clamp	1	$ 275	3	$ 825
9)	20 Foot Storage Containers	1	$ 30	3	$ 90
10)	Office Trailer	1	$ 65	3	$ 195
11)	400 Amp Disel Welder	1	$ 300	3	$ 900
12)	15 Section Flexi-Float Barge with Crane Mats	1	$ 2,000	3	$ 6,000
13)	Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	3	$ 4,800
14)	Small Push Boat	1	$ 900	3	$ 2,700
15)	4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	3	$ 3,300
					$ 49,185

PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

	MATERIAL TYPE	Quantity		Estimated Unit Cost	TOTAL MATERIAL COSTS
a)	**CONCRETE PILE:**				
1)	12" Square prestressed concrete pile by (assumed) 40' long	8	EA	$ 1,000	$ 8,000
2)	12" Square prestressed concrete pile by (assumed) 60' long	12	EA	$ 1,400	$ 16,800
3)	12" Pile driving frame	1	EA	$ 10,000	$ 10,000
b)	**CONCRETE PILE CAP:**				
1)	Furnish 3500 psi concrete	22	CY	$ 175	$ 3,889
2)	Rent Steel Formwork	1	LS	$ 4,000	$ 4,000
3)	Furnish epoxy coated reinforcing steel	3,333	LBS	$ 1.00	$ 3,333
					$ 46,022
				ITEM TOTAL	**$ 129,707**

Notes:

1) Concrete piles are assumed to be pre-stressed 12" square
2) It assumed that no test piles are to be driven
3) Pile caps are assumed to 2 feet wide by 3 feet high
4) Assuming 150 pounds of epoxy coated rebar per cubic yard of concrete

APPENDIX H: Cost Estimate Option One

Precast "NEXT" Concrete Deck (with 4" Concrete Overlay)

PART A - LABOR COSTS

LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1) Crane Operator	1	$ 1,800	3	$ 5,400
2) Carpenter Foreman	1	$ 2,000	3	$ 6,000
3) Carpenters	4	$ 6,300	3	$ 18,900
4) Construction Worker	4	$ 5,400	3	$ 16,200
				$ 46,500

PART B - EQUIPMENT COSTS

EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1) 16' Aluminum Crew Work Boats	2	$ 425	3	$ 1,275
2) Steel work Boat with Motor	1	$ 575	3	$ 1,725
3) Manitowoc 4000 - 150 Ton Crane	2	$ 8,200	3	$ 24,600
4) Air Compressor - 150 CFM	1	$ 400	3	$ 1,200
5) 20 Kw Portable power Unit	1	$ 325	3	$ 975
6) 20 Foot Storage Containers	1	$ 30	3	$ 90
7) Office Trailer	1	$ 65	3	$ 195
8) 400 Amp Diesel Welder	1	$ 300	3	$ 900
9) 15 Section Flexi-Float Barge with Crane Mats	2	$ 4,000	3	$ 12,000
10) Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	3	$ 4,800
11) Small Push Boat & Concrete Buckets	1	$ 1,100	3	$ 3,300
12) 4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	3	$ 3,300
				$ 54,360

PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

MATERIAL TYPE	Quantity		Estimated Unit Cost		TOTAL MATERIAL COSTS
a) PRECAST CONCRETE "NEXT" BEAMS & CONCRETE OVERLAY:					
1) Furnish 8 feet wide X 75 foot long X 36" deep "NEXT" beams	8	EA	$ 19,500		$ 156,000
2) Furnish concrete deck overlay (assumed to be 4" thick)	65	CY	$ 200		$ 12,907
3) Furnish welded wire mesh and curing material	1	LS	$ 4,800		$ 4,800
4) Furnish elastomeric bearings	32	EA	$ 230		$ 7,360
5) Furnish expansion joints	48	EA	$ 110		$ 5,280
b) RAILING:					
1) 4" X 6" X 8 foot pressure treated posts	122	EA	$ 16.95		$ 2,068
2) Railings - 2" X 6"X 12 foot pressure treated rail (four rails per side)	240	EA	$ 10.21		$ 2,451
3) 1/2" diameter X 8" galvanized bolts for attaching railings to railing post	1,952	EA	$ 6.00		$ 11,712
4) Cap - 2" X 6" X 12 foot pressure treated cap with lag screws	62	EA	$ 12.36		$ 764
5) 1/2" diameter X 8" galvanized bolts for attaching railing posts to joists	244	EA	$ 6.00		$ 1,464
					$ 204,806
				ITEM TOTAL	$ **305,666**

Notes:

1) Assumed 6x6 #10 welded wire fabric
2) Expansion joints are double angle with filler material
3) Assumed fifteen railing posts per span, with four horizontal railings per side per span

APPENDIX H: Cost Estimate Option One

Project Supervision

PART A - LABOR COSTS

LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1) Project Manager	1	$ 3,000	15	$ 45,000
2) Project Engineer	1	$ 2,000	15	$ 30,000
3) Safety Supervisor	0.25	$ 2,000	15	$ 7,500
4) Field Administartor	0.25	$ 1,200	15	$ 4,500
				$ 87,000

PART B - EQUIPMENT COSTS

EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1) Pick up Truck	2	$ 250	15	$ 7,500
2) Survey Van with survey equipment	1	$ 350	15	$ 5,250
3) Office Trailer	1	$ 400	15	$ 6,000
				$ 18,750

PART C - MATERIAL COSTS

MATERIAL TYPE	Quantity		Estimated Unit Cost	TOTAL MATERIAL COSTS
a) Project - Indirect Costs				
1) Telephone/computer	6	MO	$ 300	$ 1,800
2) Power	6	MO	$ 500	$ 3,000
3) Trash Removal	6	MO	$ 350	$ 2,100
4) Yard Rental	6	MO	$ 2,000	$ 12,000
5) Porta Pottys	6	MO	$ 300	$ 1,800
6) Safety Equipment	1	LS	$ 3,000	$ 3,000
7) Miscellaneous Supplies	1	LS	$ 1,500	$ 1,500
				$ 25,200
			ITEM TOTAL	**$ 130,950**

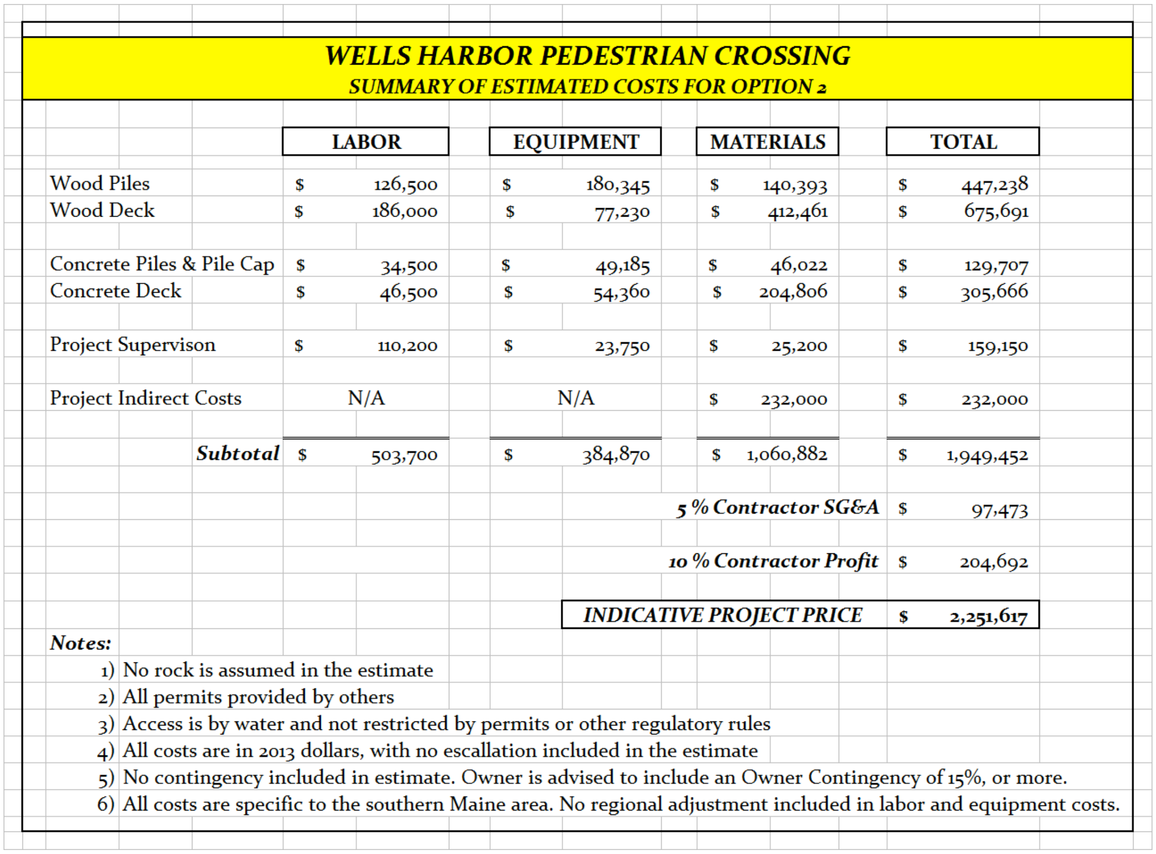
Project Indirect Costs

COST TYPE	Quantity		Estimated Unit Cost	TOTAL COSTS
a) Indirect Costs:				
1) Project Performance & Payment Bond	1	LS	$ 38,000	$ 38,000
2) Equipment Mobilization	1	LS	$ 76,000	$ 76,000
3) Equipment Operation & Maintenance	1	LS	$ 56,000	$ 56,000
4) Project Liability Insurance	1	LS	$ 28,000	$ 28,000
5) Project Marine Insurance	1	LS	$ 15,000	$ 15,000
				$ 213,000
			ITEM TOTAL	**$ 213,000**

Notes:

1) It assumed that project is tax exempt and not subject to sales tax

APPENDIX I: Cost Estimate Option Two



WELLS HARBOR PEDESTRIAN CROSSING

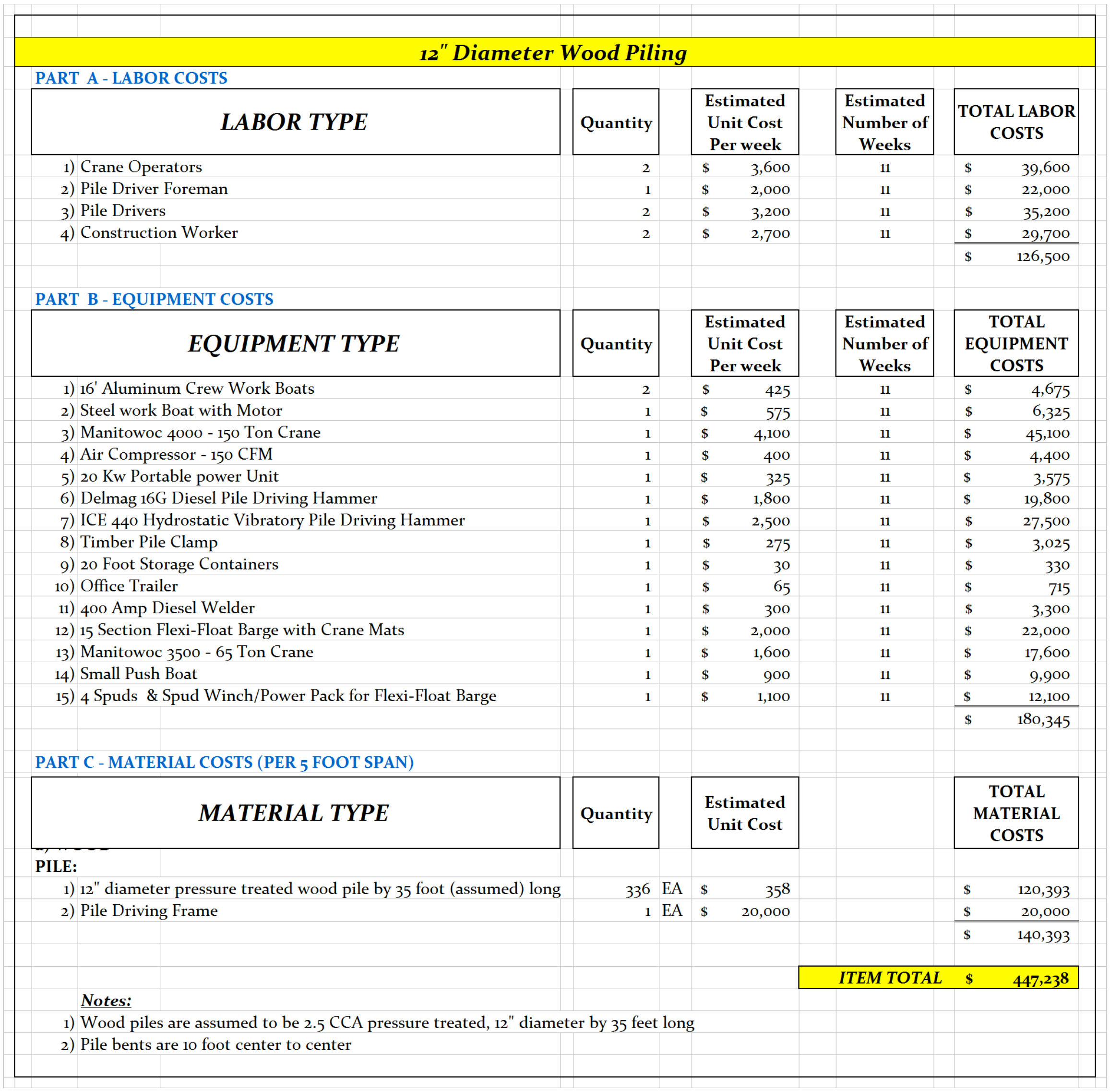
SUMMARY OF ESTIMATED COSTS FOR OPTION 2

	LABOR	EQUIPMENT	MATERIALS	TOTAL
Wood Piles	$ 126,500	$ 180,345	$ 140,393	$ 447,238
Wood Deck	$ 186,000	$ 77,230	$ 412,461	$ 675,691
Concrete Piles & Pile Cap	$ 34,500	$ 49,185	$ 46,022	$ 129,707
Concrete Deck	$ 46,500	$ 54,360	$ 204,806	$ 305,666
Project Supervison	$ 110,200	$ 23,750	$ 25,200	$ 159,150
Project Indirect Costs	N/A	N/A	$ 232,000	$ 232,000
Subtotal	$ 503,700	$ 384,870	$ 1,060,882	$ 1,949,452
			5 % Contractor SG&A	$ 97,473
			10 % Contractor Profit	$ 204,692
			INDICATIVE PROJECT PRICE	**$ 2,251,617**

Notes:

1) No rock is assumed in the estimate
2) All permits provided by others
3) Access is by water and not restricted by permits or other regulatory rules
4) All costs are in 2013 dollars, with no escallation included in the estimate
5) No contingency included in estimate. Owner is advised to include an Owner Contingency of 15%, or more.
6) All costs are specific to the southern Maine area. No regional adjustment included in labor and equipment costs.

APPENDIX I: Cost Estimate Option Two



12" Diameter Wood Piling

PART A - LABOR COSTS

LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1) Crane Operators	2	$ 3,600	11	$ 39,600
2) Pile Driver Foreman	1	$ 2,000	11	$ 22,000
3) Pile Drivers	2	$ 3,200	11	$ 35,200
4) Construction Worker	2	$ 2,700	11	$ 29,700
				$ 126,500

PART B - EQUIPMENT COSTS

EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1) 16' Aluminum Crew Work Boats	2	$ 425	11	$ 4,675
2) Steel work Boat with Motor	1	$ 575	11	$ 6,325
3) Manitowoc 4000 - 150 Ton Crane	1	$ 4,100	11	$ 45,100
4) Air Compressor - 150 CFM	1	$ 400	11	$ 4,400
5) 20 Kw Portable power Unit	1	$ 325	11	$ 3,575
6) Delmag 16G Diesel Pile Driving Hammer	1	$ 1,800	11	$ 19,800
7) ICE 440 Hydrostatic Vibratory Pile Driving Hammer	1	$ 2,500	11	$ 27,500
8) Timber Pile Clamp	1	$ 275	11	$ 3,025
9) 20 Foot Storage Containers	1	$ 30	11	$ 330
10) Office Trailer	1	$ 65	11	$ 715
11) 400 Amp Diesel Welder	1	$ 300	11	$ 3,300
12) 15 Section Flexi-Float Barge with Crane Mats	1	$ 2,000	11	$ 22,000
13) Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	11	$ 17,600
14) Small Push Boat	1	$ 900	11	$ 9,900
15) 4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	11	$ 12,100
				$ 180,345

PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

MATERIAL TYPE	Quantity		Estimated Unit Cost		TOTAL MATERIAL COSTS
PILE:					
1) 12" diameter pressure treated wood pile by 35 foot (assumed) long	336	EA	$ 358		$ 120,393
2) Pile Driving Frame	1	EA	$ 20,000		$ 20,000
					$ 140,393
				ITEM TOTAL	$ 447,238

Notes:

1) Wood piles are assumed to be 2.5 CCA pressure treated, 12" diameter by 35 feet long
2) Pile bents are 10 foot center to center

APPENDIX I: Cost Estimate Option Two

Composite Wood Decking

PART A - LABOR COSTS

LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1) Crane Operator	1	$ 1,800	12	$ 21,600
2) Carpenter Foreman	1	$ 2,000	12	$ 24,000
3) Carpenters	6	$ 6,300	12	$ 75,600
4) Construction Worker	4	$ 5,400	12	$ 64,800
				$ 186,000

PART B - EQUIPMENT COSTS

EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1) 16' Aluminum Crew Work Boats	2	$ 425	12	$ 850
2) Steel work Boat with Motor	1	$ 575	12	$ 6,900
3) Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	12	$ 19,200
4) Air Compressor - 150 CFM	1	$ 400	12	$ 4,800
5) 20 Kw Portable power Unit	1	$ 325	12	$ 3,900
6) 20 Foot Storage Containers	1	$ -	12	$ -
7) Office Trailer	1	$ 65	12	$ 780
8) 400 Amp Diesel Welder	1	$ 300	12	$ 3,600
9) 15 Section Flexi-Float Barge with Crane Mats	1	$ 2,000	12	$ 24,000
10) Small Push Boat	1	$ -	12	$ -
11) 4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	12	$ 13,200
				$ 77,230

PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

MATERIAL TYPE	Quantity		Estimated Unit Cost		TOTAL MATERIAL COSTS
a) TRANSVERSE GIRDER:					
1) 4" X 14" x 12 foot pressure treated girder	336	EA	$ 33.60		$ 11,290
2) 7/8" diameter galvanized thru bolts by 16" long with washers	672	EA	$ 4.00		$ 2,688
b) LONGITUDINAL JOISTS:					
1) 3" X 12" X 14' (includes overlap) pressure treated planking	2,184	EA	$ 21.00		$ 45,864
2) "Simpson" twist strap MTS-12 (Stainless steel) with screws	4,032	EA	$ 20.00		$ 80,640
c) COMPOSITE DECKING:					
1) 2" X 6"X 12 foot Composite or IPE Decking (with screws)	19,980	SF	$ 7.85		$ 156,815
d) RAILING:					
1) 4" X 6" X 8 foot pressure treated posts	670	EA	$ 16.95		$ 11,359
2) Railings - 2" X 6"X 12 foot pressure treated rail (four rails per side)	2,664	EA	$ 10.21		$ 27,206
3) 1/2" diameter X 8" galvanized bolts for attaching railings to railing pos	10,720	EA	$ 6.00		$ 64,320
4) Cap - 2" X 6" X 12 foot pressure treated cap with lag screws	343	EA	$ 12.36		$ 4,239
5) 1/2" diameter X 8" galvanized bolts for attaching railing posts to joists	1,340	EA	$ 6.00		$ 8,040
					$ 412,461
				ITEM TOTAL	**$ 675,691**

Notes:

1) Assumed two railing posts per span, with four horizontal railings per side per span
2) Composite deck has 2750 psi flexural strength

APPENDIX I: Cost Estimate Option Two

12" Square Concrete Piling & Concrete Pile Cap

PART A - LABOR COSTS

	LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1)	Crane Operators	2	$ 3,600	3	$ 10,800
2)	Pile Driver Foreman	1	$ 2,000	3	$ 6,000
3)	Pile Drivers	2	$ 3,200	3	$ 9,600
4)	Construction Worker	2	$ 2,700	3	$ 8,100
					$ 34,500

PART B - EQUIPMENT COSTS

	EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1)	16' Aluminum Crew Work Boats	2	$ 425	3	$ 1,275
2)	Steel work Boat with Motor	1	$ 575	3	$ 1,725
3)	Manitowoc 4000 - 150 Ton Crane	1	$ 4,100	3	$ 12,300
4)	Air Compressor - 150 CFM	1	$ 400	3	$ 1,200
5)	20 Kw Portable power Unit	1	$ 325	3	$ 975
6)	Delmag 16G Diesel Pile Driving Hammer	1	$ 1,800	3	$ 5,400
7)	ICE 440 Hydrostatic Vibratory Pile Driving Hammer	1	$ 2,500	3	$ 7,500
8)	Timber Pile Clamp	1	$ 275	3	$ 825
9)	20 Foot Storage Containers	1	$ 30	3	$ 90
10)	Office Trailer	1	$ 65	3	$ 195
11)	400 Amp Disel Welder	1	$ 300	3	$ 900
12)	15 Section Flexi-Float Barge with Crane Mats	1	$ 2,000	3	$ 6,000
13)	Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	3	$ 4,800
14)	Small Push Boat	1	$ 900	3	$ 2,700
15)	4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	3	$ 3,300
					$ 49,185

PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

	MATERIAL TYPE	Quantity		Estimated Unit Cost	TOTAL MATERIAL COSTS
a) CONCRETE PILE:					
1)	12" Square prestressed concrete pile by (assumed) 40' long	8	EA	$ 1,000	$ 8,000
2)	12" Square prestressed concrete pile by (assumed) 60' long	12	EA	$ 1,400	$ 16,800
3)	12" Pile driving frame	1	EA	$ 10,000	$ 10,000
b) CONCRETE PILE CAP:					
1)	Furnish 3500 psi concrete	22	CY	$ 175	$ 3,889
2)	Rent Steel Formwork	1	LS	$ 4,000	$ 4,000
3)	Furnish epoxy coated reinforcing steel	3,333	LBS	$ 1.00	$ 3,333
					$ 46,022
				ITEM TOTAL	**$ 129,707**

Notes:

1) Concrete piles are assumed to be pre-stressed 12" square
2) It assumed that no test piles are to be driven
3) Pile caps are assumed to 2 feet wide by 3 feet high
4) Assuming 150 pounds of epoxy coated rebar per cubic yard of concrete

APPENDIX I: Cost Estimate Option Two

Precast "NEXT" Concrete Deck (with 4" Concrete Overlay)

PART A - LABOR COSTS

LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1) Crane Operator	1	$ 1,800	3	$ 5,400
2) Carpenter Foreman	1	$ 2,000	3	$ 6,000
3) Carpenters	4	$ 6,300	3	$ 18,900
4) Construction Worker	4	$ 5,400	3	$ 16,200
				$ 46,500

PART B - EQUIPMENT COSTS

EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1) 16' Aluminum Crew Work Boats	2	$ 425	3	$ 1,275
2) Steel work Boat with Motor	1	$ 575	3	$ 1,725
3) Manitowoc 4000 - 150 Ton Crane	2	$ 8,200	3	$ 24,600
4) Air Compressor - 150 CFM	1	$ 400	3	$ 1,200
5) 20 Kw Portable power Unit	1	$ 325	3	$ 975
6) 20 Foot Storage Containers	1	$ 30	3	$ 90
7) Office Trailer	1	$ 65	3	$ 195
8) 400 Amp Diesel Welder	1	$ 300	3	$ 900
9) 15 Section Flexi-Float Barge with Crane Mats	2	$ 4,000	3	$ 12,000
10) Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	3	$ 4,800
11) Small Push Boat & Concrete Buckets	1	$ 1,100	3	$ 3,300
12) 4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	3	$ 3,300
				$ 54,360

PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

MATERIAL TYPE	Quantity		Estimated Unit Cost		TOTAL MATERIAL COSTS
a) PRECAST CONCRETE "NEXT" BEAMS & CONCRETE OVERLAY:					
1) Furnish 8 feet wide X 75 foot long X 36" deep "NEXT" beams	8	EA	$ 19,500		$ 156,000
2) Furnish concrete deck overlay (assumed to be 4" thick)	65	CY	$ 200		$ 12,907
3) Furnish welded wire mesh and curing material	1	LS	$ 4,800		$ 4,800
4) Furnish elastomeric bearings	32	EA	$ 230		$ 7,360
5) Furnish expansion joints	48	EA	$ 110		$ 5,280
b) RAILING:					
1) 4" X 6" X 8 foot pressure treated posts	122	EA	$ 16.95		$ 2,068
2) Railings - 2" X 6"X 12 foot pressure treated rail (four rails per side)	240	EA	$ 10.21		$ 2,451
3) 1/2" diameter X 8" galvanized bolts for attaching railings to railing post	1,952	EA	$ 6.00		$ 11,712
4) Cap - 2" X 6" X 12 foot pressure treated cap with lag screws	62	EA	$ 12.36		$ 764
5) 1/2" diameter X 8" galvanized bolts for attaching railing posts to joists	244	EA	$ 6.00		$ 1,464
					$ 204,806
				ITEM TOTAL	**$ 305,666**

Notes:

1) Assumed 6x6 #10 welded wire fabric
2) Expansion joints are double angle with filler material
3) Assumed fifteen railing posts per span, with four horizontal railings per side per span

APPENDIX I: Cost Estimate Option Two

Project Supervision

PART A - LABOR COSTS

LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1) Project Manager	1	$ 3,000	19	$ 57,000
2) Project Engineer	1	$ 2,000	19	$ 38,000
3) Safety Supervisor	0.25	$ 2,000	19	$ 9,500
4) Field Administartor	0.25	$ 1,200	19	$ 5,700
				$ 110,200

PART B - EQUIPMENT COSTS

EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1) Pick up Truck	2	$ 250	19	$ 9,500
2) Survey Van with survey equipment	1	$ 350	19	$ 6,650
3) Office Trailer	1	$ 400	19	$ 7,600
				$ 23,750

PART C - MATERIAL COSTS

MATERIAL TYPE	Quantity		Estimated Unit Cost	TOTAL MATERIAL COSTS
a) Project - Indirect Costs				
1) Telephone/computer	6	MO	$ 300	$ 1,800
2) Power	6	MO	$ 500	$ 3,000
3) Trash Removal	6	MO	$ 350	$ 2,100
4) Yard Rental	6	MO	$ 2,000	$ 12,000
5) Porta Pottys	6	MO	$ 300	$ 1,800
6) Safety Equipment	1	LS	$ 3,000	$ 3,000
7) Miscellaneous Supplies	1	LS	$ 1,500	$ 1,500
				$ 25,200

ITEM TOTAL **$ 159,150**

Project Indirect Costs

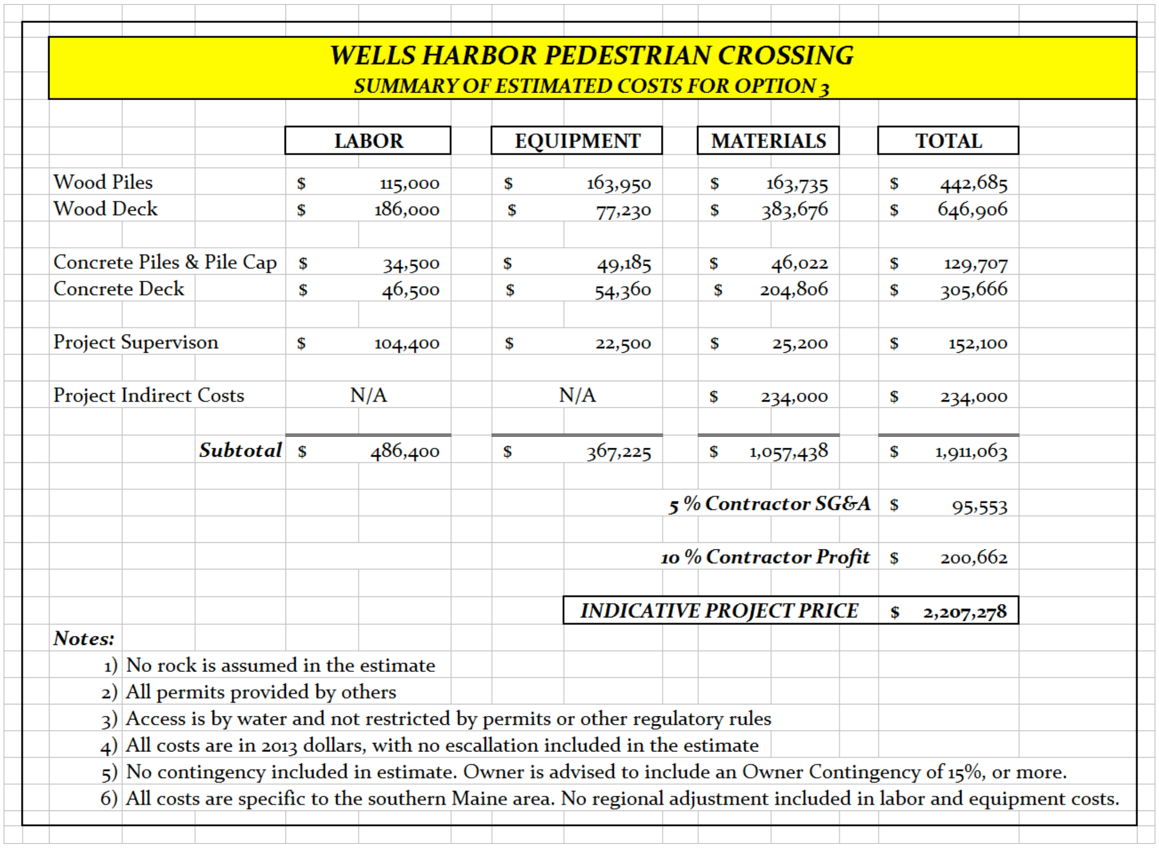
COST TYPE	Quantity		Estimated Unit Cost	TOTAL COSTS
a) Indirect Costs:				
1) Project Performance & Payment Bond	1	LS	$ 41,000	$ 41,000
2) Equipment Mobilization	1	LS	$ 76,000	$ 76,000
3) Equipment Operation & Maintenance	1	LS	$ 72,000	$ 72,000
4) Project Liability Insurance	1	LS	$ 28,000	$ 28,000
5) Project Marine Insurance	1	LS	$ 15,000	$ 15,000
				$ 232,000

ITEM TOTAL **$ 232,000**

Notes:

1) It assumed that project is tax exempt and not subject to sales tax

APPENDIX J: Cost Estimate Option Three



WELLS HARBOR PEDESTRIAN CROSSING

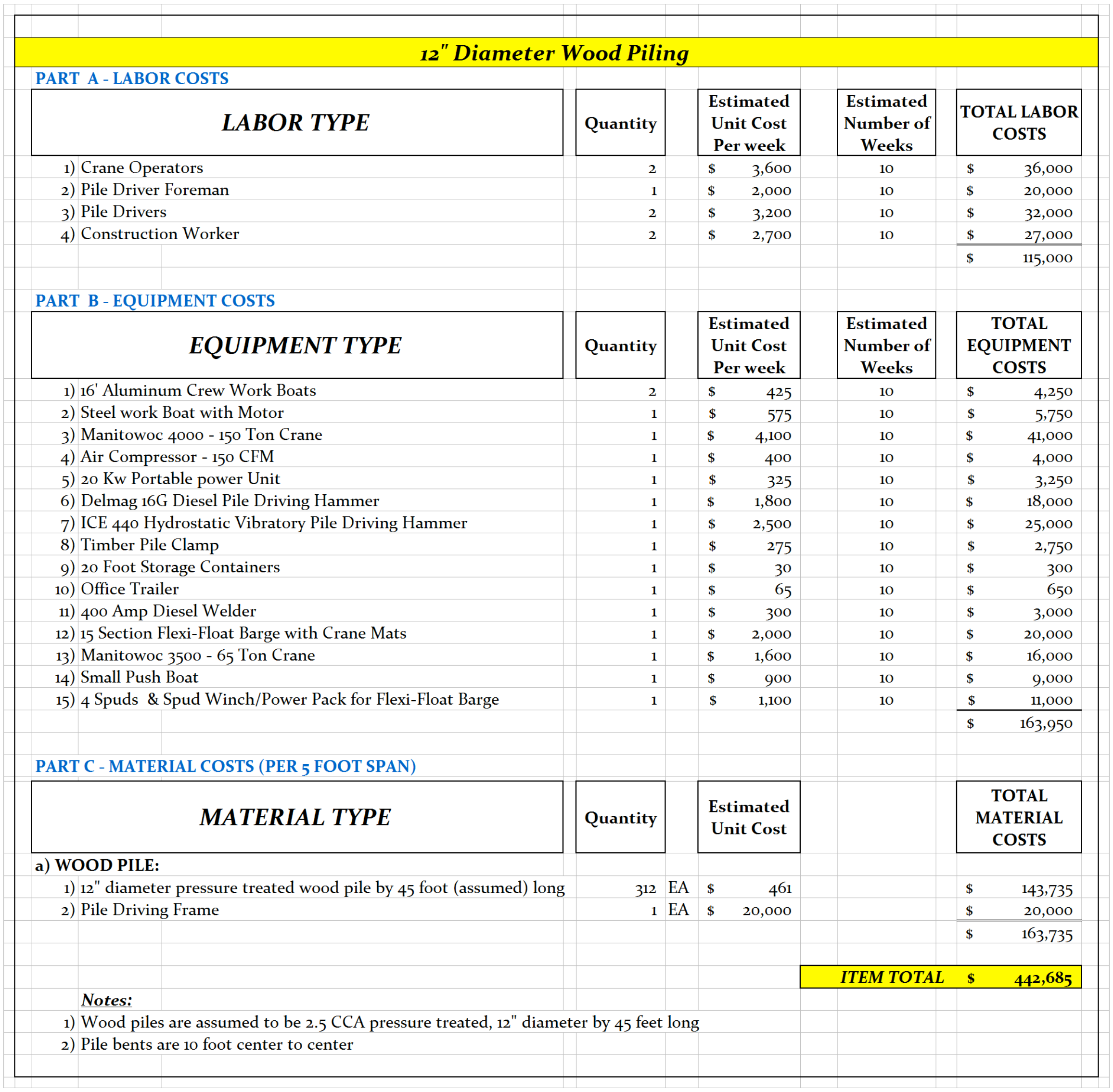
SUMMARY OF ESTIMATED COSTS FOR OPTION 3

	LABOR	EQUIPMENT	MATERIALS	TOTAL
Wood Piles	$ 115,000	$ 163,950	$ 163,735	$ 442,685
Wood Deck	$ 186,000	$ 77,230	$ 383,676	$ 646,906
Concrete Piles & Pile Cap	$ 34,500	$ 49,185	$ 46,022	$ 129,707
Concrete Deck	$ 46,500	$ 54,360	$ 204,806	$ 305,666
Project Supervison	$ 104,400	$ 22,500	$ 25,200	$ 152,100
Project Indirect Costs	N/A	N/A	$ 234,000	$ 234,000
Subtotal	$ 486,400	$ 367,225	$ 1,057,438	$ 1,911,063
			5 % Contractor SG&A	$ 95,553
			10 % Contractor Profit	$ 200,662
			INDICATIVE PROJECT PRICE	**$ 2,207,278**

Notes:

1) No rock is assumed in the estimate
2) All permits provided by others
3) Access is by water and not restricted by permits or other regulatory rules
4) All costs are in 2013 dollars, with no escallation included in the estimate
5) No contingency included in estimate. Owner is advised to include an Owner Contingency of 15%, or more.
6) All costs are specific to the southern Maine area. No regional adjustment included in labor and equipment costs.

APPENDIX J: Cost Estimate Option Three



12" Diameter Wood Piling

PART A - LABOR COSTS

	LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1)	Crane Operators	2	$ 3,600	10	$ 36,000
2)	Pile Driver Foreman	1	$ 2,000	10	$ 20,000
3)	Pile Drivers	2	$ 3,200	10	$ 32,000
4)	Construction Worker	2	$ 2,700	10	$ 27,000
					$ 115,000

PART B - EQUIPMENT COSTS

	EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1)	16' Aluminum Crew Work Boats	2	$ 425	10	$ 4,250
2)	Steel work Boat with Motor	1	$ 575	10	$ 5,750
3)	Manitowoc 4000 - 150 Ton Crane	1	$ 4,100	10	$ 41,000
4)	Air Compressor - 150 CFM	1	$ 400	10	$ 4,000
5)	20 Kw Portable power Unit	1	$ 325	10	$ 3,250
6)	Delmag 16G Diesel Pile Driving Hammer	1	$ 1,800	10	$ 18,000
7)	ICE 440 Hydrostatic Vibratory Pile Driving Hammer	1	$ 2,500	10	$ 25,000
8)	Timber Pile Clamp	1	$ 275	10	$ 2,750
9)	20 Foot Storage Containers	1	$ 30	10	$ 300
10)	Office Trailer	1	$ 65	10	$ 650
11)	400 Amp Diesel Welder	1	$ 300	10	$ 3,000
12)	15 Section Flexi-Float Barge with Crane Mats	1	$ 2,000	10	$ 20,000
13)	Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	10	$ 16,000
14)	Small Push Boat	1	$ 900	10	$ 9,000
15)	4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	10	$ 11,000
					$ 163,950

PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

	MATERIAL TYPE	Quantity		Estimated Unit Cost	TOTAL MATERIAL COSTS
a)	**WOOD PILE:**				
1)	12" diameter pressure treated wood pile by 45 foot (assumed) long	312	EA	$ 461	$ 143,735
2)	Pile Driving Frame	1	EA	$ 20,000	$ 20,000
					$ 163,735
				ITEM TOTAL	$ 442,685

Notes:

1) Wood piles are assumed to be 2.5 CCA pressure treated, 12" diameter by 45 feet long
2) Pile bents are 10 foot center to center

APPENDIX J: Cost Estimate Option Three

Composite Wood Decking

PART A - LABOR COSTS

	LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1)	Crane Operator	1	$ 1,800	12	$ 21,600
2)	Carpenter Foreman	1	$ 2,000	12	$ 24,000
3)	Carpenters	6	$ 6,300	12	$ 75,600
4)	Construction Worker	4	$ 5,400	12	$ 64,800
					$ 186,000

PART B - EQUIPMENT COSTS

	EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1)	16' Aluminum Crew Work Boats	2	$ 425	12	$ 850
2)	Steel work Boat with Motor	1	$ 575	12	$ 6,900
3)	Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	12	$ 19,200
4)	Air Compressor - 150 CFM	1	$ 400	12	$ 4,800
5)	20 Kw Portable power Unit	1	$ 325	12	$ 3,900
6)	20 Foot Storage Containers	1	$ -	12	$ -
7)	Office Trailer	1	$ 65	12	$ 780
8)	400 Amp Diesel Welder	1	$ 300	12	$ 3,600
9)	15 Section Flexi-Float Barge with Crane Mats	1	$ 2,000	12	$ 24,000
10)	Small Push Boat	1	$ -	12	$ -
11)	4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	12	$ 13,200
					$ 77,230

PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

	MATERIAL TYPE	Quantity		Estimated Unit Cost	TOTAL MATERIAL COSTS
a)	**TRANSVERSE GIRDER:**				
1)	4" X 14" x 12 foot pressure treated girder	312	EA	$ 33.60	$ 10,483
2)	7/8" diameter galvanized thru bolts by 16" long with washers	624	EA	$ 4.00	$ 2,496
b)	**LONGITUDINAL JOISTS:**				
1)	3" X 14" X 14' (includes overlap) pressure treated planking	2,028	EA	$ 21.00	$ 42,588
2)	"Simpson" twist strap MTS-12 (Stainless steel) with screws	3,744	EA	$ 20.00	$ 74,880
c)	**COMPOSITE DECKING:**				
1)	2" X 6"X 12 foot Composite or IPE Decking (with screws)	18,600	SF	$ 7.85	$ 145,984
d)	**RAILING:**				
1)	4" X 6" X 8 foot pressure treated posts	624	EA	$ 16.95	$ 10,579
2)	Railings - 2" X 6"X 12 foot pressure treated rail (four rails per side)	2,480	EA	$ 10.21	$ 25,327
3)	1/2" diameter X 8" galvanized bolts for attaching railings to railing pos	9,984	EA	$ 6.00	$ 59,904
4)	Cap - 2" X 6" X 12 foot pressure treated cap with lag screws	319	EA	$ 12.36	$ 3,947
5)	1/2" diameter X 8" galvanized bolts for attaching railing posts to joists	1,248	EA	$ 6.00	$ 7,488
					$ 383,676

***ITEM TOTAL* $ 646,906**

Notes:

1) Assumed two railing posts per span, with four horizontal railings per side per span
2) Composite deck has 2750 psi flexural strength

APPENDIX J: Cost Estimate Option Three

12" Square Concrete Piling & Concrete Pile Cap

PART A - LABOR COSTS

	LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1)	Crane Operators	2	$ 3,600	3	$ 10,800
2)	Pile Driver Foreman	1	$ 2,000	3	$ 6,000
3)	Pile Drivers	2	$ 3,200	3	$ 9,600
4)	Construction Worker	2	$ 2,700	3	$ 8,100
					$ 34,500

PART B - EQUIPMENT COSTS

	EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1)	16' Aluminum Crew Work Boats	2	$ 425	3	$ 1,275
2)	Steel work Boat with Motor	1	$ 575	3	$ 1,725
3)	Manitowoc 4000 - 150 Ton Crane	1	$ 4,100	3	$ 12,300
4)	Air Compressor - 150 CFM	1	$ 400	3	$ 1,200
5)	20 Kw Portable power Unit	1	$ 325	3	$ 975
6)	Delmag 16G Diesel Pile Driving Hammer	1	$ 1,800	3	$ 5,400
7)	ICE 440 Hydrostatic Vibratory Pile Driving Hammer	1	$ 2,500	3	$ 7,500
8)	Timber Pile Clamp	1	$ 275	3	$ 825
9)	20 Foot Storage Containers	1	$ 30	3	$ 90
10)	Office Trailer	1	$ 65	3	$ 195
11)	400 Amp Disel Welder	1	$ 300	3	$ 900
12)	15 Section Flexi-Float Barge with Crane Mats	1	$ 2,000	3	$ 6,000
13)	Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	3	$ 4,800
14)	Small Push Boat	1	$ 900	3	$ 2,700
15)	4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	3	$ 3,300
					$ 49,185

PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

	MATERIAL TYPE	Quantity		Estimated Unit Cost	TOTAL MATERIAL COSTS
a)	**CONCRETE PILE:**				
1)	12" Square prestressed concrete pile by (assumed) 40' long	8	EA	$ 1,000	$ 8,000
2)	12" Square prestressed concrete pile by (assumed) 60' long	12	EA	$ 1,400	$ 16,800
3)	12" Pile driving frame	1	EA	$ 10,000	$ 10,000
b)	**CONCRETE PILE CAP:**				
1)	Furnish 3500 psi concrete	22	CY	$ 175	$ 3,889
2)	Rent Steel Formwork	1	LS	$ 4,000	$ 4,000
3)	Furnish epoxy coated reinforcing steel	3,333	LBS	$ 1.00	$ 3,333
					$ 46,022
				ITEM TOTAL	**$ 129,707**

Notes:

1) Concrete piles are assumed to be pre-stressed 12" square
2) It assumed that no test piles are to be driven
3) Pile caps are assumed to 2 feet wide by 3 feet high
4) Assuming 150 pounds of epoxy coated rebar per cubic yard of concrete

APPENDIX J: Cost Estimate Option Three

Precast "NEXT" Concrete Deck (with 4" Concrete Overlay)

PART A - LABOR COSTS

	LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1)	Crane Operator	1	$ 1,800	3	$ 5,400
2)	Carpenter Foreman	1	$ 2,000	3	$ 6,000
3)	Carpenters	4	$ 6,300	3	$ 18,900
4)	Construction Worker	4	$ 5,400	3	$ 16,200
					$ 46,500

PART B - EQUIPMENT COSTS

	EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1)	16' Aluminum Crew Work Boats	2	$ 425	3	$ 1,275
2)	Steel work Boat with Motor	1	$ 575	3	$ 1,725
3)	Manitowoc 4000 - 150 Ton Crane	2	$ 8,200	3	$ 24,600
4)	Air Compressor - 150 CFM	1	$ 400	3	$ 1,200
5)	20 Kw Portable power Unit	1	$ 325	3	$ 975
6)	20 Foot Storage Containers	1	$ 30	3	$ 90
7)	Office Trailer	1	$ 65	3	$ 195
8)	400 Amp Diesel Welder	1	$ 300	3	$ 900
9)	15 Section Flexi-Float Barge with Crane Mats	2	$ 4,000	3	$ 12,000
10)	Manitowoc 3500 - 65 Ton Crane	1	$ 1,600	3	$ 4,800
11)	Small Push Boat & Concrete Buckets	1	$ 1,100	3	$ 3,300
12)	4 Spuds & Spud Winch/Power Pack for Flexi-Float Barge	1	$ 1,100	3	$ 3,300
					$ 54,360

PART C - MATERIAL COSTS (PER 5 FOOT SPAN)

	MATERIAL TYPE	Quantity		Estimated Unit Cost		TOTAL MATERIAL COSTS
a)	**PRECAST CONCRETE "NEXT" BEAMS & CONCRETE OVERLAY:**					
1)	Furnish 8 feet wide X 75 foot long X 36" deep "NEXT" beams	8	EA	$ 19,500		$ 156,000
2)	Furnish concrete deck overlay (assumed to be 4" thick)	65	CY	$ 200		$ 12,907
3)	Furnish welded wire mesh and curing material	1	LS	$ 4,800		$ 4,800
4)	Furnish elastomeric bearings	32	EA	$ 230		$ 7,360
5)	Furnish expansion joints	48	EA	$ 110		$ 5,280
b)	**RAILING:**					
1)	4" X 6" X 8 foot pressure treated posts	122	EA	$ 16.95		$ 2,068
2)	Railings - 2" X 6"X 12 foot pressure treated rail (four rails per side)	240	EA	$ 10.21		$ 2,451
3)	1/2" diameter X 8" galvanized bolts for attaching railings to railing post	1,952	EA	$ 6.00		$ 11,712
4)	Cap - 2" X 6" X 12 foot pressure treated cap with lag screws	62	EA	$ 12.36		$ 764
5)	1/2" diameter X 8" galvanized bolts for attaching railing posts to joists	244	EA	$ 6.00		$ 1,464
						$ 204,806
					ITEM TOTAL	**$ 305,666**

Notes:

1) Assumed 6x6 #10 welded wire fabric
2) Expansion joints are double angle with filler material
3) Assumed fifteen railing posts per span, with four horizontal railings per side per span

APPENDIX J: Cost Estimate Option Three

Project Supervision

PART A - LABOR COSTS

LABOR TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL LABOR COSTS
1) Project Manager	1	$ 3,000	18	$ 54,000
2) Project Engineer	1	$ 2,000	18	$ 36,000
3) Safety Supervisor	0.25	$ 2,000	18	$ 9,000
4) Field Administartor	0.25	$ 1,200	18	$ 5,400
				$ 104,400

PART B - EQUIPMENT COSTS

EQUIPMENT TYPE	Quantity	Estimated Unit Cost Per week	Estimated Number of Weeks	TOTAL EQUIPMENT COSTS
1) Pick up Truck	2	$ 250	18	$ 9,000
2) Survey Van with survey equipment	1	$ 350	18	$ 6,300
3) Office Trailer	1	$ 400	18	$ 7,200
				$ 22,500

PART C - MATERIAL COSTS

MATERIAL TYPE	Quantity		Estimated Unit Cost	TOTAL MATERIAL COSTS
a) Project - Indirect Costs				
1) Telephone/computer	6	MO	$ 300	$ 1,800
2) Power	6	MO	$ 500	$ 3,000
3) Trash Removal	6	MO	$ 350	$ 2,100
4) Yard Rental	6	MO	$ 2,000	$ 12,000
5) Porta Pottys	6	MO	$ 300	$ 1,800
6) Safety Equipment	1	LS	$ 3,000	$ 3,000
7) Miscellaneous Supplies	1	LS	$ 1,500	$ 1,500
				$ 25,200

ITEM TOTAL **$ 152,100**

Project Indirect Costs

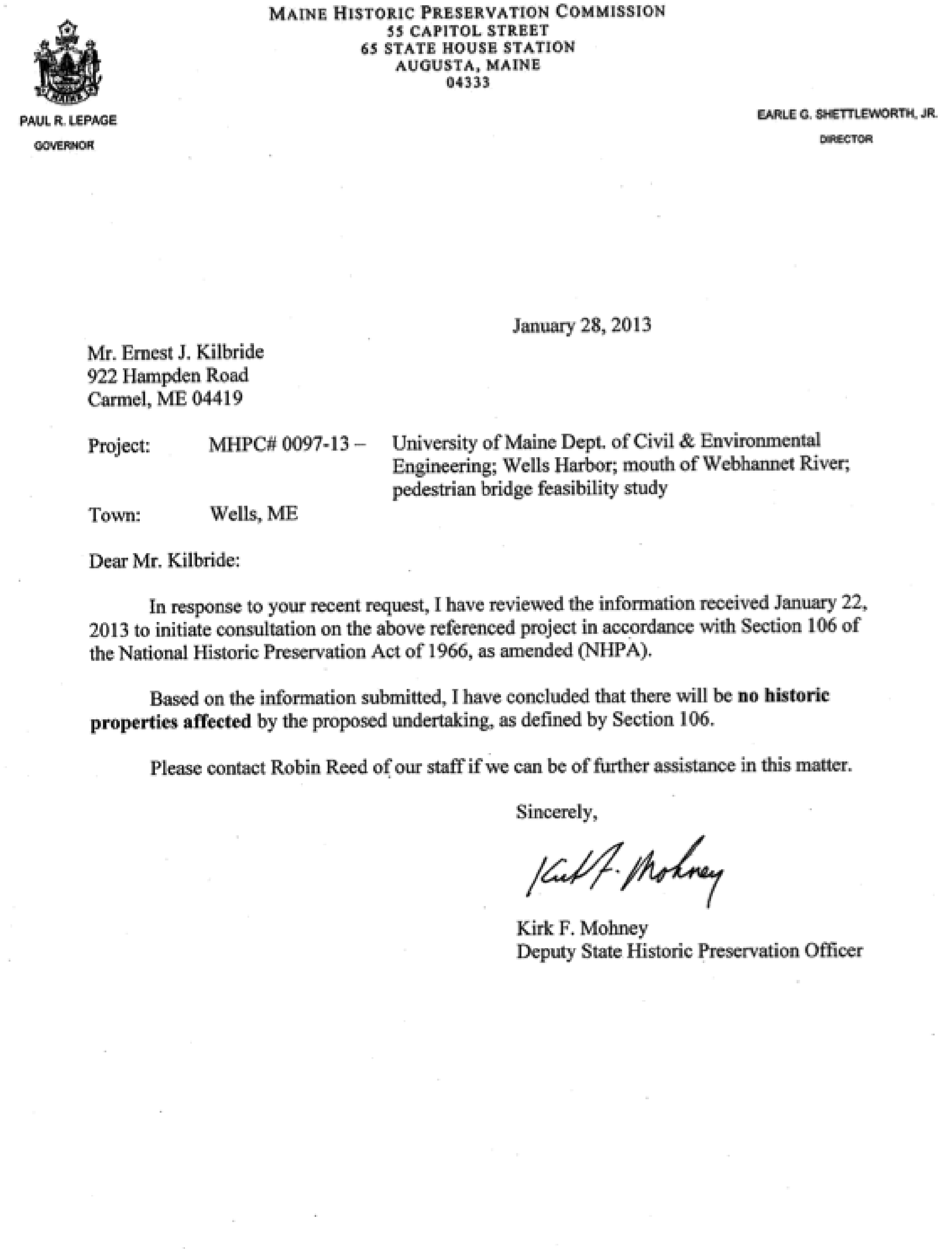
COST TYPE	Quantity		Estimated Unit Cost	TOTAL COSTS
a) Indirect Costs:				
1) Project Performance & Payment Bond	1	LS	$ 41,000	$ 41,000
2) Equipment Mobilization	1	LS	$ 76,000	$ 76,000
3) Equipment Operation & Maintenance	1	LS	$ 74,000	$ 74,000
4) Project Liability Insurance	1	LS	$ 28,000	$ 28,000
5) Project Marine Insurance	1	LS	$ 15,000	$ 15,000
				$ 234,000

ITEM TOTAL **$ 234,000**

Notes:

1) It assumed that project is tax exempt and not subject to sales tax

APPENDIX K: Maine Historic Preservation Commission Letter



MAINE HISTORIC PRESERVATION COMMISSION
55 CAPITOL STREET
65 STATE HOUSE STATION
AUGUSTA, MAINE
04333

PAUL R. LEPAGE
GOVERNOR

EARLE G. SHETTLEWORTH, JR.
DIRECTOR

January 28, 2013

Mr. Ernest J. Kilbride
922 Hampden Road
Carmel, ME 04419

Project: MHPC# 0097-13 – University of Maine Dept. of Civil & Environmental Engineering; Wells Harbor; mouth of Webhannet River; pedestrian bridge feasibility study

Town: Wells, ME

Dear Mr. Kilbride:

In response to your recent request, I have reviewed the information received January 22, 2013 to initiate consultation on the above referenced project in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA).

Based on the information submitted, I have concluded that there will be **no historic properties affected** by the proposed undertaking, as defined by Section 106.

Please contact Robin Reed of our staff if we can be of further assistance in this matter.

Sincerely,

Kirk F. Mohney

Kirk F. Mohney
Deputy State Historic Preservation Officer

PHONE: (207) 287-2132
FAX: (207) 287-2335

From: “Chris Mayo” <cmayo@wellstown.org>
To: “Chris Marchetti” <Christopher_M._Marchetti@umit.maine.edu>
Sent: Tuesday, March 19, 2013 3:15PM
Subject: Water Taxi

Hi Chris,

I am off to the annual Harbor Master’s conference but wanted to throw some very preliminary #’s your way before I leave. The impossible part of this is the unknown demand, knowing that this would circumvent the pay to park lot across the harbor for those headed to the beach as well as allow beachgoers access to the restaurants on the main harbor side.

In my opinion there is no commercial viability for a water taxi in Wells Harbor, as far as a private enterprise goes. The necessity for a Coast Guard Captains license, insurance, business license, mooring and vessel costs coupled with unknown demand (most probably low) and the need to turn a profit make this an unlikely business proposition. The only viable craft would be an enclosed small 6 passenger vessel, with shallow draft. Most probably a vessel like this; http://www.boattrader.com/listing/2005-C-Dory-22-Cruiser-101834157 .

A municipally funded operation would not be held to profit margins, but would need to be economically viable in its own right. Initial investment for used equipment would total $30,000 plus, and would incur operating and maintenance expenses totaling upwards of $1500 a year for fuel, paint, oil, trailering and other maintenance.

If you look at a ten year cost analysis, you have $3,000 a year towards the used vessel cost (capital), and $1500 a year operating. Quick figuring leads to an estimated $4500 a year revenue requirement to make sustainable. Add on the cost of a captain, which would need USCG licensing to accept any ticket fee / fare, at $20,000 a season (the going rate for a captain is staggering), and you find yourself looking at $24,500. A viable ticket price would be $5 per person in my opinion, with up to 6 persons a trip. That equates to $30 per trip from one side to the other (call it 20 minutes round trip).

Not knowing demand I am going to throw some guesstimate numbers your way:

Paying passengers per day (average) June through September (121 days): 10 (quite a generous estimate)

121 days times 10 people per day = 1210 paying passengers (estimated) at $5 per person = $6050 per year in revenue, less $4500 operating = $1550 total yearly “profit” captain’s pay notwithstanding.

To reverse engineer the revenue from a “break even” perspective, take captains pay and operating expenses of $24,500 and divide by estimated paying passengers 1210, and you get $20.25 per ticket / fare, ergo a family of four would cost $81.00 to go from the beach to the restaurant. If you made me or my assistant be the Captain then rates change, but services offered by the Harbor Master’s office and availability would suffer.

Also to be taken into consideration is replacement of the vessel's motor, and eventually hull, which would put another $30k to $40k burden over the course of 15 to 20 years.

I plan to delve into this with more detail and in a more formal format as I have time. Please comment on these figures and offer suggestions, edits, differing scenarios etc. at will. This is a draft and really just quick figuring.

Regards,
Christopher H. Mayo
Harbormaster
Town of Wells
Office: (207) 646-3236
Cell: (207) 251-1987

APPENDIX M: References

AASHTO LRFD Bridge Design Specifications. (2010) Washington, D.C.: American Association of State Highway and Transportation Officials

Della Valle, Elizabeth A., Mathew Eddy, and Wright-Pierce. (2012) *DRAFT Wells Harbor Management Plan*. Retrieved January 2013 from <http://www.wright-pierce.com/pictures/files/wells/Wells-HbrPlanUpdate.pdf>

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Woodard & Curran. (2013) Town of Wells GIS. Retrieved April 2 2013 from <http://eis.woodardcurran.com/wells/>