



Bristol Harbor Master

TOWN CLERK'S OFFICE
BRISTOL, RHODE ISLAND
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TO: Bristol Town Council
FROM: Gregg Marsili
Bristol Harbor Master
COPY: Steven Contente
Bristol Town Administrator
DATE: January 30, 2024

SUBJECT: CHURCH STREET MARINA WAVE IMPACT ANALYSIS

I have attached a letter from PARE Corporation dated January 30, 2024, Church Street Marina Expansion Limited Reflected Wave Impact Analysis Bristol, RI. This analysis was completed due to the complaint from the Bristol Elks Lodge that the Church Street Marina Expansion was adversely affecting their floating dock. This is also a response to the letter which PARE Corporation reviewed from Harbor Engineering LLC, the Bristol Elks engineering firm.

PARE Engineering would like to present this information to the Town Council at the February 7th, 2024, meeting. They have a short presentation, which will go over their findings and will be available for questions.

I have reviewed the document from PARE Corporation and they are reporting minimal occurrences throughout the boating season that wave reflection occurs and no additional means of wave attenuators are necessary. I have been on both sides of the Elks Lodge for the past 15 years and this area has always been very turbulent. It is very difficult to dock a vessel with a stiff wind out of the South or Southwest direction due to the exposure the dock has.

The agreement made between the Town and the Elks Lodge last boating season which allowed the Elks members to use the Towns Marina for dockage was utilized twice. The first time we allowed a member to use the dock he was unaware of the policy, and he felt it was just easier to use are dock. The

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second time the wind and sea conditions were marginal, but we allowed it. I was not at the marina on either occasion, but looking at the cameras and weather information I gave permission for the use of our docks.

My recommendation is aligned with PARE Corporations recommendation that no additional wave attenuating equipment needs to be installed and we continue with the current agreement we have in place with the Elks Lodge. In addition, I recommend that we make slight adjustments to the agreement for the upcoming year with more definition for dock usage and draft a written memorandum of understanding.

January 30, 2024

Mr. Gregg Marsili
Bristol Harbor Master
Town of Bristol
127 Thames Street
Bristol, RI 02809

Re: **Church Street Marina Expansion**
Limited Reflected Wave Impact Analysis
Bristol, RI
(Pare Project No. 16136.00)

Dear Mr. Marsili

In response to your request, Pare Corporation (Pare) has evaluated potential effects of the wave attenuator, along the perimeter of the Town's marina expansion, on the Elks Lodge floating dock immediately to the south of the wave attenuator float. Pare has completed a limited wave analysis and probability, described below, that takes into consideration the reflective properties of the wave attenuator in relation to good and moderate docking conditions as outlined herein.

BACKGROUND

The Church Street Marina was expanded in February 2022 with floating docks protected by a perimeter of new concrete wave attenuating floats. These wave attenuating floats are attached to mooring anchors with elastomeric tendons to provide protection against waves up to 5 feet in height.

Approximately 120 feet south of the expanded marina is a dock owned and maintained by the Elk's Lodge. The dock consists of two portions of timber floats that form a "T" shape. The end terminal float, is approximately 60 feet long and is capable of mooring up to 4 boats (according to CRMC permitting documents). The Elk's Lodge dock is located between the expanded Church Street Marina (120 feet to the north) and a Coast Guard operated dock and pier (100 feet to the south).

During the summer months of 2022 and 2023, members of the Elk's Lodge indicated concerns of increased waves within the basin between the expanded marina and the Coast Guard pier resulting in difficulties berthing and mooring to their dock. In response to these concerns, the Town requested that Pare investigate the frequency of effects from the Town's wave attenuator on the Elk's Lodge dock.

Per the Design of Marine Facilities reference material, by John Gaythwaite, *allowable wave heights in berthing areas may range from 1 ft for small craft to 4 to 5 ft for large vessels* in Harbors. Additionally per the ASCE Design Guidelines for Small Craft Harbors, a 1-foot wave is acceptable for good berthing conditions and 1.25 ft is acceptable for moderate conditions.

WAVE ANALYSIS RESULT SUMMARY

Pare Corporation has reviewed the letter prepared for Bristol County Elks Lodge by Harbor Engineering LLC, regarding the expansion at Church St, and specifically the concrete wave attenuator. The letter presented by Harbor Engineering has indicated the possibility of adverse impacts from the expansion on the Elks Lodge coastal property, including: the revetment slope, and the floating dock system supporting the operation of 2-3 boats for their property. Although the letter suggested the possibility of impacts from the attenuator, there was no completed analysis or impacts presented or provided in the initial letter.

There are several factors and variables that are present in the coastal environment relating to wave reflection, wave diffraction, and wave energy. All these factors would contribute to the wave state observed at the Elks Lodge, in both the pre-construction, and post-construction conditions; and would be crucial in considering the frequency and severity of any impacts. Pare has not completed a refined wave reflection model to determine the conditions expanded to the extents of the Elks Lodge but has evaluated several parameters in determining the criteria of wave reflection and the surrounding impacts of the wave attenuator. Specifically, these parameters were compared to parameters provided in *Planning and Design Guidelines for Small Craft Harbors* ASCE Manual (2012) and the *Design for Marine Facilities* manual by Gaythwaite (2016).

The Elks Lodge dock is considered to be exposed and is directly susceptible to waves approaching out of the South to the West directions and is partially protected by wave approach from the South to South-Southeast by the adjacent Coast Guard pier. It should be noted that reports from the Coast Guard indicate that the condition of the wave fence integral to the Pier is possibly in need of repairs and is not as effective as in years past, making the Elk's floats more exposed from southerly winds. The Elks Lodge dock is also now protected from northerly wind-driven waves by the new marina expansion; however the dock is now susceptible to some reflected waves from the south and south-southeast.

A wave analysis was completed to evaluate the Town's Church Street Marina Expansion potential at reflecting waves back towards the Elks Lodge dock and negatively impacting the use of the dock. It is important to note that the Elks Lodge property does contain a sea wall behind their floating dock that is capable of producing wave reflections independently of the wave attenuator and these waves were not considered as part of this study.

When performing wave analyses there are several factors involved in estimating wind generated waves, and specifically wind generated waves in sheltered harbors such as Bristol Harbor. The analysis of sheltered harbors is more complex than waves that are generated over open water existing between land masses which will affect the wind and the wave propagation. The functions for wind generated waves tend to be defined as either fetch limited, or duration limited. Fetch refers to the total length of water that the wind can affect. To be fetch limited implies that the wind speed analyzed will act with sufficient duration over the specified fetch. To be duration limited would imply that the duration is not sufficiently long to produce the maximum waves across the specified fetch. Generally, it was found within Pare's analysis, that wave growth would begin to surpass duration limited and become fetch limited once wind speeds begin surpassing 11.5 knots for the larger fetches from the south-southwest directions.

The wave attenuators put in place during the Church St. expansion project are intended to reduce the wave environment within the marina, by reflected waves generated outside of the attenuator. The intention of this is to ensure that the transmitted wave produced through the attenuator would be limited to less than six inches to one-foot; which would ensure that the wave state experienced in the marina always maintains the safe and operable conditions per the previously referenced standards.

This process is based on the conservation of energy; where the incident wave energy is equal to the wave energy transmitted through the attenuator, plus the energy absorbed by the attenuator, and the energy reflected. The amount of energy that is absorbed has many contributing factors (incident wave force, anchoring cable parameters, and structural and operating parameters). There are not many studies approaching the estimation of this subject, so for simplicity of this analysis it will be assumed absorption will be treated as zero. Based on observable operation conditions the transmitted energy was treated to be 10% while reflected energy was treated as 90% of the remaining energy. For example, an incident wave with a height of one-foot will transmit an assumed 0.1 foot wave, and reflect a 0.9 foot wave. This reflective wave then compounds and superimposes its wave height with the approaching incident wave height. With this interactions waves directly in front of the wave attenuator can be realized as a maximum of 1.9 feet.

The following table shows the wind speed required to generate a 12-inch wave pre-marina and a 12-inch wave post-marina. Post marina waves were calculated, conservatively assuming a 100% wave reflection off the attenuator, stacking (doubling) the height of the wave. In this instance, reflected waves from the south to west-southwest were considered susceptible to this wave stacking.

Wind Direction	Wind Speed Required to Generate a 1-foot wave Pre Marina (knots)	Wind Speed Required to Generate a 1-foot wave Post Marina (knots)
SSE ¹	118.4	22.0
S ¹	117.5	11.5 ²
SSW	18.2	11.5 ²
SW	19.9	11.5 ²
WSW	29.3	15.9
W	34.1	37.7
WNW	34.1	93.3
NW	37.8	108.3
NNW	79.1	114.6

¹ Conservatively assumes the wave fence at the Coast Guard pier is in working condition and does not transmit any waves through the fence

² Duration limited waves that generate a 6-inch wave or 12-inch stacked reflected wave

Preliminary analysis was performed based upon all the information discussed. With the desired operational wave height set by ASCE to be one-foot, the goal became explaining how often this wave-state occurs. Assuming a reflection would cause wave buildup of 1.9 times the incident wave, an incident wave height of 6.0 inches was chosen as the maximum allowable. If the boating season occurs between May 1st to October 31st and between the hours of 7am and 9pm there are 183 days and 2,562 operational hours during the recreational season. To determine how often these conditions would be undesirable the wind growth methods mentioned above were used.

Data provided by NOAA weather stations to determine the maximum frequency of occurrence of these events. . Based on these conditions we have determined that wind speeds that could produce undesirable wave environments would range between 11 knots and 22 knots. This range is representative of a duration and fetch limited approach and requires further analysis to determine if that duration has historically occurred. It is our opinion that the data available from NOAA for its Newport station would be more representative of the wind seen on the Elks Lodge site; based on shoreline geography and approach angles. This was the station data chosen for this presentation. Under these conditions it was found this wave environment would have been present for 110 hours out of a rough total of 2,562 possible hours during the boating season. This would mean that the maximum percentage of occurrences in the past year would be 4.5%. It is the current opinion of Pare that these numbers do not suggest adverse conditions at an appreciable frequency.

SUMMARY AND CONCLUSIONS

Based on a review of available 2023 wind data, it appears that the frequency the wave attenuator increases the waves within the basin below a good condition is less than is 4.5% of the boating

Mr. Marsili

(5)

January 30, 2024

season and in our opinion does not suggest adverse conditions below a moderate condition at an appreciable frequency.

A possible resolution was proposed for the installation of a "wave eater"; however, after our analysis and review of the conditions observed at the subject area, Pare does not believe there is a need for the "wave eater" and its installation would not appreciably improve the wave state that exists at the Elk's Lodge. Based on the review of wind data the frequency of condition created as stated above, the proposed solution is not anticipated to have an appreciable impact as the frequency in which this solution would be utilized is limited to as low as a 4.5% occurrence.

An additional aspect to this discussion is the partially obstructed wave approach from the South and South by Southeast. This area was previously partially obstructed by the wave fence under the Coastguard pier. Recently Pare was informed of the deterioration of this structure that would reduce its capacity to attenuate waves from those approach angles. This would further increase possible impacts on the Elks Lodge in recent years.

A full engineering simulation model could be created if desired to evaluate the wave eater alternative or other alternatives if the town would like to address additional options however the data has indicated that the minor increase of 4.5% does not warrant any alterations or combinations outside the wave attenuator.

Very truly yours,

A handwritten signature in black ink, appearing to read 'B. Dutra', enclosed within a hand-drawn oval.

Brian M. Dutra, P.E.
Senior Project Engineer
Waterfront/Marine Group

A handwritten signature in blue ink, appearing to read 'Todd D. Turcotte', with a long horizontal flourish extending to the right.

Todd D. Turcotte, P.E.
Vice President
Waterfront/Marine Group