The Ramsgate Society
Dry Dock Condition Survey
April 2016

Smeaton Dry Dock

THE RAMSGATE SOCIETY

ARUP

The Ramsgate Society

Smeaton Dry Dock, Ramsgate

Condition Survey

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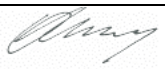
		Signature			
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1 Introduction

The Ramsgate Society are negotiating to take over the lease of The Clock House, which houses Ramsgate Maritime Museum, and the adjacent dry dock from the Steam Museum Trust. The Society wish to understand the current condition of the dry dock to allow them to include the dry dock in their future development plans. Arup have been commissioned to undertake a condition survey of the Smeaton Dry Dock which is located in Ramsgate's inner basin (see Figure 1).

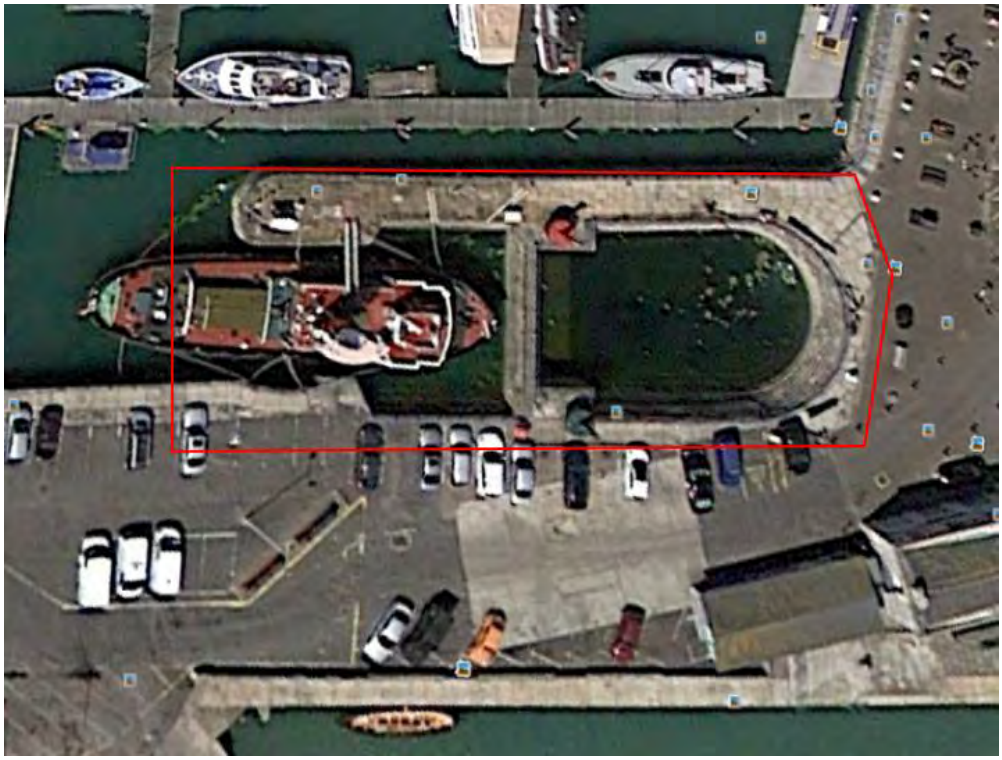

Figure 1 - 2013 Aerial photograph of Smeaton Dry Dock Ramsgate © Google 2016

As part of the condition survey, research was carried out on the historical context of the dry dock identifying areas to be targeted during the condition survey and any potential constraints on future development – see Section 2. An above-water visual inspection was carried out of the structure with the findings presented below – see Section 3.

Based on the findings of the visual inspection, engineering options for future different uses of the dry dock structure are offered and considered. This includes returning the dock to a dry dock condition or the use as a permanently flooded dock – see Section 4. Note that Section 4 is outside the scope of the condition survey and should not be relied upon; but is intended to be a helpful response to the discussions during the site visit.

2 Historical Context

2.1 Sources

Historical accounts of the dry dock were sourced from literature and archives retrieved from the library of the Institution of Civil Engineers (ICE) and Arup archives. With reference to the following publications, below is a summarised history considering aspects of the construction of the dry dock and the commercial use of the structure over its life which are relevant to this report.

[1] East Kent Maritime Trust, Historical Study No. 1, Construction of Ramsgate harbour 1749 – 1985, Robert B. Matkin.

[2] East Kent Maritime Trust, Restoration of John Smeaton's Dry Dock, 1984.

[3] John Smeaton, FRS, Edited by A.W. Skempton, Thomas Telford Limited, London, 1981.

[4] Civil Engineering South England, R. A. Otter, Thomas Telford Limited, London, 1994

An insight into the history of the dock was also gained from numerous discussion and verbal communications prior to and during the condition survey.

2.2 Construction of the Dry Dock

In 1782 John Smeaton set about designing a dry dock for Ramsgate's inner basin. By 1784 as a consultant to the harbour trustees he had completed the design for a 110 feet long, 15 feet deep and 31 foot wide dock. The floor of the dock was proposed to be formed from timber. However, the trustees considered it better to begin construction with the walls and without consulting Smeaton commissioned Henry Cull to draw up plans for a stone-floored dock.

Henry Cull produced an inverted arch design believing that the stone was structurally stronger than the wood and resilient against wood worm. Aware of the porous nature of the chalk bed on which the dock sat Cull widened the Northern wall to resist the lateral pressures induced by the water uplift pressure on the base. Despite this, upon completion in August 1786, the dock experienced lifting of large parts of the base and water rising from beneath. Cull proposed that the stone floor was replaced by larger 4ft × 3ft × 2ft 6inch Portland stones and by 1787 this had been completed. A trial was conducted at high water on the 22 August 1787 resulting in not only the larger stone base lifting but also nearly 100ft of the north wall.

Upon consideration, Smeaton presented the trustees with 3 options. The first was to significantly increase the mass of the north wall and battering it on the outer face. The second involved adapting a timber bottom to the masonry now standing and the third was to completely re-build with a timber base from the bottom up. Smeaton was then asked to again prepare a design for the dry dock. In January 1788 he wrote a letter enclosing the section drawing adopting the third option for

the dock as shown in Figure 2. According to historical sources, this option was subsequently built and is thought to have existed to the present day.

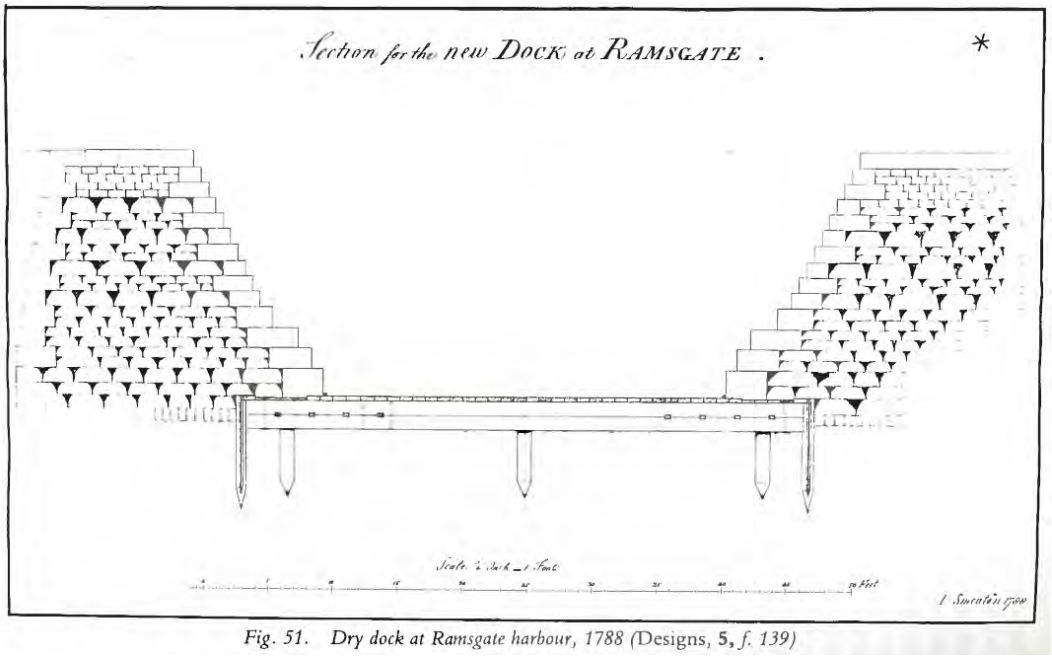

*Fig. 51. Dry dock at Ramsgate harbour, 1788 (*Designs, **5**, *f. 139)*

Figure 2 - Smeaton's 1788 Design for the Dry Dock [3]

From 1815-1816 the dry dock was extended by 20 feet at the eastern end (curved section) to enable the dock to accommodate larger vessels extending the total length of the dry dock to 130ft. Following this in 1859, repairs were made to the dock gates. However, due to the cease of use of the dock in 1877 and the desire to use a tug to drag sediment in the basin around to the sluices at the entrance to the dock, the harbour permitted the partial demolition of the dock. This constituted the removal of the dock gates and removal of a length of the Northern wall of the dock.

The historical account is helpful to understand the development of the dock, but should not be relied upon as an accurate account of the existing structure. Figure 3 showing exposed timbers appears to be consistent with the cross section shown in Figure 2.

2.3 Commercial History

The construction of a commercial slipway in Ramsgate in 1838 damaged the commercial viability of the dry dock and led to the ceasing of business and subsequent decay. In 1893 a dividing wall was constructed of reinforced concrete to isolate the eastern section. This eastern section was converted into an ice store to service the fishing industry. The ice storage facility was used up until 1923 when the eastern section was covered over enabling the area to be used for car parking.

In 1983 works were carried out to restore and reveal the original dry dock structure. The restoration works exposed the timber beams of the dock floor which appeared to be in relatively good condition considering their age see Figure

3. This relatively good condition is thought to be attributed to their constant saturation in seawater and silt.

Figure 3 - Photograph from 1983 restoration works on the dry dock

After restoration, the dry dock was kept dry through a series of pumps preventing the water level from rising above the floor. These pumping operation were however ceased in 1990s due to significant concerns such as: damage being caused to the timber floor from the wetting/drying process, the cost of constantly pumping to maintain the dock in a dry state, the leaks that formed in the stone walls and overall stability of the walls.

3 Condition Survey

3.1 General

A visual inspection of the dry dock structure was undertaken by James Turley and Oliver Davey of Arup on 7 March 2016. They were accompanied part time by John Walker of The Ramsgate Society, Colin Browne of Port of Ramsgate and Michael Cates previously of Ramsgate Maritime Museum.

The findings of the condition survey are summarised below with further records and photographs in Appendix A. A simplified plan diagram of the structure has been produced to aid the description and locating of specific items; refer to Figure 4.

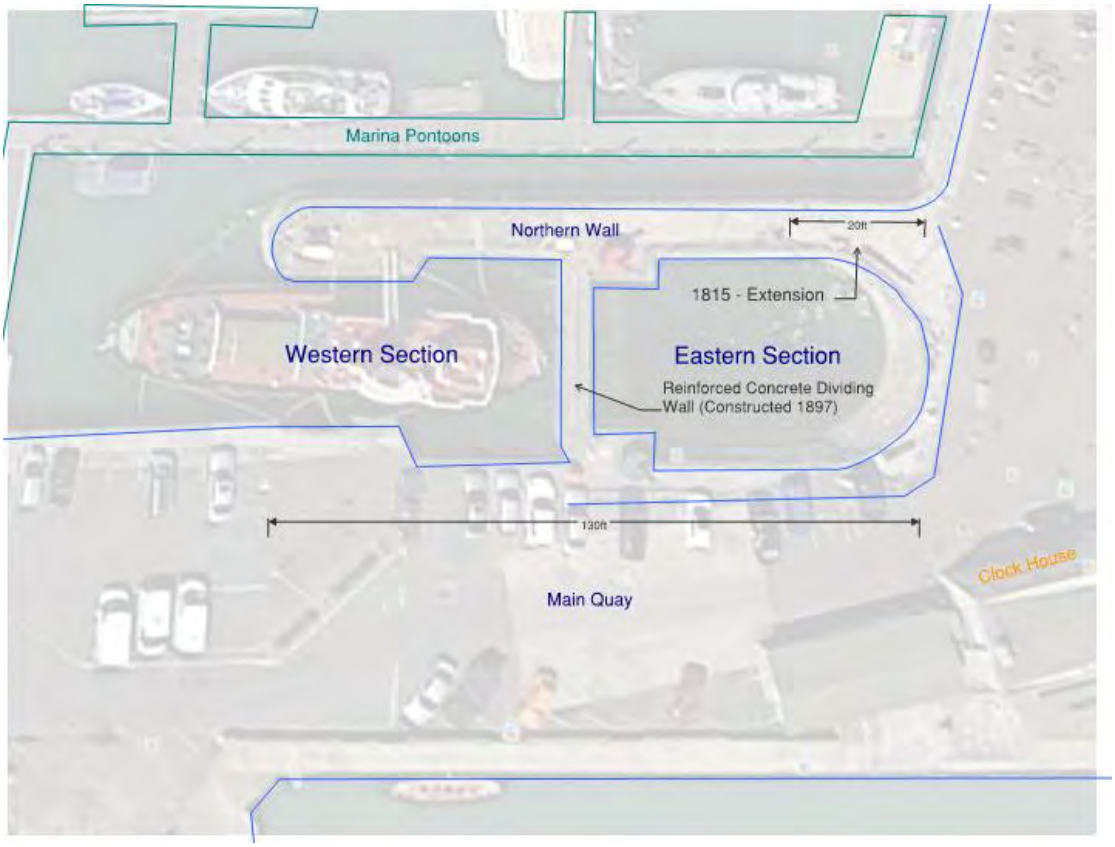

Figure 4 - Dry Dock General Arrangement

The dock was inspected visually from the quayside. Access was gained to all three sides of the dock however access to the Northern Wall adjacent to the Western Section was not possible due to a locked gate. Access was also gained to the marina pontoons which allowed a visual inspection of the Northern Wall from the marina side.

Visual inspection of many elements was undertaken from a distance and small defects may therefore not have been identified. A thorough 'hands on' inspection would require underslung access platforms or similar. No underwater inspection was carried out. No structural assessment/analysis, material samples or testing was undertaken.

3.2 Overall Condition

Based on visual appearance alone, the dock appears to have variable conditions around its perimeter. With various defects and damage observed as detailed below. There are no visible signs of significant current movement of the dock walls although there are signs of previous historic movement. The horizontal alignment of the walls appears to be as originally intended. The curved section at the rear of the dock is geometrically regular as seen in Figure 5. There is however evidence of localised vertical movement of the northern section of the dock wall.

Figure 5 - Curved Stonework Alignment

There is evidence of vertical movements of individual stone courses in the walls but the surfacing around the dock does not show any signs of distress; although it may be that the surfacing is spanning over and concealing any defects or voiding below.

3.3 Specific Issues

3.3.1 Vertical Movement of North Wall

There is evidence on site of possible indications of past vertical movements of the stone courses; see Figure 6. It is clear that the bedding joints, which elsewhere within the dock are very tight and regular, have opened up and there are now significant horizontal gaps between the blocks. It can be seen that several attempts to plug these gaps with grout and during the visit to site Michael Cates recalled the plugging attempts with wooden pegs.

Figure 6 - Evidence of vertical movement of courses on the North side of dock with grout repairs visible

The cause of the differential movement of the north wall blocks could be due to a number of reasons. Whilst the exact reason is not known, it could be due to uplift from the bed of the structure and then settlement or due to the scour of the sediment below the wall and erosion of the stone caused by the flushing and jetting through the wall, as shown in Figure 7.

Figure 7 - Leaking North Wall 14th November 2007

When the dock was operational, it is likely that these gaps caused extensive leaking of the dock and attempts were made to establish a watertight seal. The differential pressure between the outside and inside of the dock when it was dry may have led to failure of these repairs in the North wall from which the leaks

were propagating. Allowing the structure to remain pumped out with these leaks through the masonry joints would have induced erosion from the flushing of water and sediment through the walls. This may have eroded the core material of the North wall leading to lack of fines and voiding which may have caused further damage.

The grouting and the majority of the repair works have evidently been carried out to the North wall rather than the South wall. This is likely due to the proximity to the tidal water (partially impounded) in the inner basin behind the North wall. It is noted that the flow path for water through the North wall is much shorter than the flow path through the Main Quay.

3.3.2 Movement of Northern Wall Roundhead

As shown in Figure 8 there has been displacement of part of the roundhead as evidenced by the continuous crack through the structure.

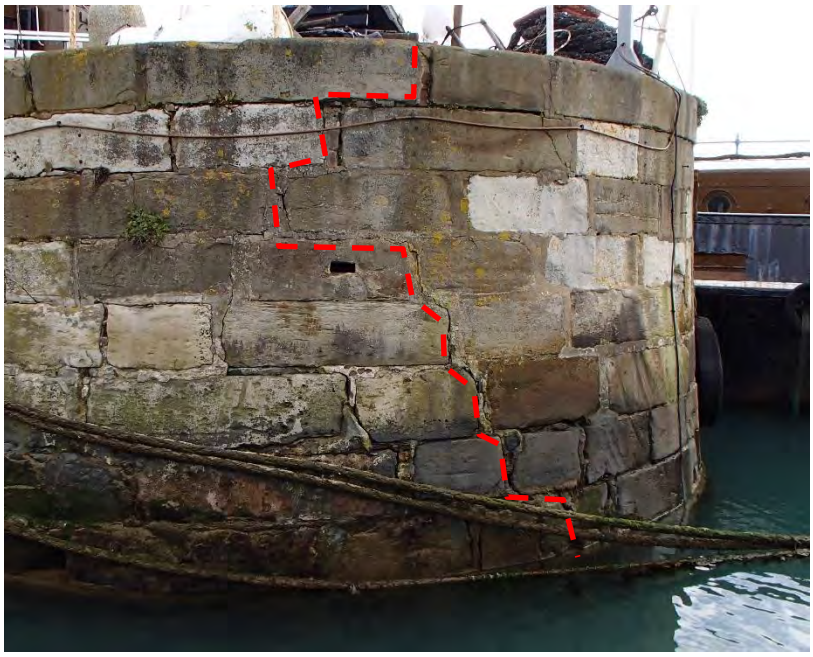

Figure 8 - Movement of Northern Wall Roundhead

The cause of the apparent displacement of this section is unclear and would require further investigation and monitoring.

3.3.3 Stone Degradation

There is evidence of weathering and degradation of the stones in the wall as shown in Figure 9. Within the dock this appears to be localised and small scale.

Figure 9 - Southern Wall Stone Degradation

The weathering and degradation is potentially caused by mechanisms such as freeze-thaw or plant growth. Within the dock at this time, the degradation is unlikely to have significant stability or structural implications.

However, on the marina side of the Northern Wall the degradation is more severe and it appears whole blocks have been affected.

Figure 10 - Marina side of Northern Wall Stone Degradation

These blocks have become very permeable and fractured meaning that any works in this area would be difficult, risky and relatively expensive.

3.3.4 Core Material

The condition of the core material behind the stone blocks is unknown and details of the material used have not been found. Note that it was common for masonry walls at the time to use inferior quality rock for the interior of the walls and often

randomly placed rubble. It is possible that the fill material constitutes excavated chalk that could have experienced chemical weathering or washout throughout its life. It is likely that voids will existing in this material; the size and number of which are unknown.

Prior to any work being undertaken in the vicinity of the dock, the number and size of voids and the condition of the core material should be determined.

3.3.5 Dividing Wall

The condition of the dividing wall is poor with a large section of the block facing having failed and fallen into the dock. The condition of the reinforced concrete behind the non-structural facing appears to be satisfactory although details of the construction of the dividing wall are unknown.

Figure 11 - Dividing Wall looking West

3.3.6 Conclusion of Dock Condition

On the basis of this visual inspection only, the dock appears to be in a variable condition with significant fracturing and concern over the cause of movement of the northern wall which is unknown. The age of the dock and the historic issues with structure would suggest that works on the dock would be high risk and should be carried out with caution. There are no visible signs of significant distress in the dock walls and the horizontal alignment of the walls. However vertically there appears to be differential displacement.

Perhaps of most risk to the current (and future) custodian of the dock are the items highlighted in the above section which are hidden from view. In particular the following risk items are noted:

- Deterioration of core material and voiding within or beneath the dock walls;
- Movement of the roundhead;
- Deterioration of the marina side of the Northern Wall.

4 Option Feasibility

4.1 General

Following discussions with the Ramsgate Society, three potential options for different future uses of the dry dock have been considered. Each option is discussed in more detail below.

As part of any works, the existing stone structure could also be restored to extend its life and improve the aesthetics of the dock. However, it is noted that any change or works to this ageing structure has its risks and could have unforeseen consequences.

For all of the options below there would be a need to carry out site investigations and undertake a feasibility study to establish and quantify the risks. Consultation with Historic England and other stakeholders would also be required along with calculations to confirm the stability of the dock walls without the dividing wall and to estimate the cost of the works. Subsequently, design and approvals of the works would be required prior to commencing a tender process to select a contractor to undertake the works.

4.2 Option 1 – Restore as fully functioning dry dock

4.2.1 General

The first option is to fully restore the structure to its original function as a dry dock through limiting water ingress, reinstating dock gates and reintroducing pumps.

With this option the dry dock could potentially be used to do repair works to the historic Cervia vessel (and possibly other vessels) and then house her in a permanent dry state.

It is evident from the history of the structure that difficulties have been met when attempting to maintain the dry status of the dock. This is in part due to the porous nature of the core material and also the short flow path through the Northern wall and potential leakage through the base. In order to overcome the excessive leaking whilst not undermining the structural integrity or the original aesthetics of the historic structure, a cut-off around the basin perimeter could be introduced combined with adequate drainage to relieve uplift pressures.

4.2.2 Cut-off around the Dock

A cut-off would create an impermeable perimeter around the dock to reduce water ingress from the surrounding ground, water bodies and from beneath the dock from springs/streams. The cut-off would extend from existing ground level to a level below ground as required to increase the length of the flow path or to tie into an impermeable stratum.

The cut-off could be formed by injection grouting, sheet piles or a diaphragm wall. As indicated in Figure 12, the services that run around and up to the dock may require re-routing and diversion.

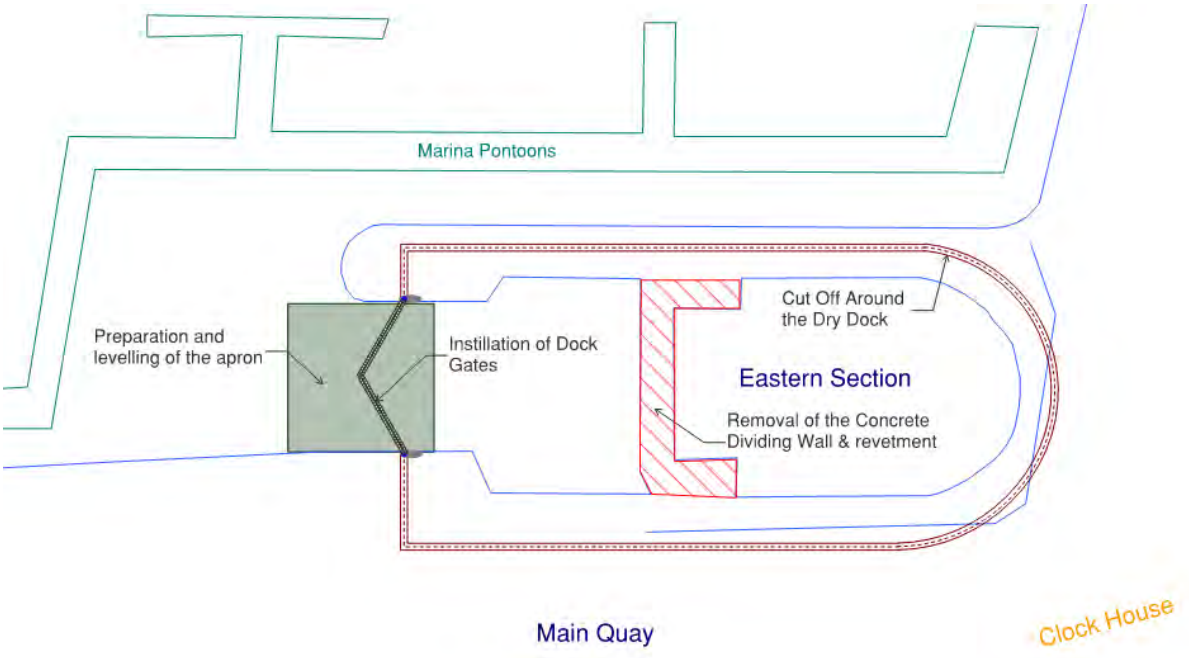

Figure 12 - Plan of works for dry dock reinstatement

4.2.3 Dock Gates & Equipment

In establishing the structure back to the working dry dock status it will require the installation of bespoke dock gates. These will need to be designed to fit the geometry of the opening and works at the dock walls will be required to establish a suitable hinge, seal and interface. In order to de-water the dock there will be a significant amount of equipment both hydraulic and electrical pumps. To power the equipment, the dock will require an electrical supply.

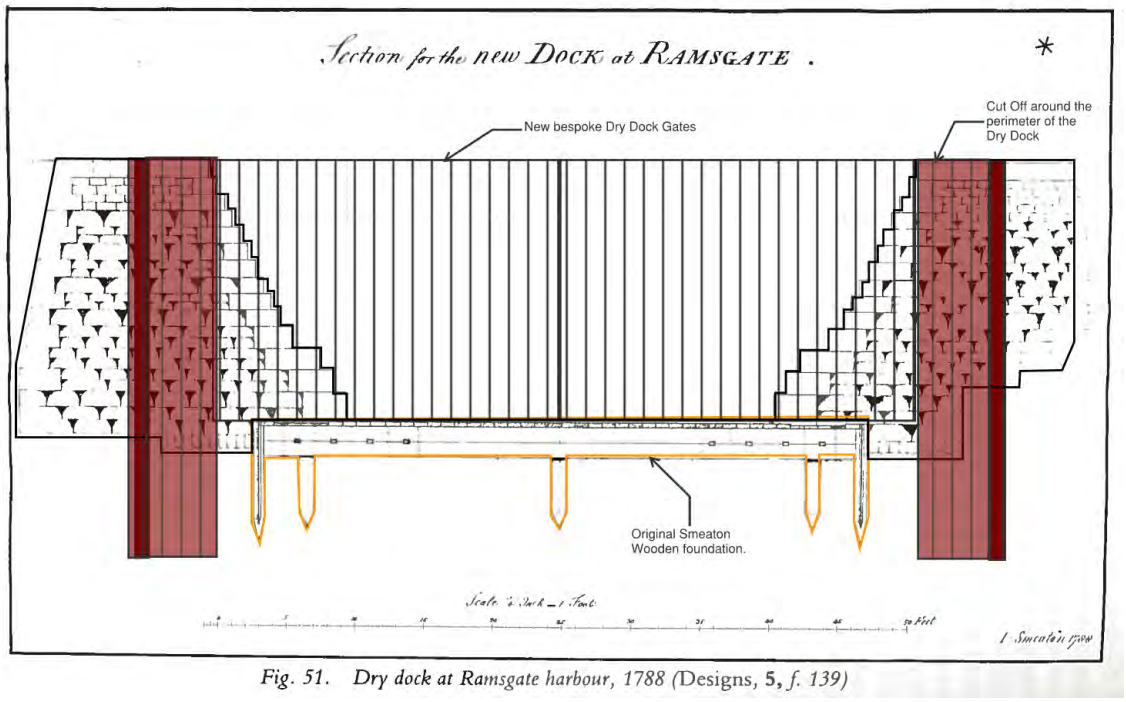

*Fig. 51. Dry dock at Ramsgate harbour, 1788 (*Designs, **5,** *f. 139)*

Figure 13 - Elevation of Dry-Dock Construction Requirements

Risks: There are significant risks and unknown complications that are found with remediating an old structure. Injection grouting is an inherently uncertain process; confidence in material quantities, costs and certainty of achieving the desired outcome would be significant risks. In piling through the wall and the uncovering of the timber base there are intrinsic risks of damage to the structure. There is also risk working with close proximity to the marina and with high probability of obstructions in the ground. There is also residual risk from detrimental effect of loading around the structure with heavy plant, especially on the Northern Wall.

The records show that in the past dewatering led to uplift of the north wall and this remains a potential risk.

In de-watering and exposing the original timbers there is also a risk that this drying process could result in degradation and damage to the existing foundations and floor of the dock.

It is noted that keeping the Cervia in a permanently dry state is not necessarily the right solution for the vessel and naval architecture advice should be sought in this regard.

The works required to achieve this concept are so extensive that arguably much of the historic fabric of the structure could be lost.

Alternatively the permanent cut-off could be installed, the existing partition removed as described above and the Cervia could be manoeuvred fully into the dry dock. Then a new solid wall across the mouth of the dock could be constructed. This would create a fully sealed dock from which the water can then be removed by a series of pumps, see Figure 14.

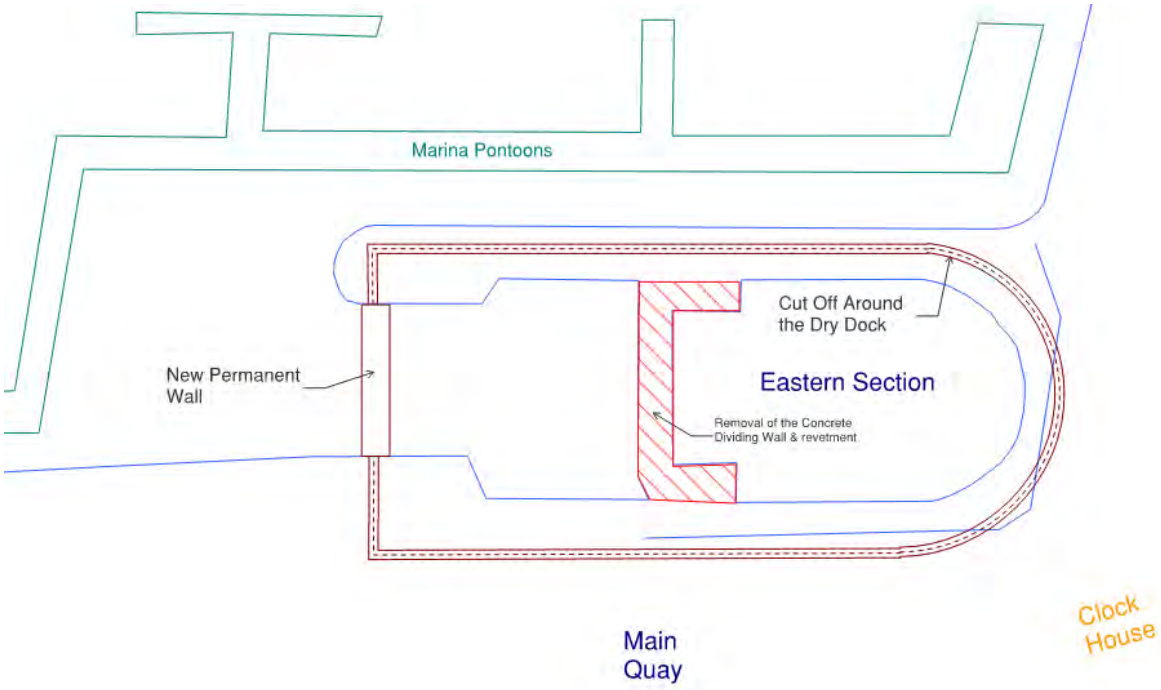

Figure 14 - Permanent sealing of the dock

Cost risk: The costs associated with this option are far greater than the other options with a significant sums required to design and construct these works. The cost of piling in a confined space also requires significant temporary works and/or specialist plant. There are many unknowns which could lead to increased costs for the reconstruction works and for ongoing maintenance costs. There are also additional running and maintenance costs attributed to the infrastructure to keep the dock functional.

Conclusion: This is likely to be a very expensive and high risk option. The feasibility of achieving this concept is uncertain.

4.3 Option 2 – Removal of the dividing wall

The second option looks to bring the Cervia closer to the refurbished clock house and to restore the original profile of the dry dock without seeking to dry the dock. The reinforced concrete (RC) central wall could be removed to allow the vessel to be fully moored within the dock; this is shown in the plan view of the existing wall see Figure 15. The Victorian RC wall consist of a section across the dock supported by buttresses at both ends and a concrete sill.

It is understood that the wall is an early example of reinforced concrete and therefore consultation with Historic England (and other stakeholders) and the appropriate approvals would be required.

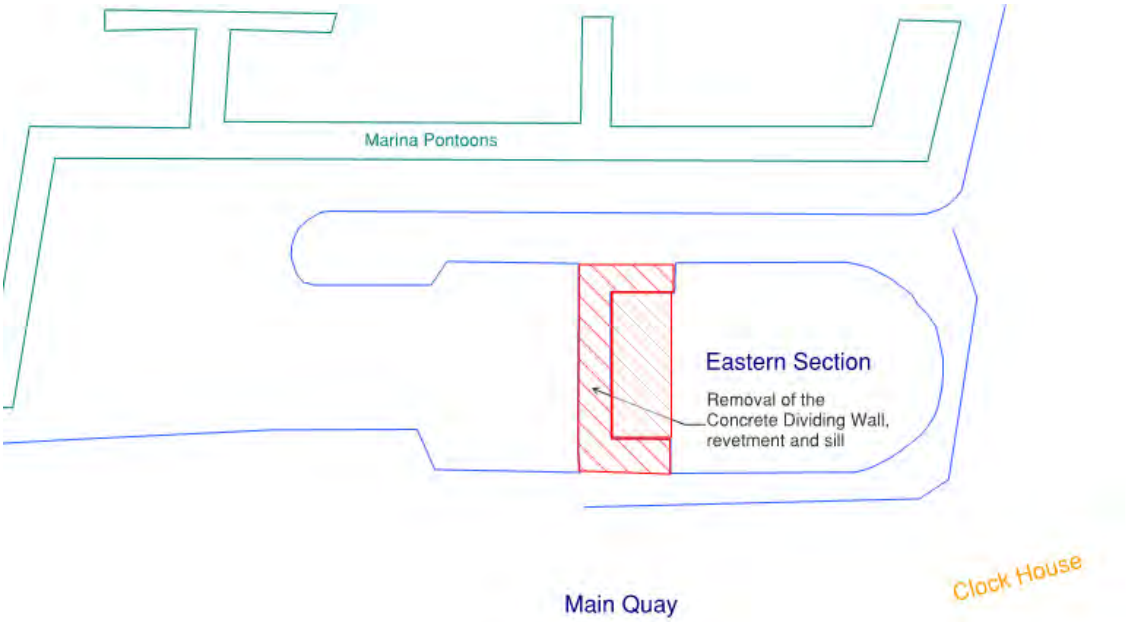

Figure 15 - Plan view of the removal of the RC wall

The exact volume of concrete to excavate is not clear, however it is a significant quantity that will need to be removed using large plant. There is also a steel structure that spans across the dock which will require removing see Figure 16.

Figure 16 - Reinforced concrete wall and sill (visible below water)

Structurally the removal of the concrete wall in its entirety will have some impact on the original dock structure under the wet conditions. The wall currently acts as a stiffening section to the outer walls. However, removal of the wall would also allow the water levels and pressures to equalise on both sides of the north wall which would reduce loads on the wall. The more rapid change in water levels in

the east dock could potentially have an adverse effect on the south wall. Removing the concrete sill would remove a stiffening element in the dock floor and there may no longer be a timber floor in this location. Investigations and calculations should be undertaken to understand potential impacts on the dock stability.

Mock or dummy dock gates could also be installed to the dry dock (perhaps only to low water level) under this option to create the impression of a working dry dock.

Risk: The risk with removing the wall is fairly low, however unknown complications could be found with tie in and damage to the original stone structure due to removal. There are higher risks with what will be found when removing the sill and the buttresses

Cost risk: The cost of the removal of the wall will require specialist plant and a competent contractor to remove and dispose of the excess material. It will also entail cleaning and repair works to the stone to preserve and improve the condition of the walls. Cost estimation is not part of the scope of this report but it is expected this option would require a six figure expenditure.

Benefits: The benefits of this option are that the Cervia will be able to be located entirely within the dock therefore making the vessel and original function of the dock more understandable to visitors. The heritage value would need to be discussed with Historic England but the reinstating of the original profile of the dock could be seen as an improvement under this option.

4.4 Option 3 – Infilling the dock below the Cervia

The fourth option is to remove the dividing wall, transfer Cervia fully into the dock next to the museum, then back fill the dock around and under her to establish a supportive medium on which the vessel can sit during lower states of the tide.

Risk: The main risk is that the vessel is not structurally sound enough to rest on the bed at low tide. A further risk is that with the vessel rising and falling onto aggregate or similar medium, this repetitive action would damage any coating on the steel hull. Additionally, regular wetting and drying of the hull is not ideal from a corrosion perspective and would limit the effectiveness of any cathodic protection. There is also a risk that with a mobile supportive medium such as pea gravel, the vessel may not always come to rest in the same location and there is potential for listing of the vessel which, without correction, may worsen over time.

Cost risk: The cost risks with this option are primarily associated with removal of the wall and sill (as for option 2) and the risk to the vessel.

Appendix A

Record Photographs

Appendix A - Record Photographs

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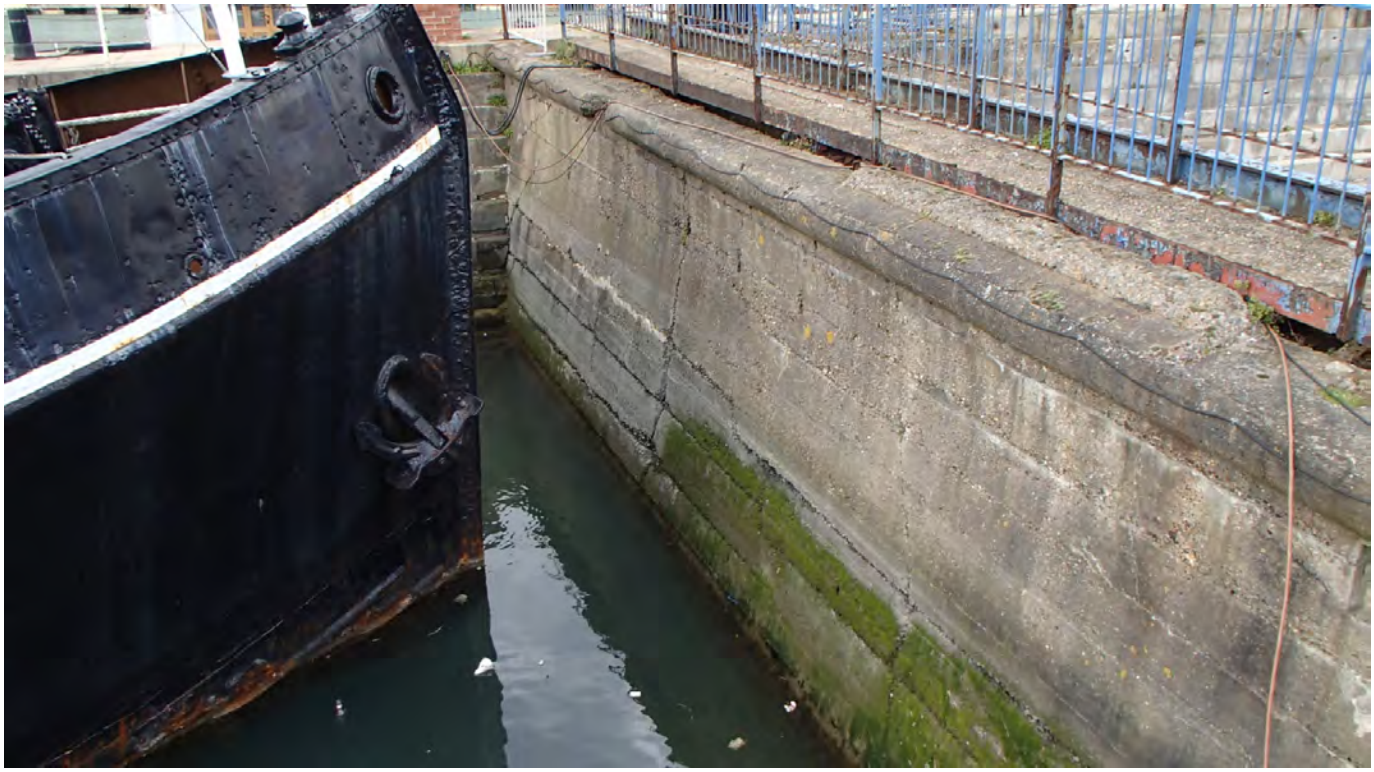

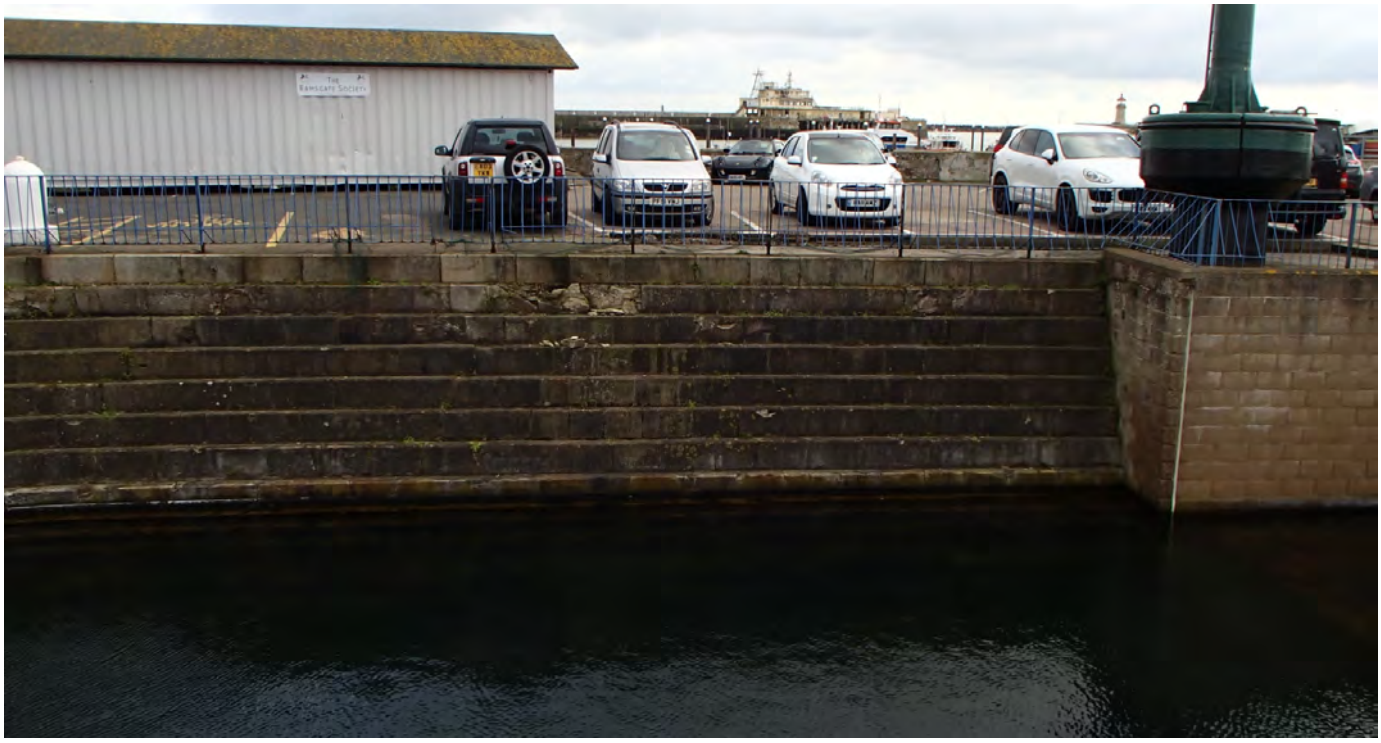

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