

# SPRINGFIELD DESIGNS Ltd

BRIDGE ELEVATION -  
A1-A1 - NTS

Sub Sta

Hotel

Car Park

Sand Quay

Prince of Wales Dock

Bollards

Car Park

Face of Dock Wall

Face of Dock Wall

MOORINGS TO BE  
PROVIDED TO ALLOW  
DOCKING OF 32 QTY  
BOATS ON NORTHERN  
SIDE

PEDESTRIAN ACCESS TO  
MOORINGS TO BE  
PROVIDED VIA SECURITY  
KEY VIA RAMPED  
ACCESS FROM CENTRE  
OF BRIDGE DECK

MOORINGS TO BE  
PROVIDED TO ALLOW  
DOCKING OF 32 QTY  
BOATS ON SOUTHERN  
SIDE

ILLUMINATION TO BE PROVIDED BY INSTALLATION OF  
ACROSPIRE DEFENDER LANTERNS AFIXED TO BRIDGE  
DECKING VIA 76.1mm COLUMNS. SHORT COLUMN  
AFIXED TO BRIDGE DECK VIA BOLT DOWN SYSTEM.  
SOLAR LIGHTING TO BE INSTALLED AT 15M C/C  
INTERVALS

ILLUMINATION TO BE PROVIDED BY INSTALLATION OF  
ACROSPIRE DEFENDER LANTERNS AFIXED TO BRIDGE  
DECKING VIA 76.1mm COLUMNS. SHORT COLUMN  
AFIXED TO BRIDGE DECK VIA BOLT DOWN SYSTEM.  
SOLAR LIGHTING TO BE INSTALLED AT 15M C/C  
INTERVALS

DRAWING TITLE

PHASE 7 - BRIDGE MOORINGS AND  
LIGHTING SYSTEM.

PROJECT TITLE

ACBA6003 - SPRINGFIELD DESIGNS -  
PEDESTRIAN BRIDGE

DRAWING No.

PED1-SPR-DR-C-0016-S1

CAD REF.

CAD

DRAWN BY

RM

11/22

SCALE

SHOWN

CHECKED

XXX

X/XX

PROJECT

PHASE

REV.

REV.

DESCRIPTION

BY

DATE

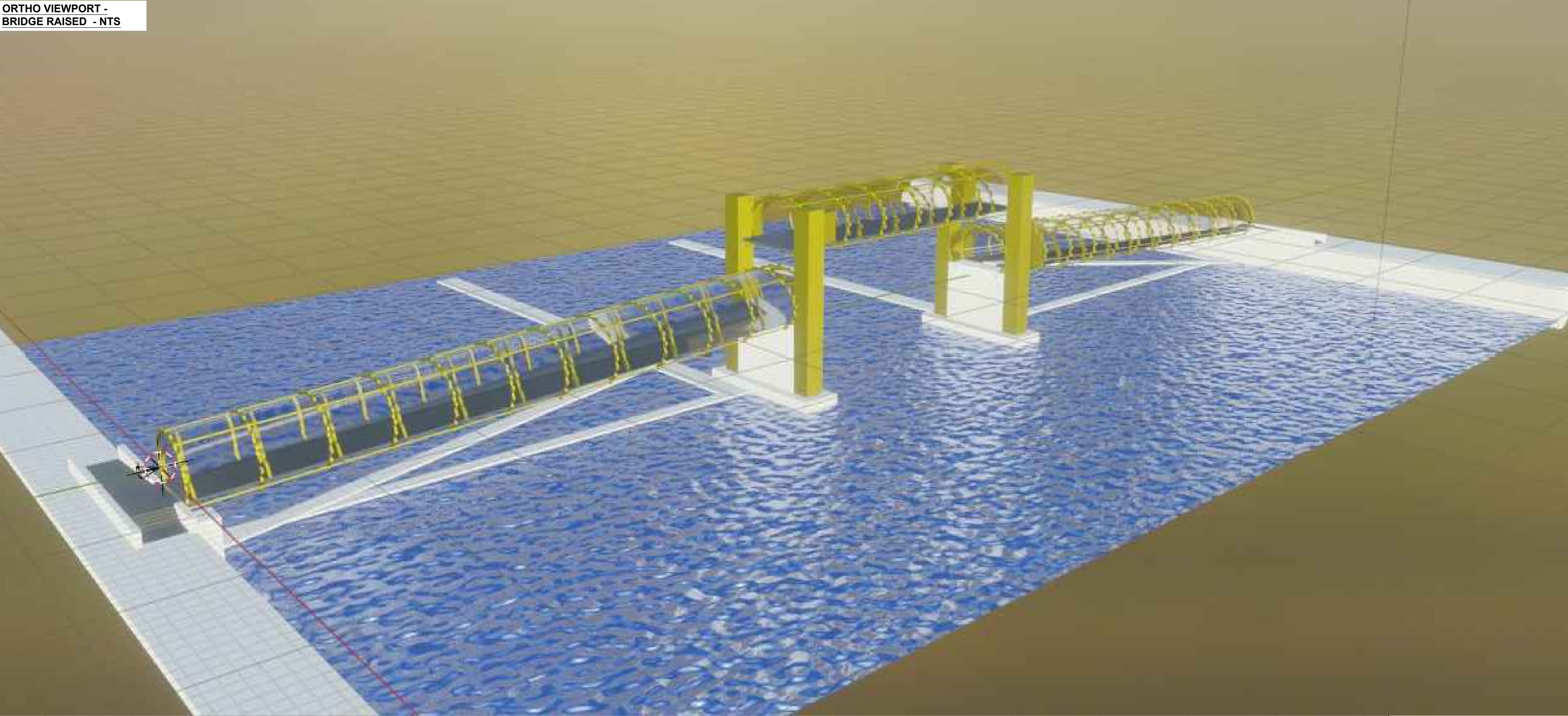
1 to 44

45 to 98

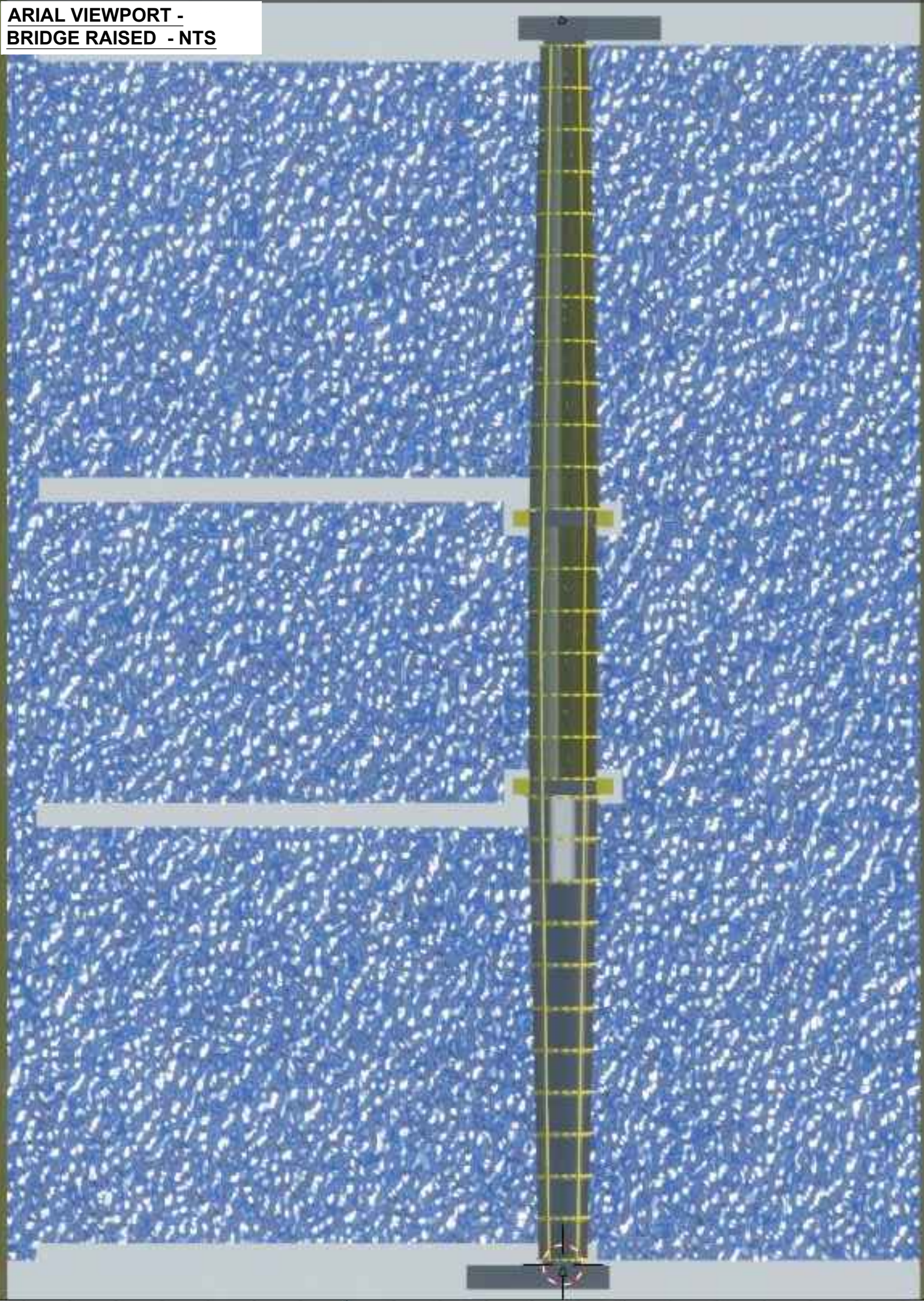
Sub Sta

# SPRINGFIELD DESIGNS Ltd

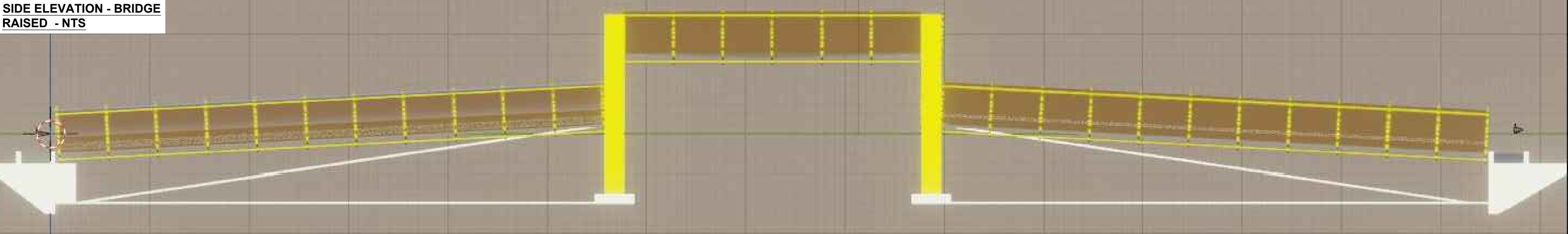
ORTHO VIEWPORT -  
BRIDGE RAISED - NTS



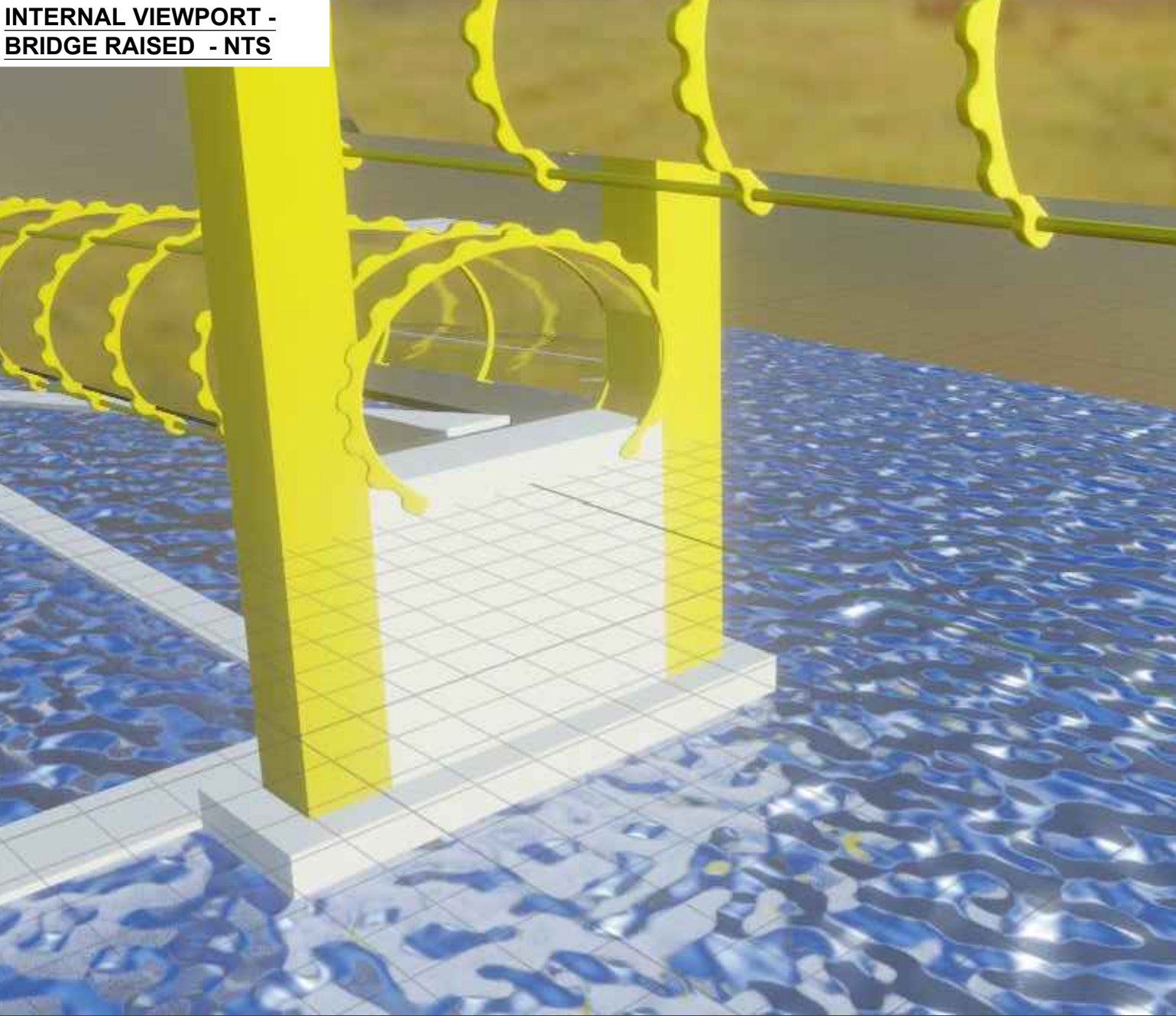
ARIAL VIEWPORT -  
BRIDGE RAISED - NTS



SIDE ELEVATION - BRIDGE  
RAISED - NTS



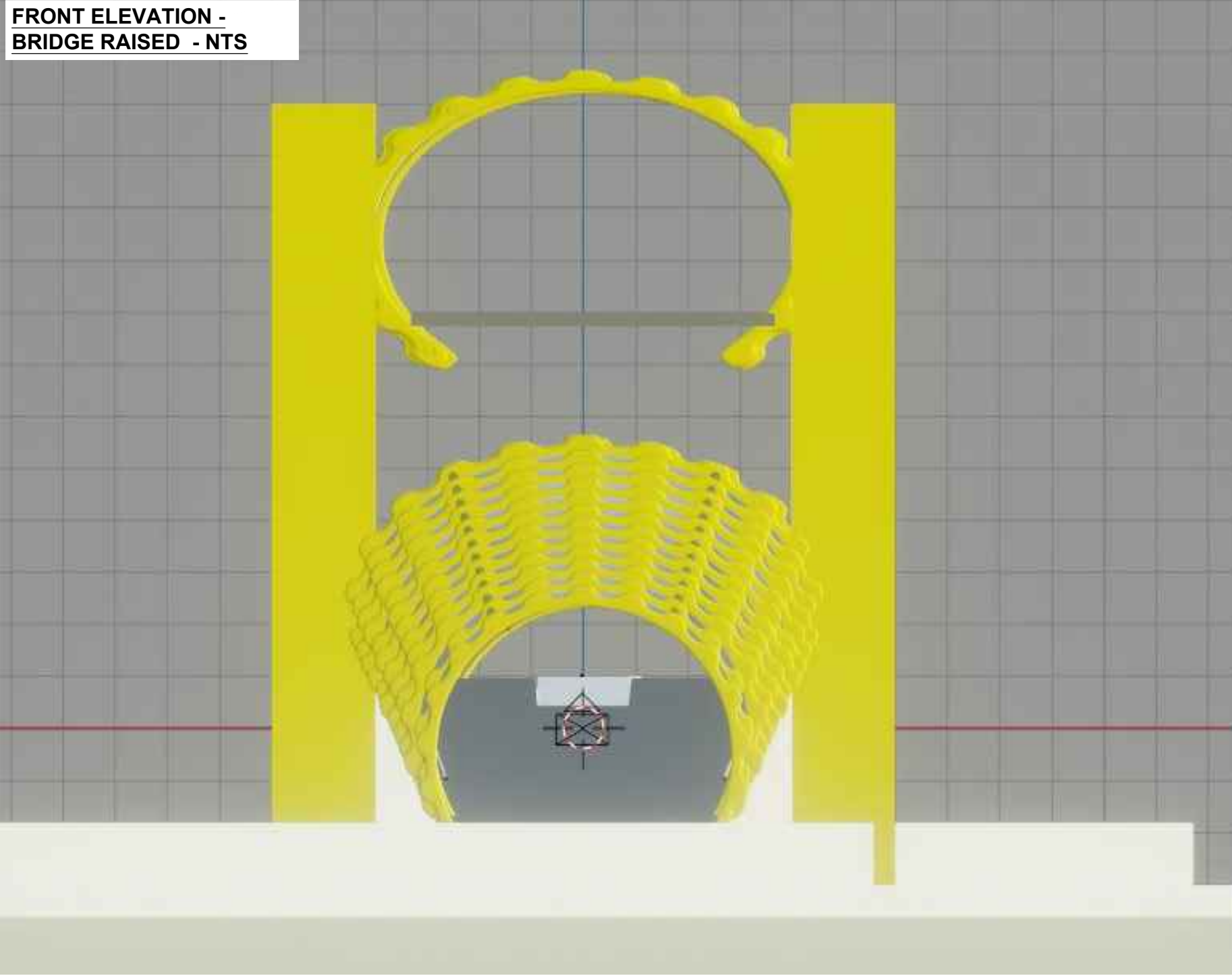
INTERNAL VIEWPORT -  
BRIDGE RAISED - NTS



USER VIEWPORT - BRIDGE  
RAISED - NTS



FRONT ELEVATION -  
BRIDGE RAISED - NTS



DRAWING TITLE  
**BRIDGE ELEVATIONS AND VISUALIZATIONS  
(RAISED - BLENDER FILE)**

|          |     |      |       |       |
|----------|-----|------|-------|-------|
| DRAWN BY | RM  | 5/23 | SCALE | SHOWN |
| CHECKED  | xxx | x/xx |       |       |

PROJECT TITLE  
**ACBA6003 - SPRINGFIELD DESIGNS -  
PEDESTRIAN BRIDGE**

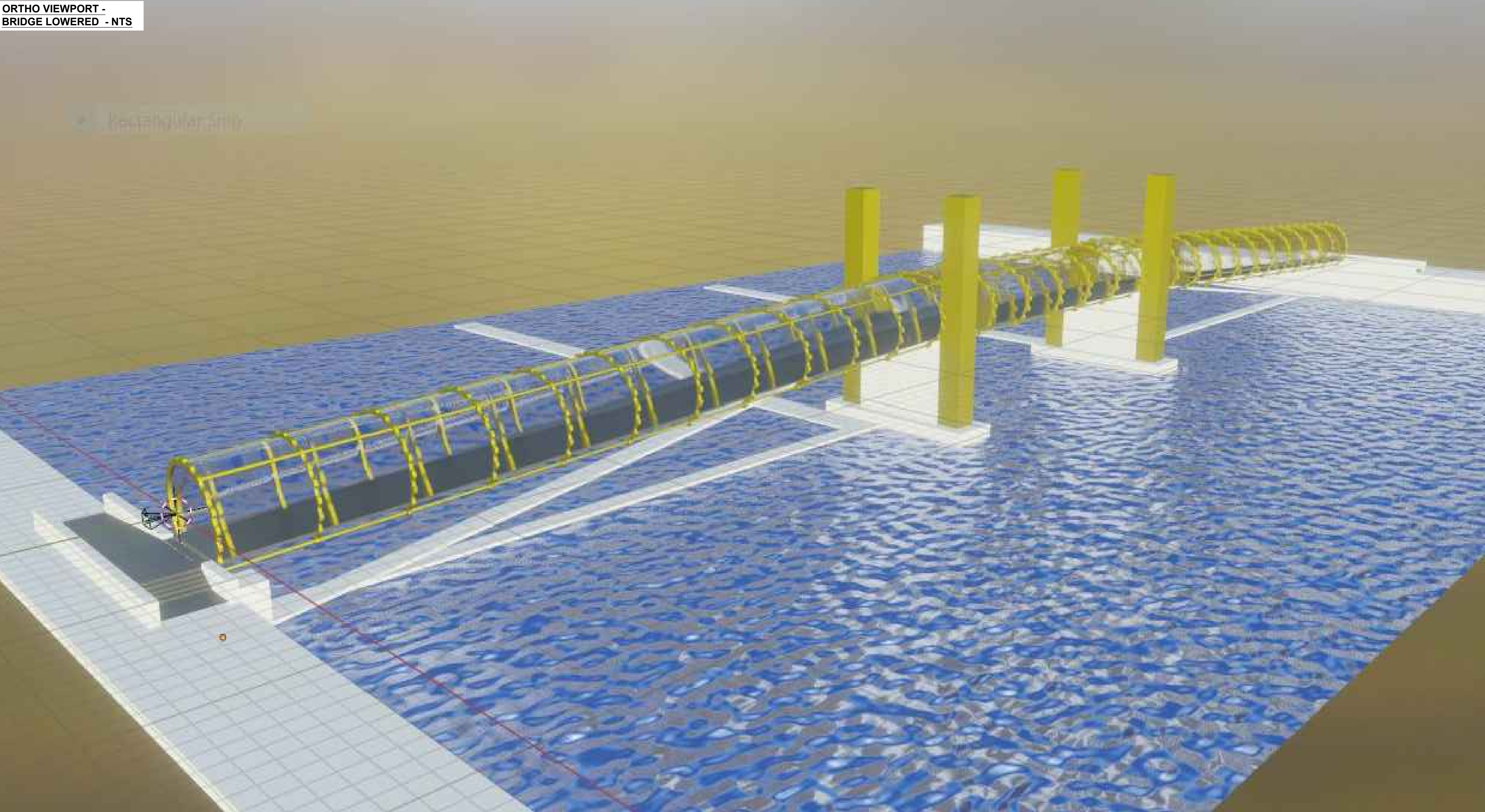
|               |       |      |
|---------------|-------|------|
| CAD REF.      | CAD   |      |
| PROJECT PHASE | PHASE | REV. |
|               |       |      |
|               |       |      |
|               |       |      |
|               |       |      |

DRAWING No.  
**PED1-SPR-DR-C-0017-S1**

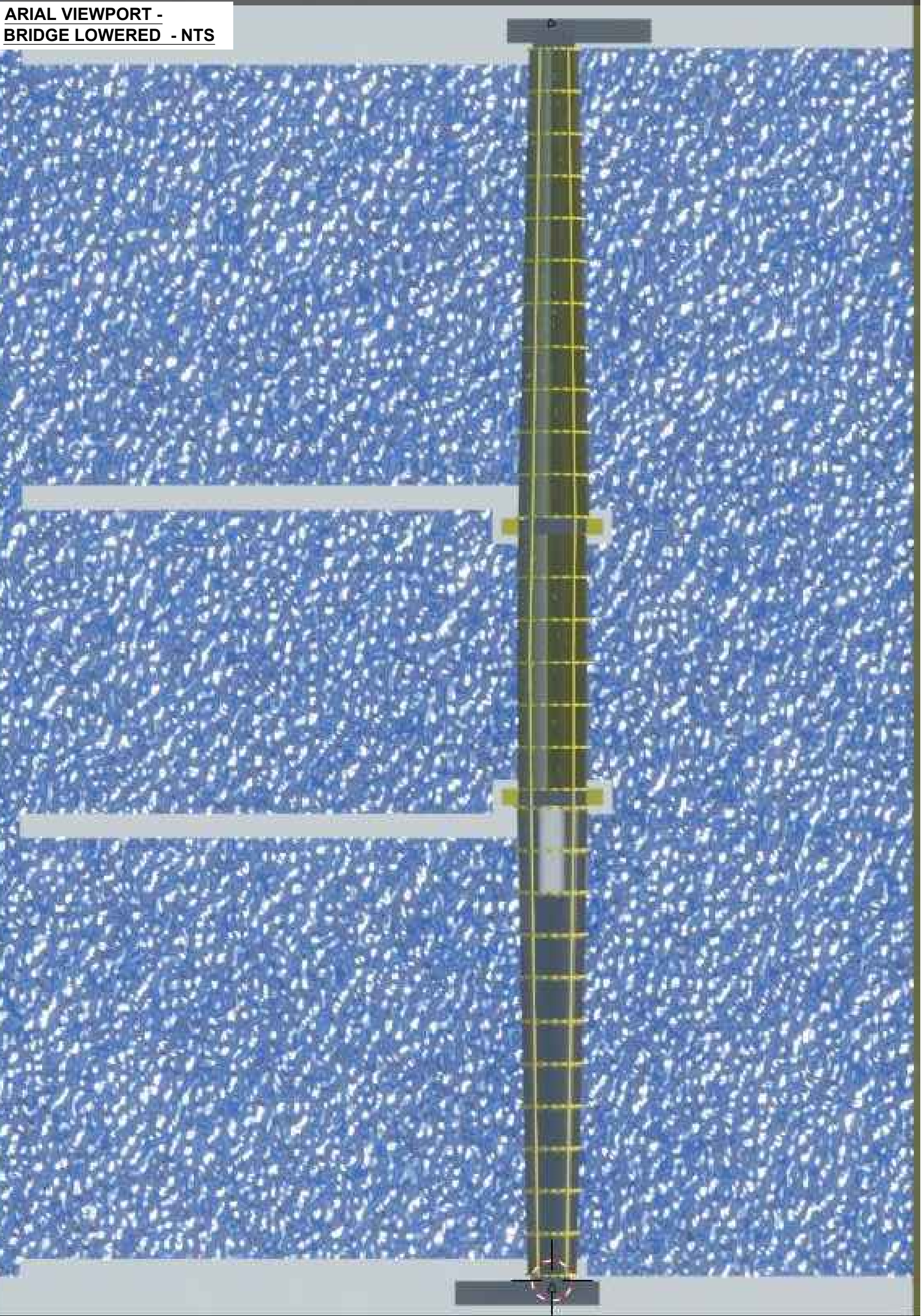
|      |             |    |      |
|------|-------------|----|------|
| REV. | DESCRIPTION | BY | DATE |
|      |             |    |      |
|      |             |    |      |
|      |             |    |      |
|      |             |    |      |
|      |             |    |      |

# SPRINGFIELD DESIGNS Ltd

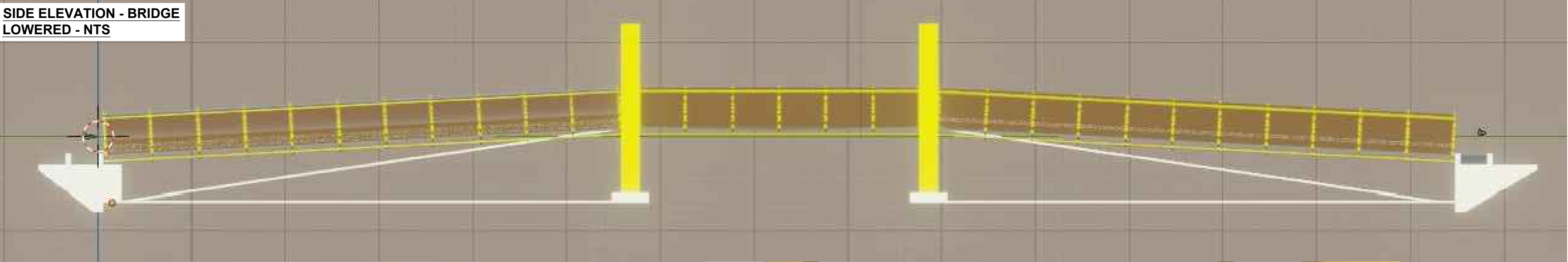
ORTHO VIEWPORT -  
BRIDGE LOWERED - NTS



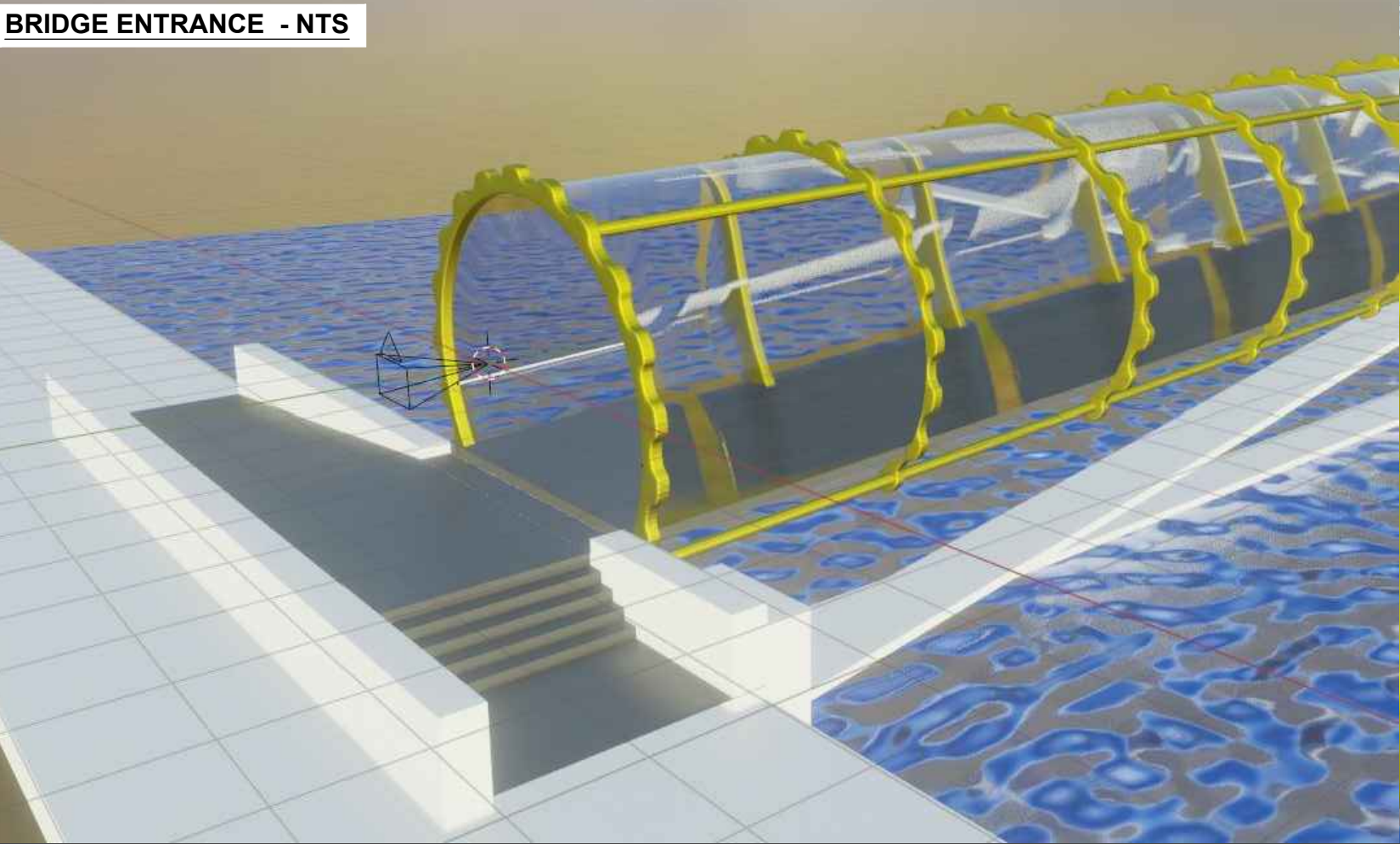
ARIAL VIEWPORT -  
BRIDGE LOWERED - NTS



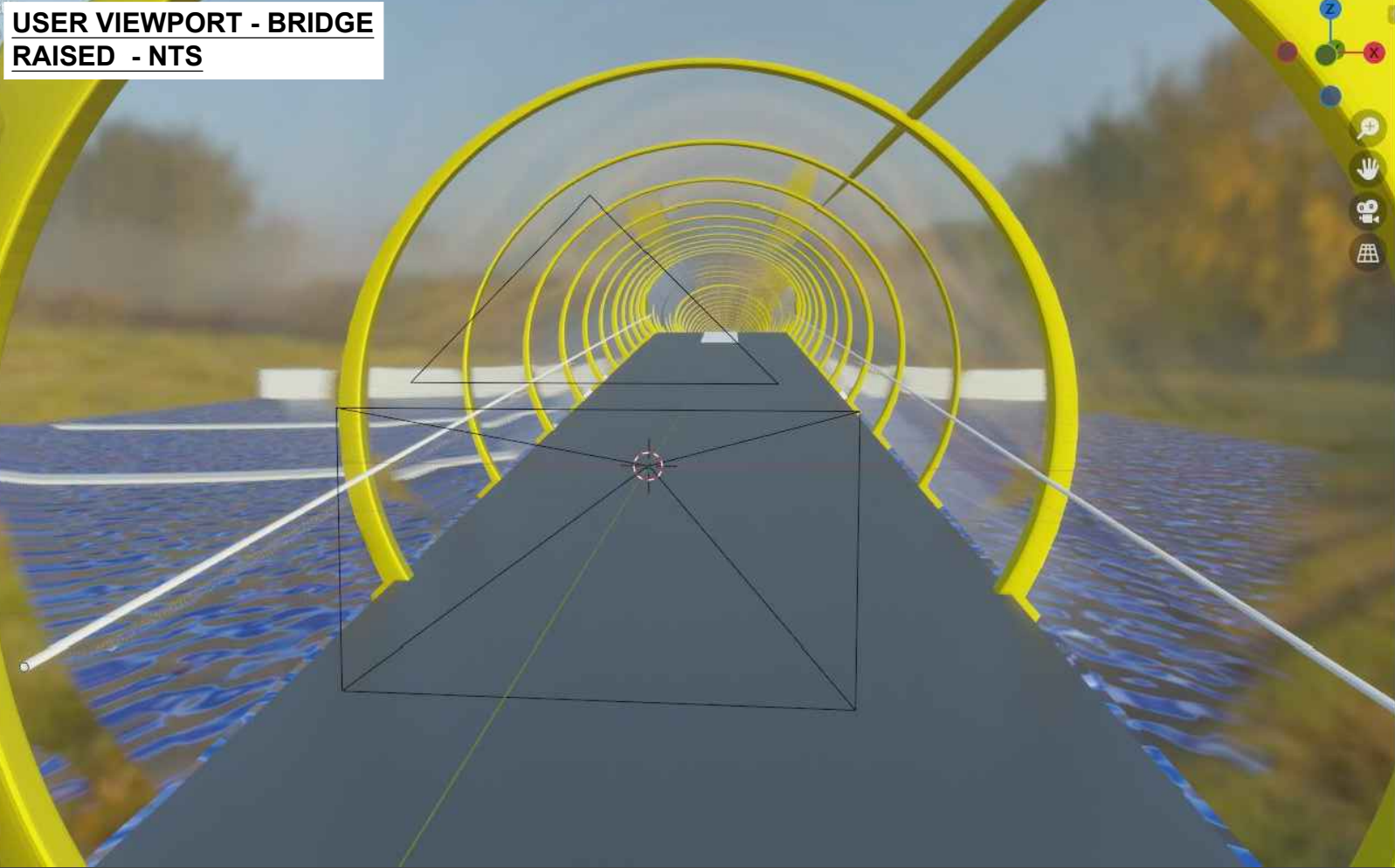
SIDE ELEVATION - BRIDGE  
LOWERED - NTS



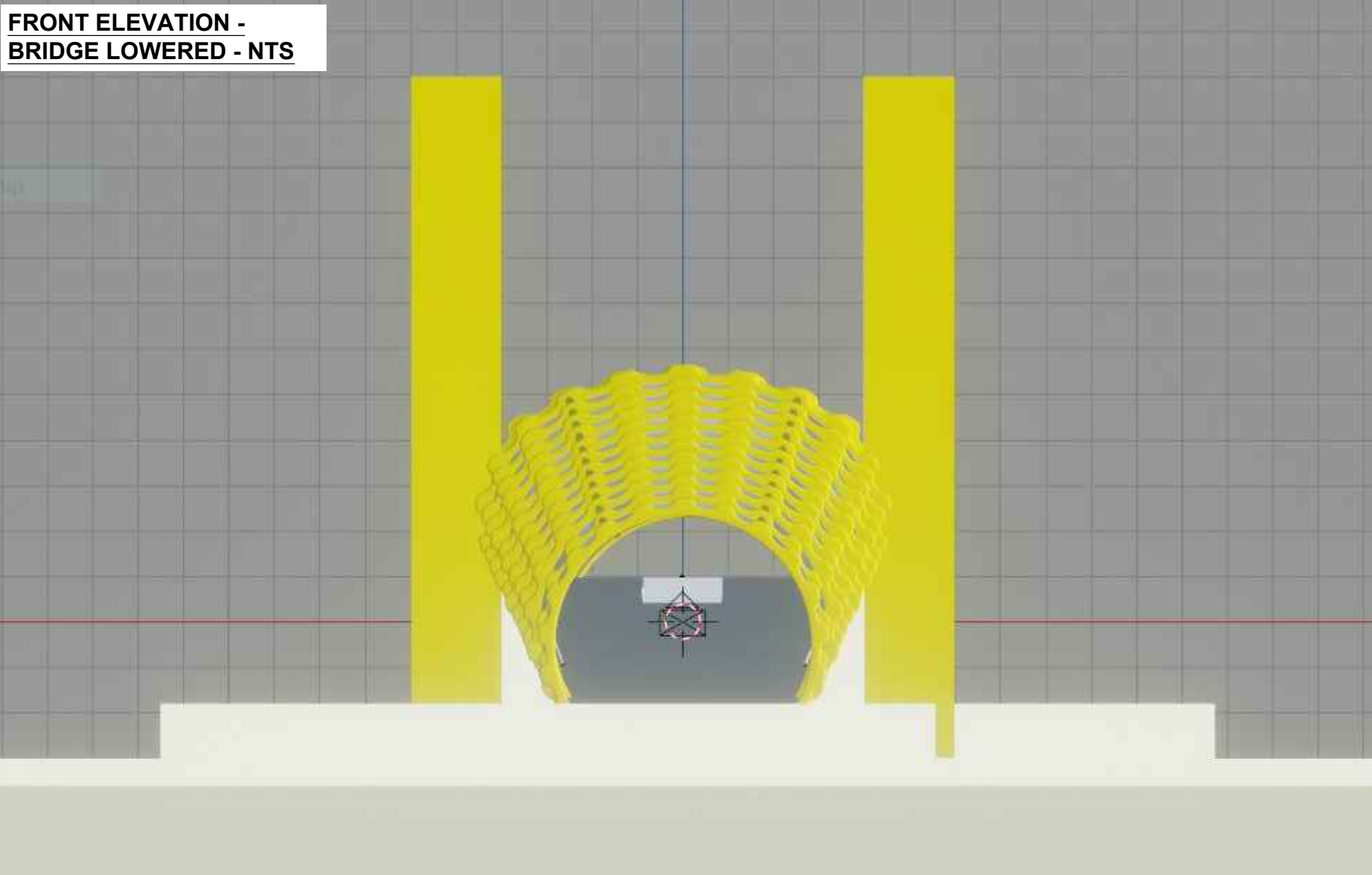
BRIDGE ENTRANCE - NTS



USER VIEWPORT - BRIDGE  
RAISED - NTS



FRONT ELEVATION -  
BRIDGE LOWERED - NTS



DRAWING TITLE  
**BRIDGE ELEVATIONS AND VISUALIZATIONS  
(RAISED - BLENDER FILE)**

|          |     |      |       |       |
|----------|-----|------|-------|-------|
| DRAWN BY | RM  | 5/23 | SCALE | SHOWN |
| CHECKED  | xxx | x/xx |       |       |

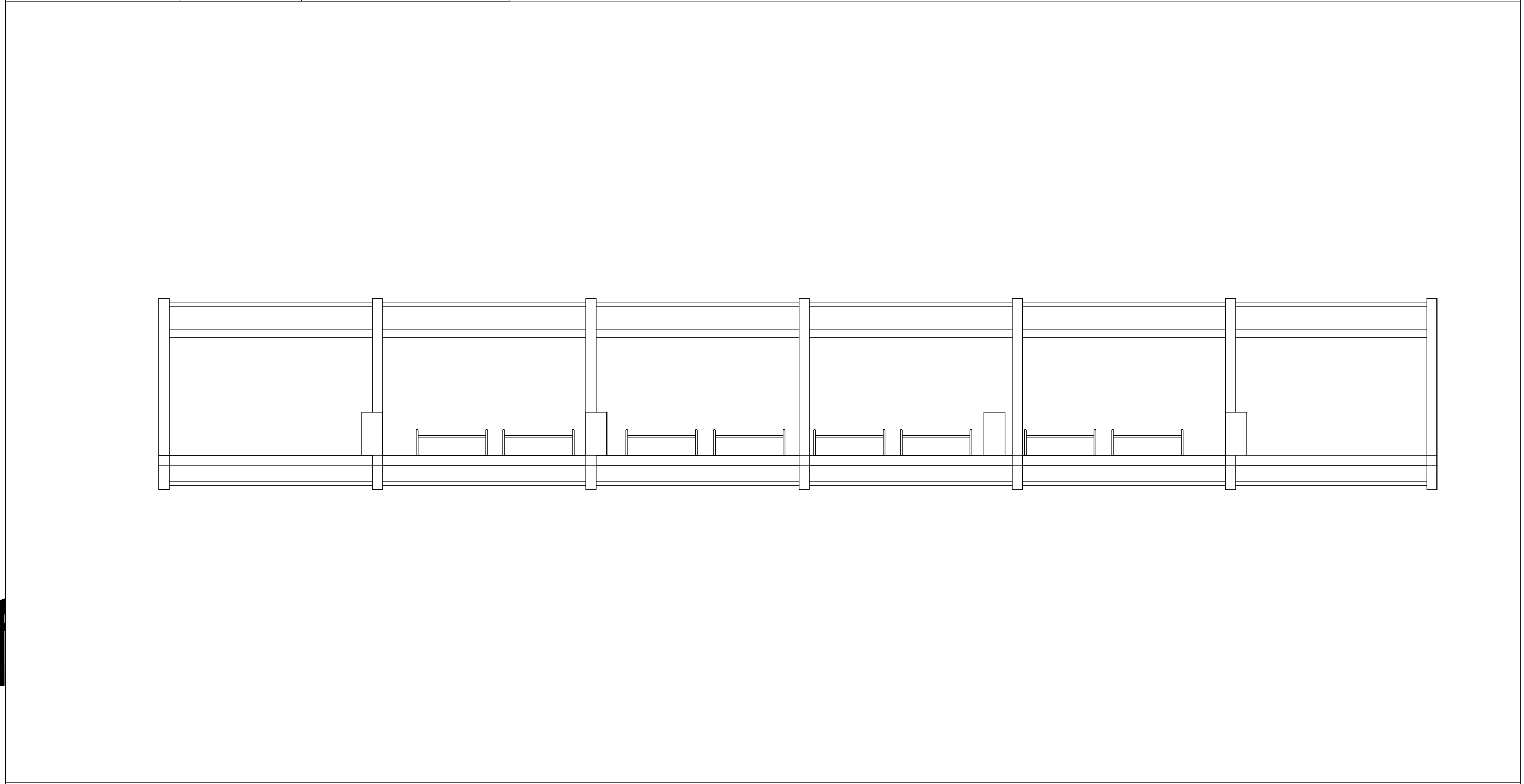
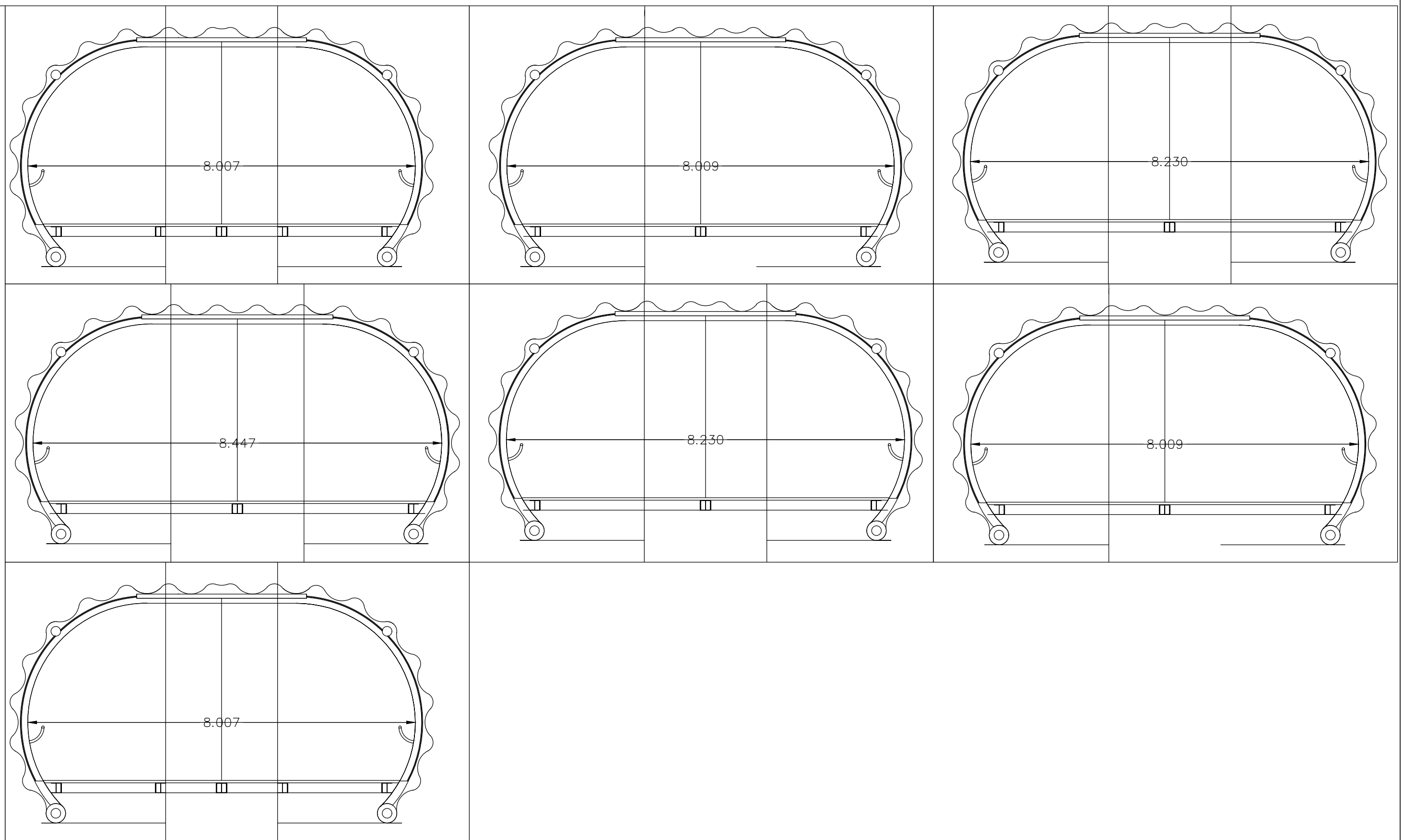
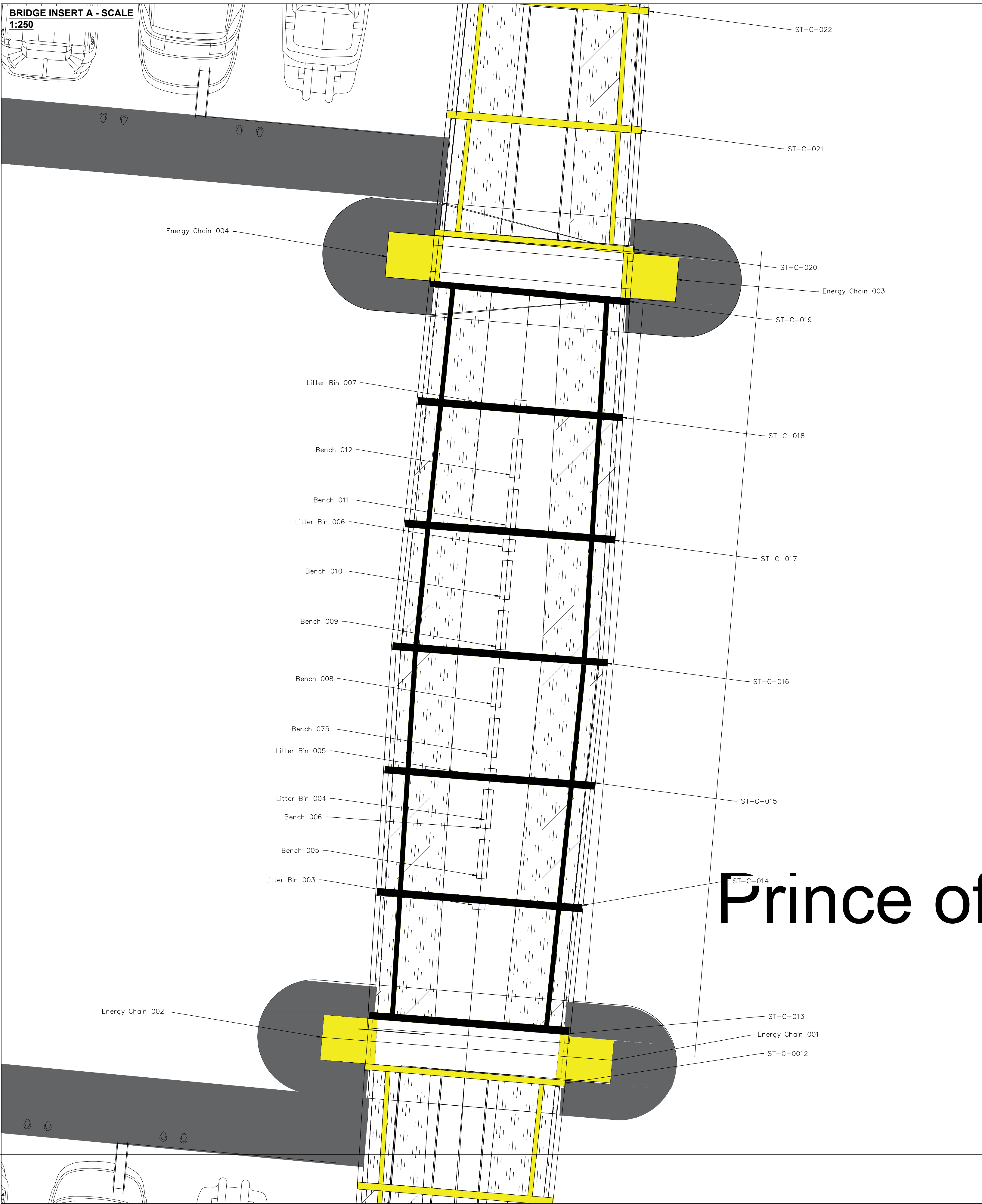
PROJECT TITLE  
**ACBA6003 - SPRINGFIELD DESIGNS -  
PEDESTRIAN BRIDGE**

|               |       |      |
|---------------|-------|------|
| CAD REF.      | CAD   |      |
| PROJECT PHASE | PHASE | REV. |
|               |       |      |

DRAWING No.  
**PED1-SPR-DR-C-0018-S1**

|      |             |    |      |
|------|-------------|----|------|
| REV. | DESCRIPTION | BY | DATE |
|      |             |    |      |

SPRINGFIELD DESIGNS Ltd

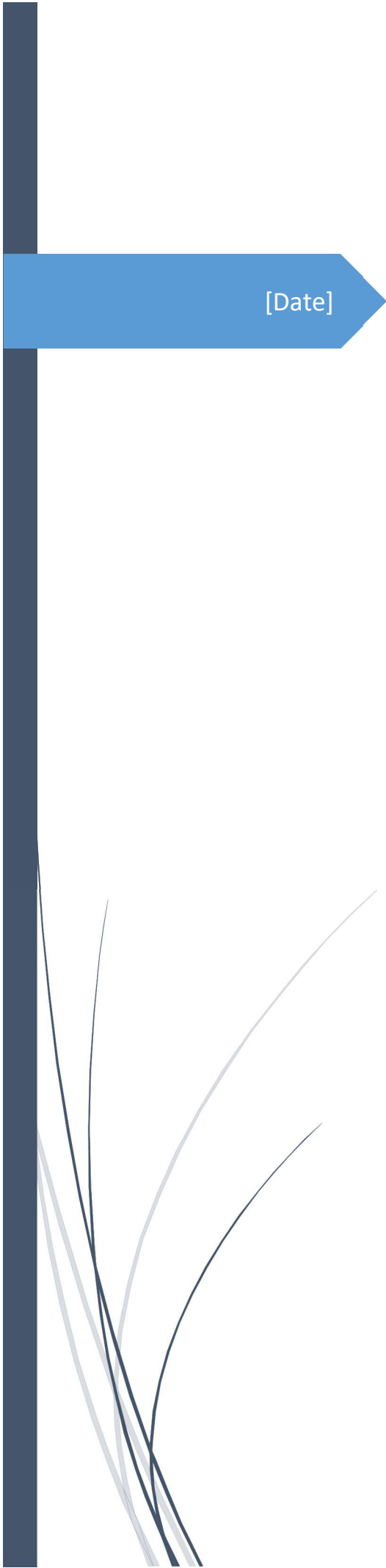


DRAWING TITLE  
PHASE 6 - PROPOSED BRIDGE LAYOUT,  
COG DETAIL AND ASSET LOCATION PLAN

PROJECT TITLE  
ACBA6003 - SPRINGFIELD DESIGNS -  
PEDESTRIAN BRIDGE

DRAWING No.  
PED1-SPR-DR-C-0015-S1

|          |     |       |       |       |               |       |  |  |  |  |  |      |  |  |  |  |  |      |             |    |      |
|----------|-----|-------|-------|-------|---------------|-------|--|--|--|--|--|------|--|--|--|--|--|------|-------------|----|------|
| DRAWN BY | RM  | 11/22 | SCALE | SHOWN | CAD REF.      | CAD   |  |  |  |  |  | REV. |  |  |  |  |  | REV. | DESCRIPTION | BY | DATE |
| CHECKED  | XXX | X/XX  |       |       | PROJECT PHASE | PHASE |  |  |  |  |  |      |  |  |  |  |  |      |             |    |      |



[Date]

## 4.1 – Identify the Different Material and Compounds Used – Considering Material Choices

Murray, Richard

SPRINGFIELD DESIGNS LTD

WORK COMPLETED BY RICHARD MURRAY WILL BE HIGHLIGHTED

YELLOW

## Contents

|                                         |   |
|-----------------------------------------|---|
| Introduction .....                      | 2 |
| Possible Material Choices .....         | 2 |
| Material Choices .....                  | 2 |
| Selected Material Choices.....          | 3 |
| Justification for Material Choice ..... | 4 |
| Possible Material Compounds .....       | 4 |
| Material Choices .....                  | 6 |
| Selected Material Choices.....          | 6 |
| Justification for Material Choice ..... | 7 |
| Conclusion.....                         | 8 |

## Introduction

The design and development of the Pedestrian Bridge in accordance with the brief has required research into the possible material choices. It is important to ensure that each chosen material utilised in the design and construction of the pedestrian bridge is chosen for the specific purpose in mind, while keeping its material properties in mind, or creating a compound which could in turn serve to reduce the disadvantages associated with a specific material thus allowing it to be utilised within the construction process.

## Possible Material Choices

### Material Choices

Typically when constructing a bridge the typical material choices would be;

- Wood
- Concrete
- Steel
  - Post Tensioned
  - Pre Tensioned

Each of the above materials has their own specific advantage, and disadvantage;

### Wood

While wood is a perfectly acceptable material to construct a pedestrian bridge from, as it is light weight (depending on the amount used), can be sourced sustainably and in many cases is a cheap material to utilise. In this instance it is not a suitable material for the below reasons;

- Physical Strength over long distances would require extensive cross bracing or reinforcement.
- Location over a marine environment would cause the wood to rot, which in turn would affect the durability of the bridge.
  - This could be overcome with effective maintenance, however the maintenance would need to be frequent which in turn would be expensive.

Due to the maintenance required in order to keep the wood at a suitable strength, any cost saving on the project would be quickly consumed in maintenance costs. Also the innate structure of the wood allows for large flexibility in the strength of the wood (while this can be standardised through testing, any knots that exist within the wood would introduce a potential structural weakness within

the material. While the rotting of the bridge could be reduced by painting the bridge, wood would not be a suitable material.

## Concrete

Constructing the bridge out of concrete would be a perfectly suitable as concrete has a high compressive and tension properties when suitably reinforced. However as indicated this would require extensive reinforcement, which in turn would require the deck of the bridge to be extremely thick (especially when compared to steel).

This additional thickness would in turn result in additional weight, which may result in further reinforcement or potentially expensive redesign. As such utilising concrete for the construction of a bridge is suitable, however this would typically be utilised where extensive loading (i.e. vehicle loads) would be expected, as the brief requested a pedestrian bridge these high loads are not expected.

Concrete is also subject to corrosion, especially in the event that the covering protecting the reinforcement is compromised, in this instance the steel within the concrete would be subject to the Marine environment. This would in turn introduce erosion directly into the reinforcement, which if compromised would substantially reduce the tensional strengths of the concrete. As such maintenance costs would be higher (when compared to steel as the concrete would need to be checked, and any defects treated).

Utilising concrete would also be a slow process, as each section would potentially be made of smaller sections, which would be lifted, then connected together to allow installation of the spans required. This would be slow on site, which in turn could lead to higher cost on site.

The lifting mechanism would also need to be constructed from an alternative material, as indicated above concrete would be too heavy to lift, as such steel would be the reasonable choice for this element.

## Steel

Steel is one of the preferred materials for constructing pedestrian bridges as it is lightweight, can be treated to protect against weathering, and can be pre constructed to very low tolerances prior to installation on site. As such the process of installing a steel pre fabricated bridge is extremely quick and efficient especially when compared to concrete.

However steel as a material does have its weaknesses, when compared to concrete it's compressive strength is less, and is susceptible to bending and buckling.

Also without correct treatment the material it's self will suffer from erosion, however as indicated above, the potential solutions to this are as below;

- Powder Coating
- Painting
- Utilising Stainless Steel
- Utilising an Alloy

From the above, Powder coating and painting would be among the cheapest and most cost effective.

Powder coating the steel at the factory would allow for the steel to be protected straight from the factory, and would in turn allow for any colour to be utilised, in the instance of the brief Copper coloured paint/powder coating could be utilised to create the chosen finish.

Painting would be utilised if any defects in the powder coating process were encountered, or during the life cycle of the project. However powder coating can fail, or potentially small areas could be missed, this in turn would introduce weaknesses, or the powder coating could be removed through the act of installation (tightening up of bolts).

As such constructing the bridge out of stainless steel, or utilising another alloy with a higher resistance to corrosion would be advisable. However utilising different steel alloys is potentially very expensive, as such this will be investigated further below.

## Selected Material Choices

Steel Bridge Deck with concrete supports

### Justification for Material Choice

The nominated material choice is steel, this has been chosen as the material is comparatively light weight, especially when compared to steel, and allows for precise fabrication of the deck prior to installation. The deck could be installed in a single piece, with additional reinforcement provided in the form of Steel I Beams suitability designed by structural calculations to resist the imposed loads expected on this pedestrian bridge.

As indicated above the steel deck and I Beam will need to be pre-treated, or constructed from material alloys which would allow for a resistance to erosion. As such potential alloys will be

explored below, however for areas where structural steel is to be utilised (I Beam Support) these should all be powder coated prior to installation, with regular maintenance utilised to ensure the steel is not directly exposed to the elements.

Concrete supports will be utilised in order to take the static or imposed loads and translate this load into the structural supports. Concrete will be utilised as concrete as high compressive strength, as such concrete is the best material choice to utilise in this instance.

## Possible Material Compounds

### Material Choices

As steel is the nominated material choice, there are a substantial amount of Steel compounds or Alloys which could be utilised. However for the construction of the pedestrian bridge the below alloys will be discussed;

- Stainless Steel
- Copper Nickel Alloy

Stainless steel as explained by Velling. A (2020) describes a group of 200 alloys of steel, which contains a minimum of 10.5% of chromium, it's this chromium which improves its resistance. Due to this the material is highly sought after due to its resistance or organic and chemical erosion, however utilising stainless steel in the construction of a pedestrian bridge would incur an extreme high cost, it would also have a silver colour, which would not be in keeping with the proposed brief of the pedestrian bridge which must have links to the copper history of Swansea.

Copper Nickley alloy, also known as Cupronickel is widely utilised in Marine environmental where protection from Seawater is important. Nickel Institute (No Date). Indicates that the main uses for copper nickel allows is in seawater piping, heat exchangers and condensers. This is due to the protection from erosion and high resistance.

Copper Nickel Alloys however do not have the same structural strength as regular steel due to the higher concentration or Nickel and Copper in their construction. As such it is not recommended for the construction of the bridge that this is used as a structural component, instead it is proposed to utilise the Copper Nickel Alloy as a cladding as shown by Mark. L (2015) used in Garden Bridge to provide the aesthetic appeal of the bridge to tie into the copper history of Swansea.

### Selected Material Choices

From the above the chosen material will be Structural Steel, powder coated for the Decking of the bridge, with Copper Nickel Alloy utilised for the individual cog sections to allow the bridge to satisfy the requirement of the brief to tie into the historic nature and cultural history of Swansea's Copper works.

### Justification for Material Choice

Utilising the materials in the above manner will allow the structural strength of steel to be utilised where it is required, however will also allow for a new and innovative material to be utilised in the bridge which will tie into the developing nature and substantial copper developments currently in construction around Swansea as shown in BBC News (2022).

## Conclusion

From the above analysis of possible material choices for the development of the pedestrian bridge across the Prince of Wales Dock, the below material choices has been selected;

- Steel Decking –suitability Reinforced with I structural I Beams to resist bending and shear forces as determined by structural calculations.
  - Powder Coated Copper
- Copper Nickel Alloy Steel cogs to provide the cultural link to the heritage of Swansea and to produce the land mark requirement of the brief.
- Coper Nickel Cladding to be added to structural elements of Steel (i.e. Lifting device columns)

Please see drawing No. PED1-SPR-DR-C-0017-S1 and PED1-SPR-DR-C-0018-S1 for visualisations of the material choice.

## References

Velling. A (2020) *What Is Stainless Steel? Properties and Applications*. (Available from; <https://fractory.com/what-is-stainless-steel/>) (Accessed 2/5/2023)

Nickel Institute (No Date). *Applications of copper-nickel Alloys*. (Available from <https://nickelinstitute.org/en/about-nickel-and-its-applications/copper-nickel-alloys/applications-of-copper-nickel-alloys/>) (Accessed 2/5/2023)

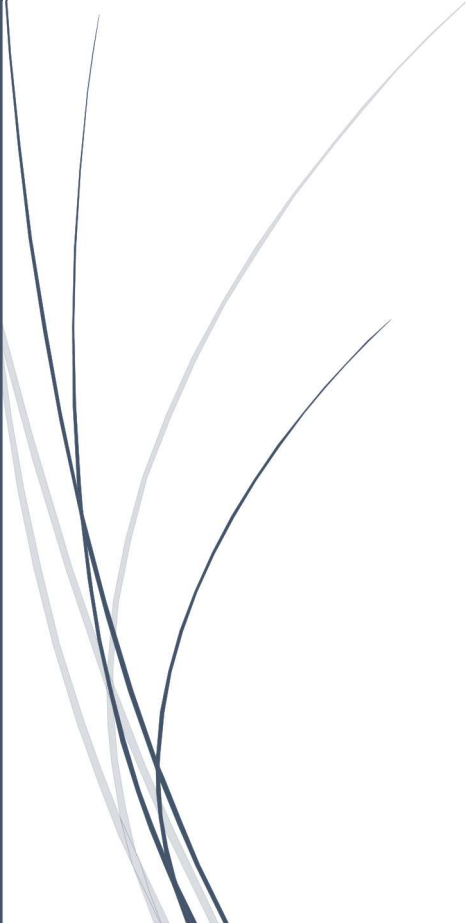
Mark. L (2015) First image of Garden Bridge's copper cladding revealed. (Available from; <https://www.architectsjournal.co.uk/news/first-image-of-garden-bridges-copper-cladding-revealed>) (Accessed 2/5/2023)

BBC News (2022). *Swansea: £135m Copr Bay district opens to the public*. (Available from; <https://www.bbc.co.uk/news/uk-wales-60604290>) (Accessed 2/5/2023)

A dark blue vertical bar runs down the left side of the page. A blue arrow points to the right from this bar, containing the date 5/2/2023.

5/2/2023

## 4.2 Identify the construction methods and machinery used

Several thin, curved, light blue lines sweep upwards from the bottom left corner of the page.

Jonathan Triggs & Richard Murray

SPRINGFIELD DESIGNS

WORK COMPLETED BY RICHARD MURRAY WILL BE HIGHLIGHTED  
YELLOW

## Contents

|                       |   |
|-----------------------|---|
| Steel .....           | 2 |
| CFA Piling.....       | 3 |
| Cofferdam Piling..... | 4 |
| Conclusion.....       | 5 |

## Steel

Firstly the design of the bridge has allowed the construction to be split up into 3 sections. This is due to steel being strong and being able to span large distances. This makes the construction of the bridge much easier as the steel sections can be pre-fabricated off site and then bolted together once on site which also takes up much less storage space which isn't available on this site. Due to steel being prefabricated off-site and then quickly assembled on site, this saves time and reduces disruption to local communities during the construction process. Steel is an extremely strong and durable material, which makes it ideal for building bridges that can withstand heavy loads and extreme weather conditions. With this bridge being close to the sea and above water this is essential in the sustainability of the bridge as it will be exposed to the harshest of weather conditions. Steel can be shaped and welded into a variety of different forms, allowing engineers to design bridges that are highly customized to meet specific needs and requirements. This flexibility allowed us to come up with a unique design which pays tribute to the history of Swansea. Although the upfront cost of steel may be higher than some other materials, it is more cost-effective in the long run due to its durability and low maintenance requirements. As the bridge spans over water access to maintain the bridge would be difficult and costly so using a durable material is essential. Steel is also a highly sustainable material that can be recycled and reused, making it an environmentally friendly choice for bridge construction.

## CFA Piling

CFA piles are more cost-effective than other types of foundation systems, such as drilled shafts or driven piles, because they require less equipment and labour to install. Due to the bridge being above water and access being difficult this was a major aspect in choosing CFA piles as there is less of an access requirement needed to being able to construct the piles. CFA piles can be installed quickly and efficiently, which reduced project timelines and minimizes disruption to surrounding areas which again played part as the access to where the abutments needed to be piled were within water this made the construction process quick and effective. CFA piling produces less noise and vibration during installation compared to other types of piles, which is crucial in not disrupting the near wildlife within the body of water and the surrounding high rise buildings which could be effected by the vibration of piling. CFA piles have a high load-bearing capacity, this is essential in the design of the bridge as it allows us to use large spans across the water with minimalizes the work required to construct the bridge structure.. As CFA piles can be installed in a variety of soil types and ground conditions, this makes them a versatile foundation solution for different types of construction projects. The underwater nature of the piles could cause adverse damage on the piles so CFA piles were suitable option to combat this. CFA piles produce minimal spoils or waste during installation, which reduces the environmental impact and this reduces any potential spills into water courses which would effect the wildlife living in the dock.

## Cofferdam Piling

Cofferdam Piling unlike CFA Piling is a type of piling which is used in order to keep the working area dry, this would typically be utilised when construction is undertaken below the water table, or within a Marine environment. As construction of the bridge supports needs to be carried out within the Prince of Wales Dock, and large amounts of water will make CFA Piling impossible due to water mixing with the concrete mixture; the options are as below;

- Drain the Harbour
- Remove the Water from the working area

The option to drain the harbour would be feasible, if the harbour was a small area, or a dry dock, as the harbour does not have the capacity to drain itself, and this would adversely affect the marine ecology located within the harbour, the only viable means would be to remove the water from the working area.

This would be achieved by installing large sheet piles or interlocking sheets in a perimeter around the proposed zone, these would be sealed, and then the internal water pumped out of the working area.

This in turn would allow construction to take place within the marine environment in a safe, and dry manner.

As outlined in the proposed plans larger piling would first be installed in order to allow for the installation of a pile cap, with the internal area inside the Cofferdam area filled with suitable material allowing for the formation of the pile cap.

There are a wider array of Cofferdam types which could be utilised, however in this instance Steel Sheet Piling would be the most applicable, as the depth of the Prince of Wales Bay would require a substantial pile. This pile would then need to be suitably braced to resist the hydrostatic pressures associated with the water depth.

## Conclusion

CFA Piling would be utilized in the first instance with a large steel cone placed by specialist marine equipment, this in turn would allow for the creation of large piles drilled to a suitable depth. This would in turn allow for the loads associated with the bridge to be transferred directly into the strata.

The addition of Cofferdam would be to allow the construction of suitable reinforcement for the pile cap, and introduction of suitable material around the main Concrete Pile. Due to the location of the excavation the exclusion of water from the working zone is an important factor, as such cofferdam construction would be a requirement in this instance.