

Construction Technology 2 – Assignment 2



[Royal Haskoning DHV (2024)]

Construction Technology 2 - ACBA5019

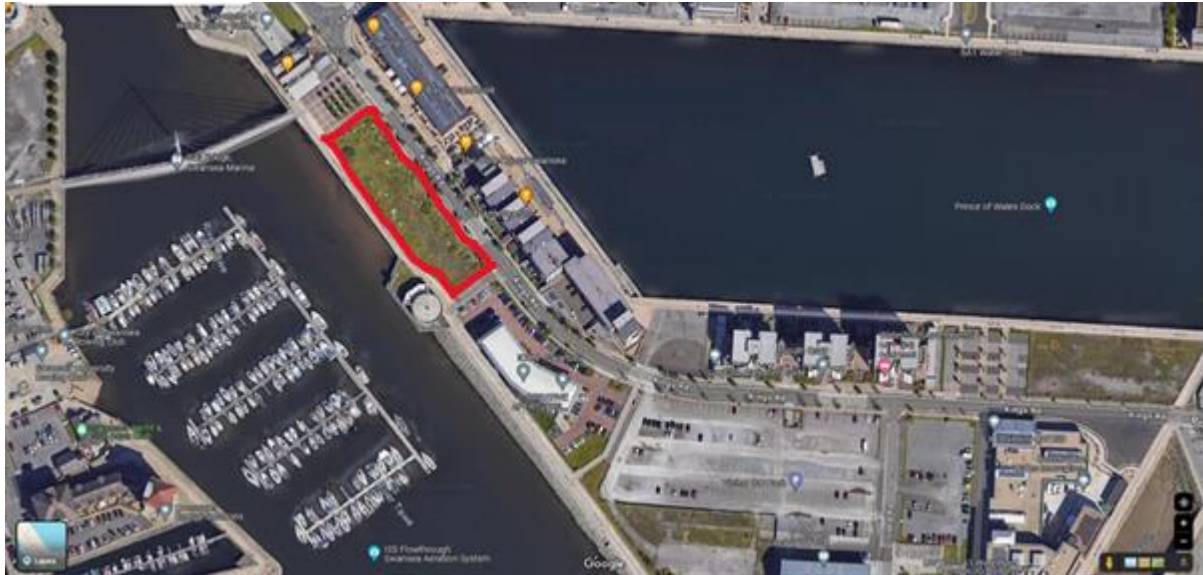
Dylan Horne 2320097



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Introduction

The aim of this report is to identify and consider how the SA1 plot that has been previously designed can be changed in the future to undertake a different role and whether all environment considerations have been made in the previous design. The location of this plot is shown highlighted below.

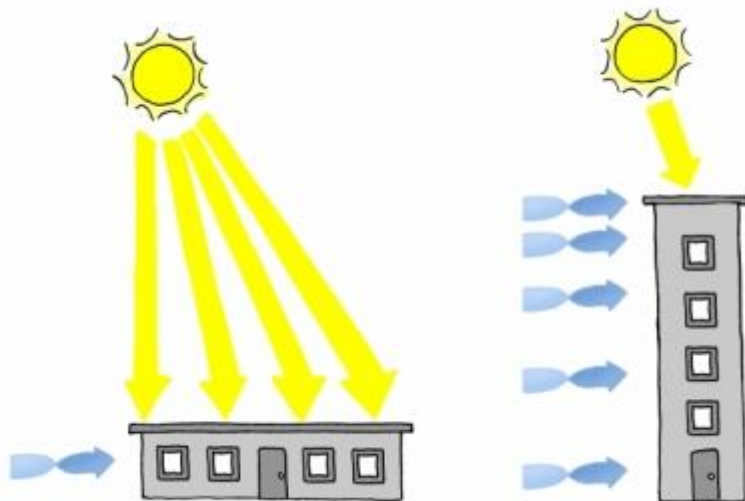


The original role of the building was student accommodation and is in an urban environment as such it would have to adhere to the existing aesthetic of the area to allow for planning permission for the erection of the building. This is a large consideration when choosing cladding for the building.

The original design would include piled foundations due to the poor bearing capacity of the ground; this will provide sufficient stability for the building. The original design also includes steel frame construction; this is due to the versatility of steel and the ability to manufacture off site for greater tolerances. It also means that no internal partitions are load bearing, which is advantageous for changing the function of a building. The external cladding was also chosen to be steel; this is because of the exposed area of the plot requiring a resilient facing to ensure an acceptable lifespan and reduce maintenance costs. An advantage of using steel for both the cladding and frame of the building is that it can be recycled once the building reaches its end of life.

Environmental Impact

The orientation of the building can help to reduce the overall running costs. By orientating the building to the south, it will receive more sunlight this will help to reduce heating costs as well as the reliance on electric lighting [Vitality (n.d.)]. To ensure that the building benefits from the orientation it's important to install larger windows on the elevations that will be exposed to the sun, for the proposed development this would be on the south and southwest elevation. This will allow more sunlight into the building helping to heat it in the colder months and reducing the necessity for artificial lighting. Solar panels should also be fitted to either the south or southwest elevation to ensure they receive the most sunlight possible throughout the day.

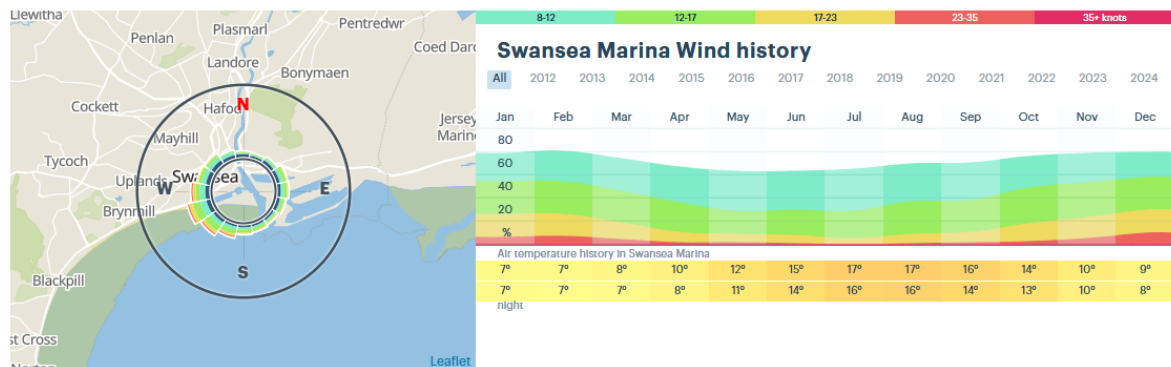


[Sustainability Workshop.

(n.d.)]

Orientation can also be used to increase passive ventilation throughout the building. Passive ventilation can be increased by positioning the building's long section perpendicular to the prevailing winds [Sustainability Workshop. (n.d.)]. By positioning the buildings long section perpendicular to prevailing winds we can increase the amount of air the building "catches". We can account for this when designing the building to allow for cross flow ventilation through the building, which can reduce the need for mechanical ventilation, therefore reducing the running costs of the building. Using the below wind-rose diagram we can

see the most common direction for the wind is southwest, this will mean it hits the northeast of the plot.



[Windy.com (n.d.)]

By using orientation to maximise both sunlight and passive ventilation we can help to reduce running costs and therefore reduce the amount of unsustainable energy used. In reducing electricity consumption through the day more of the electricity from the solar panels can be stored in batteries and used during the evening/night, helping to further reduce the reliance on unsustainable energy.

Both steel framing and cladding have decades long lifespans which help to reduce Maintenance requirements and waste. Steel framed buildings are typically designed with lifespans of around 50 years however, with proper maintenance and regular inspections can exceed 100 years [National Steel Buildings (n.d.)]. Steel cladding typically has a life expectancy of 25 to 50 years; this is heavily affected by the weather conditions of an area [Sheeting Giant (n.d.)]. The lifespan of the cladding should be accounted for when considering future maintenance on the building as it will likely have to be renewed during its lifespan.

Steel is a widely recyclable material which helps to reduce the environmental impact of the building. Over 90% of a steel building or fixture can be recycled which is better than other common building materials [US Bridge (n.d.)]. With over 90% of steel being recyclable it means that it can be repurposed and used on future projects reducing waste from the building at the end of its life.

Plasterboard is widely recyclable and has a decades long lifespan. Gypsum plasterboard has an expected service life more than 50 years; however, this can be affected by environmental conditions [Gypsum Association (n.d.)]. Plasterboard is also a highly sustainable product with new plasterboard having a high recycled content and being recyclable at the end of its life [GPDA (n.d.) *Sustainability*]. Due to the long lifespan of plasterboard and the recyclability already established in the manufacturing process, it is a sensible choice for meeting the sustainability criteria in a development.

The facade of other buildings in the area are:

- Brick
- Smooth Render
- Steel Cladding

The original design considered steel cladding due to innkeeping with the existing aesthetic of the area as well as the sustainability and durability of steel. No other developments in the area have undertaken a green approach.

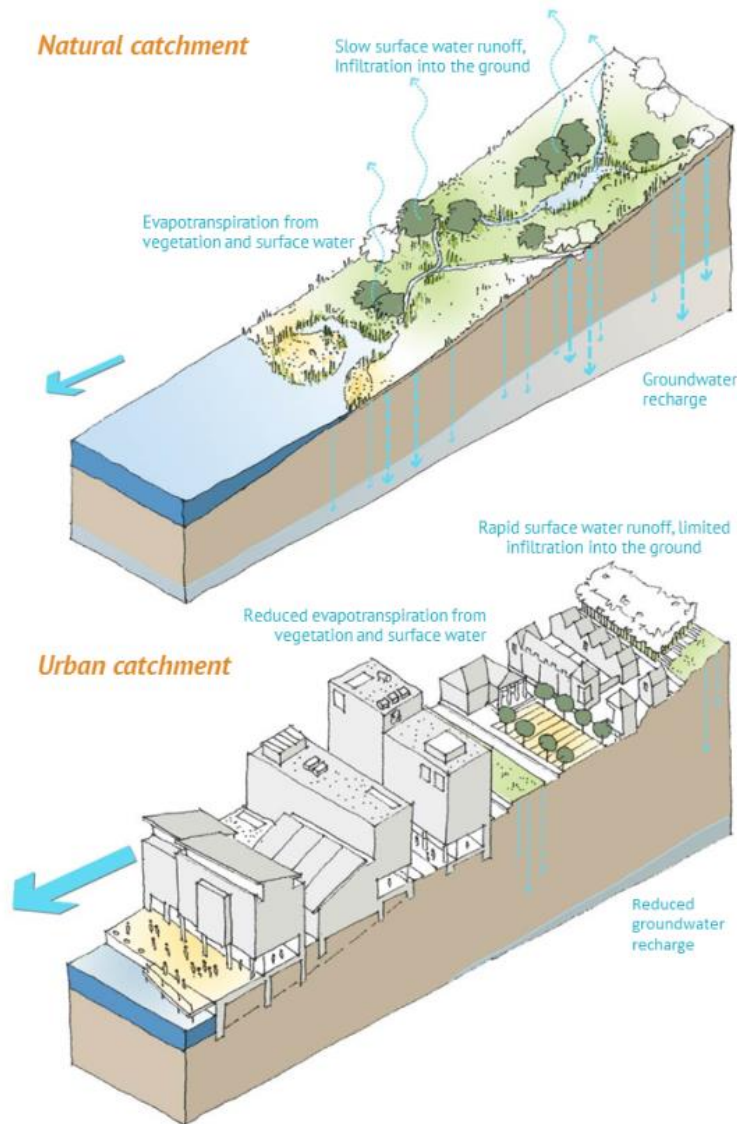
The original steel design ties into the heritage of the area. Swansea dockyard has previously been a heavily industrial area as such the proposed design ties modern construction methods with the history of the area surrounding the plot, however with the proposal of the Blue Eden project from Swansea Council (Swansea Council, 2021) the SA1 area is likely to be transformed into a more sustainable and eco-conscious area.

Due to the developments of the area heavily focussing on increasing sustainability and being more eco-conscious over more green facades could be used to match the future aesthetic of the area.

Facade Greening & SUDS

Facade greening is achieved by growing plants into the ground at the base of walls or by using living wall systems. This

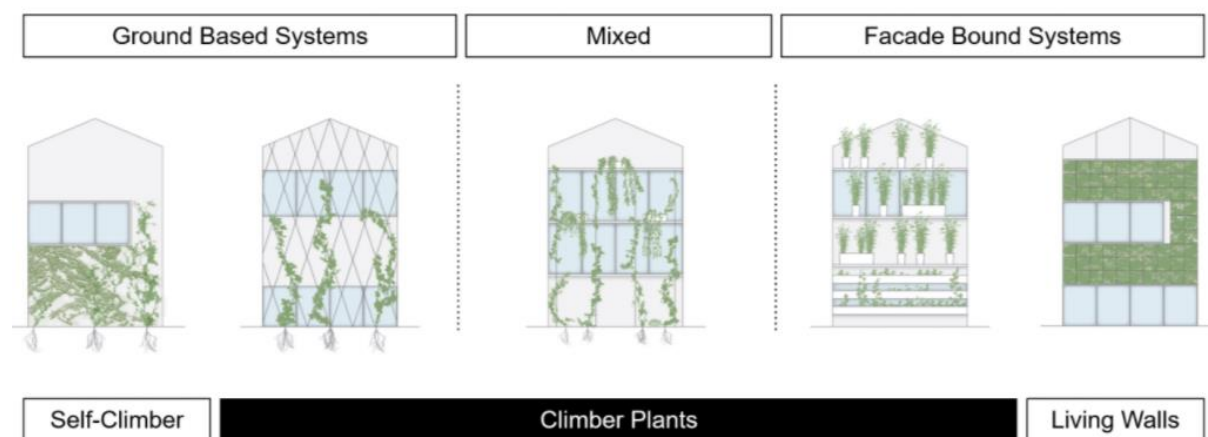
integrates plants into the aesthetics of the building [NBS (n.d.)]. Sustainable urban drainage systems are used to mimic nature, this helps to reduce flood risks, improve water quality and enhance urban environments [SuDSnet (n.d.)].



[SuDSnet (n.d.)]

Green walls can be used to the exterior of the building to incorporate nature in the design of the building. There are three forms of green walls, these are ground based systems, mixed systems and facade bound systems. The first two can be achieved using self-climbing or climber plants, this allows for the plants to grow naturally from the top or bottom of the walls

to cover the existing facade [Tensile Design & Construct (n.d.)]. Facade bound systems would include living walls, these are man-made systems that can be used internally and externally. The systems include a growth medium as greenery is planted directly into the system, they also have irrigation systems built into them. Green walls differ from green facade because the growth medium is on the surface of the structure of the wall whereas a green facade has greenery naturally grow along the wall [Naava (2017)].

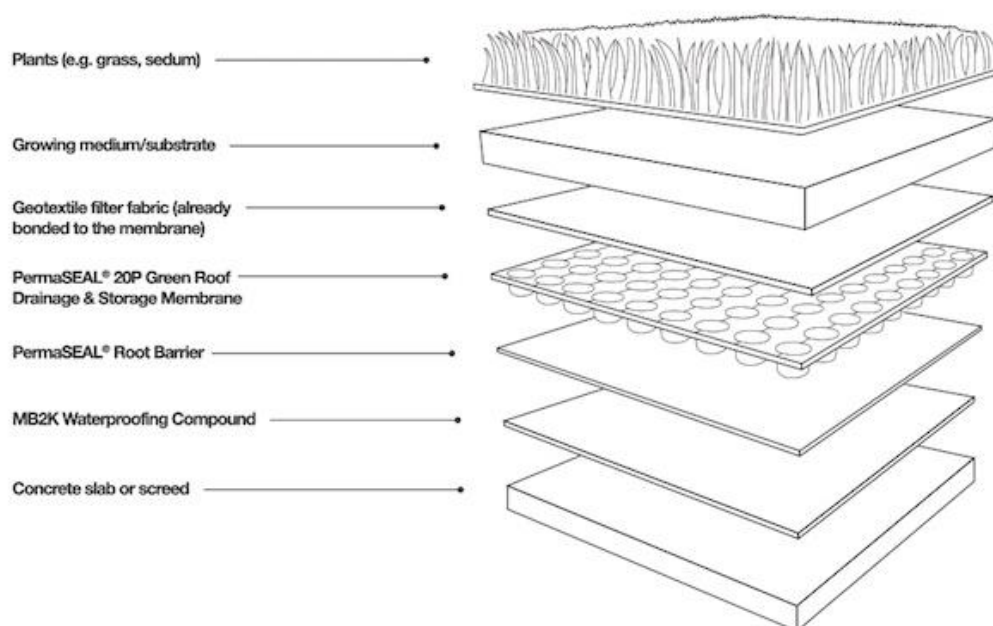


[Tensile Design & Construct (n.d.)]

Green walls contain many benefits, some of which cannot be achieved by normal building practices. Green walls help to reduce noise; this is due to the strong absorption properties of the plants used, they can also help to provide temperature control and heat reduction in a building due to plants absorbing sunlight and, in the winter, they help to increase the thermal performance of a building [Fantastic Gardeners (n.d.)]. The biggest benefit of green walls is that they help to increase the air quality of an area by removing/capturing pollutants and undesirable gases in the air [Biotope (n.d.)].

A green roof could also be used to increase biodiversity and greenery in the area. A green roof is partially or completely covered in vegetation or plants. This is achieved by planting over a drainage membrane along with root barriers and water proofing products that sit on top of the roof structure. This allows for the plants to thrive on the roof without causing damage to the building.

The benefits of a green roof are that it increases biodiversity in the area by creating a space for insects, birds and plants to thrive. Green roofs also help to cool a building down in the warmer season because sunlight is absorbed by the plants and not the building fabric, they also improve air quality by removing pollutants and toxins from the air. Green roofs also help to reduce flood risks as they absorb rainwater, this makes them a perfect choice in addition to SUDS for a development [Permagard (n.d.)].



Green roofs also benefit from longer lifespans helping to reduce maintenance costs as well as waste. Green roofs have a life expectancy of around 40 to 50 years; this allows them to outperform alternative roofing options. They achieve this longevity because the plants and vegetation help to take the brunt of the weathering [Roofing Megastore (n.d.)].

SUDS are used to manage rainfall by using natural processes. This is done by transporting and slowing run off surface water so that it can be absorbed into the ground and transpired through vegetation [NatureScot (n.d.)]. SUDS should be designed for an area's rainfall.

There are many forms of SUDS used in modern developments however, not all will be applicable to our plot. The following could be used to manage and disperse rainwater effectively:

- Green Roof / Green Walls
- Permeable Paving
- Rainwater Harvesting

Green roofs and green walls have been discussed previously they help to absorb rainwater, reducing the amount of surface water for the plot.

Permeable pavements offer a green approach to pathways on a plot of land. They also increase the water storage of the area helping to reduce flooding and controlling the runoff speed. They also provide benefits in reducing the number of pollutants as the plants in the soil collect and store the pollutants. During colder months permeable pavements require less de-icing than standard pavements.

Permeable pavements are susceptible to being clogged with sediments, this would prevent them from effectively storing

rainwater. This also means that they require regular maintenance to prevent blockages. Permeable pavements are also unable to endure heavy loads; this would still require traditional pavements or roads on the plot [Urban Water (n.d.)].

Rainwater harvesting systems can be used to reduce the reliance on mains water. Rainwater harvesting systems work by collecting rainwater from rooftops and gutters, from here it is filtered to remove contaminants then stored into a holding tank appropriate to the building size for use. Rainwater harvesting systems are used to reduce running costs of a building and increase sustainability [Urban Water, 2025].

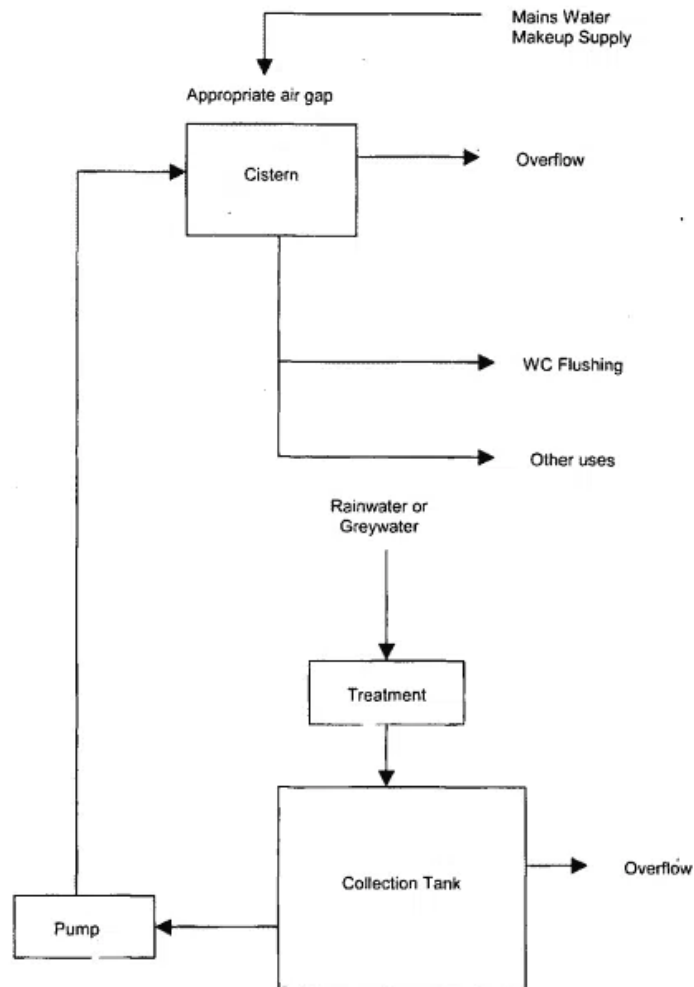


Figure 2.1 Conceptual water use system

CIRIA C539

[Urban Water,

2025]

The biggest benefit of rainwater harvesting is that it reduces the running costs of a building and increases the sustainability, this is because harvested water is used for non-potable uses like flushing toilets which accounts for 35% of an average household's water usage. Due to the proposed use of the building being student accommodation rainwater harvesting can help to greatly reduce the running costs of the building. There are disadvantages to rainwater harvesting one of which is the upfront cost this can mean the return on investment may be several years and having to have additional pipework installations for mains water to stand in

for any faults with the system or if it's not raining [Renewable Energy Hub (n.d.)].

SUDS Calculations

$Q = \text{Peak runoff } m^3/s$
 $C = \text{Runoff Coefficient (land dependant) - Assume } 0.75$
 $I = \text{Rainfall intensity - MS-60} = 17 \text{ mm}$
 $A = \text{Catchment area hectares} = 0.336 \text{ hectares}$

$$Q = 2.78 \times C \times I \times A$$

$$2.78 \times 0.75 \times 17 \times 0.336 = 11.9 \text{ l/s}$$

Run off rate estimate

$$Q_{bar} = 0.00108 \times \text{area}^{0.89} \times S_{AAR}^{1.17} \times S_{0.1}^{2.17}$$

$\text{Area} = 0.00336 \text{ km}^2$
 $S_{AAR} = 1136 \text{ mm}$
 $S_{0.1} = 0.37$

$$0.00108 \times 0.00336^{0.89} \times 1136^{1.17} \times 0.37^{2.17} = 2.95 \times 10^{-3} \text{ m}^3/s$$

2.95×10^{-3} for 50 Hectares
 $2.95 / 50 = 0.059 \text{ l/s/ha}$
 $0.059 \times 0.336 = 0.02 \text{ l/s}$

$\text{Volume} = (\text{Inflow} - \text{Outflow}) \times \text{Duration}$
 $\text{Inflow} = \text{Peak runoff}$ $\text{Duration} = \text{Length of storm}$
 $\text{Outflow} = \text{Greenfield runoff}$

$$(11.9 - 0.02) \times 3600 = 42768 \text{ L}$$

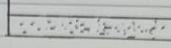
$$42768 \text{ L} = 42.76 \text{ m}^3$$

Storage Volume

1x1

Rain Garden -

$$\text{Soil Volume} = 1 \times 1 \times 0.45 \text{ m} \\ = 0.45 \text{ m}^3$$

	Soil (0.45m)
	Gravel (0.1m)

$$\text{Storage Volume} = 0.45 \times 0.26 = 0.117 \text{ m}^3$$

$$\text{Gravel Volume} = 1 \times 1 \times 0.1 = 0.1 \text{ m}^3$$

$$\text{Storage Volume} = 0.1 \times 0.255 = 0.0255 \text{ m}^3$$

Total Storage Volume:

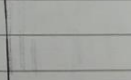
$$0.117 + 0.0255 = 0.14 \text{ m}^3 \text{ per m}^2 \text{ of proposed drain}$$

Green Roof

L=80m W=25m

$$\text{Volume roof mix} = 80 \times 25 \times 0.2 = 400 \text{ m}^3$$

$$\text{Storage} = 400 \times 0.15 = 60 \text{ m}^3$$

	Green roof mix 0.2m
	Geocomposite layer 0.005m

$$\text{Volume of Geocomposite} = 80 \times 25 \times 0.005 = 10 \text{ m}^3$$

$$\text{Storage} = 10 \times 0.5 = 5 \text{ m}^3$$

$$\text{Total} = 60 + 5 = 65 \text{ m}^3$$

Permeable Paving - Whole Perimeter

Length = $80 + 80 + 25 + 25 = 210 \text{ cm}$

Width = 2 m

Volume Gravel = $210 \times 2 \times 0.035 = 14.7 \text{ m}^3$

Storage = $14.7 \times 0.255 = 3.74 \text{ m}^3$

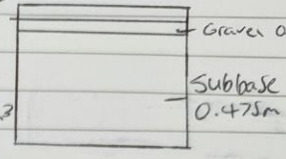
Volume Subbase = $210 \times 2 \times 0.475 = 199.5 \text{ m}^3$

Storage = $199.5 \times 0.195 = 38.9 \text{ m}^3$

Total = $3.74 + 38.9 = 42.64 \text{ m}^3$

Total Proposed -
 Other rain garden
 $65 \text{ m}^3 + 42.64 \text{ m}^3 = 107.64 \text{ m}^3 \text{ of Storage}$

Estimated rainfall Volume = 42.76 m^3



Flexibility In Design And Use

Building adaptability is important for lengthening a building's lifespan by making it possible to adapt the space with minimal disruption or work. By considering adaptability during the design process, we can reduce waste materials from the need to demolish a building.

Adaptability can be implemented through many strategies to create a changeable building. The use of internal non-load bearing walls allows for floor plans to be changed without the need for structural changes to the building, this can also tie into having clear spans to create wide spaces without internal load bearing walls, should this not be achievable consistent spans allow for more flexibility [AIA (2024)].

Large floor to ceiling heights should also be considered during the design as these allow for switching between commercial and residential uses, it also aids in upgrading future building services. A strong structural system should be considered to achieve long spans and account for additional live and dead loads after changing the buildings use, however it can also allow for additional stories to be added to the building in the future if required [AIA (2024)]. Building Information Modelling should be considered as well as this allows for a fully modelled building with information on service runs and materials / fittings. This will help to reduce costs when changing the use of the building and save time identifying services.

Building adaptability should also consider the deconstruction of a building to help reduce the environmental and economic impact once the building reaches its end of life. This can be achieved by incorporating the separation of systems, this ensures that no system is tied into the building removing the need to cause damage to other systems when removing. Mechanical fasteners should be used to allow for re-use or recycling at the end of life and allow for a more controlled demolition as opposed to the use of adhesives. Low toxicity materials should also be used to reduce exposure to hazardous materials during demolition or refitting [AIA (2024)].

Considerations have already been made to allow for building adaptability; by using steel frames, piling and plasterboard finished internally no load-bearing partitions will be used internally and plasterboards recyclability reduces waste materials from the building.

Due to the choice of using a full load bearing steel frame other possible uses for this building could be:

- Residential Accommodation
- Office Building
- Care home
- Hotel

Conclusion

In conclusion, it's important for modern buildings to consider building adaptability in future to reduce hazards and costs to remodel or demolish a building once it reaches its end of life. Sustainable solutions should also be considered to increase biodiversity and sustainability in urban areas through green facades as well as SUDS. Conscious decisions should also be made when choosing materials to consider the recyclability and sustainability of these materials to reduce carbon emissions and waste in construction.

References

AIA (2024) *Design for deconstruction, adaptability and reuse*. [PDF] Available at: https://www.aia.org/sites/default/files/2024-11/AIA_Design_Deconstruction_Adaptability_Reuse.pdf [Accessed 2 May 2025].

Biotope (n.d.) *Benefits of exterior living walls*. Available at: <https://www.biotope.uk.com/benefits-of-green-walls/benefits-of-exterior-living-walls/> [Accessed 9 May 2025].

Fantastic Gardeners (n.d.) *What are the benefits of a green wall?* Available at: <https://www.fantasticgardeners.co.uk/living-walls-installation/what-are-the-benefits-of-a-green-wall/> [Accessed 6 May 2025].

GPDA (n.d.) *Sustainability*. Available at: <https://gpda.com/sustainability/> [Accessed 1 May 2025].

Gypsum Association (n.d.) *Life-cycle resources*. Available at: <https://gypsum.org/life-cycle-resources/> [Accessed 10 May 2025].

Naava (2017) *What are green walls?* Available at: <https://www.naava.io/editorial/what-are-green-walls> [Accessed 7 May 2025].

National Steel Buildings (n.d.) *How long do steel buildings last?* Available at: <https://nationalsteelbuildings.co.uk/how-long-do-steel-buildings-last/> [Accessed 4 May 2025].

NatureScot (n.d.) *Sustainable drainage systems (SuDS)*. Available at: <https://www.nature.scot/professional-advice/placemaking-and-green-infrastructure/green-infrastructure/sustainable-drainage-systems-suds> [Accessed 8 May 2025].

NBS (n.d.) *The NBS guide to façade greening: part two*. Available at: <https://www.thenbs.com/knowledge/the-nbs-guide-to-facade-greening-part-two> [Accessed 5 May 2025].

Permagard (n.d.) *Introducing green roofs and benefits*. Available at: <https://www.permagard.co.uk/advice/introducing-green-roofs-and-benefits> [Accessed 3 May 2025].

Renewable Energy Hub (n.d.) *Benefits of rainwater collection*. Available at: <https://www.renewableenergyhub.co.uk/main/rainwater-harvesting-information/benefits-of-rainwater-collection> [Accessed 7 May 2025].

Roofing Megastore (n.d.) *An introduction to green roofs*. Available at: <https://www.roofingmegastore.co.uk/blog/an-introduction-to-green-roofs.html> [Accessed 9 May 2025].

Royal HaskoningDHV (2024) *Eco-enhanced data centres: The impact of green facades*. Available at:

<https://www.royalhaskoningdhv.com/en/newsroom/blogs/2024/e-co-enhanced-data-centres-the-impact-of-green-facades>
[Accessed 5 May 2025].

Sheeting Giant (n.d.) *What is the life expectancy of galvanised metal roof sheeting?* Available at:
<https://www.sheetinggiant.com/blog/news/what-is-the-life-expectancy-of-galvanised-metal-roof-sheeting/> [Accessed 1 May 2025].

SuDSnet (n.d.) *Sustainable drainage*. Available at:
<https://www.susdrain.org/delivering-suds/using-suds/background/sustainable-drainage.html> [Accessed 10 May 2025].

Sustainability Workshop. (n.d.). *Massing & Orientation for Cooling*. VentureWell. Available at:
<https://sustainabilityworkshop.venturewell.org/buildings/massing-orientation-cooling.html> [Accessed 9 May 2025].

Swansea Council, 2021. £1.7 billion Blue Eden project announced for Swansea. Available at:
<https://www.swansea.gov.uk/BlueEden?lang=en> [Accessed 9 May 2025].

Tensile Design & Construct (n.d.) *Green façade types – the differences explained*. Available at:
<https://www.tensile.com.au/green-facade-types-the-differences-explained/> [Accessed 8 May 2025].

Urban Water (n.d.) *Permeable pavements*. Available at:
<https://urban-water.co.uk/permeable-pavements/> [Accessed 3 May 2025].

Urban Water, 2025. Rainwater Harvesting. Available at: <https://urban-water.co.uk/rainwater-harvesting/> [Accessed 9 May 2025].

US Bridge (n.d.) *Recycled steel in construction*. Available at: <https://usbridge.com/recycled-steel-in-construction/> [Accessed 6 May 2025].

Vitality (n.d.) *How does building orientation affect energy efficiency?* Available at: <https://vitality.io/how-does-building-orientation-affect-energy-efficiency/> [Accessed 2 May 2025].

Windy.com (n.d.) *Swansea Marina – statistics*. Available at: <https://windy.app/forecast2/spot/2666221/Swansea+Marina/statistics> [Accessed 4 May 2025].