University of Glasgow

# Glasgow's Floating Estuarine Wetlands Baseline Monitoring Report

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This report has been prepared as an output of Scottish Marine Environmental Enhancement Fund (SMEEF) funding awarded to Glasgow Science Centre. The baseline monitoring was co-led by Naylor, Curley, Lacsny and McGregor and carried out by the University of Glasgow by the following large team of experts:


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## Acknowledgements


This report outlines the baseline study of the Canting Basin before the floating wetlands were installed. An interdisciplinary team of researchers from the University of Glasgow designed and undertook this study with support from Glasgow Science Centre and Biomatrix. We would like to thank Biomatrix for supporting the physical geography side of the study by providing plant and substrate samples to analyse and Nature Scotland, Marine Scotland Scottish Enterprise and Clyde Peel Ports for their permissions and encouragement for this project. Preconstructed datasets were obtained from a variety of sources including the Glasgow Black-headed Gull Survey led by Dr Paul Baker; the National Biodiversity Network; and a Phase 1 habitat survey commissioned by Glasgow Science Centre. Findings from a recent University of Glasgow undergraduate dissertation by Lewis Henry on Glasgow Science Centre's Outer Space Rewilding Project provided additional, locally specific baseline information on public perceptions of transforming Glasgow Science Centre's Outer Space by greening the grey. This report was reviewed by A. Kaplan and J. Galbraith.

# Executive Summary

This report presents findings of a winter 2023 (Feb-March) baseline assessment of the current condition of the Canting Basin habitat, and the baseline conditions of the floating wetland substrate and vegetation. This assessment brought together pre-constructed and newly collected data. These data will provide a clear baseline against which future improvements to the ecosystem services it provides.

## Supporting Ecosystem Services

- A habitat assessment demonstrates very limited habitat in the Canting Basin to support ecosystem functioning, with featureless smooth vertical walls that lack habitat enhancements and an absence of estuarine vegetation.
- A combination of biodiversity monitoring techniques show current use of the basin by 8 bird species, with a further 15 species using the surrounding area. The basin currently only supports resting opportunities.
- Secondary data sources indicate that the area surrounding the Canting Basin is used by 3 bat species and 20 fish species. The basin does not currently provide supporting services for water voles, otters or seals. These species may use the River Clyde to commute and forage, showing potential for use of the basin by these species with improvement to the habitat.
- The Canting Basin does not currently provide habitat suitable to support reproductive behaviours, i.e., nesting or spawning; feeding behaviours (as there are no primary producers to support the food web); or sheltering opportunities from predators and adverse weather.
- Limitations to the baseline monitoring were partially mitigated by the use of secondary data sources, however there are large data gaps for the biodiversity of the Canting Basin. The ecological monitoring methods implemented in this baseline study were restricted to the winter season and will not account for seasonal changes in biodiversity caused by phenology i.e., migration, hibernation, and reproductive behaviours. Further baseline monitoring is proposed for summer 2023.

## Regulating Ecosystem Services

- Continuous water quality measurements showed Dissolved Oxygen (RDO), pH, and salinity levels in the surface water to be adequate to support aquatic life. Variation in recorded parameters are correlated with fluctuations in tidal depths. Substantial changes in Total Dissolved Solids (TDS) evidence the observed debris build up at the site during particular tidal conditions, likely to impact the ecological health of the area.
- Grain size analysis of the basin substrate samples (n=12) showed an extremely high similarity with silt sized particles dominating the fine (<2 mm diameter) sediment composition.
- Analysis of heavy metals in the basin surface water samples found all analysed metals in all samples were below instrumental detection limits except for total iron (Fe). Concentrations of Iron were in a typical range for these water bodies.
- Analysis of heavy metals in the Canting Basin and River Clyde sediment samples found extremely high levels of some pollutants, notably chromium, lead and cadmium. These are likely reflective of the industrial history of the basin.

- Heavy metal concentrations were substantively lower in the substrate being used as the growing medium for the floating wetlands except for Arsenic, Aluminium, Colbalt, Copper and Molybdenum. Further analysis of the substrate is highly recommended.
- In situ, continuous water measurements were recorded  in one location. A more rigorous approach would ideally have at least two long-term water quality data loggers, positioned at the installation site and at the entrance to the basin to monitor fluctuations in water quality across the environment, in response to changes in tidal conditions. Water sampling across a range of depths is also recommended in future assessments to explore the extent of mixing in the water column, and the potential establishment of stratified layers in water quality parameters, where equipment and budgets allow.
- Limitations to the baseline monitoring included insufficient time due to the project delays to undertake all of the analyses that are possible with the sediment, plant and water samples collected. As these samples have been safely processed and stored for use as future baseline reference samples, further funding would support enhancement of the baseline results presented in this report. Suggestions for this are provided.

## Social and Cultural Ecosystem Services

- The social research found that the Canting Basin supports many cultural and social ecosystem services, and this is expected to increase with the installation of the floating wetlands.
- Positive benefits for health and wellbeing are already being observed from the participant responses, indicating that this is a key driving force for their engagement and that it encourages them to keep coming back to the area.
- Public education and science communication for communities are significant factors of interest for participants, indicating that this is another key driving force for continued engagement in the space.
- Outputs from the workshops show that there is a strong connection to the arts through the creation of a community almanac and inclusion of drawings and paintings from the workshops on the interpretive display boards.
- Many social and cultural ecosystem service assessments were affected by the winter timing of this baseline monitoring survey, where winter conditions may have impacted levels of public engagement for the following parameters:
    - Tourism
    - Recreation
    - Wildlife watching
    - Seascapes
- For all the affected parameters, the researchers anticipate that the summer season will lead to increased social cultural benefits to be gained from the wetlands. Moreover, it is proposed that all of the social and cultural ecosystem services identified are more rigorously assessed as outlined in the proposed long-term monitoring plan. This is important as the wetlands will take longer than one growing season to become fully established, and it will take time for people to learn of their existence, experience them and evaluate the benefits they provide for different recreational pursuits, businesses (e.g. river tours) and individuals well-being.

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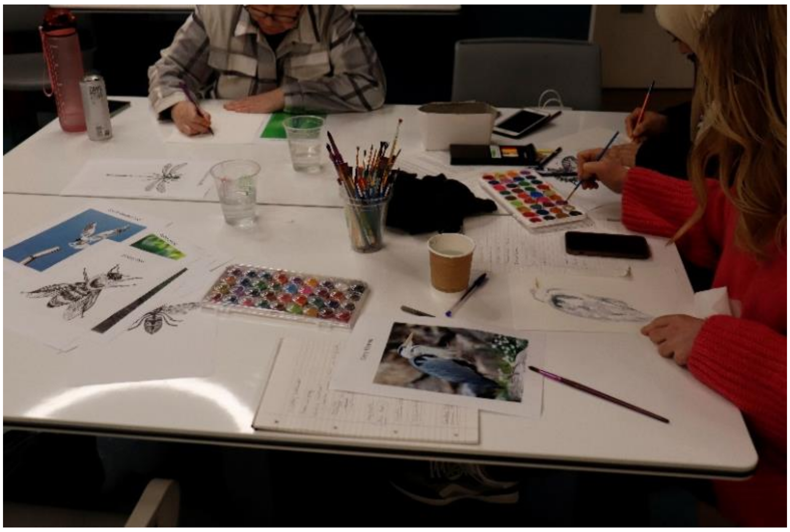


Pictured: Community workshop participants composing creative representations of wetland species at Glasgow Science Centre. Photographed by A. Kaplan.


Pictured: Research team collecting water and sediment samples from the Canting Basin. Photographed by Glasgow Science Centre.

## 1. Introduction

Urban estuarine habitats are rare in the many highly urbanised UK estuaries where flood and quay walls provide limited natural habitat to improve the resilience, function and value of urban estuarine ecosystems for nature and people. Increasing efforts are being made to green these greyest parts of our urban areas, including estuarine 'blue' spaces such as urban waterbodies. The city of Glasgow has the most urbanised section of the River Clyde within its geopolitical boundaries, and one of the densest populations across Scotland. Improving the amount of urban estuarine habitat has the potential to improve outcomes for nature and people. The lack of suitable habitat in the urban River Clyde corridor was a catalyst for this project (Figure 1). This report characterises the baseline ecosystem services providing in the Canting Basin, Glasgow, and the control samples of the floating wetland basin vegetation and substrate that have been collected and stored as reference material against which changes in plant and sediment properties can be assessed over time, as part of the proposed Long-term Ecosystem Services Monitoring and Evaluation Plan (hereafter, long-term plan, Fowler et al. 2023). Full details of the rationale for the Ecosystem Services approach used here can be found in the long-term plan (Fowler et al. 2023).

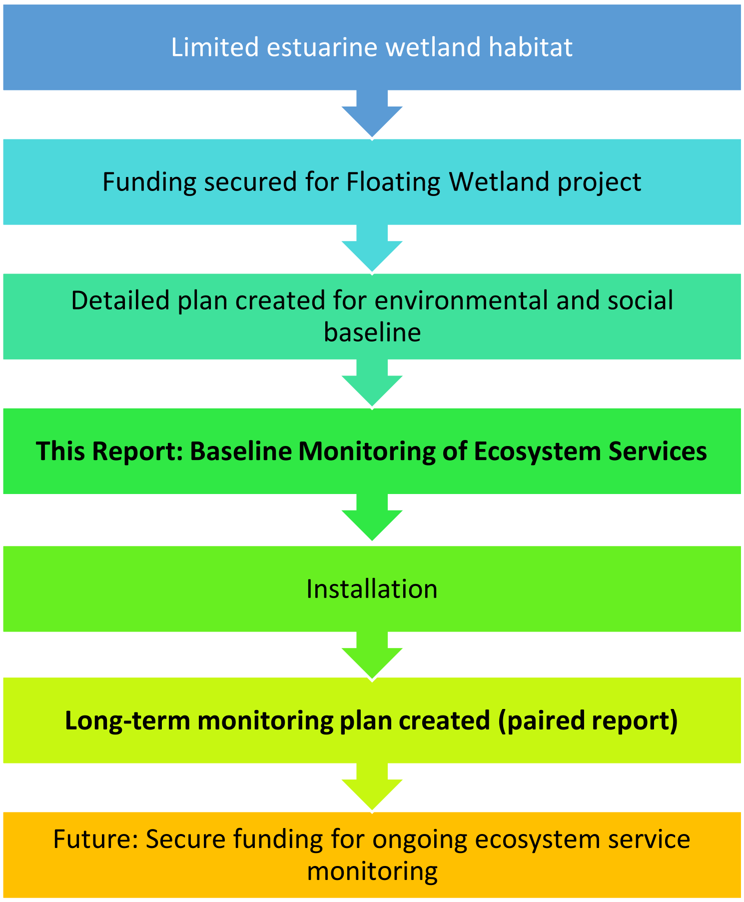



*Figure 1. Flow diagram illustrating the rationale for this project, and in bold, the two outputs from the SMEEF funded Glasgow Floating Wetlands Project: Baseline, this report Woolfenden et al. 2023) and Long-term plan (Fowler et al. 2023).*

Baseline monitoring permits us to assess the ecosystem services provided by the existing environment and assists us in making predictions regarding the benefits and disbenefits that may be provided by implementing coastal or estuarine blue-green infrastructure (Naylor et al. 2023).

Further to this, it acts as a reference point for assessing the changes in ecosystem services provided by the area over time after implementing a green infrastructure measure. Baseline 'control or reference' samples were also collected, processed and stored in the University of Glasgow's laboratories. These will allow future comparisons between the pre-installation characteristics of wetland vegetation and substrate, prior to the

The baseline monitoring of the Canting Basin at Glasgow Science Centre aimed to assess the following ecosystem services based upon the existing features and the history of the area, as shown in Table 1.

*Table 1. Ecosystem services, variables measured and types of methods used in the baseline data analysed in this report.*

| Ecosystem Service | Measured Variables | Measured Variable - Details | Field or Laboratory Methods |
|---|---|---|---|
| **Supporting** | Biodiversity<br>Habitat diversity | Types of habitat<br>Species presence and abundance of birds and mammals<br>Use of the space by wildlife (i.e., locations used by wildlife, and use of the area e.g., feeding) | Field sampling using:<br>Visual surveys<br>Camera traps<br>Acoustic recorders |
| **Regulating** | Water and Sediment Quality/Health | Nutrient content (nitrogen, phosphate, carbon)<br>Pollutants (Heavy metals, etc)<br>Grain Size Analysis | Field sampling for laboratory analysis using:<br>- Spectrolyser<br>- Optical emission and visible light spectrophotometry<br>- Mass spectrometry<br>- DOC analyser<br>- Particle grain size analyser |
| **Social and Cultural** | No. of Visitors<br>Visitor Perceptions:<br>- Space<br>- The project<br>- Greening goals | Use of space by visitors – perceptions, demographics, movements (e.g., areas used by visitors, activities carried out in the area (e.g., walking), distance travelled to get there).<br>Visitor perceptions of the outdoor space, the floating wetlands project, and urban greening objectives. | Online and in person research involving:<br>- Ethnography<br>- Questionnaires<br>- Workshops<br>- Participant Observation |

## 1.2 Report format

The report is divided according to Ecosystem Service, including Ecology (supporting), Water/Sediment (Regulatory/Maintaining), and Social and Cultural (Cultural). The associated sub-chapters present key results, findings, and analysis for each Ecosystem Service assessed. Section 2 outlines the baseline monitoring approach, timescale, geographical extent and limitations of carrying out short duration (2-month) baseline studies during winter months.

Section 1 of this report provides results of the three types of ecosystem services monitored where section 2 details the key baseline conditions and findings of the winter 2023 monitoring. It also outlines which types of data have been collected during the winter monitoring period which could serve as future reference samples for the proposed long-term monitoring programme, as well as additional data not included in this report due to the time and budget constraints of the current project reported on here. These data are captured in each section, along with those collected and analysed in this report, to guide future work. The rationale and detailed overview for each method used or proposed for summer baseline monitoring can be found in the long-term monitoring plan report (Fowler et al. 2023). Specific data gathering and analysis methods are provided in accompanying appendices for each sub-section.

Section 3.1 discusses supporting services and the winter biodiversity the current Canting Basin habitat support. Section 3.2 background Water and Sediment data, as well as baseline conditions on nutrient and pollutant levels to enable future comparisons to assess Regulating Services that may be provided by the wetlands. Section 3.3 describes the perceived Social and Cultural Services provided by the basin and the potential benefits the participants saw in the floating estuarine wetlands. Section 3.4 discusses the plant selection process, and recommended species list to optimise wetland design for regulatory, as well as supporting and cultural services. It also characterises aspects of the substrate and outlines potential future analyses of stored pre-installation vegetation and substrate samples to provide reference samples upon which post-installation baseline monitoring of supporting, regulating and social/cultural services provided by the wetlands can be based.

Lastly, key findings from the baseline are reported in the executive summary and limitations are outlined in Section 1.

# 2. Baseline monitoring approach, timescale and geographical extent

The combination of primary and secondary (or preconstructed) data. Typically, baseline studies are predominately desk-based with limited field data collection. In this project, secondary data sources explored from a variety of sources including the National Biodiversity Network (NBN) Trust (2023), Glasgow Black-headed Gull (*Chroicocephalus ridibundus*) Survey (Baker, 2023), British Geological Survey (Clyde Urban Super Project), Scottish Environment Protection Agency (WAT-SG-53). For social and cultural services, secondary data was accessed from a recent University of Glasgow undergraduate dissertation on Glasgow Science Centre's Outer Space Rewilding Project, including locally specific baseline information on public perceptions of transforming Glasgow Science Centre's Open Space by greening the grey. Additional baseline data was collected directly through methods outlined in Section 3.3 Social and Cultural Services, focusing on public perception.

Substantive secondary data gaps were identified for the majority of ecosystem services, for example phosphates, water and sediment characteristics and environmental quality, as well as social and cultural impacts of blue space. In this location, Glasgow Science Centre staff confirmed that there has been no known water or sediment quality sampling in the Canting Basin for at least a decade (although Clyde and Glasgow Urban Super Project data exist for the urban reaches of the River Clyde sediments Jones et al., 2017 and waters; Smeadley et al., 2017), so the data provided here is a new reference point for future work in the Canting Basin. The majority of baseline study involved acquisition of new data as the study by Jones et al., 2017 did not sample in the Canting Basin. Similarly, existing studies around ecosystem services and/or social impacts of lack of blue space in cities was limited, particularly in relation to resulting cultural ecosystem services (see Fowler et al. 2023 for more detail).

## 2.1 Location and Timing of Baseline Monitoring

Baseline monitoring was carried out in and around the Canting Basin Site, prior to installation of the Floating Wetlands (Figure 2A-B). The baseline monitoring was conducted during February – March in the winter of 2023. The wetlands were installed between 6$^{th}$ – 10$^{th}$ March 2023; apart from the online questionnaire survey and the Aquatroll *in situ* water quality monitoring equipment (kept in place until 20 March 2023), all baseline field sampling was completed prior to the installation of the wetlands.

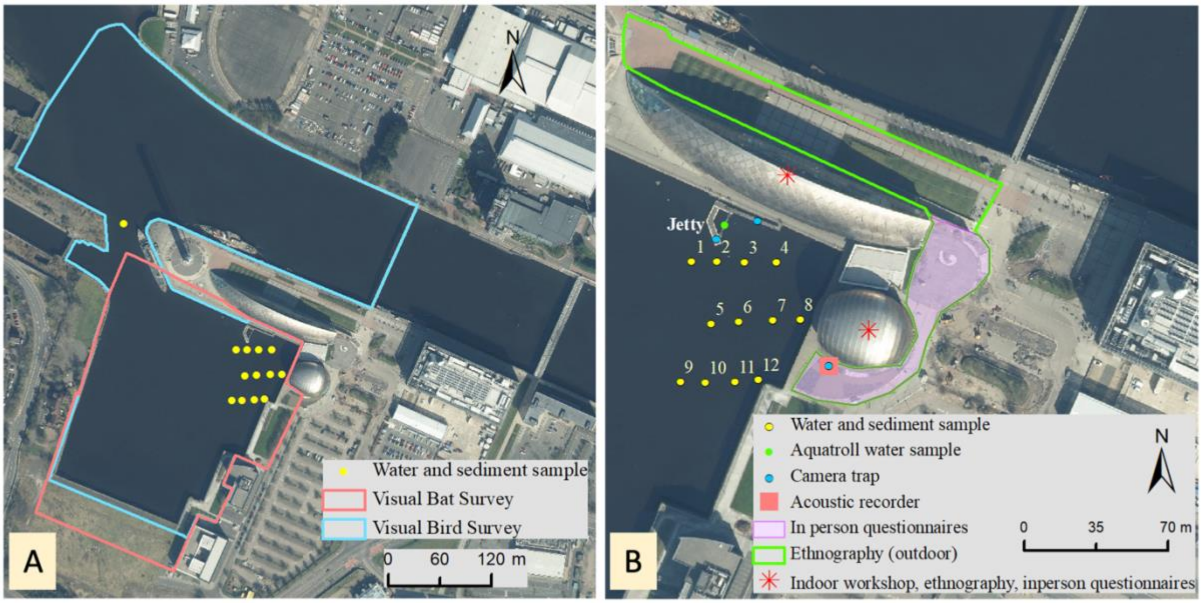



*Figure 2A-B. Baseline maps showing locations of: A) visual bat and bird surveys for assessment of supporting services and the locations of sediment and water sampling points in the basin, and the one sampling point at the confluence of the Canting Basin and the River Clyde referred to in the report as sample 13); B) i) acoustic recorders and camera traps for supporting services; ii) Aquatroll continuous for background water quality parameters; iii) basin water and sediment samples numbers 1-12 and iv) various social and cultural services data gathering methods*

This limited study period was due to the very short-term nature of the project between approval and completion (3.5 months), therefore not all potential components of each ecosystem service were able to be monitored. Despite these limitations, it was possible to gain useful baseline measurements of supporting, regulating and social/cultural parameters, details of which are discussed sequentially below. For example, social and cultural ecosystem services were monitored during the winter period, focussing predominantly on engaging with members of the public via online and in-person methods indoors, as part of workshops organised by Glasgow Science Centre to engage community groups about the Glasgow Floating Wetlands project.

Season and weather conditions at the time of the baseline monitoring limited the accessibility to certain measurable variables, including: a) Supporting: aquatic invertebrates which have a seasonal (spring – autumn) lifespan; phytoplankton and bats which also hibernate in winter and reappear in the spring season; b) Social/Cultural: many of the parameters would be expected to have higher engagement during the warmer and drier summer months including tourism, wildlife watching, recreation and art/creativity. For example, summer baseline monitoring would allow inclusion of methods to monitor the seasonal changes in biodiversity, to cover species that are not present during the winter such as migrating species of bird and fish; species that are inactive during the winter (e.g. macroinvertebrates and bats); and the use of the area by animals for seasonal purposes, such as breeding. In the summer it will ideally be able to add methods to monitor these more extensively.

## 2.2 Limitations

As described above, there were limitations to the baseline monitoring due to the short-term nature of the project. Due to time constraints, we were unable to conduct ecological surveys for all taxonomic groups, including fish, plankton, aquatic macroinvertebrates and terrestrial mammals, and there were no surveys to measure baseline ecology below the water. Where available, secondary and anecdotal data have been used to supplement our baseline monitoring to provide a more extensive understanding of the ecological services currently supported by the area.

The timeline for the baseline monitoring spanned across the winter, which limits our results to use of the area by winter species, such as resident birds. However, this does not account for the variation in species presence and functions provided by the space throughout the year.

The locations of sampling sites for the baseline survey were informed by consultation with Glasgow Science Centre and Biomatrix. The selected sampling sites spanned the extent of three possible installation locations for the floating wetland (accessed on 06/02/2023). However, final locations for floating wetland installation were not fully aligned with the initial plans. Instead, the floating wetlands were installed closer to the basin walls to provide easier viewing for the public. Consequently, sampling sites were not aligned with final installation locations; thus, data from the sediment and water baseline survey is only partially representative of the environment in which the floating wetlands currently reside. Despite this, any differences in characteristics of soil and water are likely to be marginal between the survey sites and final installation locations, due to their close proximity and homogenous nature of the corresponding environment. Likewise, weather conditions on the day of boat sampling meant it was challenging to remain fully stationary at each sampling point which also added variation between planned locations and sampling on the day.

Similarly, winter months impacted the social research, limiting both the use of outdoor space and engagement by participants, as well as the ability of researchers to collect data in the outside space directly. We anticipate that summer months will see a change in public use of the Canting Basin, resulting in changes to public perception and the ability to carry out further observation and in-person methodologies in this area.

## 2.3 Recommended next steps

For these reasons, we recommend funding is secured to undertake summer baseline monitoring during the summer of 2023 that also includes the opposite area of the basin to that which was sampled during this winter 2023 baseline reported here . This could be used as a proxy site to monitor the parameters measured in this report, as well as those which require and/or would derive a more meaningful dataset from a summer monitoring period. Figure 3 illustrates the geographic location proposed for these surveys, where the survey areas for supporting and social/cultural services are illustrated.

Moving forward, it the proposed long-term monitoring plan is funded, it would allow for repeat monitoring during summer periods, allowing a comparison between the winter and summer baselines of 2023, to future impacts of the wetlands on supporting, regulating and social/cultural ecosystem services these systems provide.

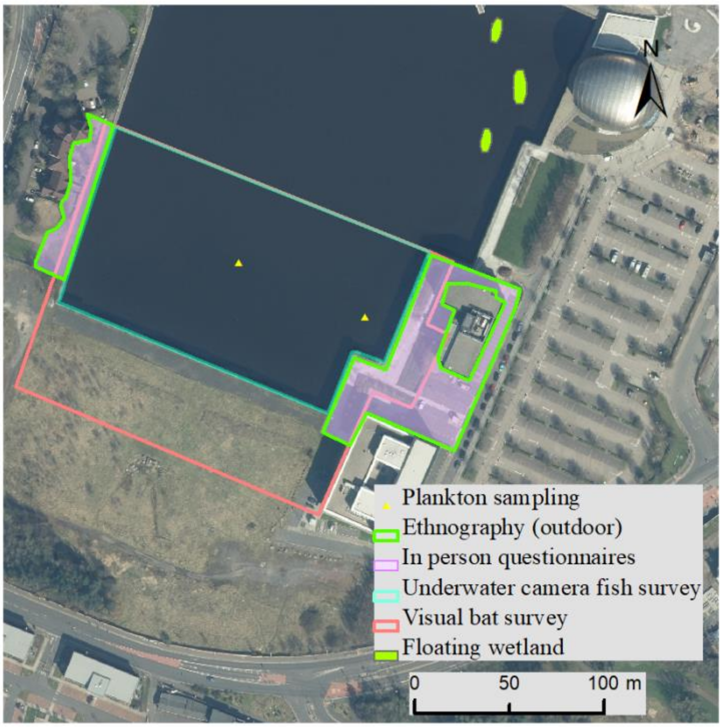



*Figure 3. Map of suggested locations for an additional baseline study to be conducted in the summer of 2023 to collect data that was beyond the scope of the winter baseline monitoring due to seasonal changes in ecology of the area, or time limitations.*

# 3. Pre-Wetland Installation Baseline Survey Results

## 3.1 Supporting Services

To understand the ecosystems that the existing environment supports, the biodiversity in the area was assessed using a range of methods to appropriately survey target taxa. Assessing the species present allows us to understand the interlinked supporting services provided by the basin, such as the food web it may support, based on these species' roles within the ecosystem. This section provides results of these monitoring methods, such as visual surveys to record diversity and abundance of taxa, including birds and mammals. It is organised by taxa and the corresponding methodologies for each survey type can be found in Appendix A. Other recommended parameters to measure in the future are outlined in the long-term monitoring plan (Fowler et al. 2023).

*Table 2. Showing: i) Baseline Completed which included the type of data collected, analysed, reported and ii) Baseline Stored which includes data which was collected and stored electronically during the baseline monitoring period (winter 2023) for each taxonomic group.*

| | **Baseline Completed (Year -1, Winter 2023)** | | | | **Baseline Stored (collected in Year -1, Winter 2023)** | | | |
|---|---|---|---|---|---|---|---|---|
| **Methods:** | **S** | **V** | **CT** | **A** | **S** | **V** | **CT** | **A** |
| Birds | X | X | X | X | Z | Z | Z | Z |
| Bats | X | X | - | - | - | - | - | - |
| | | | | | | | | |
| **Methods:** | **S** | **V** | **CT** | **A** | **S** | **V** | **CT** | **A** |
| Fish | X | - | - | - | - | - | - | - |
| Marine Mammals | X | - | - | - | - | - | - | - |
| | | | | | | | | |
| **Methods:** | **S** | **V** | **C** | **L** | **S** | **V** | **C** | **L** |
| Plankton | - | - | - | - | - | - | - | - |
| Invertebrates | - | - | - | - | O | - | - | - |

S: Secondary data source; V: Visual survey; CT: Camera trap; A: Acoustic equipment (e.g. acoustic recorder or hydrophone); C: Sample collection; L: Laboratory analysis (i.e., microscope). - : no data collected, analysed, reported or stored, and/or survey method not applicable for that taxonomic group; X: already completed, analysed and reported in the Baseline Monitoring Report. Z: already collected, waiting for analysis and reporting in a future updated Baseline Monitoring Report. O: not yet collected, analysed or reported and would be included in a Year 1 – onwards Post-Installation Monitoring and Evaluation Report. Note that camera and acoustic recordings are not applicable for plankton or invertebrates (e.g. insects). Methods for monitoring these taxa include collecting samples from the field for identification and assessments of abundance of these features in the laboratory.

The reported findings of the surveys carried out in Table 2 (and Figure 2) are linked to the specific supporting services or roles within the ecosystem that these species are known to provide. For example, birds are known to act as seed dispersers or as pest (e.g. rodent and insect) control (Whelan et al., 2008); fish are known to recycle nutrients and maintain sediment processes (Holmlund & Hammer, 1999); and bats are known to control insect populations and recycle nutrients (Ramírez-Fráncel et al., 2022). It can be difficult to measure the individual components that make up supporting ecosystem services, such as habitat provision, food web and genetic diversity that contribute to the overall function of the ecosystem. Biodiversity is a good indicator of ecosystem function (Hong et al., 2022), and therefore is used in this report as a metric for supporting ecosystem services. Biodiversity is important for maintaining stability of trophic interactions, i.e. the food web (Worm & Duffy, 2003).

### 3.1.1 Study area

The study site for the baseline supporting services monitoring encompassed the entire Canting Basin for all species monitored. Secondary data often extended beyond this geographic area, as data were often lacking or very limited in the basin itself. For example, fish use of the Clyde were available at a coarse resolution allowing identification of potential species that may be found in the basin with further monitoring. For the purposes of the baseline monitoring, the basin is the habitat providing the supporting service. This habitat is first described, followed by a species order assessment of what is currently occupying the basin during winter months, prior to the wetland installation.

### 3.1.2 Pre-wetland Installation Phase 1 Habitat description

A visual assessment of the site (Figure 2B) revealed that there are not a diverse range of habitats, and the area is lacking green space. The habitats present include the basin which is bound by vertical stone walls, with few structures (notable structures include a disused sea plane jetty that comes down from the north side basin wall, one buoy located in the south of the basin, and the railings). There are no aquatic plants present in the basin and the water is brackish and tidal, entering from the River Clyde which runs across the north of the site, through the City of Glasgow. This is consistent with the extended Phase 1 habitat survey carried out by Gow (2020) who found very limited habitat with the basin and its walls, where the vertical featureless basin walls lack enhancements for ecology and/or any natural wetland habitat.

The immediate surrounding area is largely terrestrial habitat that includes a moat/pond next to Glasgow Science Centre, with approximately 11 wetland plant species installed in 2021; a small patch of grass and trees along the east side of the basin; disused grassland along the south side of the basin; and graving docks along the west side of the basin. The basin itself has very limited habitat, with featureless smooth vertical walls that lack habitat enhancements to improve ecological outcomes and a lack of natural foreshore which means the basin is devoid of estuarine vegetation. This provides extremely limited habitat for estuarine and marine species to breed, feed and/or shelter within the Canting Basin.

### 3.1.3 Bird use of the basin

To assess bird use of the Canting Basin, we used secondary data and three survey methods: visual surveys, camera trap and acoustic surveys over a 19-day period. Each method gives a different layer of understanding of how the basin is used by birds. Visual surveys (Appendix A) give an opportunity to observe the whole area to understand how the space is being used, including an opportunity to observe behaviour and use of different structures and locations within the study site. Camera trap surveys (Appendix A) give a better understanding of how key areas within the study site are used through time, including during different times of day and across different days of the week. Acoustic recorders (Appendix A) are able to record less visually detectable species, such as small, elusive songbirds, and have the benefit of being able to record over long periods of time and key times of day, such as the dawn chorus, when more species are vocally active. Secondary data (Appendix A) allow us to gain an understanding of the species present in the wider area, to see what species may potentially be attracted to the floating wetlands and use the space more frequently. It also provides long-term data that would otherwise be outside of the scope of this study.

The baseline monitoring data collected through these methods show that there are currently 8 bird species that consistently use different parts of the Canting Basin (Table 3), indicating that the current environment provides some limited supporting services for these species. Based upon the species ecology and field observations, these individuals are benefitting from the resting opportunities provided by the area. Current structures in the Canting Basin, including the disused sea plane jetty, the buoy and the railings, are all being utilised by birds in the area (Figure 4). Camera trap surveys showed a high level of use of the disused sea plane jetty by birds (Table 3), with evidence of both diurnal and nocturnal use of this structure (Figure 5), but more frequent and intensive use during the daytime.

A further 15 bird species were identified using the surrounding habitat (Table 3) including the River Clyde and the moat, and visual observations of piscivorous feeding behaviour were made when surveying birds using the Clyde corridor adjacent to the basin.

*Figure 4A-B: Examples of loafing behaviour exhibited by birds on the existing structures in the Canting Basin, including A) disused sea plane jetty, and B) the basin railings.*

*Figure 5. An example of nocturnal use of the sea plane jetty by several bird species (red outlines show groups of birds), including two mute swans. Image taken by camera trap on 09/03/2023 21:41.*

### 3.1.4 Bat use of the basin

Secondary data sources (NBN Atlas 2023; Gow, 2020) confirm there have been bats present in the area (as recently as 2020), with one record of Soprano pipistrelle *(Pipistrellus pygmaeus)* presence within a 0.5km radius of the Canting Basin site. (*Records provided by Bat Conservation Trust, accessed through NBN Atlas website.*)

A Phase 1 habitat survey (Gow, 2020) revealed that the site surrounding the basin are deemed of negligible potential to support roosting bats, however the environment does have the potential to support commuting and foraging bats through the River Clyde, tree lines, hedgerows and woodland.

A desk study also identified records of Daubenton's bat, common pipistrelle and soprano pipistrelle bats within 2km of the site, including a maternity roost of soprano pipistrelles 1.37km north of the site.

*Table 3. Species presence list of birds observed in the Canting Basin and surrounding area over the baseline monitoring period (February to March, 2023), as well as additional secondary data between October 2022 and January 2023.*

| Common Name | Scientific name | Detection method | Area |
|---|---|---|---|
| **Black headed gull** | *Chroicocephalus ridibundus* | Visual survey, Camera trap, Secondary data | Sea plane jetty, Basin |
| **Cormorant** | *Phalacrocorax carbo* | Visual survey, Camera trap, Secondary data | Sea plane jetty, Basin, River Clyde |
| **Mute swan** | *Cygnus olor* | Visual survey, Camera trap, Secondary data | Basin, River Clyde |
| **Mallard** | *Anas platyrhynchos* | Visual survey, Camera trap, Secondary data | Sea plane jetty, Basin |
| **Moorhen** | *Gallinula chloropus* | Visual survey, Camera trap, Secondary data | Sea Plane jetty |
| **Common gull** | *Larus canus* | Visual survey, Secondary data | Sea plane jetty |
| **Herring gull** | *Larus argentatus* | Visual survey, Secondary data | Sea plane jetty, Basin |
| **Lesser black backed gull** | *Larus fuscus* | Visual survey | Sea plane jetty, Basin |
| **Goldeneye** | *Bucephala clangula* | Visual survey, Secondary data | River Clyde |
| **Blue tit** | *Cyanistes caeruleus* | Acoustic recorder | Moat |
| **Magpie** | *Pica pica* | Acoustic recorder, Secondary data | Moat |
| **Goldfinch** | *Carduelis carduelis* | Acoustic recorder | Moat |
| **Great tit** | *Parus major* | Acoustic recorder | Moat |
| **Blackbird** | *Turdus merula* | Acoustic recorder | Moat |
| **Carrion crow** | *Corvus corone* | Acoustic recorder, Secondary data | Moat |
| **Wren** | *Troglodytes troglodytes* | Acoustic recorder | Moat |
| **Little grebe** | *Tachybaptus ruficollis* | Secondary data | Glasgow Science Centre - Unspecified |
| **Robin** | *Erithacus rubecula* | Secondary data | Glasgow Science Centre - Unspecified |
| **Wood pigeon** | *Columba palumbus* | Secondary data | Glasgow Science Centre - Unspecified |
| **Goosander** | *Mergus merganser* | Secondary data | Glasgow Science Centre - Unspecified |
| **Pied wagtail** | *Motacilla alba* | Secondary data | Glasgow Science Centre - Unspecified |
| **Song thrush** | *Turdus philomelos* | Secondary data | Glasgow Science Centre - Unspecified |
| **Jackdaw** | *Corvus monedula* | Secondary data | Glasgow Science Centre - Unspecified |

No bats were detected from our surveying efforts during the baseline monitoring period; however, as described in the limitations above, bats are likely to be hibernating until around April. There is a need to repeat the baseline monitoring in Summer of 2023; recommended locations for this can be found in (Figure 3).

### 3.1.5 Other mammal use of the basin

Camera traps can be used to capture a variety of taxa, however no mammals were detected during our camera trap surveys (Appendix A) during the baseline monitoring period, demonstrating that mammals do not regularly use the sea plane jetty. Further to this, no mammals or mammal signs were observed during the visual assessments or surveys of the site, however mammals are more elusive and fugitive than other taxa, and often exhibit nocturnal behaviours in urban areas and therefore detectability during these surveys may be low.

A Phase 1 habitat survey (Gow, 2020) revealed unsuitability of the basin for aquatic mammals due to the vertical stone walls making it unsuitable for water voles, otter holt construction, as well as a lack of suitable locations for seals to haul out. However, the River Clyde adjacent to the basin provides suitable habitat for an otter or seal to commute and forage along the river and travel into the basin. This is supported by anecdotal data of species presence from staff members at Glasgow Science Centre, including one report of a juvenile seal hauled out on the Sea Plane Jetty.

### 3.1.6 Fish use of the basin

An NBN Atlas search of fish species presence within a 0.5km radius of the Canting Basin returned no results, highlighting the lack of data for the site (NBN Atlas 2023) and the need for repeating baseline monitoring in Summer 2023; recommended locations for this can be found in (see Figure 3 above). A wider search of a 2km radius confirms 117 records of 20 species of fish present within a 2km radius of the Canting Basin (Table 4), the duration of which these records span is unknown.

*Table 4.Secondary data records showing 20 species of fish found within a 2 km radius of the Canting Basin; records provided by Biological Records Centre, accessed through NBN Atlas website.*

| Common name | Scientific name | No. of records |
|---|---|---|
| **Common Bream** | *Abramis brama* | 2 |
| **Common Sturgeon** | *Acipenser sturio* | 1 |
| **European Eel** | *Anguilla anguilla* | 15 |
| **Stone Loach** | *Barbatula barbatula* | 9 |
| **Goldfish** | *Carassius auratus* | 3 |
| **Bullhead** | *Cottus gobio* | 1 |
| **Pike** | *Esox lucius* | 7 |
| **Three-spined Stickleback** | *Gasterosteus aculeatus* | 21 |
| **Gudgeon** | *Gobio gobio* | 1 |
| **Dace** | *Leuciscus leuciscus* | 2 |
| **Smelt** | *Osmerus eperlanus* | 1 |
| **Perch** | *Perca fluviatilis* | 9 |
| **Minnow** | *Phoxinus phoxinus* | 12 |
| **Flounder** | *Platichthys flesus* | 2 |
| **Common Goby** | *Pomatoschistus microps* | 1 |
| **Roach** | *Rutilus rutilus* | 8 |
| **Atlantic Salmon** | *Salmo salar* | 8 |
| **Brown Trout** | *Salmo trutta subsp. fario* | 6 |

| | | |
|---|---|---|
| **Brown/Sea Trout** | *Salmo trutta* | 6 |
| **Grayling** | *Thymallus thymallus* | 1 |

### 3.1.7 Summary

Whilst the Canting Basin is able to provide sufficient space to support wildlife and is used (mostly by birds) for resting on the few structures present and the water surface, previous studies and the baseline data reported here show it does not support further functions within the ecosystem. The Canting Basin does not currently provide habitat suitable to support reproductive behaviours, i.e., nesting or spawning; feeding behaviours (as there are no primary producers to support the food web); or sheltering opportunities from predators and adverse weather.

### 3.1.8 References for Supporting Ecosystem Services


Fowler, E, Woolfenden, C, Kaplan, A, Gill, A, Lacsny, A, Curley, E, Naylor, LA, McGregor, A, Bailey, D, Bass, A, Gauchotte-Lindsay, C, Li, Y, Moreau, J, Nager, R, White, S, Olive, V, Palmer, E, Prentice, T, Roberts, K, Slaymark, C, and Wang, Y. (2023). "Glasgow's Floating Estuarine Wetlands Long-Term Ecosystem Services and Function Monitoring and Evaluation Plan". *University of Glasgow*. DOI: 10.36399/gla.pubs.295313

Gow, A. (2020) "Preliminary Ecological Appraisal (Confidential)", *ITPEnergised for Glasgow Science Centre*. Permission to cite this report given by Glasgow Science Centre.

Holmlund, C.M. and Hammer, M. (1999), "Ecosystem services generated by fish populations", *Ecological Economics*, Elsevier, Vol. 29 No. 2, pp. 253–268, doi: 10.1016/S0921-8009(99)00015-4.

Hong, P., Schmid, B., De Laender, F., Eisenhauer, N., Zhang, X., Chen, H., Craven, D., *et al.* (2022), "Biodiversity promotes ecosystem functioning despite environmental change", *Ecology Letters*, John Wiley & Sons, Ltd, Vol. 25 No. 2, pp. 555–569, doi: 10.1111/ELE.13936.

National Bat Monitoring Programme (2023) *Sunset/Sunrise Survey, Bat Conservation Trust*. Occurrence dataset on the NBN Atlas. NBN Atlas occurrence download at NBN Atlas accessed on Wed Mar 29 14:50:42 UTC 2023. https://doi.org/10.15468/brmbw2. These data have not been changed and are available under an OGL data licence: https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/.

National Biodiversity Network (NBN) Trust (2023). *The National Biodiversity Network (NBN) Atlas*. https://ror.org/00mcxye41.

Ramírez-Fráncel, L.A., García-Herrera, L.V., Losada-Prado, S., Reinoso-Flórez, G., Sánchez-Hernández, A., Estrada-Villegas, S., Lim, B.K., *et al.* (2022), "Bats and their vital ecosystem services: a global review", *Integrative Zoology*, John Wiley & Sons, Ltd, Vol. 17 No. 1, pp. 2–23, doi: 10.1111/1749-4877.12552.

Whelan, C.J., Wenny, D.G. and Marquis, R.J. (2008), "Ecosystem services provided by birds", *Annals of the New York Academy of Sciences*, Blackwell Publishing Inc., Vol. 1134, pp. 25–60, doi: 10.1196/ANNALS.1439.003.

Worm, B. and Duffy, J.E. (2003), "Biodiversity, productivity and stability in real food webs", *Trends in Ecology & Evolution*, Elsevier Current Trends, Vol. 18 No. 12, pp. 628–632, doi: 10.1016/J.TREE.2003.09.003.

## 3.2 Regulating Services

To examine the regulating services of the existing basin environment, a mixed methods approach was utilised to measure environmental characteristics associated with the water quality, in addition to the composition and structure of the basin substrate and the substrate of the wetland pre-installation (see Section 3.4 below). Baseline sampling involved those analyses which were carried out and reported here (Sections 3.2 and 3.4) and those which have been collected, prepared and safely stored to serve as reference conditions as part of future monitoring proposed in the Long-term Monitoring Plan (Fowler et al. 2023), see Table 5.

The floating wetlands may absorb, accumulate and cycle nutrients and/or pollutants from water in the basin through time; thereby potentially providing an important regulatory ecosystem service. Detritus from the decomposition of the wetland plants may reach the basin water and be deposited on the estuarine bed, altering the structure and chemical composition of the associated substratum. It is thus important to characterise the baseline conditions of the water and sediment in the basin prior to installation of the wetlands.

*Table 5. Illustrates A) baseline data collected versus b) baseline data collected and stored for future analysis to enhance the baseline data reported here.*

| | **Baseline Completed (Year -1, Winter 2023)** | | | | **Baseline Stored (Collected in Year -1, Winter 2023)** | | | |
|---|---|---|---|---|---|---|---|---|
| | BW | BS | WS | WP | BW | BS | WS | WP |
| pH | **X** | **-** | **-** | **-** | **O** | **-** | **-** | **-** |
| Temperature | **X** | **-** | **-** | **-** | **O** | **-** | **-** | **-** |
| Salinity | **X** | **-** | **-** | **-** | **O** | **-** | **-** | **-** |
| Conductivity | **X** | **-** | **-** | **-** | **O** | **-** | **-** | **-** |
| Rugged dissolved oxygen (RDO) | **X** | **-** | **-** | **-** | **O** | **-** | **-** | **-** |
| Turbidity | **-** | **-** | **-** | **-** | **O** | **-** | **-** | **-** |
| Dissolved organic carbon (DOC) | **X** | **-** | **-** | **-** | **O** | **-** | **-** | **-** |
| Phosphate | **X** | | | | **O** | **O** | **O** | **O** |
| Nitrate | **X** | | | | | **O** | **O** | **O** |
| Metals | **X** | **X** | **X** | **Z** | **O** | **O** | **O** | **O** |
| Microplastics | - | **Z** | | | **-** | **O** | **O** | **-** |
| Pharmaceuticals | **Z** | **Z** | **-** | **-** | **O** | **O** | **O** | **-** |
| Total Organic Carbon | | **Z** | **Z** | **Z** | **-** | **O** | **O** | **O** |
| Grain size | | **X** | **Z** | | **-** | **O** | **O** | **-** |

BW – baseline water, BS – Baseline sediment, WS – wetland sediment, and WP – wetland plants. X already completed, analysed and reported in the BMR, Z already collected, waiting for further funding to enable analysis and reporting in a future updated BMR, O not yet collected, analysed or reported and would be included in a Year -1 - onwards Post-Installation Monitoring and Evaluation Report, - not carried out due to methodology not being suitable for this environmental setting and/or material type.

This section provides results of the monitoring methods, such as long-term monitoring of water quality in the basin and the lab-based analysis of water and sediment chemistry. It is organised to provide background conditions in the water and sediment first, followed by water and sediment chemistry, in addition to nutrients and heavy metals present in the planting medium. Corresponding methodologies for the *in-situ* monitoring and lab analysis can be found in Appendix B. Recommendations towards future monitoring approaches are outlined in the long-term monitoring plan (Fowler et al. 2023).

### 3.2.1 Background water conditions

Measurements of surface water quality were continuously recorded over a 39-day period using a fixed positioned *in-situ* Aquatroll 600 multiparamter probe, positioned 10 metres from the final installation location of the Floating Wetland (Figure 2A-B). Measured water quality characteristics are listed in Table 6, with corresponding average (mean) readings for each measured characteristic, in addition to the observed variation (standard deviation) calculated for the recording period.

*Table 6. Average readings (Mean ± Standard Deviation), for water quality characteristics (Dissolved oxygen (RDO); pH; Conductivity; Salinity; Total Dissolved Solids (TDS); TemperaturE) in the Canting Basin. Variation in measurements for recording period provided: standard deviation, maximum value, minimum value.*

| | RDO | pH | Conductivity | Salinity | TDS | Temp |
|---|---|---|---|---|---|---|
| Mean ± SD | 9.36 ± 0.27 | 7.79 ± 0.06 | 1274.37 ± 1427.31 | 1.05 ± 1.25 | 1.32 ± 1.5 | 6.34 ± 1.01 |
| Max | 9.93 | 7.95 | 5821.14 | 5.17 | 6.15 | 8.53 |
| Min | 8.30 | 7.65 | 224.38 | 0.17 | 0.24 | 3.28 |

### 3.2.2 Background sediment conditions

Twelve sediment samples were taken from the basin bed using a grab sampler on 9th February 2022; these are samples 1-12. Sample 13 was collected at the confluence of the Canting Basin and the River Clyde (Figure). Grain size frequency distributions, as well as the cumulative curve of different shapes and textural parameters, can be an essential method to classify potential sedimentary environments and explain the sorting processes of these sediments, which are very important and useful (Glaister and Nelson, 1974; Blott and Pye, 2001; Flemming, 2007). The grain size distribution at each basin sediment sample were plotted using the data analysed through Laser Diffraction Particle Size Analysis (LDPSA), Figure 6 and Figure 7. Cumulative frequency curves and median particle diameter ($D_{50}$) of each sample were also shown below (Figure XX).

*Figure 6. Grain size frequency distribution and cumulative frequency curve of sample sites 1-6 on Figure 2B.*

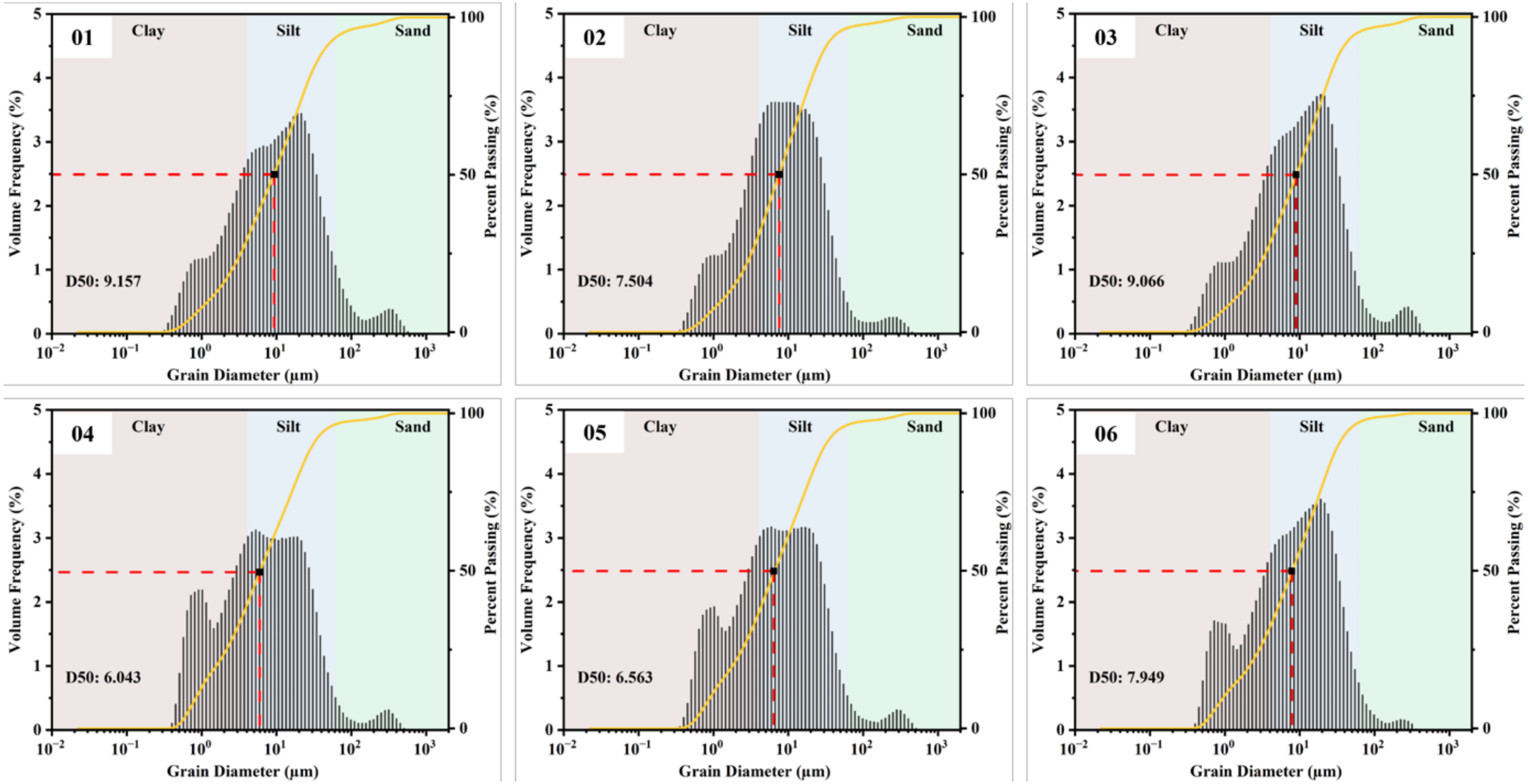


*Figure 7. Grain size frequency distribution and cumulative frequency curve of sample sites 7-12 on Figure 2B.*

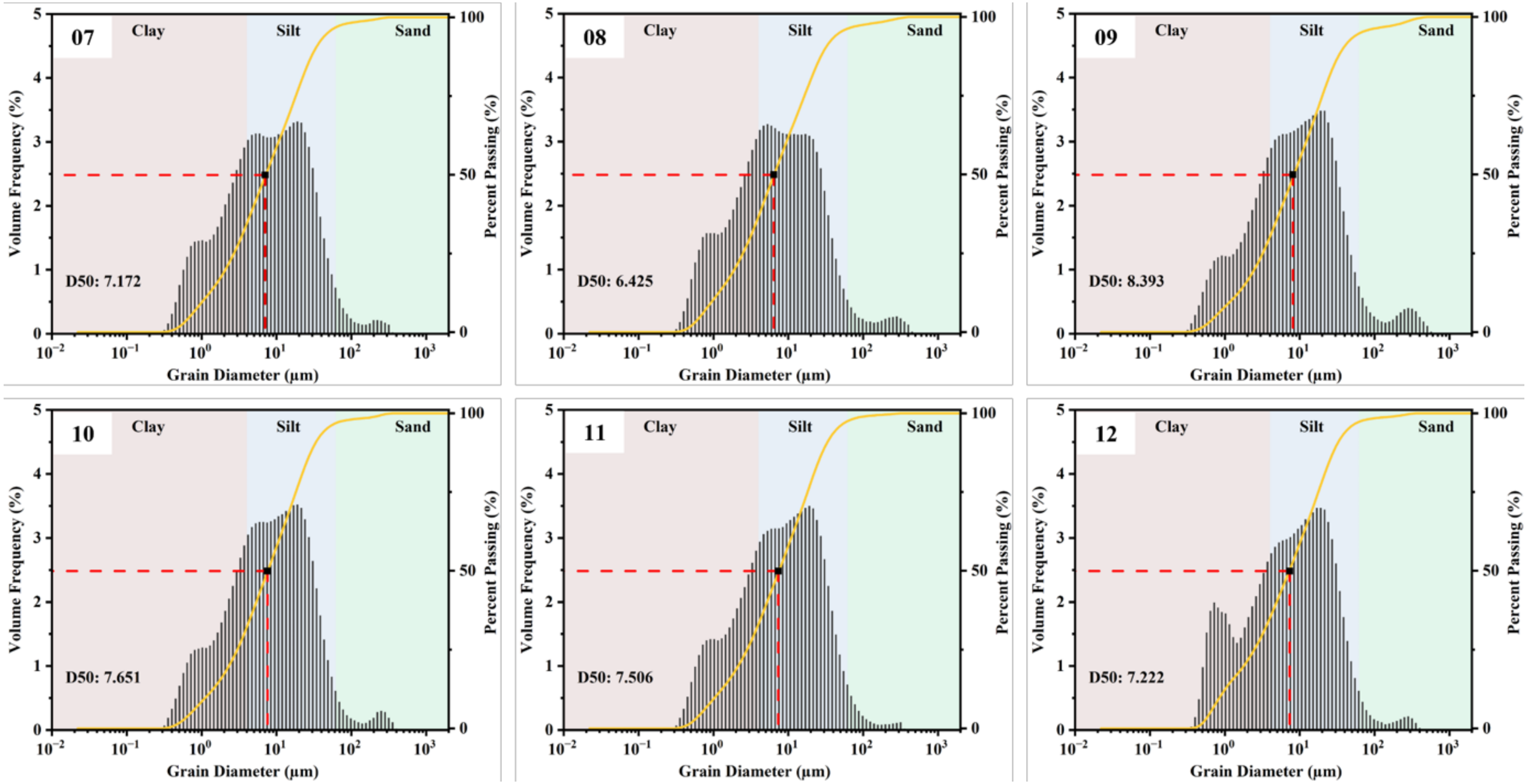
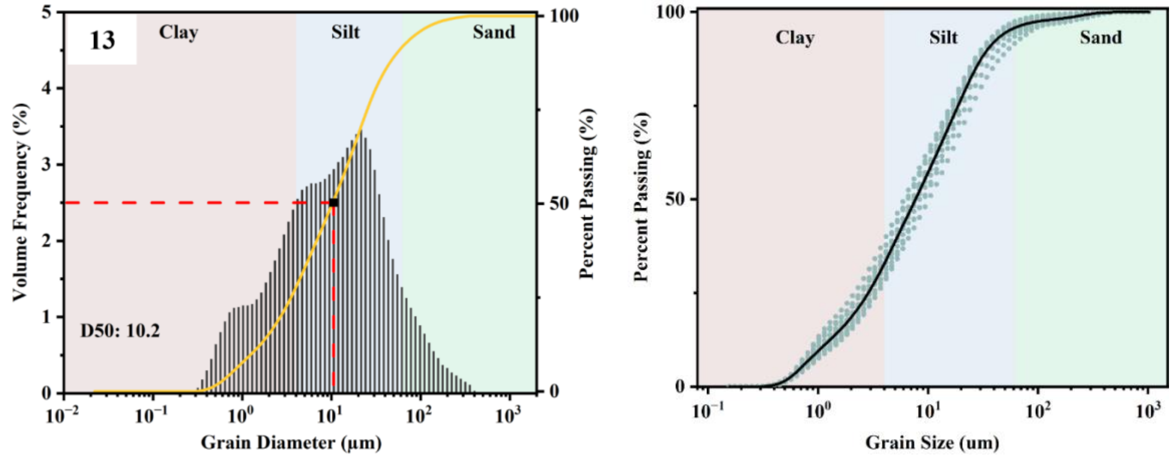
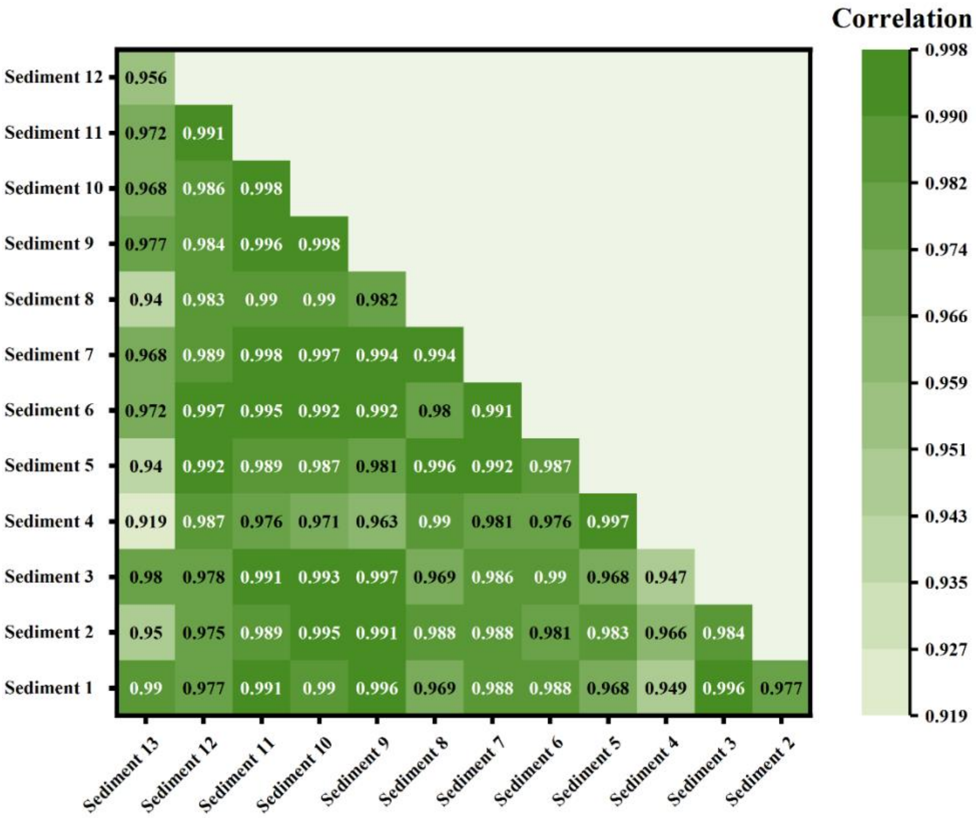


*Figure 8. A) Grain size distribution and cumulative curve at site 13 at the confluence of Canting Basin and the River Clyde (Figure 2A) and B) Mean cumulative curve of all samples. Shallow blue dots showed cumulative frequency distributions of all samples.*




When plotting all the cumulative frequency curve of each site to a single figure, high similarity becomes obvious. The black curve in Figure 8B shows the mean cumulative curve, while shallow blue dots were combined from cumulative frequency distributions of all samples. All these dots are quite near to each other with a limited deviation from the mean value, showing a high degree of similarity between samples. These similarities were evaluated statistically where the correlations between grain size frequency distributions of each sample were calculated and plotted (Figure 9).

*Figure 9. Correlations between grain size distributions of each sample.*



All correlations are larger than 0.91 which demonstrates the high similarity between different samples (after Swinscow and Campbell, 2002)[1].

### Sediment sorting

In addition, results extracted from the cumulative frequency curve are used to calculate the coefficient of uniformity ($C_u$), which can determine the sorting level of sediments, and the coefficient of gradation ($C_c$) is a companion parameter to $C_u$ (Keaton, 2018). $D_n$, the corresponding particle size when the cumulative percentage reaches n%, can be easily extracted from the cumulative frequency curve. $D_{10}$, $D_{25}$, $D_{30}$, $D_{50}$, $D_{60}$, and $D_{75}$ were calculated for each sample.

According to the formula $C_u = D_{60}/D_{10}$, and $C_c = (D_{30})^2/(D_{60}*D_{10})$, the parameters mentioned above can be calculated. A well-graded sand (SW) or gravel (GW) meets the definition of sand or gravel and has $C_u > 4$ and $1 \leq C_c \leq 3$ (Keaton, 2018). All our samples meet this level of uniformity; for silt sized particles (Table 7).

*Table 7. Grain size passing percent of 10%, 25%, 30%, 50%, 60%, and 75%. Coefficient of uniformity ($C_u$) and coefficient of gradation ($C_c$) were calculated.*

| Sample | $D_{50}$ | $D_{10}$ | $D_{25}$ | $D_{30}$ | $D_{60}$ | $D_{75}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|---|---|
| **Sample 1** | 9.157 | 1.240 | 3.301 | 4.152 | 13.390 | 22.260 | 10.798 | 1.038 |
| **Sample 2** | 7.504 | 1.285 | 3.208 | 3.940 | 9.979 | 16.970 | 7.766 | 1.211 |
| **Sample 3** | 9.066 | 1.299 | 3.469 | 4.236 | 12.963 | 20.520 | 9.979 | 1.066 |
| **Sample 4** | 6.403 | 0.851 | 2.146 | 2.720 | 8.928 | 16.040 | 10.491 | 0.974 |
| **Sample 5** | 6.563 | 0.913 | 2.410 | 3.017 | 9.545 | 16.690 | 10.455 | 1.044 |
| **Sample 6** | 7.949 | 0.967 | 2.866 | 3.574 | 11.311 | 18.670 | 11.697 | 1.168 |
| **Sample 7** | 7.172 | 1.045 | 2.693 | 3.335 | 10.580 | 18.090 | 10.124 | 1.006 |
| **Sample 8** | 6.425 | 0.972 | 2.474 | 3.119 | 9.231 | 16.420 | 9.497 | 1.084 |
| **Sample 9** | 8.393 | 1.212 | 3.190 | 3.951 | 12.092 | 20.030 | 9.977 | 1.065 |
| **Sample 10** | 7.651 | 1.146 | 2.982 | 3.696 | 10.939 | 18.130 | 9.545 | 1.090 |
| **Sample 11** | 7.506 | 1.056 | 2.804 | 3.457 | 10.580 | 18.040 | 10.019 | 1.070 |
| **Sample 12** | 7.222 | 0.860 | 2.470 | 3.225 | 10.580 | 17.700 | 12.302 | 1.143 |
| **Sample 13** | 10.200 | 1.267 | 3.497 | 4.379 | 15.050 | 25.060 | 11.878 | 1.006 |

### 3.2.3 Water Nutrient Characteristics

Across the 12 surface water samples collected in the basin (Figure 2B), mean average nitrate concentration is 1.44 mg/L, dissolved organic carbon (DOC) is 1.48 mg/L and phosphate concentration is 0.31 mg/L. There was little variation in DOC, whilst Nitrate and Phosphate did vary by >30% across the basin (Table 8). Nitrate levels are within safe limits; Nitrate is well below 50 mg/L the threshold used by SEPA in groundwater to designate an area as a Nitrate Vulnerable Zone (NVZ) (EC Nitrates Directive). Phosphate however consistently exceeds the safe limit of 0.1 mg/L for rivers set by the EC Water Framework Directive; where all but two samples are more than double this safe limit, with the average 3x the safe limit. There are no limits set for DOC as it is not considered a pollutant.

[1] A coefficient of 0–0.19 suggests very weak correlation, 0.2–0.39 suggests weak correlation, 0.40–0.59 suggests moderate correlation, 0.6–0.79 suggests strong correlation, and 0.8–1 suggests very strong correlation

*Table 8. Surface water nutrient and dissolved oxygen levels from the 12 basin samples.*

| Sample number | Nitrate (mg/L) | DOC (mg/L) | Phosphate (mg/L) |
|---|---|---|---|
| **S1** | 1.2 | 1.59 | 0.34 |
| **S2** | 1.3 | 1.48 | 0.24 |
| **S3** | 0.9 | 1.48 | 0.33 |
| **S4** | 2 | 1.48 | 0.39 |
| **S5** | 2.3 | 1.36 | 0.47 |
| **S6** | 1.3 | 1.25 | 0.28 |
| **S7** | 1.5 | 1.48 | 0.19 |
| **S8** | 1.4 | 1.36 | 0.41 |
| **S9** | 1.5 | 1.59 | 0.42 |
| **S10** | 1 | 1.59 | 0.2 |
| **S11** | 1.3 | 1.59 | 0.22 |
| **S12** | 1.6 | 1.59 | 0.19 |
| ***average*** | ***1.44*** | ***1.48*** | ***0.31*** |
| ***standard deviation*** | ***0.39*** | ***0.11*** | ***0.10*** |

### 3.2.4 Water Chemistry including Heavy Metals

Water samples were taken in the surface layer of the water which is heavily mixed and refreshed as part of tidal cycling. Water samples were below detection limits for all analytes (major cations and trace metals) save total iron. Analytes measured are listed in Appendix B. This is not unexpected and likely reflects high dilution factors for most elements save major cations (e.g., Na, Ca, Mg, Si, Al, K) typical of freshwaters. The average iron concentration for the basin (n=12) is 0.27 ppm and standard deviation is 0.01 ppm. It is recommended that future monitoring of the basin water is carried out as a vertical profile to capture any variations in water quality between the surface and the estuary bed, due to the high levels of certain pollutants found in the basin sediment (see Section 3.2.5).

### 3.2.5 Sediment Chemistry including Heavy Metals

A full list of the elements measured in the basin and river sediments is available in Appendix B. Of concern are concentrations of Arsenic (As), Cadmium (Cd), Chromium (III) (Cr), Lead (Pb) and Vanadium (V), averages (n=6) and standard deviations shown for these metals are shown in

Table 9 below.

*Table 9. Summary of pollutant metal concentrations in the basin sediment (mean for all 6 samples is reported here. Soil Guideline Values given are for allotment status (Environment Agency 2009a,b).*

| | **As** ppm | **Cd** ppm | **Cr** ppm | **Pb** ppm | **V** ppm |
|---|---|---|---|---|---|
| basin sediments (mean) | 15.2 | 2.5 | **451.0** | **174.0** | 138.0 |
| standard deviation | 1.32 | 0.25 | 46.08 | 17.24 | 19.46 |
| River channel | 12.3 | 2.45 | 327 | 183.4 | 144 |
| CLEA Soil Guideline Values 2009 | 49 | 3.9 | 130 | 80 | n/a |

| | | | | | |
|---|---|---|---|---|---|
| SEPA water quality standard | 0.0500 | 0.0015 | .032* | 0.0140 | 0.0600 |

*as Cr(III)

Sediment samples, likely reflect a history of significant industrial contamination, with high level (in the ppm range) concentrations of total arsenic, cadmium, chromium, lead and vanadium. Table 7 shows these concentrations as the mean 6 samples obtained in the Canting Basin across a square grid. Analysed sediment samples were collected at sites 1, 4, 5, 8, 9 and 12, comprising sites located on the edge of the matrix shown in Figure 2B. Raw data at each sampling point are available in Appendix B. This is the first high resolution, chemical analysis for the basin sediments in the Canting Basin. This section of the river has not been measured at this scale before and provides a detailed insight to the chemistry of the site prior to the Floating Wetland installation. Results are broadly in line with the data published for this section of the River Clyde by Jones et al. (2017). There are acceptable levels of As and Cd but not of Cr, Pb and perhaps V. V does not have a CLEA SGV published but is included here because of its known toxicity to plants and humans at high levels. Vanadium concentration in sediment is comparable to soil concentrations for the area (Fordyce et al., 2017).

### 3.2.6 References

Blott, S. J., & Pye, K. (2001). GRADISTAT: a grain size distribution and statistics package for the analysis of unconsolidated sediments. Earth Surface Processes and Landforms, 26(11), 1237–1248.

Environment Agency, (2009a). Using Soil Guideline Values. Science Report SC050021/SGV introduction. Bristol: Environment Agency.

Environment Agency, (2009b). Human health toxicological assessment of contaminants in soil. Science Report SC050021/SR2. Bristol: Environment Agency.

Fordyce, F.M. Everett, P.A. Bearcock, J.M. Lister, T.R. Gowing, C. Watts, M. Ellen, R. (2017) Soil geochemical atlas of the Clyde Basin. Edinburgh, UK, British Geological Survey, 126pp. (OR/14/032)

Jones, D.G., Vane, C.H., Lass-Evans, S., Chenery, S., Lister, B., Cave, M., Gafeira, J., Jenkins, G., Leslie, A., Breward, N. and Freeborough, K., 2017. Geochemistry and related studies of Clyde Estuary sediments. Earth and Environmental Science Transactions of the Royal Society of Edinburgh, 108(2-3), pp.269-288

Flemming, B. W. (2007). The influence of grain-size analysis methods and sediment mixing on curve shapes and textural parameters: Implications for sediment trend analysis. Sedimentary Geology, 202(3), 425–435.

Glaister, R. P., & Nelson, H. W. (1974). Grain-size distributions, an aid in facies identification. Bulletin of Canadian Petroleum Geology, 22(3), 203–240.

Keaton, J.R. (2018). Coefficient of Uniformity. In: Bobrowsky, P.T., Marker, B. (eds) Encyclopedia of Engineering Geology. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-319-73568-9_58

Smedley, P.L.; Bearcock, J.M.; Fordyce, F.M.; Everett, P.A.; Chenery, S.; Ellen, R. (2017) Stream-water geochemical atlas of the Clyde Basin. Nottingham, UK, British Geological Survey, 168pp. Swinscow, T. D. V., & Campbell, M. J. (2002). Statistics at square one (pp. 111-25). London: Bmj. Chicago

Wentworth, C. K. (1922). A scale of grade and class terms for clastic sediments. The Journal of Geology, 30(5), 377–392.

## 3.3 Social and Cultural Services

To assess the social and cultural services of the basin, we used a mixed methods approach to gather baseline data on a series of parameters, including public perceptions of the Canting Basin pre-installation and public perceptions of 'Greening the Grey' Initiatives. Please refer to the methods statement provided in Appendix C of Fowler et al. (2023) for a summary overview of methods implemented and a summary of ethical considerations. For a detailed overview of methods, including justifications, please also refer to Appendix C in Fowler et al. (2023). Data were collected using methods of ethnography, questionnaires, workshop, and interview (Table 10).

*Table 10. Illustrates A) baseline data collected versus b) baseline data collected and stored for future analysis to enhance the baseline data reported here.*

| | **Baseline Completed (Year -1, Winter 2023)** | | | | **Baseline Stored (Collected in Year -1, Winter 2023)** | | | |
|---|---|---|---|---|---|---|---|---|
| **In-Person:** | **E** | **Q** | **W** | **I** | **E** | **Q** | **W** | **I** |
| Indoor | X | X | X | Z | X | Z | X | Z |
| Outdoor | X | O | - | O | X | O | - | O |
| | | | | | | | | |
| **Online:** | **E** | **Q** | **W** | **I** | **E** | **Q** | **W** | **I** |
| | - | X/Z | - | O | - | X/Z | - | O |

E – ethnography, Q – questionnaires, W – Workshops, I – Interviews. X already completed, analysed and reported in the BMR, Z already collected, waiting for analysis and reporting in a future updated BMR, O not yet collected, analysed or reported and would be included in a Year -1 - onwards Post-Installation Monitoring and Evaluation Report, - not carried out due to methodology not being suitable for this environmental setting.

Fieldwork exploring the social and cultural services was conducted both in-person at Glasgow Science Centre, indoors and outdoors, as well as online. Specific fieldwork locations associated with each method are available in Figure 2B.

### 3.3.1 Ethnography Results

Ethnographic data was collected within the boundaries of Glasgow Science Centre – indoor observations were taken from the IMAX café and outdoor observations were taken within the property lines at the front and back of Glasgow Science Centre (further details on the ethnographic method can be found in Appendix C).

Researchers noted that a reoccurring observation was the lack of people using the outside space. A total of 62 people were observed, all actively engaging in a range of activities such as walking, cycling, dog walking, sight-seeing, or admiring the outdoor space. Glasgow Science Centre has ample outdoor space for recreational use, including benches, interactive musical tools and reed beds and wildflower planting, though most observed participants did not engage with these spaces, likely due to winter weather. Researchers anticipate that outdoor use of space will increase during summer months and engagement with existing features and the newly installed floating wetlands will enhance tourism-related and recreational activity and once the site is established may also act as a site of continued engagement throughout winter (see also White et.al, 2021).

Additionally, the researchers' experiences of the space were negatively impacted by the presence of litter in the Canting Basin. The presence of litter caused concern among researchers, extending to their imaginings of how the floating wetlands might change the space, and if they would draw attention more to the presence of litter or potentially encourage/discourage further littering. This observation may draw attention to the wider issue of plastic pollution and the cleanliness of urban blue space, a major factor affecting urban blue space use in Glasgow (Smith et al., 2022).

Initial observations also indicated that engagement with the blue space is currently limited to activities moving through the space, rather than direct engagement with the Canting Basin. However, researchers believe this to be both weather-related and a result of ongoing renovations at Glasgow Science Centre. They anticipate that engagement will increase during summer months and once refurbishment is complete, restoring full access to the Canting Basin.

### 3.3.2 Questionnaires Results

Questionnaire data was collected within the boundaries of Glasgow Science Centre – indoors questionnaires were carried out at workshops with workshop participants and with master's students from University of Glasgow who were brought to visit the site. Questionnaires were also facilitated online via poster and QR code available at Glasgow Science Centre Café. Further details on the questionnaire method, including the number of survey responses can be found in Appendix C.

Questions for participants focussed on exploring public perceptions of the Canting Basin pre-installation, perceptions of installation visualisation, and perceptions of urban greening objectives.

Perceptions of the Canting Basin Pre-Installation:

Participants gave mixed responses:

- Sad, empty space, wasted opportunity, lots of potential, want to see more greenery, significant space for development

Perceptions of Installation Visualisation:

- Good move forward, too small, step in the right direction, looks nice, important installation, something which will bring nature into Glasgow

Perceptions of Greening Objectives:

- Important, should be done more, lots of potential, brings nature and city together, key for mental health, central to wellbeing, will increase use of space, key for physical health (White, et.al, 2020; White, et.al, 2021; Poulsen, et.al, 2022; Jo, et.al, 2022, see reference list in Appendix C)

Results indicated that participants saw this greening project as an important initiative for Glasgow Science Centre and Glasgow Science Centre more generally, with important ties to social and cultural services. This was represented as a significant benefactor towards improving mental and physical health in Glasgow and as a way of restoring nature and further enhancing biodiversity within the city. Additionally, participants indicated that this might increase education levels around greening objectives for members of the public, with long-term impacts around greener futures.

### 3.3.3 Workshops Results

Workshops permitted researchers to record participants perceptions of greening objectives and the SMEEF Floating Wetland project as well as perceptions around community education. Results from working with two workshop groups indicated that participants approached the greening project as an opportunity for community engagement, participation, and education. A clear sense of educational potential affiliated with the project was outlined by participants in conversation as a key motivation for their attendance. Specifically, participants expressed interest both in learning more about the project through extended involvement, as well as highlighting the importance of this initiative for the general public and young people's education (see also Couper, 2017). Participants were also interested to learn more about this project as transformational under the guise of greening cityscapes (see also Naylor et.al, 2017).

Additionally, participants indicated an anticipated positive impact on personal mental health and wellbeing, with increased levels of visitation a probable consequence of the floating wetlands. Most participants indicated that they would visit more frequently, primarily to see the development of the wetlands. In support, they also indicated that this continued growth and anticipated influx of fauna would have positive impacts on their mental health and physical wellbeing as it would encourage them to engage with other people and participate in the active practice of visiting.

As a tool for creative art and engagement, the workshops proved to be a key element of the methodology with participants were able to work on additions for a community almanac, creating pieces of artwork to be stored online. This artwork enabled community engagement from local Glasgow-based groups and offers potentials for future educational opportunities with the use of the community almanac; the almanac additionally offers potentials for educational engagement on-site, accessible through use of QR code.

Potential limitations around data collected from workshops include the lack of recording due to consent, with some element of data unusable. Additionally, recorded conversations were biased due to the nature of the group and who was willing to interact with the researchers. These elements both have had an impact on the results collated from the workshops, though valuable data was collected, nonetheless.

## 3.4 Baseline Conditions of the Floating Wetlands/Pre-Installation Wetland Monitoring

Plant selection is an important component of wetland design, particularly where constructed wetlands can be used to provide a range of ecosystem services (Mitsch et al. 2014). The team at University of Glasgow worked with and supported the wetland manufacturer, Biomatrix, by providing an assessment of the possible plants that could be selected, to allow identification of plants that would be most suitable for providing specific regulatory ecosystem services, such as pollutant absorption or carbon storage (Table 12 below). Biomatrix was able to source some of these recommended plants within the tight construction timescales of the project and these were planted alongside several other species known to be suitable for the environmental conditions which together will likely provide a range of supporting, regulatory and social/cultural ecosystem service benefits (Table 11).

It is important to measure the properties of the plants and growing medium (hereafter, substrate) that the wetlands are comprised of before they are placed into the Canting Basin. This involved a combination of pre-constructed data from suppliers of the substrate and collection and safe storage of samples for future analyses. Samples of each herbaceous plant species were collected, freeze dried and stored for future analyses. See Table 5 above documenting baseline completed, and baseline stored for the wetland plants and sediment alongside the basin water and sediment. This will allow any supporting service nutrient processing benefits such as carbon sequestration and storage capacity of the plants or substrate to be compared against reference, pre-installation conditions.

*Table 11. Plants selected and planted in the three installed floating wetlands. Specimens of all plants were collected from the wetlands pre-installation. The green highlighted species link to Table 12 as they are plants which have target properties, such as, uptake of nutrients and pollutants.*

| **Type of Plant** | **Species** |
|---|---|
| Less Salty Plants | *Iris Pseudacorus* |
| | *Menyanthes Trifoliata* |
| | *Caltha Palustris* |
| | *Mentha Aquatica* |
| | *Carex Paniculata* |
| | *Ranunculus Flammula* |
| | *Lythrum Salicaria* |
| | *Veronica Beccabunga* |
| | *Juncus effusus* |
| | *Juncus inflexus* |
| | *Phragmites communis* |
| | *Glyceria maxima* |
| | *Myosotis palustris* |
| | *Carex acutiformis* |
| Salty Plants | *Leymus arenarius* |
| | *Tripolium Pannonicum* |
| | *Plantago Maritima* |
| | *Armeria Maritima* |
| | *Schoenoplectus Tabermontani* |
| | *Pulcinella Distans* |

*Table 12. Plant Selection (based on species availability and baseline monitoring results to inform target properties)*

| Species Available | Heavy metals | Nitrogen | Phosphorous | Pollinators | Pharmaceuticals | Ammonium | Carbon | Visual attraction | References |
|---|---|---|---|---|---|---|---|---|---|
| ***Juncus inflexus*** | Y | Y | - | N | | | - | Reeds | (Vaněk et al., 2016)<br>(Ghamary & Mohajeri, 2021) |
| ***Juncus effusus*** | Y | Y | Y | N (but food for insects) | Y | Y | - | Reeds | (Peng et al., 2018)<br>(Matthews et al., 2004)<br>(Zhang et al., 2016)<br>(Wiessner et al., 2013)<br>(Menon & Holland, 2013)<br>(Liu et al., 2014) |
| ***Caltha palustris*** | Y | - | - | Y | | | - | Yellow flowers | (Zanin et al., 2018) |
| ***Carex acuta*** | Y | Y | - | N | | | - | Grasses | (Petrov et al., 2022)<br>(Kaštovská & Šantrůčková, 2011) |
| ***Carex pseudocyperus*** | Y | - | - | N | - | | - | Grasses | (Schück, 2022) |
| ***Iris pseudacorus*** | Y | Y | - | Y | Y | | - | Yellow flowers | (Schück, 2022) |
| ***Myosotis scorpioides*** | - | - | - | Y | | | - | Blue flowers | (Weryszko-Chmielewska, 2014) |
| ***Veronica beccabunga*** | Y | - | - | Y | | - | - | Blue flowers | (Hosseini et al., 2013) |

**References in the table**: Ghamary, E., & Mohajeri, J. (2021). Efficiency of Cyperus alternifolius, Typha latifolia, and Juncus inflexus in the removal of nitrate from surface water. Journal of Water Supply: Research and Technology-Aqua, 70(5), 654–664. https://doi.org/10.2166/aqua.2021.103; Hosseini, N., Asghari, B., Hossein, A., Frahani, K. A., & Ghorbanpour, M. (2013). PRESENTATION OF BROOKLIME (VERONICA BECCABUNGA L. SSP. ABSCONDITA M.A. FISCHER) AS A NEW HYPERACCUMULATOR OF LEAD AND CADMIUM. Trakia Journal of Sciences, 11(1), 60–65. http://www.uni-sz.bg; Kaštovská, E., & Šantrůčková, H. (2011). Comparison of uptake of different N forms by soil microorganisms and two wet-grassland plants: A pot study. Soil Biology and Biochemistry, 43(6), 1285–1291. https://doi.org/10.1016/J.SOILBIO.2011.02.021; Liu, X., Wang, B., & Su, Z. (2014). Enhanced adsorptive removal of methylene blue from aqueous solution by soft rush (Juncus effusus). Desalination and Water Treatment, 57(4), 1671–1683. https://doi.org/10.1080/19443994.2014.975284; Matthews, D. J., Moran, B. M., & Otte, M. L. (2004). Zinc tolerance, uptake, accumulation and distribution in plants and protoplasts of five European populations of the wetland grass Glyceria fluitans. Wetlands, 24, 859–869. https://doi.org/10.1016/j.aquabot.2004.06.002; Menon, R., & Holland, M. M. (2013). Phosphorus Retention in Constructed Wetlands Vegetated with Juncus effusus, Carex lurida, and Dichanthelium acuminatum var. acuminatum. Water, Air, and Soil Pollution, 224(7), 1–11. https://doi.org/10.1007/S11270-013-1602-5/TABLES/2; Peng, Y., Chen, J., Wei, H., Li, S., Jin, T., & Yang, R. (2018). Distribution and transfer of potentially toxic metal(loid)s in Juncus effusus from the indigenous zinc smelting area, northwest region of Guizhou Province, China. Ecotoxicology and Environmental Safety, 152, 24–32. https://doi.org/10.1016/J.ECOENV.2018.01.026; Petrov, D. S., Korotaeva, A. E., Pashkevich, M. A., & Chukaeva, M. A. (2022). Assessment of heavy metal accumulation potential of aquatic plants for bioindication and bioremediation of aquatic environment. Environmental Monitoring and Assessment, 195(1), 122. https://doi.org/10.1007/s10661-022-10750-0; Schück, M. (2022). Floating treatment wetlands for stormwater management : Plant species selection and influence of external factors for heavy metal and chloride removal in a cold climate (PhD dissertation, Department of Ecology, Environment and Plant sciences, Stockholm University). Retrieved from http://urn.kb.se/resolve?urn=urn:nbn:se:su:diva-208147; Vaněk, T., Moťková, K., & Podlipná, R. (2016). Accumulation of cadmium by halophytic and non-halophytic Juncus species. Theoretical and Experimental Plant Physiology, 28(4), 415–423. https://doi.org/10.1007/s40626-016-0078-2; Weryszko-Chmielewska, E. (2014). THE ANATOMY AND ULTRASTRUCTURE OF THE NECTARIES AND OSMOPHORES OF WATER FORGET-ME-NOT (MYOSOTIS SCORPIOIDES L.). Modern Phytomorphology, 6, 51–51. https://www.phytomorphology.com/articles/the-anatomy-and-ultrastructure-of-the-nectaries-and-osmophores-of-water-forgetmenot-myosotis-scorpioides-l.pdf; Wiessner, A., Kappelmeyer, U., Kaestner, M., Schultze-Nobre, L., & Kuschk, P. (2013). Response of ammonium removal to growth and transpiration of Juncus effusus during the treatment of artificial sewage in laboratory-scale wetlands. Water Research, 47(13), 4265–4273. https://doi.org/10.1016/J.WATRES.2013.04.045; Zanin, G., Bortolini, L., & Borin, M. (2018). Assessing Stormwater Nutrient and Heavy Metal Plant Uptake in an Experimental Bioretention Pond. Land, 7(4). https://doi.org/10.3390/land7040150; Zhang, Y., Lv, T., Carvalho, P. N., Arias, C. A., Chen, Z., & Brix, H. (2016). Removal of the pharmaceuticals ibuprofen and iohexol by four wetland plant species in hydroponic culture: plant uptake and microbial degradation. Environmental Science and Pollution Research, 23(3), 2890–2898. https://doi.org/10.1007/S11356-015-5552-X/FIGURES/4

## References in section above:

Mitsch W J, Zhang L, Waletzko E, et al. (2014). Validation of the ecosystem services of created wetlands: two decades of plant succession, nutrient retention, and carbon sequestration in experimental riverine marshes[J]. *Ecological engineering*, 72: 11-24.

## Characteristics of wetland substrate

The wetland substrate is a soil replacement material that is produced by LECA (www.leca.co.uk); it is classed as a lightweight, expanded clay aggregate which has a low density and high strength which is designed for use in wet environments where a traditional soil-based substrate would quickly be washed away.

Biomatrix provided technical aspects of the substrate that included toxicity of the substrate to; Rainbow Trout *(Oncorhynchus mykiss),* Freshwater bacteria and Cyanobacteria, Water fleas (*Daphnia sp.).* Concentrations of oxidisable sulphides and water-soluble sulphur were also provided.

## Heavy metals in the wetland substrate

Metals were analysed in the wetland substrate supplied from Biomatrix the manufacturer of the floating wetlands. Substrate was dried and ground to a fine powder using a pestle and mortar and underwent the same acid digestion process as the sediment samples, at the Scottish Universities Environmental Research Centre (see section 3.2.5 and Appendix B for methodology). Results are shown in Table 13 and values exceeding CLEA Soil Guideline Values are highlighted in yellow (Environment Agency, 2009). The following elements were present in the substrate in higher concentrations than in the basin sediments; Arsenic, Aluminium, Barium, Calcium, Cobalt, Copper, Manganese, Molybdenum. Arsenic can be detrimental to plant growth. However, Aluminium, Copper, Molybdenum are essential metals required by plants. Highly toxic metals; Lead, Cadmium, Chromium, and Vanadium were present in low concentrations in the substrate; which is a strong contrast to the sediment samples in the Canting Basin which had very high concentrations of Chromium and Lead (see Section 3.2.5). Further analysis of the material is recommended to examine the plant availability of all elements present in the substrate.

*Table 13. Summary of heavy metal concentrations in the wetland substrate*

| | | Concentration in Substrate | | | Concentration in Substrate |
|---|---|---|---|---|---|
| **Al** | ppm | 152636 | **Mn** | ppm | 7682 |
| | *RSD%* | *0.82* | | *RSD%* | *0.46* |
| **Ca** | ppm | 199604 | **Mo** | ppm | 31.79 |
| | *RSD%* | *0.29* | | *RSD%* | *0.75* |
| **Fe** | ppm | 106628 | **Nb** | ppm | 1.68 |
| | *RSD%* | *0.48* | | *RSD%* | *2.14* |
| **K** | ppm | 9782 | **Ni** | ppm | 255 |
| | *RSD%* | *1.47* | | *RSD%* | *0.67* |
| **Mg** | ppm | 35980 | **P** | ppm | 1182 |
| | *RSD%* | *0.61* | | *RSD%* | *1.12* |
| **Na** | ppm | 4443 | **Pb** | ppm | 19.19 |
| | *RSD%* | *0.53* | | *RSD%* | *1.16* |
| **Ti** | ppm | 3168 | **Rb** | ppm | 36 |
| | *RSD%* | *0.72* | | *RSD%* | *0.40* |
| **As** | ppm | 114.86 | **Sc** | ppm | 15 |
| | RSD% | 0.65 | | *RSD%* | *0.44* |

| | | | | | |
|---|---|---|---|---|---|
| **Ba** | ppm | 2739 | **Sb** | ppm | 7.30 |
| | *RSD%* | *0.38* | | *RSD%* | *1.60* |
| **Cd** | ppm | 0.29 | **Sn** | ppm | 20.06 |
| | *RSD%* | *6.04* | | *RSD%* | *0.65* |
| **Co** | ppm | 170 | **Sr** | ppm | 263 |
| | *RSD%* | *0.42* | | *RSD%* | *0.28* |
| **Cr** | ppm | 68 | **V** | ppm | 150 |
| | *RSD%* | *0.88* | | *RSD%* | *0.99* |
| **Cu** | ppm | 351 | **Y** | ppm | 40.96 |
| | *RSD%* | *0.87* | | *RSD%* | *1.05* |
| | | | **Zn** | ppm | 232 |
| | | | | *RSD%* | *2.25* |
| | | | **Zr** | ppm | 62.89 |
| | | | | *RSD%* | *0.67* |

# Appendices

This section describes the methodological statements used to obtain the results of the baseline monitoring of ecosystem services provided by the Canting Basin before the floating wetlands were installed, as reported above. Methodological statements are divided by the ecosystem service types that were assessed during this baseline monitoring period (supporting, regulating and cultural), and subdivided by the components that make up these ecosystem services. These methodologies are referenced throughout the report above to support the results. The rationale for these methods are outlined in the long-term monitoring plan report (Fowler et al. 2023).

# Appendix A. Supporting Services

The methodologies used to assess the supporting services provided by the Canting Basin and surrounding area are standard methods used throughout the field of ecology. This mainly focuses on the habitat provided by the area, and the ecosystems it supports, including biodiversity.

## Habitat

Habitat is characterised by broadly following the methods of an extended Phase 1 habitat survey (JNCC, 2010) of the Canting Basin and areas of the immediate vicinity (within 20 m of the basin edge) which were publicly available during the baseline monitoring period. A Phase 1 habitat survey (Gow, 2020) was commissioned by Glasgow Science Centre in 2020, and permission was granted to use the findings to supplement the habitat assessment conducted during the baseline monitoring period. These secondary data improved the habitat assessment as well as the species assessments undertaken in this baseline study.

## Secondary data

Pre-constructed datasets were identified and used to enhance our primary data collected before the Floating Wetlands were installed on the 07/03/23. These include monthly data on the winter bird species present in the study area and wider area of Glasgow between October 2022 and March 2023 (Baker, 2023). The NBN Atlas (NBN Atlas, 2023) was used to search for biological records of fish and bats in the Canting Basin by searching for records within a 0.5km radius; no fish records were returned within these parameters, so the search radius was widened to 2km to explore fish species that may travel in and around the study site. The Phase 1 habitat survey (Gow, 2020) commissioned by Glasgow Science Centre in 2020, provided data on ecological surveys to help contextualise the results of primary data collected by this project during winter 2023 baseline monitoring period.

## Visual Bird Survey

We conducted visual bird surveys once a week between 17/02/23 and 03/03/23. These surveys are based on the methodology used by the British Trust for Ornithology for their Wetland Bird Survey (Bibby et al., 2000). We recorded the species of birds present on site (excluding feral pigeons); the locations of birds on site, including any structures being utilised (Canting Basin; Railings; Buoys; Sea Plane Jetty; River Clyde); and the number of individuals of each species at each location.

All birds were recorded from the side of the basin using binoculars (Eyeskey 8x42), moving around as needed to record all birds; a secondary location at the entrance of the basin was used to record birds in the River Clyde nearby the Canting Basin (Figure 2B main report). Surveys started at approximately 9am to coincide with peak activity levels and continued until all birds on site had been recorded (usually approximately 30 minutes), taking care not to double count birds whilst moving around the area.

## Visual Bat Survey

A bat survey was conducted from the side of the Canting Basin on 02/03/23 (Figure 2). This survey method was based on the methodology used by the Bat Conservation Trust (Collins, 2016). To capture the peak activity of bats, the survey started at sunset and commenced one hour after sunset. A heterodyne bat detector (Magenta Bat 5) was used to identify species presence using call frequency, and the number of passes of each species was counted, either through visual sighting of the bat or through the audible feedback of an echolocation call from the bat detector. The heterodyne bat detector was set at a frequency of approximately 50 kHz and tuned to identify species if calls were detected. Surveys using a bat detector are able to identify bats in the area using echolocation for movement and foraging.

## Camera Trap Survey

Camera traps (Gosira and HC-810a) were positioned to view the moat and the sea plane jetty (Figure 10A-B, respectively) to record activity of wildlife in the area, particularly waterfowl and aquatic mammals. These locations were chosen based on visual observations of wildlife use of the site, and to cover the different habitat types. The camera traps were configured to capture an image once an hour to gain an understanding of species using the space across the course of the day. The camera traps were active in the 12 days before the installation of the floating wetlands (7th March 2023) to get a 'snapshot' of the wildlife activity in the area.

Three hundred and twenty-two images were captured of the sea plane jetty, and 18 images were captured of the moat. The camera trap footage was reviewed manually, and any animals present in the footage were identified to species level where image quality allowed. Malfunction of one camera trap led to a significant reduction in data for the moat area; no animals were captured in images (n=18) from this camera trap. There is a possibility for further analysis of the footage to include species abundances and behaviours, including how use of the area changes throughout the day and between weekdays and weekends.

*Figure 10A-B. Locations and set-up of the recording equipment: camera traps and acoustic recorder where: A) shows the camera trap targeting the sea plane jetty, and B) shows the camera trap and acoustic recorder targeting the moat.*

## Acoustic Recorder Survey

We placed an acoustic recorder (Song Meter Mini) in the moat next to the Canting Basin (Figure 2 and Figure 10) to capture the activity of birds in the area by analysing recordings of calls and songs. The acoustic recorder was configured to record at the pre-set bird frequency range for one hour at sunrise to record when the birds are most active, and 15 minutes of every hour for the rest of the day to gain an understanding of how species composition of the area changes throughout the day. The acoustic recorders were active in the 12 days before the installation of the floating wetlands to get a 'snapshot' of the wildlife activity in the area.

*5,010 minutes of acoustic recordings were collected across a 13 day period, and a subset one 60 minute period at dawn was analysed for species presence around the moat during the dawn chorus (*

). Species presence was recorded manually by identifying bird calls and songs captured in the recording. Further analysis is possible for a future updated baseline report (Table 2).

## Invertebrate Survey

Surveys of aquatic invertebrates were not undertaken prior to the floating wetland installation. This is due to the known seasonal shifts in invertebrate community composition and structure. During winter months many aquatic invertebrates are relatively inactive due to reduced water temperatures, others may exist in dormant pupae or egg stages of their life cycle, whilst some adult life stages migrate to terrestrial habitats to seek refuge. It may be possible to gather other secondary sources of data such as Clyde River Foundation CRIMP data on macroinvertebrates in the Clyde Catchment with further resources to support a more intensive assessment of pre-constructed datasets in the future.

## References for Supporting Ecosystem Services Methodological Statements


Baker, P. (2023), *Black-headed gull survey,* Unpublished dataset.

Bibby, C., Burgess, N., Hill, D. and Mustoe, S. (2000), *Bird Census Techniques*, 2nd ed., Academic Press

Biological Records Centre (2023). *Database for the Atlas of Freshwater Fishes*. Occurrence dataset on the NBN Atlas. NBN Atlas occurrence download at NBN Atlas accessed on Wed Mar 29 15:29:27 UTC 2023. https://doi.org/10.15468/3wfao2. These data have not been changed and are available under a CC-BY data license: https://creativecommons.org/licenses/by/4.0/.

Collins, J. (2016), *Bat Surveys for Professional Ecologists: Good Practice Guide*, 3rd ed., The Bat Conservation Trust, London.

Fowler, E, Woolfenden, C, Kaplan, A, Gill, A, Lacsny, A, Curley, E, Naylor, LA, McGregor, A, Bailey, D, Bass, A, Gauchotte-Lindsay, C, Li, Y, Moreau, M, Moreau, J, Nager, RG, White, S, Olive, V, Palmer, E, Prentice, T, Roberts, K, Slaymark, C, and Wang, Y. (2023). Glasgow's Floating Estuarine Wetlands Long-Term Ecosystem Services and Function Monitoring and Evaluation Plan. University of Glasgow. DOI: 10.36399/gla.pubs.295313

Gow, A. (2020) "Preliminary Ecological Appraisal (Confidential)" *ITPEnergised for Glasgow Science Centre*. Permission to cite this report given by Glasgow Science Centre.

JNCC (2010), "Handbook for Phase 1 habitat survey – a technique for environmental audit", *JNCC*, Peterborough, ISBN 0 86139 636 7.

National Bat Monitoring Programme (2023) *Sunset/Sunrise Survey, Bat Conservation Trust*. Occurrence dataset on the NBN Atlas. NBN Atlas occurrence download at NBN Atlas accessed on Wed Mar 29 14:50:42 UTC 2023. https://doi.org/10.15468/brmbw2. These data have not been changed and are available under an OGL data licence: https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/.

National Biodiversity Network (NBN) Trust (2023). *The National Biodiversity Network (NBN) Atlas*. https://ror.org/00mcxye41.

# Appendix B. Regulating Services

The methodologies used to examine the regulating services provided by the Canting Basin are standard methods reflected in corresponding fields of academic research. This analysis focused on composition and structure of the basin sediments in addition to the water quality, with an emphasis on the presence of particular nutrients and pollutants in the growing medium, as shown in Table 5. The findings from this analysis are presented in Section 3.2 above.

## 3.1 Field methods for water and sediment

Field methods outlined as these were standard for all water and sediment samples. Post-collection sample processing, laboratory analyses and interpretation of results varied by technique and are noted below. Background water properties were also measured *in-situ* in the field, both during sediment and water sampling for regulatory services assessment, and via continuous monitoring with the Aquatroll over a period of 26 days between 9$^{th}$ February and 20th March.  and then samples taken from field during site visit that was then processed separately

### *3..In-situ Water Quality*

A multiparameter probe was used in-situ to take readings of: Dissolved Oxygen (DO), pH, temperature and salinity. We took 5 readings on March 7$^{th}$ February within the area where the floating wetlands are to be installed shown in Table 5. Due to the weather that day being very windy and wet, turbidity was not measured in-situ and the multiparameter probe failed after a few readings were taken. Table 6 summarises these results (Table 14). However, an AquaTROLL was deployed on the jetty near where the wetlands were installed (Figure 2A), to take long term readings of DOC, pH, temperature, conductivity, and rugged dissolved oxygen (RDO), every 30 minutes over a 26-day period before the floating wetlands were installed. The AquaTROLL was collected on 20$^{th}$ March, with collected data processed and collated.

*Table 14. Summary of the limited results from the multiparameter probe before it malfunctioned in the inclement weather conditions during baseline sampling.*

| Time | Temperature (°C) | DO (mg/L) | Salinity (PSU) | pH |
|---|---|---|---|---|
| 11:52 | 6.1 | 11.81 | 0.34 | 7.56 |
| 12:08 | 5.9 | 11.49 | 0.32 | 7.63 |
| 12:21 | 6.1 | 11.48 | 0.34 | 7.55 |
| 12:28 | 6.1 | 11.33 | 0.34 | 7.45 |
| 12:34 | 6.1 | 11.22 | 0.34 | 7.46 |

### *3...Ex-situ sediment Water sampling in field for post-analysis in lab*

Two 1 litre water samples were taken from the sampling location (n=12) from where the wetlands are to be installed (Figure 2A) and one additional sample, sample 13 was collected from the confluence of the Canting Basin and the River Clyde (Figure 2B).

### *3... Sediment sampling for ex-situ lab analysis*

An Ekman grab sampler (3.5L volume) was used to retrieve sediment samples at each of the sampling locations in the basin (n=12), following the collection of a corresponding water sample. One additional sample, sample 13 was collected from the confluence of the Canting Basin and the River Clyde (Figure 2B). Once activated, the grab sample was recovered to the surface for examination, to ensure sufficient material was collected. Collected sediments were deposited in plastic zip-lock bags (0.5L volume), placed in a freezer on the day of collection and stored frozen for subsequent lab analysis.

### *3… Background water conditions.*

For the lab analysis of the water, a one litre bottle was collected and left unfiltered. This was used for analysis of nutrients in the water.

#### *3.1.1. Nutrients in Water*

Filtered water samples were prepared with Sulphuric acid to change the pH to 3.9 and kill organic matter off. The samples were analysed using a DOC analyser which had been calibrated to the standards. The samples were read three times.

A spectrolyser and a spectrophotometer both used unfiltered water samples to measure nutrients. The samples were first tested using a spectrolyser (Spectro::lyser V3 s::can) to measure nitrate and dissolved organic carbon (DOC). A Xml of unfiltered water was read by the spectrolyser and the readings were then calibrated using standard equations.

The spectrophotometer tested nitrate and phosphate. For the Phosphosphate the method used was USEPA PhosVer 3 (Ascorbic Acid) Method. This method uses PhosVer 3 Phosphate reagent powder pillow sample cells and 10ml of the unfiltered sample. The method follows standard procedures used for drinking water and wastewater, which can be found online from the Hach website. The nitrate was measured using the Cadmium Reduction Method using NitraVer 5 Nitrate Regent Powder Pollow and 10ml of the unfiltered samples. The method follows standard procedures used for drinking water and wastewater, which can be found online from the Hatch website.

#### *3.1.2. Grain size analysis*

Prior to grain size analysis organic matter was digested using hydrogen peroxide. Sediment samples were left overnight to ensure all the organic matter was digested. Sediment samples were then placed in a centrifuge at 2500 rpm for 10 minutes. This process from repeated three times to make sure organic matter was removed from the sediment. Sediment samples were left to completely dry out. Samples were then crushed and a small amount was mixed with water and Calgon. An appropriate quantity of the mixture was added to the grain size analyser (model: BetterSizer 2600).

#### 3.1.2.1 Metals in Water and Sediment

Water samples were prepared in the School of Geographical and Earth Sciences. Triplicate, 50ml samples were filtered through 0.45µm pre-combusted, glass fibre filters and acidified using concentrated Nitric Acid to 1% (v/v) in 50ml falcon tubes. Samples were stored at 4°C for no more than 1 week. Then the following elements were measured on an Agilent 5900 ICP-OES in the School of Geographical and Earth Sciences, University of Glasgow; Aluminium, Arsenic, Cadmium, Chromium, Copper, Iron, Manganese, Molybdenum, Nickel, Lead, Scandium and Zinc.

Sediment samples were freeze dried to remove water and prepared at the Scottish Universities Environmental Research Centre for metal analysis. Approximately 2g was weighed out for acid digestion using Agua Regia (50:50, HCl, $HNO_3$) and heated at 120°C on a hot plate for 4 hours to extract plant available metals from the sediment. Samples were filtered and stored in 5% $HNO_3$, ready for analysis. The following elements were measured on a Thermo-fisher iCAP 7000 ICP-MS; Aluminium, Calcium, Iron, Potassium, Magnesium, Sodium, Titanium, Barium, Manganese, Strontium and Zinc. An Agilent 7500ce ICP-OES was used to measure Cadmium, Cobalt, Chromium, Copper, Molybdenum, Niobium, Nickel, Phosphorus, Rubidium, Scandium, Antimony, Tin, Vanadium, Yttrium and Zirconium. Raw data is provided Table 15.

*Table 15. Raw data from analysis of metals in basin sediment samples. See Figure 2A for locations of the sampling points S1-S12 and Figure 2B for the location of the River Channel sample.*

| | | Sample location | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | S1 | S4 | S5 | S8 | S9 | S12 | Canting Basin Sediment Average | River Channel sample |
| **Al** | ppm | 52259 | 62416 | 48888 | 58124 | 52609 | 59558 | 55642 | 52220 |
| | *RSD%* | *8.96* | *0.36* | *0.38* | *0.28* | *0.23* | *0.15* | | *0.57* |
| **Ca** | ppm | 22125 | 23548 | 19830 | 21716 | 21011 | 22148 | 21805 | 21167 |
| | *RSD%* | *3.72* | *0.47* | *0.18* | *0.40* | *0.32* | *0.34* | | *0.16* |
| **Fe** | ppm | 162482 | 168968 | 152649 | 156929 | 159374 | 188939 | 160257 | 157185 |
| | *RSD%* | *9.05* | *0.13* | *0.88* | *0.50* | *0.26* | *0.10* | | *0.65* |
| **K** | ppm | 8649 | 9495 | 7899 | 9162 | 9163 | 6643 | 8801 | 7606 |
| | *RSD%* | *5.82* | *0.52* | *0.71* | *0.43* | *0.28* | *0.46* | | *0.40* |
| **Mg** | ppm | 36312 | 37607 | 32488 | 36054 | 34934 | 34552 | 35615 | 30323 |
| | *RSD%* | *15.08* | *0.03* | *0.66* | *0.22* | *0.35* | *0.08* | | *0.68* |
| **Na** | ppm | 60207 | 44742 | 51276 | 50348 | 61019 | 12415 | 51643 | 41803 |
| | *RSD%* | *1.53* | *0.35* | *0.61* | *0.34* | *0.31* | *0.25* | | *0.44* |
| **Ti** | ppm | 1288 | 1674 | 939 | 1401 | 1223 | 1071 | 1326 | 1135 |
| | *RSD%* | *13.08* | *0.41* | *0.60* | *0.13* | *0.33* | *0.18* | | *0.76* |
| **As** | ppm | 16.89 | 16.44 | 13.25 | 14.94 | 14.50 | 15.33 | 15.22 | 12.26 |
| | RSD% | 0.66 | 0.73 | 0.65 | 0.42 | 0.20 | 0.54 | | 0.61 |
| **Ba** | ppm | 318 | 588 | 94 | 232 | 116 | 974 | 387.07 | 766 |
| | *RSD%* | *0.22* | *0.18* | *1.09* | *0.41* | *0.16* | *0.17* | | *0.62* |
| **Cd** | ppm | 2.65 | 2.80 | 2.11 | 2.50 | 2.34 | 2.64 | 2.51 | 2.45 |
| | *RSD%* | *0.84* | *2.02* | *0.92* | *1.99* | *1.96* | *0.90* | | *1.28* |
| **Co** | ppm | 39 | 46 | 30 | 40 | 36 | 41 | 38.58 | 51 |
| | *RSD%* | *1.00* | *0.68* | *1.10* | *0.22* | *1.13* | *0.45* | | *0.53* |
| **Cr** | ppm | 486 | 507 | 377 | 455 | 424 | 456 | 450.99 | 327 |
| | *RSD%* | *0.43* | *0.25* | *0.60* | *0.15* | *0.75* | *0.38* | | *0.40* |
| **Cu** | ppm | 210 | 226 | 165 | 199 | 186 | 202 | 198.15 | 166 |
| | *RSD%* | *0.29* | *0.30* | *0.21* | *0.89* | *1.15* | *0.66* | | *0.49* |
| **Mn** | ppm | 2086 | 2114 | 1907 | 2060 | 2074 | 2768 | 2168.11 | 3724 |
| | *RSD%* | *0.26* | *0.21* | *0.61* | *0.34* | *0.38* | *0.27* | | *0.86* |
| **Mo** | ppm | 7.64 | 7.93 | 5.96 | 6.17 | 6.51 | 4.61 | 6.47 | 5.20 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *RSD%* | *0.71* | *0.52* | *0.57* | *0.47* | *0.53* | *0.55* | | *1.06* |
| **Nb** | ppm | 4.00 | 4.86 | 3.56 | 4.44 | 3.96 | 3.55 | 4.06 | 3.88 |
| | *RSD%* | *0.61* | *0.38* | *0.37* | *0.92* | *0.27* | *0.54* | | *0.15* |
| **Ni** | ppm | 94 | 114 | 72 | 100 | 85 | 97 | 93.72 | 112 |
| | *RSD%* | *0.57* | *0.44* | *0.49* | *0.88* | *0.90* | *0.47* | | *0.84* |
| **P** | ppm | 5338 | 4587 | 3374 | 4913 | 4952 | 6962 | 5021.11 | 4124 |
| | *RSD%* | *0.59* | *0.18* | *1.11* | *0.35* | *1.01* | *1.33* | | *0.35* |
| **Pb** | ppm | 171.67 | 190.85 | 152.24 | 171.54 | 160.61 | 197.20 | 174.02 | 183.43 |
| | *RSD%* | *0.50* | *0.72* | *0.64* | *0.34* | *0.56* | *0.63* | | *0.76* |
| **Rb** | ppm | 32 | 42 | 23 | 36 | 31 | 34 | 33.14 | 35 |
| | *RSD%* | *1.07* | *0.35* | *0.39* | *0.30* | *0.35* | *0.19* | | *0.86* |
| **Sc** | ppm | 13 | 16 | 10 | 14 | 13 | 12 | 13.06 | 13 |
| | *RSD%* | *0.44* | *0.79* | *1.21* | *0.53* | *0.79* | *0.11* | | *0.24* |
| **Sb** | ppm | 14.02 | 15.37 | 9.33 | 13.20 | 11.07 | 12.86 | 12.64 | 8.54 |
| | *RSD%* | *0.21* | *0.16* | *0.34* | *0.77* | *0.13* | *0.42* | | *0.42* |
| **Sn** | ppm | 34.25 | 36.67 | 28.37 | 32.87 | 31.39 | 34.27 | 32.97 | 28.05 |
| | *RSD%* | *0.78* | *0.42* | *0.19* | *0.39* | *0.91* | *0.59* | | *0.53* |
| **Sr** | ppm | 427 | 441 | 392 | 418 | 411 | 402 | 415.03 | 325 |
| | *RSD%* | *0.06* | *0.49* | *0.66* | *0.15* | *0.20* | *0.36* | | *0.47* |
| **V** | ppm | 140 | 167 | 108 | 147 | 128 | 139 | 138.02 | and |
| | *RSD%* | *0.86* | *0.06* | *0.41* | *0.43* | *0.27* | *0.50* | | *0.31* |
| **Y** | ppm | 32.46 | 38.21 | 26.85 | 33.63 | 30.22 | 35.35 | 32.79 | 35.16 |
| | *RSD%* | *0.73* | *0.48* | *0.12* | *0.28* | *0.54* | *0.19* | | *0.79* |
| **Zn** | ppm | 1310 | 1373 | 1208 | 1254 | 1220 | 1476 | 1307.01 | 1290 |
| | *RSD%* | *0.21* | *0.27* | *0.41* | *0.43* | *0.19* | *0.14* | | *0.77* |
| **Zr** | ppm | 4.19 | 4.42 | 5.22 | 3.92 | 4.21 | 3.26 | 4.20 | 2.58 |
| | *RSD%* | *0.79* | *0.51* | *0.49* | *0.51* | *0.75* | *0.54* | | *0.75* |

#### 3.1.2.2. Microplastics in sediments

Microplastics (MPs) loads will be assessed in the sediment samples- the transient nature of the water means that MP load in grab samples will not be indicative of contamination or its retention. Analysis sediments will allow us understanding whether the wetland influence the sedimentation of microplastics. As preliminary work, MPs smaller than 2.8mm were assessed with no further size fractionation. Total particle count will be produced not identification of type of plastic.

Samples are oven dried at 105C for 24h and mass of total solids in gram is calculated for weight of dried samples. Oven dried samples are sieved into 2.8mmm for 10 minutes using an automatic shaker. The 2.8mm fraction is mixed with enough Nile Red spiked NaCl solution to cover, manually shaken vigorously for 1min and left to settle overnight. The supernatant is filtered through 11micrometer cellulose filters in a Buchner Filter; filter papers are rinsed with DI water and transferred to petri dishes and dried at room temperature. Throughout the process, a white lab coat (65% polyester, 35% cotton) and rubber gloves were used and care was taken to minimise sample contamination by avoiding the use of plastic materials where possible. As the laboratory is a busy environment and it is difficult to control contamination from nearby activities, blanks were used to account for background contamination.

MPs smaller than 2.8mm are identified as being stained by the Nile Red and counted under the microscope. This final step of the analysis could not be completed within the tight project timeline and quantification is ongoing.

#### 3.1.2.3. Pharmaceuticals in water and sediment

Pharmaceuticals and emerging contaminants load will be assessed in water samples, this will allow to evaluate whether they are of relevance to the river health.

Samples were filtered at 0.7micrometer and kept at 4C before analysis. Samples will be analysed by direct injection into an LC-MS-MS (liquid chromatography coupled to mass spectrometry) without further processing for circa 160 compounds. This analysis is on-going.

# Appendix C Social and Cultural Ecosystem Services

The social research for this project focussed on exploring cultural ecosystem services of the floating wetlands at the Canting Basin. This focussed on analysing approaches to and engagement with blue space in relation to tourism, recreation, health and wellbeing, creativity and art, and science and education. A timeline of the social research is shown below in

*Figure 11*.

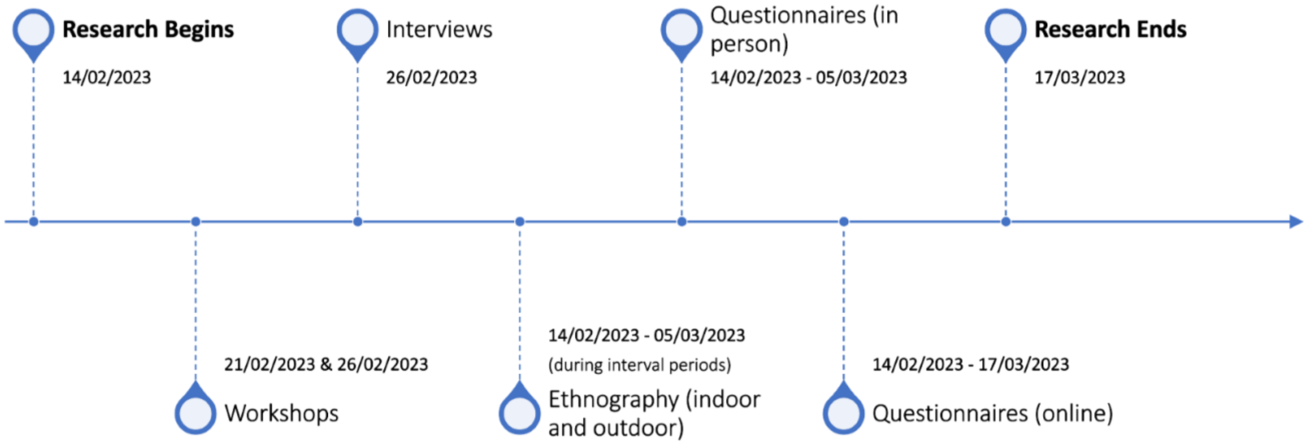



*Figure 11. Shows a timeline of the social research, including details of how much time was spent carrying out each method.*

## Ethnography

We conducted autoethnographic and ethnographic research to detail the researchers' experiences of the basin, pre-and post-installation of the floating wetlands. Once-weekly visits to the Clyde basin were undertaken by the research group in pairs and insights were recorded in fieldwork diaries. Visits were carried out at varying times on Fridays, and observations taken at multiple different areas (Figure 2B), inside and outside Glasgow Science Centre.

## Questionnaires

A baseline survey was designed in collaboration with Glasgow Science Centre aimed at providing Glasgow Science Centre visitors and members of the public with an opportunity to share their views of the River Clyde Basin and general urban greening objectives prior to floating wetland installation. The survey was split into four sections:

1. Perceptions and use of the space
2. Opinions on the design visualisations of the floating wetlands
3. Looking to the future of urban greening objectives in the River Clyde Basin
4. Participant Demographics (optional section)

A total of 56 responses were collected from participants both online and in-person at Glasgow Science Centre workshop sessions.

## Workshops

Workshops were conducted with members of the community groups working with Glasgow Science Centre, such as Gilded Lily and Hidden Gardens. Workshops were hosted by Glasgow Science Centre in their Bothy and each session worked with between 10 – 20 participants. The aim of the workshops was to involve the community groups in the floating wetlands project, designed to provide the community groups with contextual information about the project, as well as give them the opportunity to work on creative representations to be used in the space.

### Social and Cultural Services References


Couper, P.R. (2017) 'The embodied spatialities of being in nature: encountering the nature/culture binary in green/blue spaces'. *Cultural Geographies*, Vol. 25, No. 2, pp. 285 – 299. Available online at: https://doi.org/10.1177/1474474017732978

Hosaka, T., Sugimoto, K., and Numata, S. (2017) 'Childhood experience of nature influences the willingness to coexist with biodiversity in cities'. *Palgrave Communication,* Vol. 3.

Jo, T., Sato, M., Minamoto, T., Ushimaru, A. (2022) 'Valuing the cultural services from urban blue-space ecosystems in Japanese megacities during the COVID-19 pandemic'. *People and Nature*, Vol. 4, No. 5, pp. 1176 -1189. Available at: https://besjournals.onlinelibrary.wiley.com/doi/full/10.1002/pan3.10366

Naylor, L. A., Kippen, H., Coombes, M. A., Horton, B., MacArthur, M. and Jackson, N. (2017) Greening the Grey: A Framework for Integrated Green Grey Infrastructure (IGGI). Technical Report. University of Glasgow, Glasgow. Available online at: https://eprints.gla.ac.uk/150672/ [Date Accessed: 10/03/2023].

Poulsen, M.N., Nordberg, C.M., Fiedler, A., DeWalle, J., Mercer, D., Schwartz, B.S. (2022) 'Factors associated with visiting freshwater blue space: The role of restoration and relations with mental health and well-being'. *Landscape and Urban Planning*, Vol. 217. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0169204621002450

Smith, N., Georgiou, M., King, C. A., Tieges, S., Chastin, S (2022) 'Factors influencing usage of urban blue spaces: A systems-based approach to identify leverage points'. *Health & Place,* Vol. 73, DOI: https://doi.org/10.1016/j.healthplace.2021.102735

White, M.P., Elliott, L.R., Grellier, J., Economou, T., Bell, S., Braman, G.N., Cirach, M., Gascon, M., Lima, M.L., Lohmus, M., Nieuwenhuijsen, M., Ojala, A., Roiko, A., Schults, P.W., van den Bosch, M., and Fleming, L.E. (2021) 'Associations between green/blue spaces and mental health across 18 countries'. *Scientific Reports,* Vol.11, No. 8903. Available at: https://www.nature.com/articles/s41598-021-87675-0

White, M.P., Elliott, L.R., Gascon, M., Roberts, B., Fleming, L.E. (2020) 'Blue space, health, and wellbeing: A narrative overview and synthesis of potential benefits'. *Environmental Research*, Vol. 191. Available at: https://www.sciencedirect.com/science/article/pii/S0013935120310665