SuDS in Schools

Monitoring Report

south
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rivers
trust

Contents

Introduction

The SuDS in Sutton's Schools (SiSS) Project is a partnership project between the London Borough of Sutton and the South East Rivers Trust, funded by Thames Rivers Trust and the Environment Agency. The primary aim of the project is to alleviate flood risk within Sutton by retrofitting Sustainable Drainage Solutions (SuDS) on school grounds.

In a series of summative reports, the Trust aims to share the expertise and lessons learnt through the various contributions the organisation made to the project; supporting other SuDS in School initiatives in the future.

1. **SuDS Planter Design**
2. **SuDS Planter Installation**
3. **Rain Garden**
4. **Education & Engagement**
5. **Monitoring**

All reports can be found and downloaded from the South East Rivers Trust website:
www.southeastriverstrust.org/sudsinschools/

Information on the future of the SiSS Project can be found on Sutton Council's website here:
https://www.sutton.gov.uk/info/200670/environmental_sustainability/2028/suds_in_sutton_schools

Monitoring Programme

A number of monitoring plans were produced throughout the life of the SiSS Project as the SuDS proposals evolved. A brief overview of the monitoring plans not executed is provided in Appendix 1 and may provide useful information for future initiatives.

The final monitoring programme was developed to quantify the performance of the SERT SuDS planters, thereby increasing the Trust's knowledge and understanding of the range of benefits they provide. The data would contribute to the wider National evidence based for the effectiveness of SuDS.

SuDS planters can have a number of benefits including:

- Water quality improvement
- Improved amenity and mental health benefits
- Educational benefits
- Flood attenuation.

Water Quality: Whilst a level of water quality monitoring could feasibly be carried out, it was considered that the benefits of these SuDS planters to water quality would be limited simply due to the expected low level of contamination in water from roofs. This is not to say that monitoring the impacts of SuDS planters on water quality would not be of value in other circumstances.

Education and Amenity: Significant efforts were made during the design process to ensure the planters were adding value for schools including incorporating staff and pupil input to designs. For further information on this process, see the **Education and Engagement Report** and for details of the resulting designs see the **SuDS Planter Design Report**.

While there is no effective way of measuring the success of the final designs in providing education and amenity benefits, a clear link is evident between the input received and the features installed. This has also been supported through feedback from staff and responses from pupils.

"I really enjoy looking out at the flowers and wildlife while I am working." – response to the planters from an office staff member from one of the schools.

Flood Attenuation: SuDS planters have the ability to attenuate flooding by temporarily storing runoff from roofs and releasing it slowly into the surface water drainage network. This is in contrast to it travelling rapidly into the drainage network via downpipes. However, our understanding of how effectively the SuDS planters do this, and therefore their impact on flood risk, is limited.

The **SuDS Planter Design Report** describes the use of two types of material for the SuDS planter storage layer; 20 mm gravel and geo-cellular crates. The geo-cellular crates provide a greater volume of storage for water than gravel and therefore have the potential to boost the attenuation of flooding. However, the crates are more expensive than gravel and it is important to understand the degree to which they improve the attenuation performance of planters. Gravels and geo-cellular crates have been estimated to cost £505 and £507 per 1 m^3 of storage volume provided, respectively.

Monitoring Aims and Objectives

Three Monitoring Aims were identified for the Trust:

Aim 1: Quantify the impact SuDS planter on the flow of water from roof to surface water drainage
Aim 2: Quantify the relative impact of different types of material used as a planter sub-base / storage layer
Aim 3: Quantify any change in infiltration rates over time

To achieve the above aims, the following monitoring objectives were set:

Objective 1: Formulate a scientifically robust methodology for measuring flow in and out of a SuDS planter
Objective 2: Successfully install monitoring on two planters with different storage media used
Objective 3: Through Objectives 1 and 2, quantify the flow rate of water going into and coming out of the two planters
Objective 4: Devise a low-cost approach to monitoring of infiltration rates.

Early on in the process it became apparent that there wasn't a single piece of monitoring equipment that could easily achieve the objectives. A number of companies specialising in monitoring were approached to enquire about available equipment to record the flow rate in and out of the SuDS planters. However, a minimum pipe size was a key limiting factor for direct flow measurement, with a minimum pipe diameter of 150 mm typically quoted. Such equipment was also found to be generally quite expensive.

Other, more cost-effective, flow rate monitoring equipment was limited by a maximum recordable flow rate or a lack of ability to log data i.e. limited to visual inspection of the real-time flow rate.

These limitations meant that direct measurement of flow rate was ruled out and other methods of recording flow rate were explored. Experience of monitoring other Natural Flood Management (NFM) projects helped identify a potentially viable option; the use of v-notch plates matched with water level loggers.

V-notches designed to specific standards allow the definition of a specific depth-flow relationship. This means that for any specific depth of water flowing over the v-notch (measured in mm), the rate of flow past that point (measured in l/s or m^3/s) can be calculated. Through use of level loggers, the water level upstream of the v-notch can be monitored and a flow rate derived at the time of each water level recording.

Discussion with a hydrology specialist indicated that the set-up of the v-notch and housing must comply with set standards in order to yield a reliable depth-flow relationship. Further details are provided below.

Installation of Monitoring

V-Notches

As flows in and out of the planter will be relatively small in flow measurement terms, no standard sized v-notch plates were available. This meant that a custom v-notch plate, designed to cope with very small flows, would need to be designed. The v-notch design was informed by reference to 'British Standard 3680: Part 4A: 1981. Methods of Measurement of Liquid Flow in Open Channels' and external expert advice on the use of v-notches for flow measurement. The final v-notch design is shown in Figure 1.

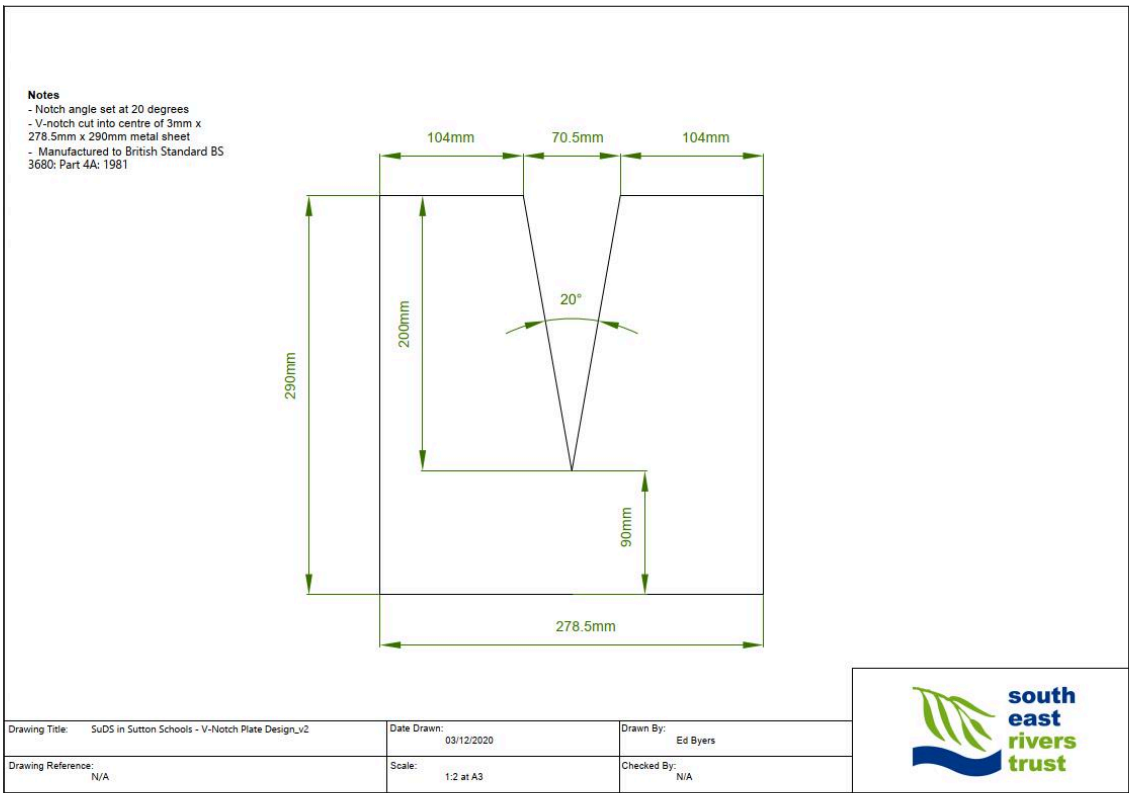

Figure 1. V-Notch Design

Once finalised, the designs were sent to a specialist to create the v-notch plates to British Standards. A local metal worker could be used to create the plates if provided with a specific design, however a company with experience in creating v-notch plates was used, as they are familiar with, and experienced in work to, the required British Standards. This ensured high quality standards in the v-notch manufacture.

It should be noted that even with the v-notch design optimised for low flows as much as feasible, if very low flows occur there is likely to be a higher level of uncertainty in the results.

To enable accurate water level readings and ensure that flow over the v-notch is as uniform as possible, there are specific requirements for the channel upstream of the v-notch relating to uniformity and length. In this case a box was used to house the v-notch and create an artificial and uniform 'channel' (see

Figure 2). This acts to still the flow from the downpipe (on the upstream end of the planter) and coming out of the planter (at the downstream end) before it flows over the v-notch. To ensure a reliable depth-flow relationship it was important to ensure the dimensions of the v-notch and housing were as close as possible to specifications set out in British Standard 3680: Part 4A: 1981.

Constructing a custom-made, waterproof, housing was considered to be beyond the scope and budget of the monitoring programme and therefore off-the-shelf water containers were adapted for use. This meant that some compromise had to be made in relation to the length of the box upstream of the v-notch. However, based on expert advice, this was not considered to be critical to the reliability of data outputs. To ensure this is the case, calibration of the v-notch plates should be carried out to verify the depth-flow relationship.

Level Loggers

Previous experience within SERT in using level loggers helped selection of appropriate equipment. Because the flows in and out of the planter are relatively small, changes in water depth above the v-notch will be small. This means that high accuracy in logging of the water level is important. For this reason vented, as opposed to non-vented (absolute), level loggers were employed. The equipment used has an accuracy of approximately 1.75 mm.

Calibration of V-Notches

Calibration of the v-notches was carried out to ensure that the v-notch set-up is creating a depth-flow relationship as expected. The process requires passing water over the v-notch whilst simultaneously recording the water level using a level logger, and the rate that the water flows out of the housing downstream of the loggers by filling a bucket. The measured rate at which the bucket fills can then be compared to the expected depth-flow relationship, which can be amended if the two vary.

Figure 2. V-notch housed in PVC box. The bottom right image shows the level logger and stilling to record water level.

Figure 3. Monitoring set-up following installation. The figure shows the monitoring boxes upstream and downstream of both plants; one with a gravel sub-base, one with a geo-cellular crate sub-base

Infiltration Testing

A simplified approach to infiltration testing was carried out on the trial planter at Denmark Road and subsequently at Carshalton High School for Girls to estimate infiltration rates for the selected soil mix. This provides information on how well the soil will allow water to infiltrate to the drainage layer of the SuDS planter, but also gives clues as to how well the soil is likely to support the plants.

The approach taken is based on guidance provided on the United States Department of Agriculture Natural Resources Conservation Service website (https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052494.pdf) and Vidacycle (https://soils.vidacycle.com/soil-tests/1-3-infiltration-rate/).

A 15 cm diameter plastic ring is pushed into the soil to a depth of approximately 1 cm to ensure water does not seep out of the sides. 450 ml of water is then poured into the ring, and the time taken for the water to disappear is recorded.

Results from testing carried out on the trial SuDS planter at Denmark Road indicated an infiltration rate of between 196 mm/hr and 234 mm/hr. The SuDS Manual states that the permeability of soil filter material should be 100-300 mm/hr. This suggested that the soil mix offered a suitable permeability and the same mix was subsequently used for future planters.

Results

The monitoring equipment could not be installed until the planters themselves were built and therefore data recording only started in January 2021. This still allowed time to capture a number of winter rainfall events. Data from the level loggers was downloaded on 24/02/2021.

However, there have been some issues with leaks associated with the planters and also the v-notch plates. In addition to this there have been a number of technical issues with the level loggers, requiring them to undergo a factory re-set.

These issues, whilst frustrating, are considered very much part of the learning process when establishing new and novel approaches to monitoring. Minor issues with leaks in the planters and v-notches have now been resolved. Additional site visits are required to carry out further testing of the loggers and if issues are not resolved they will need to be returned to the manufacturer for repair.

It is still hoped that the monitoring will be functional in time to capture data should intense summer convective storm events occur, and certainly in time for the winter of 2021/22.

Discussion

As outlined above, technical issues with the modelling have meant that no data is currently available for analysis and discussion as of March 2021. However, the monitoring is in its early stages and will be maintained to provide meaningful data. At this stage, the report will be updated.

Conclusion

The design report outlines the decisions made in designing the planters. These were made based on existing guidance and calculations. However, it is important to collect specific data to understand how measures perform, and the data collected will be invaluable in evaluating the performance of the planters over time.

Significant effort has been made to devise a scientifically rigorous approach to monitoring to ensure that the data is meaningful and reliable and it is hoped that this effort will pay off and contribute to our understanding of the benefits of SuDS planters.

Lessons Learned

Carrying out scientifically-rigorous monitoring can be both expensive and complex. The use of v-notches and level loggers offers a relatively low-cost option for monitoring flow at four locations (upstream and downstream of two separate planters) and following extensive research was found to be the best compromise between cost and obtaining reliable, accurate data.

However, the approach is still not cheap and may mean that other community-based schemes may not be able to afford such an approach. The process also required expert input which added to the cost of the monitoring. Cost and expertise are common issues for community-based Natural Flood Management and SuDS projects.

As stated above, there have been technical issues with the level loggers resulting in unreliable data. Work is currently being carried out to resolve the issues, but it highlights the complexity of setting up a reliable and monitoring regime.

It is envisaged that further lessons will be learnt from the monitoring as it progresses, both in terms of how to monitor small-scale SuDS and NFM projects, and also with regards to SuDS planter design, including a the most suitable and cost effective storage material.

Appendix 1: Monitoring Research

The aim of the monitoring was to assess the effectiveness of SuDS at the school-scale, for example incorporating features such as rain gardens, permeable paving, SuDS planters and other features. Draft monitoring schemes were developed, including a detailed draft monitoring plan, though issues such as project delays and sites being no longer incorporated in the SiSS Project made execution of an effective monitoring programme difficult. The decision was ultimately taken to monitor the SuDS planters installed by SERT. A brief overview of the monitoring plans not executed is provided below, before a detailed description of the final monitoring programme.

Biodiversity

The document: 'Building A Sustainable Sutton: Technical Guidance Note for Developers' provides guidance on how to carry out Biodiversity Accounting for a site to define enhancements to biodiversity. Within this, the Sutton Biodiversity Impact and Mitigation Calculator "provides a framework for considering impacts in a consistent and transparent way."

To determine the biodiversity gains you need to first identify what type of habitat is being evaluated. Then the condition of this habitat needs to be identified. These factors can be assigned a value to establish a score for an area of green space. As well as providing a consistent methodology, this approach also encourages detailed thought to be put in to what new habitat will be provided in order to maximise the biodiversity benefit.

The Green Space Factor can also be calculated for development to demonstrate that overall area of green space is increased as a result of development.

Rainfall and Flow

A monitoring plan focusing on recording rainfall and also flow leaving the site was developed for one school. The proposed monitoring included placing a rain gauge on site, and also using available EA rainfall monitoring to quantify the volume of rain falling on the site (the input). To measure flow leaving the site (output) it was proposed to combine a pressure transducer measuring water level with a v-notch plate. This approach allows flow to be monitored on pipes as small as roughly 150mm in diameter.

A site visit with a monitoring specialist was carried out to maximise the effectiveness of the monitoring scheme. However, the site visit indicated that the majority of drainage on the site flowed into soakaways. This information was passed onto the wider SiSS team and was later confirmed. This meant that SuDS would not be effective on the site, as surface water does not enter the Thames Water sewer network, or flow overland and therefore does not contribute to flooding in the area. For this reason, the draft monitoring plan was not taken forward.

Water Level

The use of water level loggers (pressure transducers) to monitor water levels and therefore storage in SuDS features was explored for a number of sites, such as rain gardens. The possibility of use within geocellular storage was also investigated though discussion with the designers and contractors delivering the works would need to be carried out to see if this was a viable option. Due to delays in on-the-ground delivery of the SiSS Project, these options were not developed further. The decision was made to focus on monitoring of SuDS planters delivered by SERT.

Water Quality

SuDS have great benefit to provide water quality treatment of surface water runoff, particularly when employed as part of a SuDS ‘treatment train’. Therefore, it would be advantageous to be able to monitor the impact of the proposed SuDS on water quality.

One suggested method was to carry out testing of soils within rain planters or rain gardens upon installation and then again after a period of time has passed to investigate the build-up of pollutants within the soil. However, it was thought the level of pollution coming off building roofs is likely to be limited. There may be more opportunity to pick up a pollution ‘signal’ from areas of car parking for the wider SiSS Project. For the SuDS planters, it was considered a priority to monitor their impact on slowing the flow rather than water quality.

Timelapse Cameras and Photo Posts

Timelapse cameras and photo posts – which allow the taking of photographs from the same vantage point over periods of time – were considered for appropriate SuDS features, particularly rain gardens. Images or film showing the rise and fall of stored water during rainfall events and change in vegetation with the seasons can be a useful engagement tool.

It was felt that footage would not work well with SuDS planters and therefore this monitoring option has not been employed, though it could still be considered for the wider SiSS Project.

Acknowledgements

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