**WIMBORNE MODEL TOWN DEVELOPMENT**

**STATEMENT OF REQUIREMENTS**

**FOR THE MOBILE RIVER SYSTEM VISITOR AND STAFF GUI**

**Issue 1.4**

**26th February 2021**



This work is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. To view a copy of this license, visit http://creativecommons.org/licenses/by-nc-sa/4.0/.

**Table of Contents**

[1 INTRODUCTION 4](#__RefHeading___Toc121_2006520353)

[1.1 Hamish McIntyre-Bhatty’s Open University Project 4](#__RefHeading___Toc3119_360444017)

[1.2 BACKGROUND TO THE REQUIREMENTS 5](#__RefHeading___Toc2543_437433743)

[1.3 Related Documents 5](#__RefHeading___Toc8687_2015128553)

[1.4 Related Tools 5](#__RefHeading___Toc1186_2817788786)

[1.5 Definitions 6](#__RefHeading___Toc8000_461351655)

[2 HARDWARE CONFIGURATION 7](#__RefHeading___Toc2547_437433743)

[2.1.1 Main River Circulation 7](#__RefHeading___Toc1188_2817788786)

[2.1.2 Water Collection 7](#__RefHeading___Toc1190_2817788786)

[2.1.3 Raspberry Pi Computer 8](#__RefHeading___Toc1724_458794259)

[2.1.4 NAS Box 8](#__RefHeading___Toc3582_151679121)

[2.1.5 Display Specifications (Desktop GUI) 8](#__RefHeading___Toc1696_4124242437)

[2.1.6 Device Specifications (Mobile GUI) 9](#__RefHeading___Toc3584_151679121)

[3 GENERAL REQUIREMENTS 10](#__RefHeading___Toc1192_2817788786)

[3.1 Software Environment 10](#__RefHeading___Toc8002_461351655)

[3.1.1 Visitor and Staff GUIs 10](#__RefHeading___Toc1659_163027149)

[3.1.2 Operating System 10](#__RefHeading___Toc1661_163027149)

[3.1.2.1 Development 10](#__RefHeading___Toc1663_163027149)

[3.1.2.2 Deployment 10](#__RefHeading___Toc1665_163027149)

[3.1.3 Copyright 10](#__RefHeading___Toc1667_163027149)

[3.2 Communications 11](#__RefHeading___Toc8004_461351655)

[3.2.1 Medium and Protocols 11](#__RefHeading___Toc1194_2817788786)

[3.2.2 Methodology 11](#__RefHeading___Toc1196_2817788786)

[4 FUNCTIONAL REQUIREMENTS 12](#__RefHeading___Toc8006_461351655)

[4.1 Software Requirements for the Visitor Display 12](#__RefHeading___Toc8008_461351655)

[4.2 Software Requirements for the Staff Display 13](#__RefHeading___Toc1669_163027149)

[5 NON-FUNCTIONAL REQUIREMENTS 15](#__RefHeading___Toc1198_2817788786)

[5.1 Operational 15](#__RefHeading___Toc8040_461351655)

[5.2 Aesthetic and Ergonomic Requirements 15](#__RefHeading___Toc1200_2817788786)

[5.3 Documentation 16](#__RefHeading___Toc135_2006520353)

[6 ASSUMPTIONS 17](#__RefHeading___Toc567_2006520353)

[7 SUMMARY OF CHANGES TO THIS DOCUMENT 18](#__RefHeading___Toc3871_3837260896)

Index of Tables

Table 1: Related Documents 5

Table 2: Related Tools 5

Table 3: Visitor GUI Functional Requirements 12

Table 4: Staff GUI Functional Requirements 13

Table 5: Operational Requirements 15

Table 6: Aesthetic and Ergonomic Requirements 15

Table 7: Documentation Requirements 16

Table 8: Summary of Changes to this Document 18

Illustration Index

Illustration 1: River System – Proposed Deployment – Main River and Sump Arrangement 20

Illustration 2: River System – Proposed Deployment – Water Collection System 21

Annexes

Annex A Illustrations

# INTRODUCTION

This document details the requirements for the Visitor and Staff Graphical User Interfaces (GUI). This GUI is primarily to allow visitors to view the operation and state of pumps, valves and sensors in the Wimborne Model Town (WMT) River feature. Additionally, as a subsidiary function, this GUI is required to provide control of the system for privileged users, ie the WMT staff. This part of the GUI is called the Staff GUI. This development is intended to provide the following facilities:

* For Visitors:
  + Provide an attractive display of the operation of the system, based upon a graphical representation of the river and it’s components.
  + Display the level of water in the Sump and the various Butts Farms.
  + Display the flow rate of water in the river (method of measuring yet to be decided).
  + Show the state of the various valves and pumps in the system.
  + Show the direction of flow of the water in the pipes between the sump and the Butts Farms.
* For Staff:
  + Allow manual control of the system in the event of a problem occurring or a need to switch the system off temporarily.
  + Trigger and error message on the Visitor GUI to alert staff to issues occurring.

The GUIs should be a web based system to allow staff and visitors to monitor it from devices other than the main Visitor GUI screen, should this be required. Hardware requirements are not part of this document, but are described below to aid visualisation of the system.

Data will be generated by the functional software running on a number of Raspberry Pi computers, (see Reference 1 in Section 1.4) directly connected to the pumps, valves and sensors in the River System. This data will be stored on a database in the NAS box, which collects all the data together and makes it available to the Visitor GUI software (and the river system control logic) via Ethernet.

## Hamish McIntyre-Bhatty’s Open University Project

The Open University part of this project (a subset of the overall requirements) concerns the development of a mobile visitor GUI. The work on the mobile visitor GUI will later be extended to a desktop interface. This may include any work completed by the Canford School students towards the Desktop visitor GUI at the point of integration. Furthermore, this will be extended to include a Staff GUI for control of the river system once the Open University part of the project has been completed.

The current status of the Canford students’ work can be found at <https://wmtprojectsforum.altervista.org/forum/viewforum.php?f=17>.

This project will form Hamish McIntyre-Bhatty’s dissertation for his Computing and IT degree with The Open University. Status updates will be posted to the projects forum at <https://wmtprojectsforum.altervista.org/forum/viewforum.php?f=52> at regular intervals to keep colleagues informed of the current status of the project and to co-ordinate any work that requires collaboration – for example document review and collecting feedback on prototypes.

## BACKGROUND TO THE REQUIREMENTS

Full details of the background to the Requirements for the enhancements to the river system as a whole may be found in Reference 1 in Section 1.3.

## Related Documents

The following documents are relevant to these Requirements.

Table 1: Related Documents

|  |  |  |
| --- | --- | --- |
| No | Requirement | Issue / Date |
| 1 | WMT River System Requirements | 0.5 |
| 2 | [GNU General Public License](https://www.gnu.org/licenses/gpl.html) | 3 |
| 3 | [TCP/IP](https://en.wikipedia.org/wiki/Internet_protocol_suite) | - |
| 4 | [Creative Commons Attribution-NonCommercial-ShareAlike International License](http://creativecommons.org/licenses/by-nc-sa/4.0/) | 4.0 |

## Related Tools

The following tools are relevant to these Requirements.

Table 2: Related Tools

|  |  |  |
| --- | --- | --- |
| No | Requirement | Issue / Date |
| 1 | [Raspberry Pi Computer](https://www.raspberrypi.org/) | - |
| 2 | [Hypertext Markup Language](https://www.w3.org/standards/techs/html" \l "w3c_all) | 5 |
| 3 | [Flask micro webdevelopment framework for Python](http://flask.pocoo.org/docs/0.12/) (and any associated modules) | Latest |
| 4 | [Python Programming Language](https://www.python.org/) | Latest |
| 5 | [Raspberry Pi Operating System](https://www.raspberrypi.org/) | Latest (caveat: mysql library must support NAS box database) |
| 6 | JavaScript Framework for client-side decoration (TBD) | TBD |
| 7 | Mysqldb library | Latest (with caveat) |
| 8 | [NAS Box (D-Link DNS-320L)](https://wmtprojectsforum.altervista.org/files/WMT River System Files/NAS Box/DNS_320L_Datasheet_EN_EU.pdf) | N/A |

## Definitions

|  |  |
| --- | --- |
| GUI | Graphical User Interface |
| HDMI | High Definition Multimedia Interface |
| HTML | Hypertext Markup Language |
| GUI Pi | The Raspberry Pi that displays the Visitor and staff GUIs |
| Site-Local Pi | The Raspberry Pi that has control over the given site, or physical area of the model town (also situated within that site). |
| Server | A computer or process that provides access to a resource over a network for other “client” devices or computers to use. |
| Web Server | The system that hosts the web pages used to access the visitor GUI. |
| Database Server | Stores and manages data from the River System, and makes it accessible to the Visitor and Staff GUIs. |
| River System | All elements of the WMT model river and its control and monitoring components. |
| NAS Box | Network-Attached-Storage system. This device holds the database that the river system uses to maintain state, and that will be used by the visitor and staff GUIs to display information. |
| TCP/IP | Transmission Control Protocol / Internet Protocol |
| WMT | Wimborne Model Town |

# HARDWARE CONFIGURATION

### Main River Circulation

Illustration 1 in Annex A shows the way in which the water is circulated within the river elements that are part of the WMT model, eg the Bog Garden and the two branches of the River Allen.

Please note that more water butts have been added since 2017, the time the diagram was created for the initial version of this requirements document. However, the physical design of the system has not changed so the diagram remains informative. The water wheel has also been removed due to detrimental effects on wildlife in the river.

The Sump is located at the southern end of the river and contains approximately 500 litres of water. A pump (the Sump/River Pump) recirculates this water through an underground pipe to the Bog Garden which is at the other end of the site, adjacent to the Main Entrance. Water then flows down the two river beds and back into the sump. Sump Pi will control the operation of the Sump Pump to maintain the river flow based on the measured flow rate.

Also shown on this diagram is the configuration of the water collection system as of December 2017; this includes collection of water from the roofs of some of the buildings and storage in five water butts behind the Wendy Houses. These details should make it easier to understand the full description of this system in the next Section below.

It should be noted that the river and Bog Garden contain a combined total of some 15,000 litres of water, so if the Sump Pump stops for some reason then a large quantity of this water will continue to flow into the Sump, resulting in considerable water loss through the Soak-away.

Each butts group (the Wendy butts, Stage butts, Hanham butts, and Gazebo) includes a Raspberry Pi for monitoring and local control. All control of valves to transfer water between butts groups is done through the database on the NAS box, and all of the system state at the current point in time is stored on the NAS box.

Only the Wendy butts are shown in Illustration 1 as the system has been developed further since the Illustration was created in 2017.

### Water Collection

Illustration 2 in Annex A shows the proposed layout of the water collection system. Note that the Railway Room Butts Farm is now known as the Hanham Butts Farm.

Water collected from the buildings either flows into the river or directly into water butts located at various points around the site. These water butts are grouped together in sets of five butts, each designated with a Group Number. Water levels in the Sump and in each of the Butts Groups is monitored and water is pumped to and from the Sump to ensure that it does not overflow into the Soak-away or run out of water during dry periods.

Each Butts Group is monitored by sensors connected to a Raspberry Pi and the each Pi will decide when to operate valves and pumps in its vicinity to optimise water usage and keep water levels higher downstream, closer to the sump.

The Gardeners Butts Group at G5 will not be used to refill the Sump or take water from it. Instead, this Butts Group will provide water to ‘Leaky Hoses’ (and a manual tap) to water the gardens overnight, when water loss due to evaporation will be minimised.

### Raspberry Pi Computer

Full details of the Raspberry Pi computer may be found at Reference 1 in Section 1.4. Apart from being a fully specified computer, it also has a number of General Purpose Digital Input / Output (GPIO) lines which can be programmed to be discrete inputs, discrete outputs and (for some of the lines) serial interfaces. To interface to the GPIO lines, additional circuits may be required. Some work has been done on this and a description of the current capabilities is given in Annex B.

A display may be connected to the Raspberry Pi using the High Definition Multimedia Interface (HDMI) connector.

NOTE: It is not yet agreed which Raspberry Pi will host the webserver – it may be WMT-Webserver or a new dedicated Raspberry Pi.

### NAS Box

Full details of the NAS Box (a D-Link DNS-320L) may be found at Reference 8 in Section 1.4. The NAS Box has two SATA HDDs connected in a RAID array for redundancy, and serves as a database server for the river system, as well as performing some administrative tasks periodically.

The NAS Box has been deployed with a large amount of custom, cross-compiled software in order to give it the capabilities that were needed to use it in the river system. An automated backup system has been set up for the NAS box to further lower the chance of data loss.

### Display Specifications (Desktop GUI)

Note: At the time of writing these specifications are still being agreed because the WMT would like an outdoor (IP65) Touch Screen Display, but the budget currently doesn’t include this. Any Web GUI developed for this project must therefore be flexible enough to work with a variety of screens and interfaces as defined below:

|  |  |
| --- | --- |
| Display Driver | Raspberry Pi providing a Web Browser interface into the standard HDMI port. This will be known as the GUI Pi. |
| Screen Size - IP65 (outdoor display) | 12” to 19”. |
| Screen Size - (indoor display) | 19” to 25”. |
| Visitor / Staff interface | Touch screen or  Mouse or  Trackball or  Five robust buttons connected to the Raspberry Pi GPIO pins (Cursor up, down, left, right and left click) |

### Device Specifications (Mobile GUI)

Note: As WMT does not control which devices users may use to connect to the mobile visitor GUI, a range of display sizes and platforms must be accommodated. The GUI should run on a “lowest common denominator” of low end devices, in an attempt to ensure it will work well on all devices visitors are likely to bring. This is of course limited by the availability of devices and compatibility of these devices with modern web technologies.

|  |  |
| --- | --- |
| Operating System | IOS 6.1.6 or later, or Android 5.1 and later. |
| Form Factor | Mobile/handheld (but would be good to also work on tablets). |
| Screen size | 3.5” or larger. |
| Screen resolution | 720x1080 pixels or higher. |
| Other Capabilities | Mutli-touch support.  Support for HTML5, CSS3, and JavaScript (modern web technologies) |

# GENERAL REQUIREMENTS

## Software Environment

### Visitor and Staff GUIs

The Visitor and Staff GUIs shall be implemented using code written in Hypertext Markup Language (HTML), (see Reference 2 in Section 1.4) Version 5 to carry scripts that generate and render the content. The preferred framework is Flask (see Reference 3 in Section 1.4) because it allows the Python Programming Language (see Reference 4 in Section 1.4) to be used for the scripting language. However, any fully cross-platform web framework may be used, providing that the languages and tools are open and free.

Note: Python is preferred as the scripting language because it has been used to realise the software used for the other elements of this system and also for other Projects within the WMT.

The mobile interface will also depend on another language (such as JavaScript) for client-side decoration and functionality.

### Operating System

#### Development

Any Operating System may be used for development.

#### Deployment

The Operating System used for the deployed system for the Desktop interface will be Raspberry Pi OS, (see Reference 5 in Section 1.4) version Buster, running on a Raspberry Pi so any developed software shall be tested on that platform.

Note: The deployment target for the webserver is not yet decided, but it is very likely to be the existing webserver, WMT-Webserver.

The client-side of the mobile interface will be accessible from Android and iOS (versions documented in Section 2.1.6). For phones and similar handheld devices.

### Copyright

All software will be Copyright Wimborne Model Town and Released under the GNU Public License (GPL) Version 3, (see Reference 2 in Section 1.3).

All documentation will be Copyright Wimborne Model Town and licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (see Reference 8 in Section 1.3).

For the duration of Hamish McIntyre-Bhatty’s Open University project, code and designs will be open source but Copyrighted as Hamish McIntyre-Bhatty to fulfil the requirements of the degree programme. After the project is finished, copyright of all artefacts will be handed over to Wimborne Model Town.

## Communications

### Medium and Protocols

All communications between the Visitor GUI Pi and the Master Pi shall use Transmission Control Protocol / Internet Protocol (TCP/IP) (see Reference 3 in Section 1.3) over an Ethernet link (possibly supplemented by a wireless technology).

Mobile devices will need to connect over Wi-Fi.

### Methodology

The NAS box hosts a database which contains records of each River System data item, including current status and historical readings and events. The web server shall read each record in turn before presenting the data in an HTML page for the client to render. The software on the GUI Pi (but not the mobile devices) will have permission to write to the database in order to transmit Staff commands to the NAS Box.

Visitor mobile devices will not talk directly to the NAS box database, instead communications will be via the web application server to provide some security and isolation, and reduce load on the NAS box. Permissions will be handled carefully to ensure that visitors cannot gain control of the system.

**Please note:** The staff and desktop elements are outside of the scope for the Open University part of this project. Which requirements do and do not apply to the Open University part of the project are documented below.

# FUNCTIONAL REQUIREMENTS

## Software Requirements for the Visitor Display

**All of the requirements in this section are applicable to the Open University project.**

Table 3 below details the Functional Requirements for the Visitor GUI.

Table 3: Visitor GUI Functional Requirements

| No | Requirement |
| --- | --- |
| 4.1 | The Visitor GUI shall provide a visual display of the state of the River System. |
| 4.1.1 | The Visitor GUI shall provide a level of detail appropriate for the zoom level. |
| 4.1.2 | The display shall consist of a graphical representation of the river (the Plan) and all of its elements, such as Butts, Sump, pumps and valves. |
| 4.1.3 | Each element of the Plan shall be represented by a graphical symbol that conveys its function to a non-expert viewer. |
| 4.1.4 | The graphical symbols for each element shall provide a representation of it’s state, and be animated where appropriate eg: |
| 4.1.4.1 | Each Valve element shall show whether it is open, closed or partially open. |
| 4.1.4.2 | Each Pump element shall show whether it is running or stopped. |
| 4.1.4.3 | Each Sensor element shall display its reading in terms of depth of water in the vessel or rate of water flow. |
| 4.1.4.4 | Each pipe element shall show the state of the water within it, eg stopped or flowing. |
| 4.1.4.5 | Where water is flowing within a pipe element, the Plan shall show the direction of flow. |
|  |  |
| 4.1.5 | It shall be possible for the Visitor or Staff member to select the required information from a Menu. |
| 4.1.6 | An ‘Information’ facility shall be included to explain in more detail how the River System works. |
| 4.1.6.1 | Upon interaction, more details can be shown about the state of individual elements. |
| 4.1.6.2 | Ability to navigate directly to any pop-ups via an URL (for future provision of trail/guided tour) |
| 4.1.7 | Make future provision for localising all textual aspects of the interface. |
| 4.1.8 | Make provision for an audio/video guided tour of the web application. |

Table 3.1: Visitor GUI Optional Requirements

|  |  |
| --- | --- |
| *No* | *Requirement* |
| 4.1.9 | A ‘fast replay’ feature should be provided to allow Visitors to watch the River System in Action during a recent weather event, such as prolonged rain or drought. |
| 4.1.9.1 | Make provision for the future addition of the ability to replay significant events. |
| 4.1.9.2 | Detect significant events on the server side to suggest to visitors for replay. This could involve manual curation of the significant events. |
| 4.1.9.3 | Use a local weather reporting service to improve the detection of significant events using weather data. |
| 4.1.10 | Provide a facility for allowing interested visitors to view schematic or design diagrams of certain parts of the river system. |

Notes:

1. Development of the Visitor GUI should pay cognizance to the Requirements detailed in Section 4.2 below.

2. Requirements 4.1.9 and onwards are stretch (optional) targets and should be implemented only when all other requirements have been met.

## Software Requirements for the Staff Display

**None of the requirements in this section are applicable to the Open University project, and these have been marked in italic for clarity.**

Table 4 shows the Functional Requirements for the GUI to be provided for WMT staff.

Table 4: Staff GUI Functional Requirements

| No | Requirement |
| --- | --- |
| *4.2* | The Staff GUI shall provide a visual display of the operating state of the River System. |
| *4.2.2* | The display shall provide the same information as the Visitor GUI, supplemented by additional information and controls. |
| *4.2.3* | The Staff GUI shall be protected by a login system to prevent unauthorised access. |
| *4.2.4* | The Staff GUI shall provide the following additional controls: |
| *4.2.4.1* | Overall shutdown of the system. |
| *4.2.4.2* | Shutdown of individual segments of the system (eg, Group 1 Butts Pi). |
| *4.2.4.3* | Individual Control of the pumps. |
| *4.2.4.4* | Individual Control of the valves. |
| *4.2.4.5* | Control of the ‘fast replay’ feature detailed in Requirement 4.1.5. |

Notes:

1. Development of the Staff GUI should, if possible, utilise code developed for the Visitor GUI.

2. Requirement 4.2.4.5 is a stretch target.

# NON-FUNCTIONAL REQUIREMENTS

## Operational

**All of the requirements in this section apply to the Open University project, except for requirements 5.1.2, 5.1.4, and 5.1.5, which have been marked in italic.**

Table 5 below details the operational capabilities required of the software for both the visitors and staff. The GUI will be made available on site at WMT via a screen inside one of the rooms.

Table 5: Operational Requirements

|  |  |
| --- | --- |
| No | Requirement |
| 5.1.1 | The Visitor GUI display shall be updated at frequent intervals to provide a dynamic experience for the Visitors. |
| *5.1.2* | The Staff GUI shall be accessible by use of a login with the aid of an external keyboard and mouse. |
| 5.1.3 | It is the responsibility of the Site-local Pi to enact control messages emitted by the Staff GUI, however, the Staff GUI display shall reflect the change in status within 1 second of the updated data being received. |
| *5.1.4* | The server should respond to all requests within 5 seconds. |
| *5.1.5* | The server should be able to handle simultaneous access by 50 visitors. |

## Aesthetic and Ergonomic Requirements

**All of the requirements in this section are applicable to the Open University project.**

Table 6: Aesthetic and Ergonomic Requirements

|  |  |
| --- | --- |
| No | Requirement |
| 5.2.1 | The Visitor GUI display shall be provide an attractive and eye-catching view of the operation of the River System. |
| 5.2.2 | Careful attention should be paid to colour schemes when developing the Visitor and Staff GUIs. |
| 5.2.3 | Consideration should be given to the use of animation when representing elements of the River System. |

Note: It is recognised that the Requirements detailed in Section 5.2 are more aesthetic than technical but look and feel play a major role in drawing in and keeping the interest of the user. Some guidance on what may be appropriate is provided below:

* **Colours shouldn’t be too garish or too dull**
* **Colours should be chosen to provide the viewer with visual cues of what they represent’ ie blue may be chosen for water and so on. Also, pumps, valves and other elements could be colour-coded to make interpretation easier.**
* **If animations are used, they shouldn’t be too overwhelming. Animations can rapidly become irritating if overdone.**

## Documentation

The Table below details the documentation requirements for the Visitor and Staff GUIs.

**All of the requirements in this section are applicable to the Open University project.**

Table 7: Documentation Requirements

|  |  |
| --- | --- |
| No | Requirement |
| 5.3.1 | A comprehensive design specification shall be produced (see Note 1). |
| 5.3.2 | The design specification shall include high-level descriptions of all functionality of all components of the software. |
| 5.3.3 | All software shall be fully documented with comments. |

Note 1: An example of a software design specification will be provided and it will be unnecessary for this document to provide detailed software documentation, provided that Requirement 5.3.3 has been adequately met.

# ASSUMPTIONS

The following assumptions are made.

* Developers will have the pre-requisite knowledge to design and implement the software required to realise this part of the project and subsequently enhance it.

# SUMMARY OF CHANGES TO THIS DOCUMENT

The Table below details the changes made to this document for each revision.

Table 8: Summary of Changes to this Document

|  |  |  |
| --- | --- | --- |
| Issue | Section | Summary of Change |
| 0.1 | - | First draft. |
| 0.2 | - | DPJ comments |
| 0.3 | - | Comments from the Meeting on 19th Dec. |
| 0.4 | - | Changed styles to sans-serif and fixed some typos. |
| 1.0 | - | Accepted all review comments and corrected layout errors |
| 1.1 | - | Proposed changes for Hamish McIntyre-Bhatty’s Open University Project. |
| 1.2 | - | Minor amendments and pagination improvements as suggested by Terry Coles. |
| 1.3 | - | Pagination improvements as suggested by Terry Coles. |
| 1.4 | - | Improvements to clarity and removal of references to water wheel as suggested by Patrick Wigmore and Penri Jones. |

ANNEX A – ILLUSTRATIONS

Illustration 1 – Main Main River and Sump Arrangement

Illustration 2 – Water Collection System

Illustration 1: River System – Proposed Deployment – Main River and Sump Arrangement

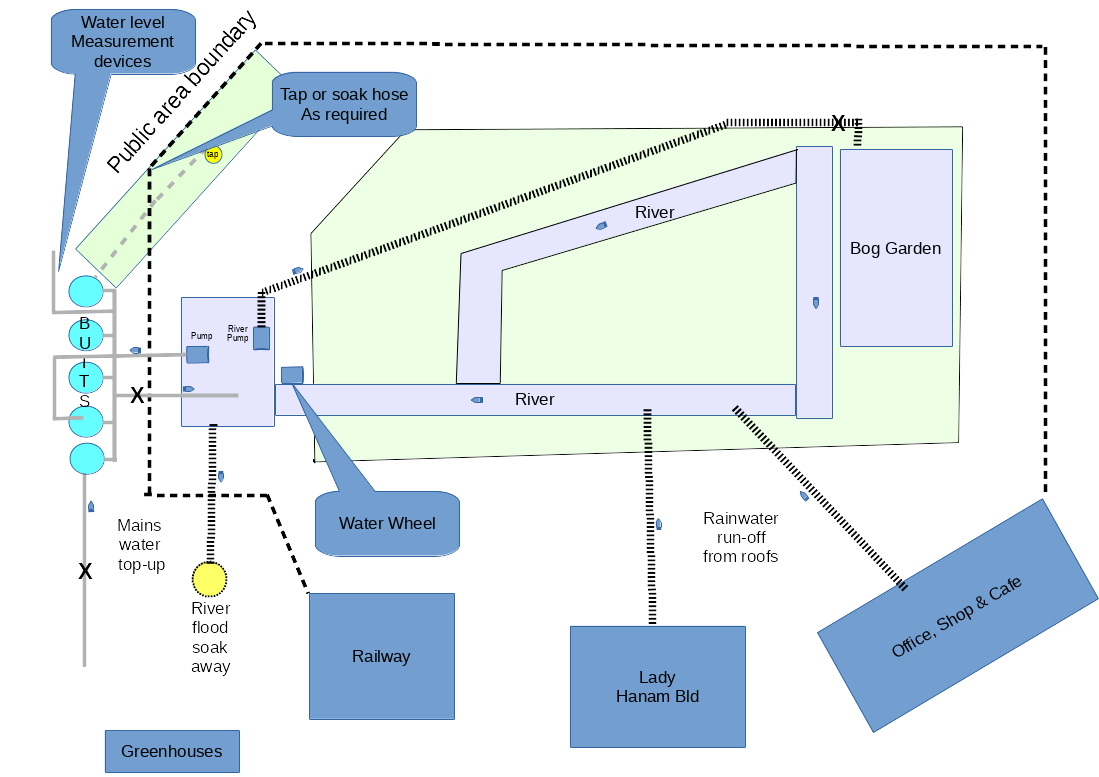


Illustration 2: River System – Proposed Deployment – Water Collection System

