



Raleigh Park

Proposal: Scoping and Monitoring Study



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1 Introduction

1.1 Background

Milestone Environmental Ltd have been asked by the Friends of Raleigh Park to advise on works to develop the understanding of the park. This is to be used for the following aims:

- Inform management;
- Facilitate protection of the park from development at its boundaries; and
- Ultimately to help understand the park's resilience to climate change.

Raleigh Park lies on the western edge of Oxford, with its downstream boundary close to the A34 trunk road. It comprises a significant groundwater discharge site, with varied hydrological features suggesting protection from intensification despite its proximity to the city. The presence of significant tufa at several locations, particularly in the upper reaches of the site, and notable botanical composition suggest a base-rich water chemistry, historically largely protected from pollution. Threats from development at the site's boundary demand a full professional assessment of the site's hydro-ecological status in order that appropriate protection can be afforded to the site in the future.

Project funding is being applied for through several potential mechanisms, and it is understood that the project requirements may need to change dependent on available funding. Milestone are flexible and will prioritise requirements as needed by the client.

Milestone are a niche consultancy founded in the use of technical expertise to provide evidence-based improvements for the environment, and in particular wetland sites. We acknowledge that each wetland site is unique in its functioning and hydro-ecological dynamics, in addition to having site-specific pressures. We pride ourselves in making and delivering bespoke solutions at each site. We use experts in each of the disciplines required on each site, and these include surface water hydrology, hydrogeology, hydrochemistry, botany and topographic surveying as required. As a small company we provide excellent value for money and are responsive to a client's needs.

Milestone have previously worked with BBOWT at their Thatcham, Cothill and Rivermead sites. We understand BBOWT's valuable contribution to managing nature reserves under its care, protecting wildlife, and educating and engaging young people with nature. We regularly engage with charitable organisations of all sizes whilst undertaking wetland assessments, and so are well placed to support this work. Milestone are based in South Oxfordshire.

The current Proposal outlines a suggested scheme of works to develop the understanding of the Raleigh Park site to achieve the above objectives. It is composed of several elements that can be chosen independently as project resources allow.



1.2 Site Summary

David Mould from Milestone was accompanied by Adam Bows and David Brown of the Friends Group on a site visit on Saturday 30th March. The main features of the site were observed, as described in summary below.

The primary features of the site are as follows. Raleigh Park is an excellent example of a groundwater-fed alkaline fen, and so is important given the rarity of this habitat in a UK and international perspective. The Scoping Study should assess the requirement for its status, for example assigning SSSI status.

1. Upper Reaches

- a. The upper reaches of the site are wooded with a main channel running through the centre of the valley;
- b. Significant and extensive deposits of tufa are observed which are likely to be of regional if not national significance;
- c. Substantial interaction with groundwater is evident from a cursory site visit, not only with springflows but more complex interactions such as sinkholes;
- d. Development threatens the boundaries of the site, in particular the use of septic tanks which may threaten the sensitive water quality of the stream and thus the wetlands downstream;
- e. Furthermore, there is potential for pollution from residential activities (e.g. lawn maintenance) to have an impact at the top of the valley given the proximity of gardens to the streamhead;

2. Fen and Pond Area

- a. A variety of transitioning habitat types in a small area;
- b. Further groundwater discharges;
- c. Fen, likely to be accompanied by peat deposits and rich botanical diversity;
- d. Pond, again with very rich diversity;
- e. Hydraulic control of surface flows out of the pond to the lower reaches of the site;

3. Tributary and Lower Reaches

- a. Some historic manipulation of the stream channel, including bed profiling;
- b. Some incising of the channel may be amenable to restorative works;
- c. Varied gradients through the long section of the streambed;
- d. Tributary joining from the north, again with springflows.



2 Milestone's Recommendation

2.1 Overview

A phased approach to the work is strongly recommended. This work should start with a scoping study, allowing the development of the understanding of the site to take place first. This will make sure that decisions made on both potential restoration methods and management approaches are those that are most appropriate for the site, and spend available budget in the most efficient way possible. This will act to minimise risk for the project. Later stages of works will be driven by the conclusions of the scoping study. This approach has been successful in many projects at wetland sites.

Thus, the first phase of works should be to increase the understanding of the site's hydro-ecological mechanisms operating at the site. This includes the various disciplines including surface hydrology, hydrogeology, the tufa presence and the hydrochemistry.

It is recommended that this phase of works also initiates a hydrological monitoring programme with the installation of a network of monitoring wells. This will allow a dataset to be developed placing conditions at any time within the context of historical records back to the start of the monitoring programme: thus establishment of this network as early as possible is beneficial. With the assessment of the impacts of climate change amongst the objectives, establishing a baseline hydrological regime before long term impacts are felt, is critical.

2.2 Surface Water Hydrology

A review of the site's surface hydrology will be undertaken. This will comprise a full site walkover, investigation of water sources, interactions with groundwater, surface water features, and dominant hydrological processes operating across the site.

Hydrology links all of the other disciplines, and thus is central to characterising the site's hydro-ecology. Other disciplines all interact with the hydrology, and thus the more of these that can provide their expertise to the project the better the conceptual understanding of the site. An understanding of the basic hydrological functioning of the site will allow effective positioning of monitoring wells, as well as optimising the locations for water quality sampling.

2.3 Hydrogeology

Subsurface hydrology is clearly critical to the mechanics of the hydro-ecology of Raleigh Park. For this reason, we feel it would be of significant benefit to the project to obtain specialist hydrogeological expertise. The initial site visit identified a strong interaction between the surface and sub-surface hydrology, with the channel running completely below the surface for a short reach in the upper wooded section, and dominance of spring outflows across various parts of the site. The hydro-chemistry of the site is very important for the ecological value, including the presence of tufa across the upper reaches of the site and the rich botanical diversity across the fen and pond area: the geology on the site will have a strong influence the water chemistry and so understanding the details of this will inform management.

The hydrogeology of the site will be surveyed during a site visit by Milestone's hydrogeologist. As outlined below in Section 5, Rob Low is very experienced at developing the conceptual model of a site's hydrogeological functioning, and the interactions with ecology.



2.4 Ecology

The tufa present is critical to the importance of the wetland site: the management regime is ultimately aimed at preventing degradation of the ecology and making improvements where possible. It reflects the special hydrology and hydrochemistry of the site. It is strongly recommended that a tufa expert assesses the extent of tufa, and the likely impacts of any monitoring and restoration approaches.

Jonathan Graham is Milestone's tufa expert. He is recognised in the field of ecology for being a leading and respected voice on tufa, its identification, development, interaction with hydrology, hydrogeology, associated ecological communities, protection and restoration. Jonathan worked with BGS and CEH to write seminal papers on tufa in Wales and Gloucestershire. He has worked on BBOWT's Rivermead Nature Park project for Milestone.

Jonathan would undertake a site visit to Raleigh Park to assess the tufa, its current status and its potential success on site given a lack of intervention. He would also advise, in collaboration with David Mould advising on the wetland hydrology, the prospects for the tufa under various management scenarios.

Given Jonathan's nationally-significant expertise in bryophytes and other wetland ecology, the survey would include these features, with data being compared to and hopefully formalising existing survey information from the Raleigh Park site. This efficiency of surveying would greatly benefit the site, making sure the hydro-ecological response to management proposals are appropriate before they begin.

2.5 Water Quality Analysis

Samples will be taken from five locations across the site for laboratory analysis. This is important to determine the water quality status of the different water sources across the site. The samples will be taken at two junctures for this project: firstly during installation of the monitoring network and secondly with a reactive visit during wet conditions. This will ensure that samples will be taken during different conditions to maximise the development of knowledge from the laboratory analysis. This is achievable given the local nature of the Raleigh Park site to Milestone's location.

The suite of analyses has been developed by Milestone for wetland sites that have various external pressures. We will analyse for total phosphorus (P), total dissolved P, soluble reactive P, nitrate, nitrite, ammonium, suspended sediment and pH. This suite of analyses will help elucidate nutrient dynamics across the site, which in conjunction with the hydrological monitoring will clarify the functioning of the system. It will clarify how pristine the site is, and whether any wastewater misconnections of polluting diffuse pollution is undermining the site's hydrochemistry.

The locations for these will be determined from the developing hydrological understanding, and in conjunction with Mike Bowes. David Mould will undertake the sampling whilst on-site to undertake hydrological work: David has expertise in taking water quality sampling and works closely with Mike to determine sampling protocol to minimise contamination and maximise utility of the results.

Water quality analysis is most cost effective where water level loggers are installed. The water quality sampling is limited to site visit dates, and so the limited frequency of sampling limits the increase in knowledge of hydrochemistry. The hydrological measurements are taken at much higher frequency when dataloggers are used. The more the understanding of site hydrology and its dynamics are developed, the more this can be related to the point observations of hydrochemistry for its interpretation.

Reporting for the water quality analysis may be provided in a revised Scoping Report, as timescales for the sampling may be delayed to provide the most effective use of the sampling. This will be discussed and agreed with the client.



2.6 Monitoring Wells

It is recommended that monitoring wells are installed. These facilitate the recording of water levels across the site, enabling long-term change to be observed as the record length of the data increases. Long datasets are of value for future management. With the continuing drought event (full recovery not seen from the 2018 event) it would be beneficial to include the potentially severe low water level conditions that may be experienced through the summer of 2019 given the poor water resources position at the end of the recharge season. At other Milestone monitoring sites, 2018 showed record low values which were important for setting management parameters.

The hydrological monitoring wells will be installed by Milestone. We recommend 42 mm wide dipwells, with thin (0.5 mm) slots to allow soil water levels at the monitoring location to equilibrate within the well, enabling observation of soil water levels. Each well will be lined with 'geosock' to prevent sediment ingress and have a cap and plug to seal off each end. The wells will be 1 m in depth, ensuring that the minimum water levels across the site are measured. The specific location of the wells will be determined on project objectives but initially considered to be based on short transects away from the main channel and key locations near the pond and groundwater discharge locations. Exact locations will be driven by local restrictions including vegetation, open water and other practical limitations. Where levels are required in surface ditches or the pond, the above system is sufficiently flexible to be able to act as a stilling well. Design of the network will be considered during the site visit, and as per Milestone's joined-up hydro-ecological approach, will consider ecological considerations.

All wells are manually measured, or 'dipped', using basic water level recorder. Costs provided include materials for ten monitoring wells (with caps and plugs), along with re-bar for securing stilling wells in position where appropriate (vertical movement will undermine readings).

Milestone cannot accept liability for wells and/or loggers that are interfered with by third parties. In our experience making wells as discrete as possible to avoid interference is the best way of reducing risk (rather than using security devices), as rural locations give time for third parties to cause problems. Risk of interference is considered low at Raleigh Park.

Once installed, the wells will need to be monitored. Friends or BBOWT staff will be provided with appropriate training to be able to dip the wells effectively, and a site visit sheet provide for accurate data collection. Milestone will supplement the dataset by dipping the wells when possible. BBOWT hold a water level dipper; costs can be provided for a separate unit to be supplied if requested.

2.7 Data Loggers

High sample rates can add a significant amount of value to hydrological monitoring programmes, clarifying critical processes driving water movements. Fine-scale water level changes will be observed that cannot be picked up from manual readings alone. With the short timescales from well installation to the start of works, the value of the data would be enhanced.

At those locations with water level logging, a data logger is suspended within well and will record water levels and temperature on an hourly basis. Logger data memory is extensive and can capture many months of data without servicing (or years, dependent on configuration). Accuracy of the instruments is approximately 1 mm, and so more accurate than manual measurements; battery life is >10 years. Milestone will provide the loggers given discounted rates available from suppliers given the multiple sites we monitor.

The data loggers measure pressure, and so are influenced not only by water level within the well but also by barometric pressure. As such, a barometric logger is required to record atmospheric pressure which is used to adjust the water level data during post-processing. The cost of this is not included as the unit in place at Cothill Fen SAC can be utilised for Raleigh Park as it is only a few miles distant.



Three loggers will be sufficient across the ten wells to develop the understanding of hydrological dynamics of the site, which will be unique and important to the management in the future. The location of the loggers is flexible as they can be moved between wells. Also, they can be used at different sites across BBOWT's wetland network: in Milestone's experience they are very durable and should provide many years' service. The cost of the loggers includes configuration and deployment, and an initial download visit to check operation is as expected, and to prepare data processing spreadsheets. Subsequent downloading and data processing will be required, although this is outside of the scope of the current works.

2.8 Topography

A topographic survey should be included if monitoring wells are installed. Milestone have a preferred supplier who we work with regularly and who knows the specific requirements of working in wetland and riverine environments.

The survey will be completed after the completion of the hydrological monitoring installation to ensure that it includes the monitoring wells. Working alongside the hydrologists, Milestone's surveyor will ensure that the topographic survey fully meets its objectives and provides the correct information for hydrological assessment. The equipment used will be a Leica GPS1200 with live Smartnet Corrections GNSS positioning system alongside a TCRP1202 R300 Total Station. Prior to the start of survey operations, the accuracy and precision of the project GNSS positioning system will be verified against the Ordnance Survey Passive Station 'Flush Bracket', located in Hugh Town. At least two new primary control stations will be established within the project area, utilising static post-processed GPS observations. At each station sufficient data will be acquired to enable a fixed solution to be determined for each point. Full network adjustment and closed loops using Leica LGO software will be used to determine the definitive X,Y,Z coordinates for each control station location within the OSGB36 National Grid. Alongside providing the baseline for the extension of horizontal and vertical control with a total station, these primary control stations will enable regular horizontal and vertical positional checks to be undertaken periodically during survey operations, and furthermore to act as a datum point for any future topographic surveys that may be carried out on the project site. These will be permanent survey markers and locations shared for any future surveys. The survey will use either GPS or total station methods dependent on GPS signal availability at different locations across the site. Temporary marker poles will be used to ensure consistent transects across the site. All equipment is calibrated annually and full quality control measures will be followed.

Coverage of the survey will include:

- Monitoring wells (top of well; top of anchor if present; and soil surface), allowing comparison of water level data between wells and thus understanding of the hydrological mechanisms;
- Channel cross sections and long sections (main channel and tributary);
- General topographic coverage as far as possible, including:
 - Notable gradient changes;
 - Survey points in each area of the site;
 - Any hydraulic control structures identified by the client;
 - Other items as required (dependent on survey time on site).

The latter items above enable further analysis (such as modelling) to be completed at a later date. They are not critical to the current works, but are efficient to be included at the same time. Milestone will provide a second man for the survey, as prices are kept low by having a single surveyor on site. The general topography can be limited by access through dense vegetation. Efficiency of the survey can also be limited by tree cover, as GPS satellite signals are obstructed. In this instance, a local grid is established and the survey undertaken using automated tracking laser theodolite. If a full topographic survey is not required, the monitoring wells can be levelled in with a dumpy level to a relative common datum. This is not likely to be cost-effective as will require a day on site with two people and processing time, and so may be similar in cost.



3 Deliverables

The following deliverables are to be completed for the above scope of works:

1. **Scoping Report**, to include:
 - a. Works completed;
 - b. Results from surveying and sampling. Dependent on options taken, this will be a full hydro-ecological appraisal incorporating expert input from various disciplines offered by Milestone on this project;
 - c. Recommendations for the way forwards, including timescales for final restoration measure designs and likely costs.Dependent upon project options taken, the following additions to the Scoping Report will be included:
 - d. **Surface hydrology** summary of the site;
 - e. **Groundwater** interactions and summary;
 - f. **Water quality** following laboratory analysis;
 - g. **Site visit from tufa expert** Jonathan Graham to assess the tufa, its current status and likely success following different restoration options. Given Jonathan's botanical expertise, he will also advise here accordingly;
 - h. **Data loggers** deployed on site within monitoring wells (including configuration), and an initial dataset downloaded, quality-assured, processed and delivered to the client.
2. **Installation of the hydrological monitoring network** by surface water hydrologist David Mould within four weeks of project approval, to include:
 - a. Ten shallow surface wells;
 - b. Training for BBOWT staff on site and a site visit sheet for continuing manual level monitoring;
 - c. Data from Milestone readings of wells will be passed onto the client;
 - d. Preparation of a processing spreadsheet
3. **Topographic survey** for levelling in of the monitoring network:
 - a. Survey sheets with summary maps;
 - b. Spreadsheet-based summary of all information collected including processing for long sections and cross sections and monitoring network summaries where appropriate.



4 Pricing

The table below outlines Milestone’s cost profile for the work package outlined herein. Clearly this is an early proposal to allow for budgeting and includes many different elements of work. We are happy to work with the client to refine this proposal as requirements change before the time at which the work will be needed. The costs are broken down as much as possible for transparency. Milestone cannot be held liable for the loss of monitoring equipment, which can be replaced at the client’s cost. Note that the costs of the loggers are for three units, and these costs can be refined as required. They are excluded from a separate sub-total given their cost. The cost for the topographic survey is the expected upper limit, and some savings may be achieved. David Mould, as Director of Milestone, will oversee the coordination of different disciplines and undertake project management. If this option is required please confirm cost requirements with Milestone. All costs are exclusive of VAT which will be applied at the prevailing rate. Prices are valid for 60 days.

Item	Staff [on-site] £	Staff [reporting] £	Consumables £	Water Quality Analysis	Travel £	Subsistence £	Total £
Surface Hydrology	£550.00	£825.00			£15.30		£1,390.30
Hydrogeology	£650.00	£975.00			£99.00		£1,724.00
Ecology (Tufa)	£550.00	£825.00			£95.40		£1,470.40
Water Quality	£110.00	£325.00		£1,232.00	£15.30		£1,682.30
Monitoring Wells	£825.00		£248.98		£15.30		£1,089.28
Topographic Survey			£2,065.00				£2,065.00
Project Management		£181.50					£181.50
Sub-Total							£9,602.78
Data Loggers			£2,242.50				£2,242.50
					Grand total		£11,845.28



5 Expertise and Experience

Milestone's core capabilities lie in wetland hydro-ecological assessment and management. We recognise that hydrology, ecology and nutrient dynamics are intricately linked and understanding their individual status as well as their interaction, is critical to effective site management. Milestone comprises of experts established in their field and with a track record of delivery. We think creatively to solve problems and find practical ways forward for managing wetland environments. Milestone's team has an existing expert knowledge of the type of habitats exhibited at Raleigh Park.

We have a growing corporate experience of excellent project delivery on wetland projects to enhance the individual experience of the core contributing staff. We provide a comprehensive multi-expertise service for wetland environments. This covers the design of monitoring networks and multi-disciplinary data collection, data management, analysis, interpretation, development of conceptual models, and recommendations for site management. These recommendations are founded in expert knowledge of modern best practices and experience of how ecosystems respond to change and management. Milestone have worked for Wildlife Trusts, Councils and Natural England for wetland work.

All of Milestone's experts have a strong academic background, with recognised skills refined in consultancy and operational environments. All our work is founded in science and excellent practice to achieve the highest standards. This allows us to build a complete picture using the various expert fields required at each site we work at. We create a bespoke project plan for each site according to its unique characteristics, rather than using 'off the shelf' approaches that may not be effective. Milestone's team work together with an effective, productive and professional approach.

Dr. David Mould is a surface water hydrologist and project manager. He completed his PhD in wetland hydrology at the Centre for Ecology and Hydrology (CEH) and UCL. He has instrumented many wetland sites including several designated sites (SSSI and SAC) in Oxfordshire and Berkshire, the Somerset Levels and Moors, alluvial wetlands in Somerset and Norfolk, fenlands in northeast Germany and various wetland types in Poland and Hungary. He has developed conceptual models of wetland water dynamics, quantifying transfers and stores, modelling the impact of change on a site's effect on wider catchment response. David has worked in research, consultancy and operational environments to build a reputation for delivering difficult water-related projects. He is currently Principal Hydrologist leading a team managing water resources and water-related technical issues on the waterway network. David is a Chartered Water and Environmental Manager through CIWEM, and has extensive experience working on flooding issues, including previously managing the national flood estimation software products and training Environment Agency staff on their use. David sits on CIWEM's Rivers and Coastal Group National Committee. He has notable experience working in the charitable sector, including managing volunteer input, and so is ideally placed to work with the Friends and Wildlife Trust to complement the project.

Jonathan Graham is a wetland botanical expert but with specialist expertise in tufa management and restoration projects. Jonathan Graham is a national expert in both lower and higher plants. From 1992 – 2007 he worked for the Countryside Council for Wales (now Natural Resources Wales) and English Nature (now Natural England), and therefore has extensive experience of vegetation survey and management. Jonathan has surveyed heathland restoration areas (adjoining Studland Heath, Dorset), mapped upland habitats within the Brecon Beacons National Park (South Wales), undertaken condition assessment of wet heath (Gower Commons, South Wales) and recently undertaken a hydro-ecological assessment of base-rich flushes in Welsh mires (with Gareth Farr, British Geological Survey). As such he is recognised as a leading national expert on tufa, including under restoration projects. He has specialist skills in bryophyte and lichen identification, is the co-author of *The Mosses and Liverworts of Carmarthenshire*, and is undertaking fieldwork in preparation for a *Flora of Fenland*.

Dr. Mike Bowes is Senior Nutrient Hydrochemist with 20 years' environmental research experience at CEH. He manages their nutrient laboratory facilities and is Head of the Water Quality Processes Group. He researches the sources and fates of the major plant nutrients (phosphorus, nitrogen and silicon) within rivers at the catchment



scale, and specialises in nutrient interactions with river biota and bed-sediment. Mike leads Milestone's water quality analysis and interpretation, and will undertake the laboratory analysis of water samples directly for the Raleigh Park project.

Dr. Rob Low has 20 years professional experience as a hydrogeologist. After obtaining a BSc (Physical Geography) and an MSc (Environmental Management) in broad-based environmental subjects, he specialised in hydrogeology through completing a PhD by researching the dynamics of dissolved radon in the groundwater in the Chalk aquifer of East Anglia. Rob has worked on a wide range of projects, but has retained and developed notable core interests. Analysis and interpretation of hydrogeological data for development of conceptual models is Rob's core skills base, which he demonstrates primarily through acting as senior technical specialist on a number of large projects to develop regional-scale conceptual and numerical groundwater models for the Environment Agency. Rob was responsible for coordinating data collation and analysis, development of conceptual models and management of numerical modelling. Rob has expertise in the hydrogeology of the chalk aquifers, having carried out a large number of groundwater resource and impact assessment projects on the Chalk aquifers. Rob excels at developing approaches and techniques for hydrogeological impact assessment, specialising in the assessment of impacts relating to groundwater abstraction and quarry dewatering. Rob wrote parts of the Environment Agency's guidance on hydrogeological impact assessment, and has a detailed appreciation of the various techniques available for impact assessment, and related data requirements and uncertainties. Rob's hydrogeological knowledge is complimented by his eco-hydrology, on which Rob has developed a large body of knowledge and experience on matters relating to the interface between hydrology and ecology. He was a co-author of the Environment Agency's ecohydrological guidelines series, author of three chapters in the recently published Fen Management Handbook, has provided training in hydrology for conservation practitioners, and has carried out a large number of projects relating to eco-hydrology.

Brian Gamet is an established RICS Chartered land and hydrographic Surveyor. Brian has over 15 years of experience in the conduct and management of both topographic and hydrographic surveys for clients across a number of sectors, both within the UK and overseas, and has experience of working in a range of topographic, marine and wetland environments. Brian is a committed survey professional, evidenced by both his membership of the Royal Institution of Chartered Surveyors and through the retention of an academic post with Plymouth University where he leads an MSc programme in advanced Hydrography for professionals, on which he also teaches both land and hydrographic survey practice and management. Brian manages Milestone's topographic surveying, and will ensure coverage of the required topography, instrumentation and water control infrastructure if this element of work is required at the Raleigh Park site.

