



Grand Union  
Canal Transfer

# GUC SRO Gate 3 Annex B1 Water Quality Monitoring Report

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AtkinsRéalis



# Gate 3 Water Quality Monitoring Report

Severn Trent, Affinity Water and Canal & River  
Trust

18 March 2025

5222090 / 7 / DG / 043

# GRAND UNION CANAL STRATEGIC RESOURCE OPTION WATER QUALITY MONITORING

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## Client signoff

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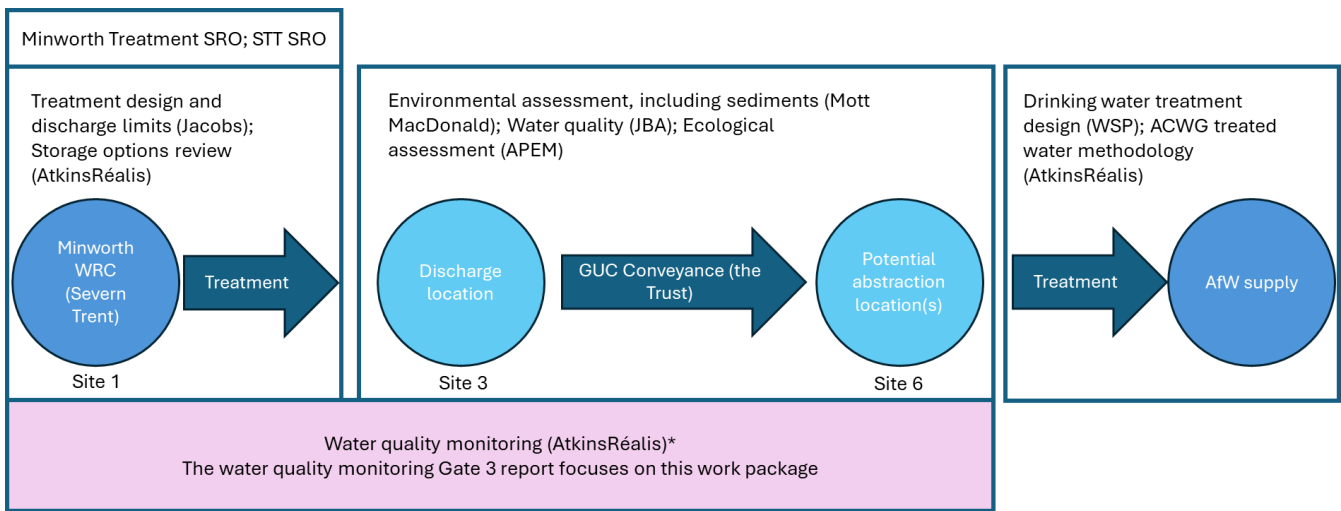
# INTRODUCTION



# 1. Introduction

## 1.1 Background

The Grand Union Canal (GUC) is a Strategic Resource Option (SRO) in which Affinity Water (AfW) and Severn Trent (ST) are working together alongside the Canal & River Trust (The Trust). The scheme looks to transfer water from ST’s Minworth Wastewater Recycling Centre (WwRC) in the Midlands to AfW in the South East using the existing GUC network. Under the GUC SRO, there are multiple work packages covering the different scheme elements. A schematic diagram conceptualising the different scheme elements and associated work packages is shown in Figure 1-1. The purpose of this report is to present the results from the water quality monitoring work package relating to the GUC SRO. This work package will feed into other work packages, the results of which will be reported elsewhere.



**Figure 1-1 - Conceptualisation of the GUC scheme and work packages (site information provided in Table 2.1.)**

There have been four previous water quality monitoring project phases since Gate 1. Phase 1 water quality monitoring was undertaken by ALS between May 2020 and March 2021 at 15 locations along the transfer route. The sampling programme for Phase 1 involved spot water sampling on a monthly basis. Phase 2, undertaken by AtkinsRéalis and RPS, was commissioned for the 6-month period between April and September 2021, with the view to further investigate changes in water quality along the transfer route and included a more in-depth investigation into water quality at the potential abstraction locations to drinking water requirements. The programme included a more in-depth suite of determinands and continuous monitoring sondes. Phase 3 was commissioned (October 2021 – June 2022) to continue the Phase 2 monitoring programme, with the removal of some monitoring sites in the upper section as a result of potential discharge locations being ruled out. Sampling under Phase 4 ran between July 2022 – June 2023 with the removal of some monitoring locations in the lower section as a result of potential abstraction locations being ruled out. Sampling under Phase 5 began in July 2023 and runs to November 2024. More detail is given on sampling site selection and rationale in Section 2.1. The GUC project phases are summarised in Figure 1-2 below.

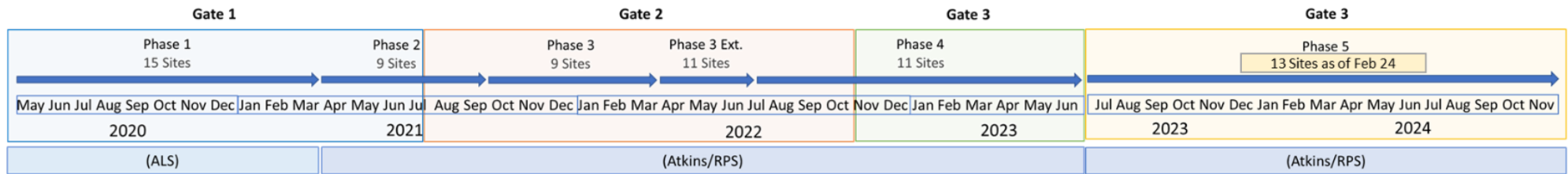


Figure 1-2 – Schematic diagram showing the GUC monitoring Phases



## 1.2 Monitoring drivers and aims

The key drivers for monitoring water quality for this SRO are:

- Drinking Water Safety Planning – the scheme involves utilisation of a new source for public drinking water supply. As such, assessment of the risks to human health from this new source, and development of control measures sufficient to reduce these risks to an acceptable level, is critical to ensuring safeguarding public health while meeting demand for public water supply of future generations and compliance with the legislative requirements for drinking water quality.
- An All Company Working Group (ACWG) treatment water methodology for drinking water risk assessment and water safety planning of all SROs has been developed, which will require water quality data to inform judgements of drinking water risk. This ACWG methodology was updated for the GUC transfer scheme at the end of Phase 1 and was revisited as part of Phase 3 using updated monitoring data.
- Environmental water quality – the scheme would result in changes to the sources of water entering the canal and therefore may change water quality in the receiving water body and local environment which may in turn affect the local ecology. Water quality data is key to identifying and mitigating potential environmental impacts of the scheme. In particular, the requirements of the Water Framework Directive (WFD) determinands and Environmental Quality Standards Directive (EQSD) have been referred to in the development of this monitoring programme.
- Lastly, this monitoring programme will help inform treatment design at both selected discharge and abstraction locations.

The aim of the water quality monitoring programme is to obtain a baseline dataset to allow characterisation of different study reaches in terms of drinking water safety risks (particularly with respect to current and future regulated parameters), the WFD determinands, and EA Surface Water Pollution Risk Assessment Parameters (referred to as EQSD parameters here) to characterise the baseline risk and inform modelling. The Monitoring programme for Phases 1-5 included both water quality spot sampling and continuous monitoring (30-minute resolution data for dissolved oxygen, ammonium, temperature, conductivity, pH, and turbidity).

## 1.3 Purpose of this document

The purpose of this document is to provide an overview of the Gate 3 GUC water quality monitoring programme which covers a period of 24 months between April 2022 and March 2024. It provides information regarding sampling locations and site selection rationale along with information pertaining to sampling procedure and analytical methodologies. This document is designed to serve as a point of reference for all aspects of the Gate 3 monitoring programme and read in conjunction with the data summary reports, produced on a quarterly basis and included as an annex to this report.



# METHODOLOGY



## 2. Methodology

### 2.1 Site locations

Under the Phase 1 water quality monitoring programme, samples were taken at 15 monitoring locations in the upper and lower sections of the GUC to characterise baseline water quality at the potential discharge and abstraction locations. Sites were selected based on the scheme route, which focused on source, discharge and abstraction sites. A summary of monitoring locations and their analysis suites are provided in Table 2-1. At the onset of Phase 2, a number of discharge sub-route options and abstraction point sub-options were no longer being progressed as part of the scheme, so it was necessary to adapt the monitoring programme accordingly. For Phase 2 and 3, monitoring was conducted at a total of nine locations across the canal network. A detailed analysis of monitoring data collected under Phases 1-3 including an analysis of environmental and drinking water quality standards can be found in the GUC Gate 2 Annex B1.4 Water Quality Monitoring report.

Monitoring conducted during Phase 3 and Phase 4 of the GUC Transfer Scheme was modified to take account of Site 3 (Coventry Canal at Atherstone) and Site 6 (GUC at Grove Lock, Leighton Buzzard) being selected as the discharge location and potential abstraction location, respectively. Existing sites, comprising Site 2 (Birmingham & Fazeley Canal at Minworth), 4 (GUC at Leamington Trough Pound), 7 (GUC at Beggars Lane, Tring), 8 (GUC at Little Heath Lane Bridge, Hemel Hempstead) and 9 (GUC at The Grove, Hunton Bridge) were discontinued and an additional seven sites added to the monitoring programme at key instream intersections (e.g., major confluences). During Phase 5 two new reservoir sites were added to the Middle GUC. This added Site 17 Daventry Reservoir and Site 18 Drayton Reservoir. A total of 13 sites are now being monitored during Phase 5. Sites currently being monitored are summarised in Table 2-2. This monitoring programme was discussed with the EA and DWI at workshops held on 23/04/2021 and 21/05/2021. They were offered the opportunity to comment on the programme so any required amendments could be incorporated into the programme. We subsequently engaged with them on a quarterly basis throughout Gate 2 and Gate 3.

For the purpose of conceptualising the monitoring programme, the GUC system has been split into three main geographical sections, an overview of which can be seen in Figure 2-1 with specific reach maps found in Appendix A, these are summarised below:

- **Upper section** - Covering the discharge from Minworth to the discharge location (Coventry Canal at Atherstone).
- **Middle section** - GUC from the Braunston Junction to the Aylesbury Arm (Marsworth, North of Tring).
- **Lower section** - GUC from the Aylesbury Arm to Hanwell, London. This section includes the potential abstraction location (GUC at Grove Lock, Leighton Buzzard).

**Table 2-1 - Summary of monitoring locations across each phase plus analysis suites**

|                            |          |  | Phase 1            | Phase 2                 | Phase 3              | Phase 4             | Phase 5               |
|----------------------------|----------|--|--------------------|-------------------------|----------------------|---------------------|-----------------------|
| Section                    | Site no. | Location description                             | May 20 - March 21* | April 21 - September 21 | October 21 - July 22 | August 22 - June 23 | July 23 – November 24 |
| <b>GUC: Upper Section</b>  | 1        | Minworth WwRC Final Effluent                     | ✓                  | WFD, EQSD, DWSP         | WFD, EQSD, DWSP      | WFD, EQSD, DWSP, ES | WFD, EQSD, DWSP, ES   |
|                            | 2        | Birmingham and Fazeley Canal at Minworth         | ✓                  | WFD, EQSD               | -                    | -                   | -                     |
|                            | 3        | Coventry Canal at Atherstone                     | ✓                  | WFD, EQSD               | WFD, EQSD            | WFD, EQSD, ES       | WFD, EQSD, ES         |
|                            | 4        | GUC at Leamington Trough Pound                   | ✓                  | WFD, EQSD               | -                    | -                   | -                     |
| <b>GUC: Middle Section</b> | 10       | GUC at Bedworth                                  | -                  | -                       | WFD                  | WFD                 | WFD                   |
|                            | 5        | GUC at Welton Lane, Daventry                     | ✓                  | WFD                     | WFD                  | WFD                 | WFD, EQSD             |
|                            | 17       | Drayton Reservoir                                | -                  | -                       | -                    | -                   | WFD, EQSD             |
|                            | 18       | Daventry Reservoir                               | -                  | -                       | -                    | -                   | WFD, EQSD             |
|                            | 11       | GUC at Long Buckby                               | -                  | -                       | WFD                  | WFD                 | WFD                   |
|                            | 12       | GUC at Gayton                                    | -                  | -                       | WFD                  | WFD                 | WFD                   |
|                            | 13       | GUC at Stoke Bruerne                             | -                  | -                       | WFD                  | WFD                 | WFD                   |
|                            | 14       | GUC at Cosgrove                                  | -                  | -                       | WFD                  | WFD                 | WFD                   |
| <b>GUC: Lower Section</b>  | 15       | GUC at Stoke Hammond                             | -                  | -                       | WFD                  | WFD                 | WFD                   |
|                            | 7        | GUC at Beggars Lane, Tring                       | ✓                  | WFD, DWSP               | WFD, DWSP            | -                   | -                     |
|                            | 8        | GUC at Little Heath Lane Bridge. Hemel Hempstead | ✓                  | WFD, DWSP               | WFD, DWSP            | -                   | -                     |
|                            | 9        | GUC at The Grove, Hunton Bridge                  | ✓                  | WFD, DWSP               | WFD, DWSP            | -                   | -                     |
|                            | 6        | GUC at Grove, Leighton Buzzard                   | ✓                  | WFD                     | WFD, DWSP            | WFD, DWSP, ES       | WFD, DWSP, ES         |
|                            | 16       | GUC at Marsworth                                 | -                  | -                       | WFD                  | WFD                 | WFD                   |

WFD = Water Framework Directive; EQSD = Environmental Quality Standards Directive; DWSP = Drinking Water Safety Plan; ES = Emerging Substances

\*Phase 1 was undertaken by another ALS and as such the analysis suite drivers are unknown. Sites are therefore marked with a ✓ if they were sampled in Phase 1.



**Table 2-2 - Monitoring locations**

Grid references for monitoring locations redacted

| Section                            | Site no. | Location description         | NGR | Rationale   | Sampling                                  | Land access |
|------------------------------------|----------|------------------------------|-----|---|---|-------------|
| <b>GUC:<br/>Upper<br/>Section</b>  | 1        | Minworth WwRC Final Effluent |     | Official Minworth WwRC final effluent sampling point. To characterise potential future influence on the GUC prior to additional treatment which is likely to be deemed necessary.   | Spot sampling + continuous monitoring     | ST          |
|                                    | 3        | Coventry Canal at Atherstone |     | A site to characterise the reach and understand baseline water quality around sub-route 3 discharge point. This site is aligned with the Phase 1 water quality monitoring point for consistency.  | Spot sampling + continuous monitoring**   | The Trust   |
| <b>GUC:<br/>Middle<br/>Section</b> | 10       | GUC at Bedworth              |     | To understand baseline water quality south of the interaction with the Ashby Canal and Oxford Canal. Spot sampling at this site commenced in April 2022.  | Spot sampling                             | The Trust   |
|                                    | 5        | GUC at Welton Lane, Daventry |     | Site on the GUC east of the point where the GUC and Oxford Canal interlink and before the Leicester Line at Norton Junction to characterise water quality at the upper end of the middle section and to understand baseline of water being 'passed forward' within the middle section. This is a new water quality monitoring location aligned with previous APEM ecological monitoring location in this reach. | Spot sampling + continuous monitoring**** | The Trust   |
|                                    | 17       | Daventry Reservoir           |     | Added to understand baseline water quality downstream of Norton Junction south of the interaction with the Leicester Line. Spot sampling at this site commenced in February 2024.   | Spot sampling + continuous monitoring**** | The Trust   |
|                                    | 18       | Drayton Reservoir            |     | Added to understand baseline water quality upstream of Site 5. Spot sampling at this site commenced in February 2024.   | Spot sampling + continuous monitoring**** | The Trust   |
|                                    | 11       | GUC at Long Buckby           |     | Added to understand baseline water quality downstream of Site 5. Spot sampling at this site commenced in February 2024.   | Spot sampling                             | The Trust   |
|                                    | 12       | GUC at Gayton                |     | To understand the baseline water quality upstream of the interactions with the River Nene in order to determine whether there is likely to be any deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.   | Spot sampling                             | The Trust   |
|                                    | 13       | GUC at Stoke Bruerne         |     | To understand the baseline water quality upstream of the interactions with the River Tove in order to determine whether there is likely to be any   | Spot sampling                             | The Trust   |



| Section                           | Site no. | Location description                | NGR | Rationale   | Sampling                                 | Land access |
|-----------------------------------|----------|-------------------------------------|-----|---|--|-------------|
|                                   |          |                                     |     | deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.   |  |             |
|                                   | 14       | GUC at Cosgrove                     |     | To understand the baseline water quality upstream of the interactions with the River Great Ouse in order to determine whether there is likely to be any deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.   | Spot sampling                            | The Trust   |
|                                   | 15       | GUC at Stoke Hammond                |     | To understand the baseline water quality upstream of the interactions with the River Ouzel in order to determine whether there is likely to be any deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.  | Spot sampling                            | The Trust   |
| <b>GUC:<br/>Lower<br/>Section</b> | 6        | GUC at Grove Lock, Leighton Buzzard |     | A site to characterise and understand water quality at the lower end of the middle section after interactions with other watercourses. This is a new water quality monitoring location upstream of Tring before the Aylesbury and Wendover Arms converge with the GUC. Continuous monitoring sonde is installed at this example abstraction location to give an indication of sub-daily water quality variability, as a result of biological activity discharges and/or tributaries*. | Spot sampling + continuous monitoring*   | The Trust   |
|                                   | 16       | GUC at Marsworth                    |     | To understand baseline water quality at the most downstream influence of the transfer scheme before the Tring summit. Spot sampling at this site commenced in April 2022.   | Spot sampling + continuous monitoring*** | The Trust   |

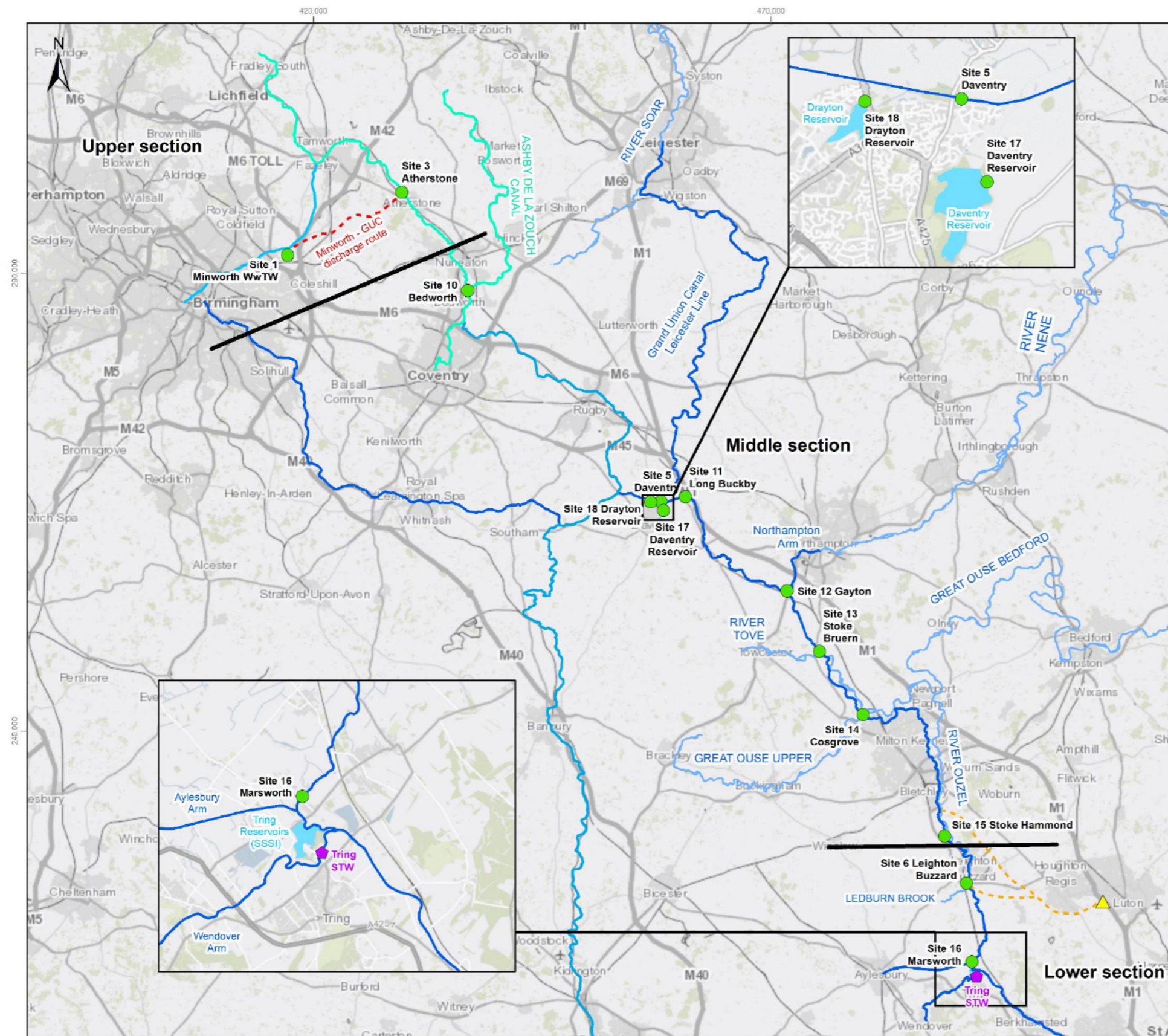
\* Continuous monitoring commenced at Site 6 on 25/11/2021.

\*\* A continuous monitoring sonde was installed at this site on 11/05/2022.

\*\*\* A continuous monitoring sonde was installed at this site on 24/05/2022.

\*\*\*\* A continuous monitoring sonde was installed at this site on 01/04/2024.





### Grand Union Canal WQ monitoring locations

**Legend**

- WQ Monitoring Location
- - - Potential Discharge Route
- - - Feasible routes from canal to Affinity Water supply area
- ▲ Water Storage Reservoirs
- ◆ Sewage Treatment Works

**Watercourses**

- Grand Union Canal
- Birmingham & Fazeley Canal
- Coventry Canal
- Oxford Canal
- Interacting Main Rivers

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Data sources: Environment Agency, Canal & River Trust, Ordnance Survey

0 5 10 20 Km  
Scale (at A3): 1:400,000

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|                    |                                 |                     |                          |
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Figure 2-1 - Key elements/ reaches of the GUC scheme (black lines notate the upper, middle and lower sections)



## 2.2 Analysis suites

Water quality monitoring and analysis is being conducted where there is a key legislative or design driver. As a result, the water quality analysis suites break down into the following components:

- **Environmental risks as required by WFD** – which cover analysis of samples for 83 determinands as previously agreed to be suitable as part of Phase 1, and, set out in the 2015 WFD Directions<sup>1</sup>. This includes supporting parameters such as hardness, alkalinity, dissolved inorganic carbon and acid neutralising capacity (ANC), some of which are required to determine river categorisation in order to calculate site specific Environmental Quality Standards (EQS) values.
- **Environmental permitting risks as required by the EQSD** – which cover analysis of samples for the 95 determinands set out in the surface water pollution risk assessment for environmental permits<sup>2</sup>, at sites that may require permitting.
- **Drinking Water** – the following have been reviewed to establish an appropriate list of 263 determinands to characterise the expected raw water quality to be abstracted from the GUC and to inform a water safety planning approach to control measures as required by DWI:
  - Existing regulations including the Water Supply (Water Quality) Regulations 2016 (England), with 2018 amendments consolidated<sup>3</sup>.
  - Future legislation – notably the revised EU Drinking Water Directive (DWD).
  - Determinands identified as posing a potential risk to human health by the recent UK Water Industry Research (UKWIR) review of the Chemical Investigations Programme (CIP) data<sup>4</sup>.
  - DWI feedback and agreements on other SRO water quality monitoring programmes.
  - Determinands contained in appropriate Drinking Water Safety Plans (DWSPs) – including comparable source type DWSPs (e.g., canal sources and industrially contaminated surface water sources), and existing receptor Site DWSPs (to enable any change in the scale of existing risks to be evaluated).
  - The ACWG methodology for drinking water risk assessment for all SROs.
- **Emerging substances** – This suite, added during Phase 4, covers 152 substances identified as emerging in a review conducted by AtkinsRéalis (GUC Gate 2 Annex B1.6 Emerging Substances). Analysis of these substances will determine whether there is any deterioration in environmental risks associated with the transfer scheme.

Some sites include two or more analysis suites (e.g., WFD and EQSD or WFD and Drinking Water). Where there are overlaps between the different analytical suites (e.g., because of a recurring parameter, or sampling is already being undertaken by another SRO for the same parameter, at the same point and at the same frequency), the analysis is only undertaken once.

### 2.2.1 WFD suite

The 2015 WFD Directions include 118 different parameters comprising of 'physico-chemical parameters', 'specific pollutants', 'priority substances', 'priority hazardous substances' and 'other pollutants'. These parameters are often the starting point for any monitoring programme to allow a characterisation of environmental risk. During Phase 1 of the GUC water quality investigation (2020-21) a condensed list of 74 parameters were agreed between ST, AfW and the EA to cover determinands of relevance and to allow a characterisation of environmental risk.

<sup>1</sup> The Water Framework (Standards and Classification) Directive (England and Wales) 2015 accessed via: [The Water Framework Directive \(Standards and Classification\) Directions \(England and Wales\) 2015 \(legislation.gov.uk\)](#)

<sup>2</sup> Accessed via: <https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit>

<sup>3</sup> The Water Supply (Water Quality) Regulations 2018 <https://www.legislation.gov.uk/ksi/2018/647/contents/made>

<sup>4</sup> UKWIR DW13S204: Risk Assessment of CIP Data with Respect to Implications for Drinking Water Sources 2019

The monitoring programme for Phases 2 – 5 has continued to include these 74 parameters. These were included at the start of the Phase 2 programme and were communicated to the EA and the DWI.

AtkinsRéalis have recommended that, where missing from this list, the following core environmental suites comprising determinands that pose a risk to WFD status deterioration were also included:

- Supporting parameters required to do WFD specific calculations such as bioavailable fractions.
- The Minworth final effluent permitted determinands (point source emissions to water) for secondary treated sewage effluent with nutrient removal.

As a result, we included a further nine parameters in this suite: acid neutralising capacity, dissolved inorganic carbon, hardness, organic nitrogen, total oxidised nitrogen, nitrite, ammonia, salinity (conductivity) and trichloroethylene. This WFD suite therefore currently consists of a total of 83 different compounds. This analysis suite was used for all sites to characterise environmental risks.

## 2.2.2 EQSD suite

The EA surface pollution risk assessment list includes a total of 95 different parameters. For the requirements of future discharge permitting assessments, these determinands are included only at sites where discharges are proposed as part of the scheme. For Gate 3 these sites include the potential discharge location at Coventry Canal, Atherstone, the two reservoir sites and the reservoir discharge location at Welton Lane, Daventry. Removing duplication of WFD parameters results in an additional 87 different compounds to be analysed.

It is noted that due to the GUC being classed as an artificial waterbody, clarity needs to be sought from the EA on the permitting options and expectations for water quality discharge risk assessments. There may be a view that environmental risks are covered sufficiently by the WFD suite, and this may subsequently reduce the expectations for additional monitoring under EQSD.

## 2.2.3 Drinking water suite

There are 263 different compounds making up the Drinking Water suite for the source water and the example intake / abstraction locations. Removing duplication with WFD / EQSD parameters, this results in a total of 239 additional parameters to be analysed. These will be compared against Prescribed Concentration or Values (PCVs) obtained following consultation with DWI. It should be noted that PCVs only apply to treated drinking water and not raw water values and have been compared solely as an indicator as to which determinands may be of concern following abstraction.

While the Drinking Water suite may appear large, it is important to note that:

- The sampling programme must be comprehensive to secure confidence that the solutions and proposed mitigation will not present a risk to human health – this is particularly important for reuse schemes from both a regulatory and public perspective.
- Monthly sampling to characterise expected parameter envelopes which may be presented to treatment is critical to appropriate sizing of treatment and other control measures, which in turn ensures fulfilment of the two key responsibilities of the water company – the effectiveness of risk management and the availability of water resources when required.
- A targeted approach is recommended – to restrict use of this suite to relevant locations only. Example abstraction points and discharge from Minworth to allow quantification of new sources / any change to risk in the canal catchment.



## 2.2.4 Emerging substances

Under Phase 4 of the GUC monitoring programme AtkinsRéalis were commissioned to conduct a review of emerging substances associated with Minworth WwRC (GUC Gate 2 Annex B1.6 Emerging Substances). This review identified 152 emerging substances classified as either 'Foreseeable Protection Measures' or 'Potential Protection Measures'. In addition to their inclusion at Minworth WwRC, to determine whether there is any deterioration in environmental risks associated with the transfer scheme, these were added at the point of discharge (Site 3 Coventry Canal, Atherstone) and to determine the drinking water risks associated with the scheme, these substances were also added to Site 6 Leighton Buzzard. Substances identified at these sites are compared to Drinking Water Inspectorate Predicted Concentration Values. Currently, samples are collected for the analysis of 54 PFAS compounds, this was increased from PFAS20, previously monitored at Minworth final effluent and Leighton Buzzard prior to September 2022.

## 2.3 Sampling and analysis procedures

### 2.3.1 Continuous water quality monitoring sondes

A continuous monitoring sonde was installed at the potential abstraction site (Site 6 GUC at Grove, Leighton Buzzard) on 25/11/2021. Additional sondes were installed at the discharge site (Site 3 Coventry canal at Atherstone, 16/05/2022) and at the base of the catchment (Site 16 GUC at Marsworth, 14/05/2022). A sonde was also installed to characterise the source water (Minworth WwRC treated discharge) as part of the STT SRO monitoring programme on 04/03/2021. A recent addition to the monitoring programme involved installing continuous monitoring sondes at Site 17 (Daventry Reservoir) and Site 18 (Drayton Reservoir) on 01/04/2024. A new continuous monitoring sonde was also installed at Site 5 (GUC at Welton Lane, Daventry) on this date.

Each continuous monitoring location includes:

- A modular system complete with an MCE-ESNET2 telemetry unit and a Xylem EXO2 multiparameter sonde, deployed at approximately 1 metre depth and sensors for temperature, conductivity, dissolved oxygen, ammonium, pH, chlorophyll and turbidity.
- A limited sensor suite (dissolved oxygen, pH, and temperature) was included at Minworth during Phase 2 and 3 installed under the STT scheme, however, this suite was upgraded in April 2022 to include comparable parameters to Sites 3, 6, and 16, with the exception of chlorophyll.
- 20 W solar panel kit allowing autonomous year-round operation.
- 30-minute resolution telemetered data with secure web portal access via the Cloud, using a Tier III secure data centre.
- Daily data integrity checks undertaken via the Cloud.

Dedicated maintenance visits occur around every four to six weeks to proactively clean and replace equipment with newly calibrated sondes, when necessary. When sensors experience drift or fail in between that time, reactive repair and maintenance of the sondes is undertaken. In addition, it was required to respond to events of vandalism and theft following a drop out of live telemetry data. The water quality sonde at Atherstone was stolen on 14/07/2022, with engineers installing a replacement on 17/08/2022 and as such there is a gap of approximately 1 month in the data record.

### 2.3.2 Spot water quality sampling

It is noted that many of the WFD, EQSD and DWSP parameters have low EQS and will therefore require laboratory analysis to a very low concentration. Appropriate sampling and analysis methods have been used, along with suitably experienced staff, to target the required LoD and prevent risk of cross-contamination. Water quality



samples have been collected monthly using project-specific Standard Operating Procedure (SOP), which follows the approach outlined in the EA Operational Instruction 19-09<sup>5</sup>. Samples have been taken from a site representative of the bulk of water being assessed (the volume of sample taken at each site has been determined by the laboratory to cover the required analysis). In addition to the EA Operational Instruction, we also adhere to 'best practice' guidance for organic contaminant sampling set out by the US Environment Protection Agency (EPA)<sup>6</sup>. It is very important that cross contamination of samples is avoided. This is especially important owing to the very low EQS concentrations for WFD and PCV for DWSP parameters. These additional measures include:

- A sampling pole and food grade stainless steel and plastic sampling buckets have been used to collect water to fill the sampling bottles. These buckets are also used by the EA and prevent metal leaching. Each bucket will be thoroughly rinsed out downstream before any samples are taken to avoid any cross-contamination issues. One set will be dedicated to each scheme and not used for other projects, keeping all sampling containers in a dedicated 'clean' bag until used.
- Use of clean / sterile sampling bottles for any sampling round, including discarding any bottles inadvertently opened during transit.
- Use of specialist sampling containers for different analytes, some of which contain preservatives, for which indirect sampling will be used.
- Use of vinyl sampling gloves. Use new clean gloves for each new sample and dirty gloves and other dirty personal protective equipment (PPE) stored in a designated 'dirty' bag.
- With regard to Perfluorooctanesulfonic acid (PFOS), avoiding PFOS-containing PPE and equipment (e.g., Gore-Tex jackets and boots, waterproof notepads), unless required for Health & Safety purposes (e.g., life jackets).

In addition to taking spot water samples for laboratory analysis, the following water quality parameters were measured *in-situ* using a calibrated YSI handheld multiparameter probe: dissolved oxygen (% saturation and mg/l), temperature, conductivity, and pH.

Samples are maintained at a cool temperature during transit by using refrigerated vehicles. The laboratory (RPS) provides temperature data loggers and temperature blanks to record temperature during transit to ensure that the samples have not been exposed to environmental conditions that may adversely affect any analytical test for which they are scheduled. The samples are dropped off at the laboratory's nearest pick up point or collected directly from site by RPS on the same day of collection and delivered to the laboratory overnight, thus maintaining compliance with the UK Accreditation Service (UKAS) Policy on Deviating Samples<sup>7</sup> (e.g., 24 hours for microbiological parameters and Biochemical Oxygen Demand (BOD)).

### 2.3.3 Laboratory analysis suites

Sample analyses were undertaken by RPS laboratories RPS is fully accredited (UKAS ISO 17025) and highly experienced in both WFD and DWSP analysis suites. RPS offers all WFD and almost all EQSD and PCV determinands at or below the associated EQS. There are a small number of exceptions to this including 3,4-dichloroaniline, cyfluthrin, doramectin, formaldehyde, hydrogen sulphide and methiocarb.

Table 2-3 below sets out the analysis suite for each of the current 13 monitoring sites. Appendix B-F contains detail on the analytical suites.

<sup>5</sup> Environment Agency Operational Instruction 19\_09: Chemical and microbiological sampling of water. Issued 03/02/10

<sup>6</sup> See [www.epa.gov](http://www.epa.gov), <https://www.epa.gov/quality> and <https://www.epa.gov/quality/procedures-collecting-wastewatersamples>. For example, [https://www.epa.gov/sites/production/files/2019-02/documents/pfas\\_methods\\_tech\\_brief\\_28feb19\\_update.pdf](https://www.epa.gov/sites/production/files/2019-02/documents/pfas_methods_tech_brief_28feb19_update.pdf) for PFOS

<sup>7</sup> [TPS 63 UKAS Policy on Deviating Samples](#)



**Table 2-3 - Overview of analysis suites**

| Section             | Sites  | Continuous Monitoring Sonde | WFD             | EQSD <sup>2</sup> | DWSP <sup>3</sup> | PFAS54          | Emerging substances | AtkinsRéal Analysis Suite (Appendix B-F) |
|---------------------|--|-----------------------------|-----------------|-------------------|-------------------|-----------------|---------------------|--|
| GUC: Upper Section  | 1. Minworth WwRC Final Effluent <sup>1</sup> | ✓                           | ✓               | ✓ <sup>10</sup>   | ✓                 | ✓               | ✓ <sup>8</sup>      | Suite 9                                  |
|                     | 3. Coventry Canal at Atherstone              | ✓ <sup>6</sup>              | ✓               | ✓                 | ✗                 | ✓               | ✓ <sup>8</sup>      | Suite B                                  |
| GUC: Middle Section | 10. GUC at Bedworth <sup>5</sup>             | ✗                           | ✓               | ✗                 | ✗                 | ✓               | ✗                   | Suite A                                  |
|                     | 5. GUC at Welton Lane, Daventry              | ✓ <sup>9</sup>              | ✓               | ✓ <sup>10</sup>   | ✗                 | ✓               | ✗                   | Suite D                                  |
|                     | 17. Daventry Reservoir                       | ✓ <sup>9</sup>              | ✓ <sup>10</sup> | ✓ <sup>10</sup>   | ✗                 | ✓ <sup>10</sup> | ✗                   |  |
|                     | 18. Drayton Reservoir                        | ✓ <sup>9</sup>              | ✓ <sup>10</sup> | ✓ <sup>10</sup>   | ✗                 | ✓ <sup>10</sup> | ✗                   |  |
|                     | 11. GUC at Long Buckby <sup>5</sup>          | ✗                           | ✓               | ✗                 | ✗                 | ✓               | ✗                   | Suite A                                  |
|                     | 12. GUC at Gayton <sup>5</sup>               | ✗                           | ✓               | ✗                 | ✗                 | ✓               | ✗                   |  |
|                     | 13. GUC at Stoke Bruerne <sup>5</sup>        | ✗                           | ✓               | ✗                 | ✗                 | ✓               | ✗                   |  |
|                     | 14. GUC at Cosgrove <sup>5</sup>             | ✗                           | ✓               | ✗                 | ✗                 | ✓               | ✗                   |  |
|                     | 15. GUC at Stoke Hammond <sup>5</sup>        | ✗                           | ✓               | ✗                 | ✗                 | ✓               | ✗                   |  |
| GUC: Lower Section  | 6. GUC at Grove, Leighton Buzzard            | ✓ <sup>4</sup>              | ✓               | ✓ <sup>10</sup>   | ✓ <sup>4</sup>    | ✓               | ✓ <sup>8</sup>      | Suite C                                  |
|                     | 16. GUC at Marsworth <sup>5</sup>            | ✓ <sup>7</sup>              | ✓               | ✗                 | ✗                 | ✓               | ✗                   | Suite A                                  |

<sup>1</sup> Minworth WwRC final effluent already being sampled as part of the STT SRO monitoring programme. Only parameters identified in the Drinking Water suite that are not already being sampled as part of this programme will need to be sampled.

<sup>2</sup> EQSD parameters are only required to be sampled at discharge sites.

<sup>3</sup> Drinking Water parameters are only required to characterise the source water and to understand baseline conditions at the potential abstraction locations.

<sup>4</sup> DWSP parameters were added to the analysis suite at Site 6 in October 2021 and a continuous monitoring sonde was added in November 2021 (previous analysis suite consisted of WFD parameters only April-September 2021).

<sup>5</sup> These sites were added to the programme in April 2022.

<sup>6</sup> Continuous monitoring sonde installed at this site 11/05/2022.

<sup>7</sup> Continuous monitoring sonde installed at this site on 24/05/2022.

<sup>8</sup> Emerging substances added to sites on 12/09/2022.

<sup>9</sup> Continuous Monitoring sonde installed at this site 01/04/2024

<sup>10</sup> These parameters were added to these sites in February 2024.

## 2.4 Data analysis

Data analysis following each round quarterly monitoring will be published in the separate Water Quality Monitoring Summary Reports (see Section 3). For data compilation and the completion of standard data quality assurance procedures, descriptive statistical analyses were conducted on data from all sites, including the generation of mean, maximum, minimum statistics in addition to percentile values including the 95<sup>th</sup>, 90<sup>th</sup>, and 10<sup>th</sup> percentiles. Samples



at the limit of detection were included in the analysis and used at face value to adhere to discharge permitting assessment guidance. Any significant outliers were removed from the analysis. Relevant EQS (relating to both WFD<sup>8</sup> and EQSD<sup>9</sup>) were then obtained following consultation with the EA against which running mean data have been compared. Sites with potential abstraction applications have been compared against additional drinking water PCVs obtained from the UK's Water Supply (Water Quality) Regulations (2016) Schedule 1<sup>10</sup> with some determinands defined as indicator parameters being found in Schedule 2<sup>11</sup>. Additionally, many of the pesticides included are not named within the regulations but fall under the category of 'other pesticides' and so were given a PCV of 0.10 µg/l. Unlike EQS's these are considered on a per sample basis rather than a mean.

In addition, high-resolution sensor data collected from all four sites will be rigorously checked for sensor drop out, instrument drift, and anomalous readings that may impact interpretation. The sensor data are provided in the separate Quarterly Water Quality Monitoring Reports.

Not all substances included following the addition of the emerging substances suite in September 2022 have an associated EQS or PCV. It is therefore proposed that where EQS values are not available that Predicted No-Effect Concentrations (PNEC) be used as an environmental benchmark against which to facilitate a comparison between sites. These were selected for inclusion in the Phase 4 Quarterly Report January to March 2023 following consultation with ST, the EA and DWI.

## 2.5 Rainfall data

Rainfall data will be obtained from the EA for the entire monitoring period for a single location along the GUC (Dancers End Reservoir, EA Satiation Number: 261602). This site was selected to aid data interpretation as Dancers End Reservoir is situated in the same location as the potential abstraction location, (Site 6 Leighton Buzzard), and coincides with the locations of the continuous monitoring sonde. The use of this dataset to infer catchment processes was therefore deemed sufficient for this interpretation. The rainfall data collected from this location informs the analysis of the quarterly water quality monitoring reports.

## 2.6 Stakeholder engagement

The initial monitoring programme was discussed with the EA and DWI at workshops held on 23/04/2021 and 21/05/2021. They were offered the opportunity to comment on the programme so any required amendments could be incorporated into the programme. We subsequently engaged with them on a quarterly basis throughout Gate 2 and Gate 3. Results were presented and any potential risks discussed during these sessions.

<sup>8</sup> The Water Framework (Standards and Classification) Directive (England and Wales) 2015 accessed via: [The Water Framework Directive \(Standards and Classification\) Directions \(England and Wales\) 2015 \(legislation.gov.uk\)](#)

<sup>9</sup> Environment Agency statutory and operational EQS accessed via <https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit>

<sup>10</sup> <https://www.legislation.gov.uk/ukxi/2016/614/schedule/1>

<sup>11</sup> <https://www.legislation.gov.uk/ukxi/2016/614/schedule/2>



# RESULTS



# 3. Reporting

Historical reporting on Phases 2 and 3 are available in the GUC Gate 2 Annex B1.4 Water Quality Monitoring report.

The results for each quarter of the Gate 3 monitoring period were published in eight separate Quarterly Water Quality Monitoring Reports. These reports comprise:

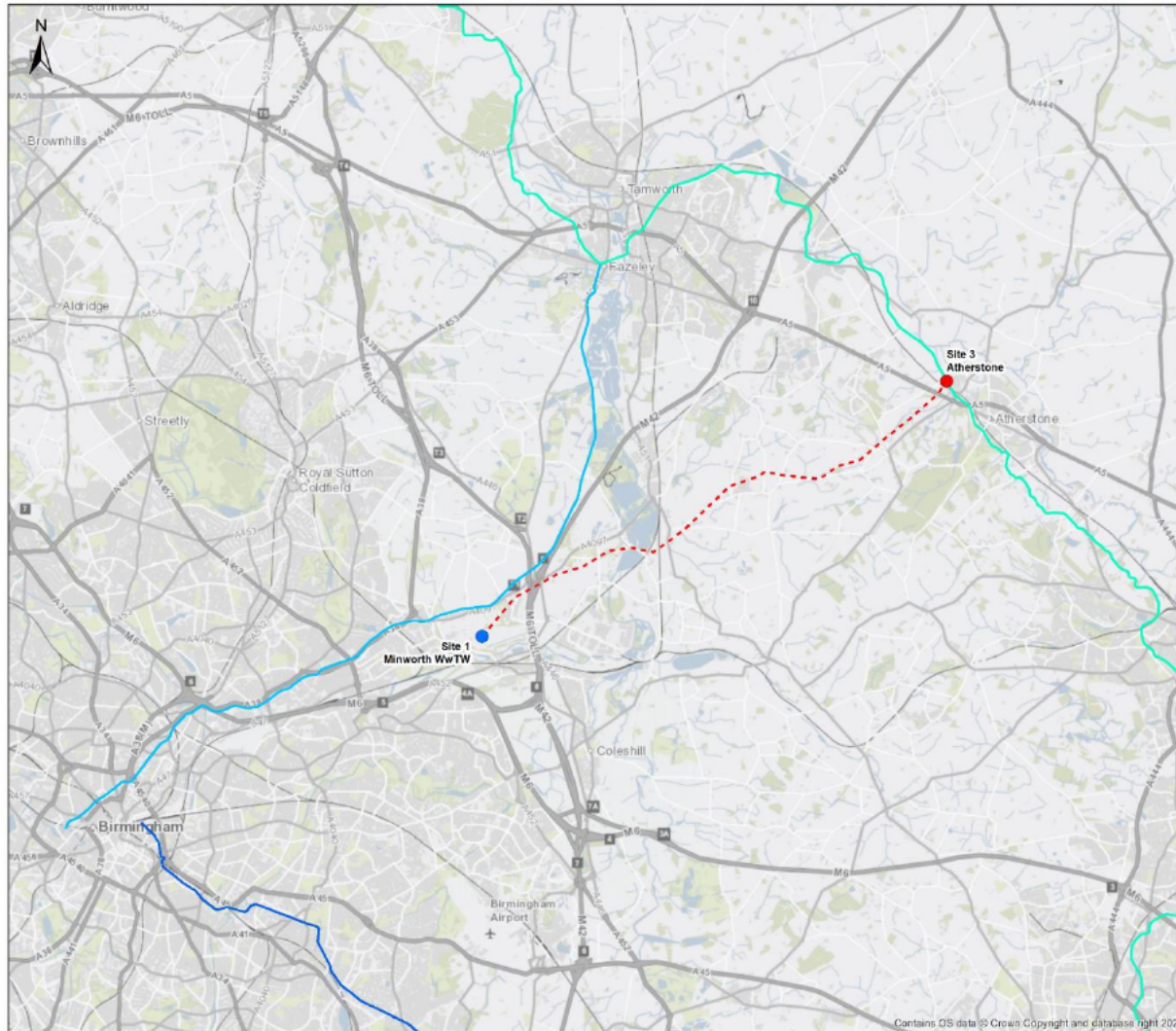
- **ANNEX 1: Phase 4 Q1 Report** – April 2022 – June 2022
- **ANNEX 2: Phase 4 Q2 Report** - July 2022 – September 2022
- **ANNEX 3: Phase 4 Q3 Report** - October 2022 – December 2022
- **ANNEX 4: Phase 4 Q4 Report** - January 2023 – March 2023
- **ANNEX 5: Phase 4 Q5 Report** - April 2023 – June 2023
- **ANNEX 6: Phase 5 Q6 Report** – July 2023 – September 2023
- **ANNEX 7: Phase 5 Q7 Report** – October 2023 – December 2023
- **ANNEX 8: Phase 5 Q8 Report** – January 2024 – March 2024



# APPENDICES



# Appendix A. Monitoring site location maps



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## Grand Union Canal Upper section WQ monitoring locations

### Legend

#### Water Quality Monitoring Locations

- WQ Monitoring: Source - Minworth WwTW Final Effluent
- WQ Monitoring: Discharge Location
- WQ Monitoring Locations
- Sewage Treatment Works
- Potential Discharge Route

#### Watercourses

- Grand Union Canal
- Birmingham & Fazeley Canal
- Coventry Canal



Data sources: Environment Agency,  
Ordnance Survey



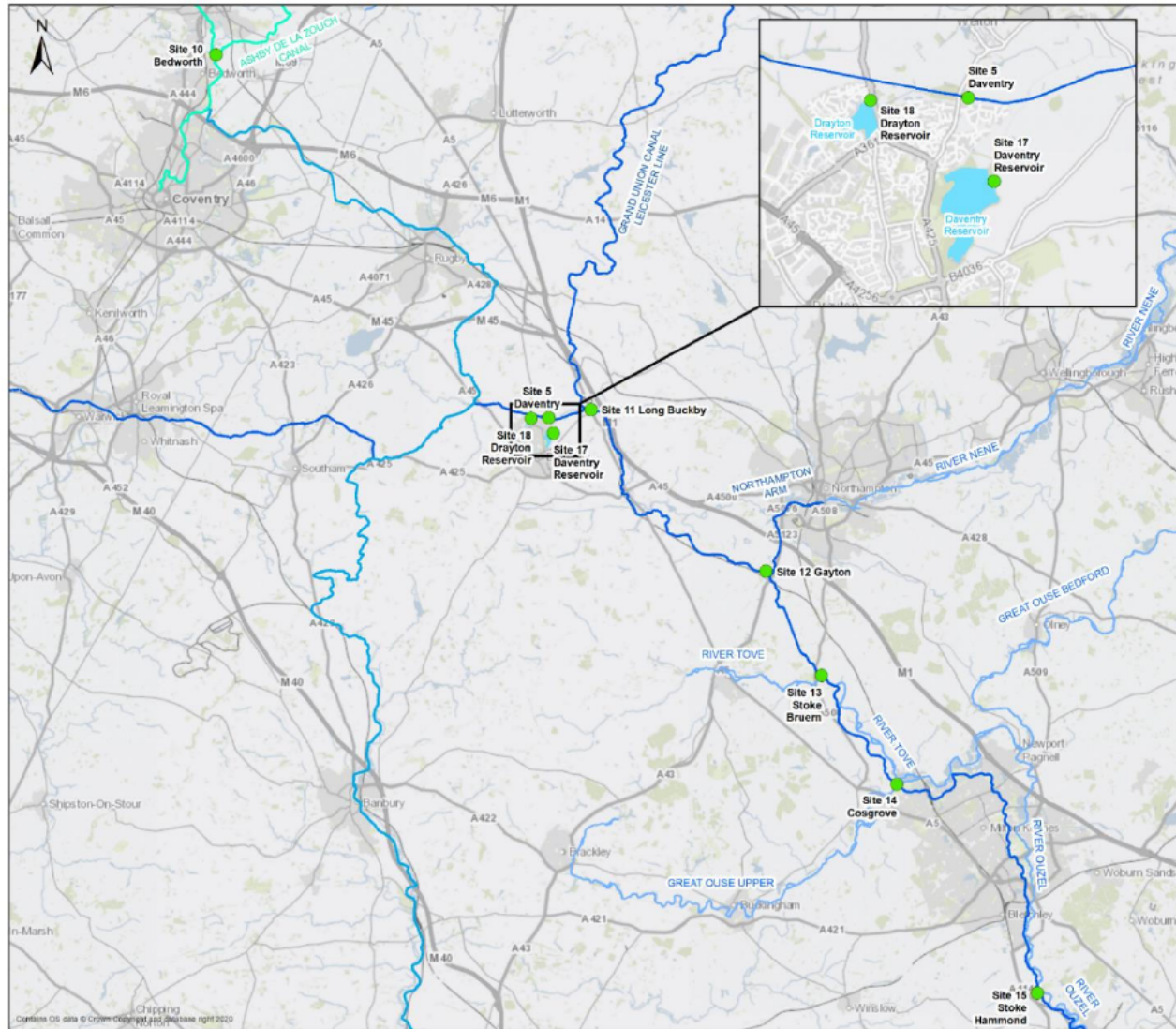
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|         |                   |      |                        |
|---------|-------------------|------|------------------------|
| Status: | Purpose of issue: | Rev: | Model File Identifier: |
| S1      | For Reporting     | 1.0  | -                      |

Reference: 522090  
 01/06/24 01/06/24 01/06/24  
 Woodside Drive, Ashley Road, Epsom, Surrey, KT18 5RW  
 www.atkinsrealis.com





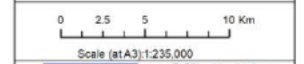
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### Grand Union Canal Middle section WQ monitoring locations

- Legend**
- Water Quality Monitoring Locations
- Watercourses**
- Grand Union Canal
  - Birmingham & Fazeley Canal
  - Coventry Canal
  - Oxford Canal
  - Interacting Main Rivers
  - Daventry Reservoirs



Data sources: Environment Agency, Canal & River Trust, Ordnance Survey



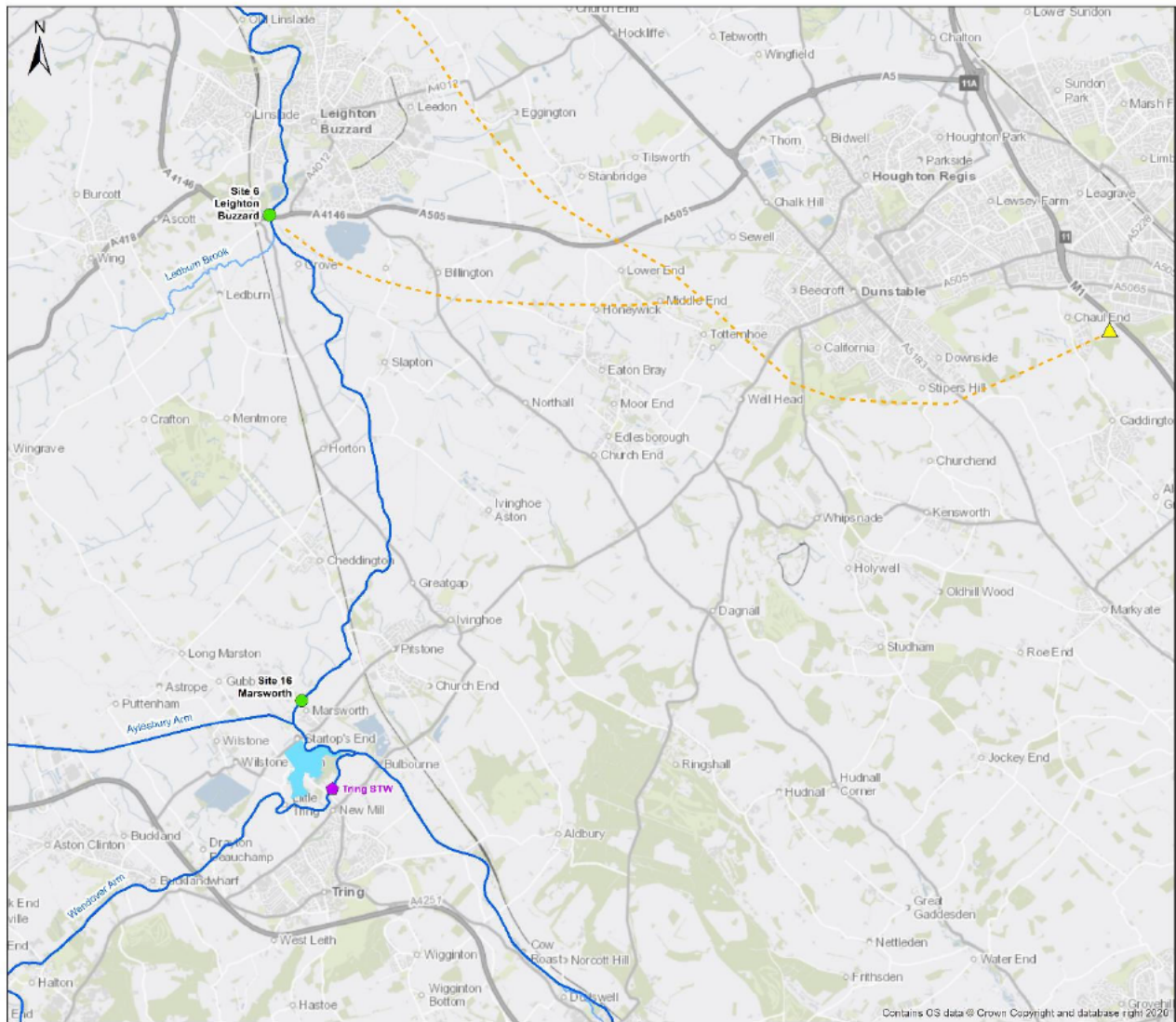
Taking care of your water

|                   |                                 |          |                        |
|-------------------|---------------------------------|----------|------------------------|
| Status: 01        | Purpose of Issue: For Reporting | Rev: 1.0 | Model File Identifier: |
| Reference: 522090 |                                 |          |                        |

Woodbote Grove, Ashley Road, Epsom, Surrey, KT18 5BW  
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Author names redacted





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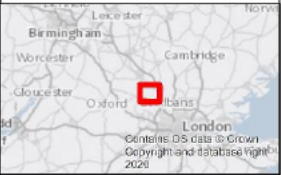
### Grand Union Canal Lower section WQ monitoring locations

#### Legend

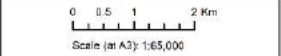
- WQ Monitoring Locations
- ▲ Water Storage Reservoir
- Sewage Treatment Works
- - - Feasible routes from canal to Affinity Water supply area

#### Watercourses

- Grand Union Canal
- Interacting Main Rivers
- Tring Reservoirs



Data sources: Environment Agency, Ordnance Survey



|                       |                                   |             |                                      |
|-----------------------|-----------------------------------|-------------|--------------------------------------|
| Status:<br>24         | Period of Issue:<br>For Reporting | Rev:<br>6.0 | Model File Identifier:<br>[REDACTED] |
| Reference:<br>5222090 |                                   |             |                                      |

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Author names redacted



# Appendix B. Suite 9

| SUITE 9 – WFD + EQSD + DWSP + Emerging Subs + Olfactory | Parameter   | Unit      | LOD <sup>12</sup> | Accreditation <sup>13</sup> |
|---|---|-----------|-------------------|-----------------------------|
| <b>General Parameters</b>                               | pH  | pH        | 0.1 pH unit       | in house                    |
|   | BOD 5   | mg/l      | 1                 | UKAS (sub) UKWIR Validated  |
|   | Chemical Oxygen Demand (COD)  | mg/l      | 5                 | UKAS                        |
|   | Chlorine total  | mg/l      | 0.1               | sub                         |
|   | Chlorine free   | mg/l      | 0.1               | sub                         |
|   | ORP   | mV        | -500              | in house                    |
|   | Reactive phosphorus   | mg/l      | 0.01              | UKAS (sub) UKWIR Validated  |
|   | Total phosphorus  | mg/l      | 0.01              | UKAS (sub) UKWIR Validated  |
|   | Silica Reactive (SiO <sub>2</sub> )   | mg/l      | 0.1               | UKAS                        |
|   | Salinity @ 20°C   | uS/cm     | 1                 | UKAS (sub)                  |
|   | Conductivity @ 20°C   | uS/cm     | 1                 | sub                         |
|   | Bromate   | ug/l      | 2–10              | in-house                    |
|   | Bromide   | mg/l      | 0.01              | in house                    |
|   | Bromine – total residual oxidant  | mg/l      | 0.05              | in house                    |
|   | Fluoride  | mg/l      | 0.01              | in house                    |
|   | Chlorite  | mg/l      | 0.01              | in house                    |
|   | Chlorate  | mg/l      | 0.7               | in house                    |
|   | Chloride as CL  | mg/l      | 0.1               | UKAS                        |
|   | Ortho Phosphate as PO <sub>4</sub>  | mg/l      | 0.01              | UKAS                        |
|   | Sulphate as SO <sub>4</sub>   | mg/l      | 0.1               | UKAS                        |
|   | Ammonium as NH <sub>4</sub>   | mg/l      | 0.1               | UKAS                        |
|   | Ammonia (un-ionised)  | mg/l      | 0.02              | in house                    |
|   | Ammonia (as N)  | mg/l      | 0.1               | UKAS (sub) UKWIR Validated  |
|   | Ammoniacal Nitrogen   | mg/l      | 0.015             | UKAS                        |
|   | Nitrate (as NO <sub>3</sub> )   | mg/l      | 0.1               | UKAS (sub) UKWIR Validated  |
|   | Nitrite (as NO <sub>2</sub> )   | mg/l      | 0.1               | UKAS (sub) UKWIR Validated  |
|   | Nitrite as N  | mg/l      | 0.0306            | UKAS                        |
|   | Nitrate as N  | mg/l      | 0.0227            | UKAS                        |
|   | Nitrite & Nitrate calculation   | mg/l      | 1.0227            | UKAS                        |
|   | Total nitrogen (oxidised as N)  | mg/l      | 5                 | UKAS (sub) UKWIR Validated  |
|   | Kjeldahl nitrogen   | mg/l      | 0.2               | UKAS                        |
|   | Organic nitrogen  | mg/l      | calc              | calc from above             |
|   | Total anions (sum of Br, Cl, F, NO <sub>2</sub> , NO <sub>3</sub> , PO <sub>4</sub> , SO <sub>4</sub> ) | mg/l      |                   | in house                    |
|   | Cyanide Free (easily liberable)   | ug/l      | 0.1               | UKAS                        |
|   | Cyanide Total   | ug/l      | 0.1               | UKAS (sub)                  |
|   | Sulphide or hydrogen sulphide   | ug/l      | 10                | UKAS                        |
|   | Alkalinity as CaCO <sub>3</sub>   | mg/l      | 10                | UKAS (sub)                  |
|   | Alkalinity as HCO <sub>3</sub>  | mg/l      | 10                |                             |
|   | Acid Neutralisation Capacity (ANC) (unfiltered)   | mg/l      | 5                 | UKAS (sub)                  |
|   | Hardness as CaCO <sub>3</sub>   | mg/l      | 0.1               | UKAS (sub)                  |
|   | Hardness Total as CA  | mg/l      | 0.04              | UKAS                        |
|   | Dissolved organic carbon  | mg/l      | 0.5               | UKAS (sub) UKWIR Validated  |
|   | Total organic carbon  | mg/l      | 1                 | UKAS (sub) UKWIR Validated  |
|   | Particulate Organic Carbon (calculated from TOC and DOC results)  | ug/l      | 0.5               | in house                    |
|   | Turbidity (NTU)   | NTU       | 1                 | UKAS                        |
|   | Colour  | mg/lPt/Co | 1                 | UKAS                        |
|   | Solids, Suspended @ 105°C   | mg/l      | 2                 | UKAS                        |
|   | Total Dry Solids @ 180°C  | mg/l      | 2                 | UKAS                        |
|   | Dissolved solids  | mg/l      | 2                 | calculation                 |
|   | Chlorophyll   | ug/l      | 10                | in house                    |
| Phaeophytin   | ug/l  | 20        | in house          |                             |
| <b>Microbiology</b>                                     | Algae cell count (total algal cells)  | no        | /ml               | sub                         |

<sup>12</sup> The LOD will be raised if the sample needs diluting during analysis

<sup>13</sup> Indicates UKAS ISO 17025 accreditation / UKWIR validation for testing and calibration laboratories. 'In house' and 'sub' indicates an unaccredited test.



| SUITE 9 – WFD + EQSD + DWSP + Emerging Subs + Olfactory | Parameter   | Unit      | LOD <sup>12</sup> | Accreditation <sup>13</sup> |
|---|---|-----------|-------------------|-----------------------------|
|   | Algal speciation (diatoms/blue-green cyanobacteria etc) | n/a       | n/a               | sub                         |
|   | Somatic Coliphages                                      | pfu       | /ml               | sub                         |
|   | Legionella  | cfu       |                   | sub                         |
|   | 22C PC NEAT (PLATE COUNT)                               | no/ml     | /ml               | UKAS (sub)                  |
|   | 37C PC NEAT (PLATE COUNT)                               | no/ml     | /ml               | UKAS (sub)                  |
|   | Odour   | coded     |                   | UKAS (sub)                  |
|   | CL. PERFRINGENS-VEG & SPORES CONFIRMED                  | no/100ml  | /100ml            | UKAS (sub)                  |
|   | CRYPTOSPORIDIUM   | no/litre  | /10 Litres        | UKAS (sub)                  |
|   | number of crypto like bodies 4-6um                      | /10L      | /10L              |                             |
|   | Giardia   | no/litre  | /10 Litres        | UKAS (sub)                  |
|   | Oocyst Count  | Number    |                   | UKAS (sub)                  |
|   | Enterococci Confirmed                                   | no/100ml  | /100ml            | UKAS (sub)                  |
|   | Coliform Total  | MPN/100ml | /100ml            | UKAS (sub)                  |
|   | E. coli   | MPN/100ml |                   | UKAS (sub)                  |
|   | PSEUDOMONAS CONFIRMED                                   | no/100ml  | /100ml            | UKAS (sub)                  |
| <b>Radioactivity</b>                                    | ALPHA ACTIVITY – TOTAL                                  | Bq/l      | 0.02              | UKAS (sub)                  |
|   | BETA ACTIVITY – TOTAL                                   | Bq/l      | 0.04              | UKAS (sub)                  |
|   | RADON   | Bq/l      | 10                | UKAS (sub)                  |
|   | TRITIUM   | Bq/l      | 10                | UKAS (sub)                  |
| <b>Metals</b>   | Aluminium Total   | ug/l      | 10                | in-house UKWIR Validated    |
|   | Aluminium Dissolved*                                    | ug/l      | 10                | UKAS                        |
|   | Antimony Total  | ug/l      | 0.17              | in-house                    |
|   | Antimony Dissolved*                                     | ug/l      | 0.17              | UKAS                        |
|   | Arsenic Total   | ug/l      | 0.16              | in-house UKWIR Validated    |
|   | Arsenic Dissolved *                                     | ug/l      | 0.16              | UKAS (sub) UKWIR Validated  |
|   | Barium Total  | ug/l      | 0.26              | in-house                    |
|   | Barium Dissolved  | ug/l      | 0.26              | UKAS                        |
|   | Beryllium Total   | ug/l      | 0.1               | in-house                    |
|   | Beryllium Dissolved                                     | ug/l      | 0.1               | in-house                    |
|   | Boron Total   | ug/l      | 12                | in-house                    |
|   | Boron Dissolved   | ug/l      | 12                | in-house                    |
|   | Cadmium Total   | ug/l      | 0.02              | in-house UKWIR Validated    |
|   | Cadmium Dissolved *                                     | ug/l      | 0.02              | UKAS UKWIR Validated        |
|   | Cobalt Total  | ug/l      | 0.16              | in-house                    |
|   | Cobalt Dissolved  | ug/l      | 0.16              | UKAS                        |
|   | Calcium Total   | mg/l      | 0.09              | in-house                    |
|   | Calcium Dissolved                                       | mg/l      | 0.09              | UKAS                        |
|   | Copper Total  | ug/l      | 0.4               | in-house UKWIR Validated    |
|   | Copper Dissolved  | ug/l      | 0.4               | UKAS UKWIR Validated        |
|   | Chromium(III) Dissolved*                                | ug/l      | 1                 | UKAS                        |
|   | Chromium(VI) Dissolved*                                 | ug/l      | 0.05              | in house                    |
|   | Chromium Dissolved                                      | ug/l      | 0.25              | in-house UKWIR Validated    |
|   | Chromium Total  | ug/l      | 0.25              | in-house                    |
|   | Iron Total  | ug/l      | 5.5               | in-house UKWIR Validated    |
|   | Iron Dissolved  | ug/l      | 5.5               | UKAS UKWIR Validated        |
|   | Lead Total  | ug/l      | 0.09              | in-house UKWIR Validated    |
|   | Lead Dissolved  | ug/l      | 0.09              | UKAS UKWIR Validated        |
|   | Magnesium Total   | mg/l      | 0.02              | in-house                    |
|   | Magnesium Dissolved*                                    | mg/l      | 0.02              | UKAS                        |
|   | Manganese Total   | ug/l      | 10                | in-house UKWIR Validated    |
|   | Manganese Dissolved*                                    | ug/l      | 0.22              | UKAS UKWIR Validated        |
|   | Mercury Total   | ug/l      | 0.001             | in-house UKWIR Validated    |
|   | Mercury Dissolved*                                      | ug/l      | 0.001             | UKAS UKWIR Validated        |
|   | Molybdenum Total  | ug/l      | 1.1               | in-house                    |
|   | Molybdenum Dissolved*                                   | ug/l      | 1.1               | UKAS                        |
|   | Nickel Total  | ug/l      | 0.5               | in-house UKWIR Validated    |
|   | Nickel Dissolved*                                       | ug/l      | 0.5               | UKAS UKWIR Validated        |
|   | Potassium Total   | mg/l      | 0.08              | in-house                    |
|   | Potassium Dissolved*                                    | mg/l      | 0.08              | UKAS                        |
|   | Selenium Total  | ug/l      | 0.25              | in-house                    |
|   | Selenium Dissolved*                                     | ug/l      | 0.25              | UKAS                        |
|   | Silver Total  | ug/l      | 1                 | in-house                    |
|   | Silver Dissolved*                                       | ug/l      | 1                 | UKAS                        |

| SUITE 9 – WFD + EQSD + DWSP + Emerging Subs + Olfactory | Parameter  | Unit  | LOD <sup>12</sup>    | Accreditation <sup>13</sup> |
|---|--|-------|----------------------|-----------------------------|
|   | Sodium Total   | mg/l  | 0.07                 | in-house                    |
|   | Sodium Dissolved*  | mg/l  | 0.07                 | UKAS                        |
|   | Strontium Total  | mg/l  | 0.4                  | in-house                    |
|   | Strontium Dissolved*   | mg/l  | 0.4                  | UKAS                        |
|   | Tin Total  | ug/l  | 0.4                  | in-house                    |
|   | Tin Dissolved*   | ug/l  | 0.4                  | UKAS                        |
|   | Titanium Total   | ug/l  | 0.3                  | in-house                    |
|   | Titanium Dissolved*  | ug/l  | 0.3                  | UKAS                        |
|   | Tungsten Total   | ug/l  | 10                   | in-house                    |
|   | Tungsten Dissolved*  | ug/l  | 10                   | in-house                    |
|   | Uranium Total  | ug/l  | 10                   | in-house                    |
|   | Vanadium Total   | ug/l  | 10                   | in-house                    |
|   | Vanadium Dissolved*  | ug/l  | 10                   | UKAS                        |
|   | Zinc Total   | ug/l  | 0.5                  | in-house UKWIR Validated    |
| Zinc Dissolved*   | ug/l   | 0.5   | UKAS UKWIR Validated |                             |
| Organo Phosphorous Pesticide Suite                      | Diazinon   | ug/l  | 0.01                 | in house                    |
|   | Dimethoate   | ug/l  | 0.02                 | in house                    |
|   | Chlorfenvinphos  | ug/l  | 0.02                 | in house                    |
|   | Chlorpyrifos (Chlorpyrifosethyl)                                       | ug/l  | 0.02                 | in house                    |
|   | Dichlorvos   | ug/l  | 0.001                | in house                    |
|   | Propetamphos   | ug/l  | 0.02                 | In house                    |
|   | Parathion  | ug/l  | 0.02                 | In house                    |
|   | Cyanazine  | ug/l  | 0.02                 | In house                    |
|   | Tributyl phosphate   | ug/l  | 0.02                 | in house                    |
|   | Coumaphos  | ug/l  | 0.02                 | in house                    |
|   | Demetons   | ug/l  | 0.02                 | in house                    |
|   | Fenchlorphos   | ug/l  | 0.02                 | in house                    |
|   | Fenitrothion   | ug/l  | 0.01                 | in house                    |
|   | Mevinphos  | ug/l  | 0.02                 | in house                    |
|   | Omethoate  | ug/l  | 0.01                 | in house                    |
|   | Pirimiphos-methyl  | ug/l  | 0.01                 | in house                    |
|   | Malathion  | ug/l  | 0.02                 | In-house                    |
|   | Azinphos methyl (dissolved) this needs separate run after filtration * | ug/l  | 0.02                 | in house                    |
| Acid Herbicide Suite                                    | 2, 4 Dichlorophenoxyacetic acid (2, 4 D)                               | ug/l  | 0.02                 | UKAS                        |
|   | Mecoprop   | ug/l  | 0.02                 | UKAS                        |
|   | Pentachloro-phenol   | ug/l  | 0.02                 | UKAS                        |
|   | 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)                            | ug/l  | 0.02                 | UKAS                        |
|   | 4-(2,4-dichlorophenoxy)butanoic acid (2,4-DB)                          | ug/l  | 0.02                 | UKAS                        |
|   | MCPA   | ug/l  | 0.02                 | UKAS                        |
|   | MCPB   | ug/l  | 0.02                 | In-house                    |
|   | Bentazone  | ug/l  | 0.02                 | UKAS                        |
|   | Bromoxynil   | ug/l  | 0.02                 | In-house                    |
|   | Clopyralid   | ug/l  | 0.02                 | UKAS                        |
|   | Dicamba  | ug/l  | 0.02                 | In-house                    |
|   | Dalapon  | ug/l  | 0.02                 | In-house                    |
|   | loxynil  | ug/l  | 0.02                 | In-house                    |
|   | Dichloprop   | ug/l  | 0.02                 | UKAS                        |
|   | Fenoprop   | ug/l  | 0.02                 | UKAS                        |
|   | Fluroxypyr   | ug/l  | 0.02                 | In-house                    |
|   | Triclopyr  | ug/l  | 0.02                 | In house                    |
|   | Picloram   | ug/l  | 0.02                 | In house                    |
|   | Propyzamide  | ug/l  | 0.01                 | In house                    |
|   | Quinmerac  | ug/l  | 0.02                 | In house                    |
|   | Bromanil   | ug/l  | 0.02                 | in house                    |
| Benazolin   | ug/l   | 0.025 | In-house             |                             |
| Carbamate pesticide                                     | Carbendazim  | ug/l  | 0.1                  | in house                    |
| Fungicide   | Methiocarb   | ug/l  | 0.1                  | in house                    |
| Uron Herbicide Suite                                    | Linuron  | ug/l  | 0.01                 | in house                    |
|   | Diuron   | ug/l  | 0.05                 | UKWIR Validated             |
|   | Isoproturon  | ug/l  | 0.002                | in house                    |

| SUITE 9 – WFD + EQSD + DWSP + Emerging Subs + Olfactory | Parameter  | Unit | LOD <sup>12</sup>  | Accreditation <sup>13</sup> |
|---|--|------|--------------------|-----------------------------|
|   | Monuron  | ug/l | 0.05               | In-house                    |
|   | Diflubenzuron  | ug/l | 0.001              | in house                    |
| OCL Insecticide Suite                                   | Alachor  | ug/l | 0.02               | in house                    |
|   | Aldrin   | ug/l | 0.02               | in house                    |
|   | Dieldrin   | ug/l | 0.02               | in house                    |
|   | Endrin   | ug/l | 0.02               | in house                    |
|   | Isodrin  | ug/l | 0.02               | in house                    |
|   | DDT total  | ug/l | 0.025              | in house                    |
|   | para-para-DDT (CAS 50-29-3)  | ug/l | 0.01               | in house                    |
|   | ortho-para-DDT (CAS 789-02-6)  | ug/l | 0.01               | in house                    |
|   | TDE OP* or p'p'-DDD (CAS 72-54-8)  | ug/l | 0.01               | In house                    |
|   | TDE PP* or o'p'-DDD (CAS 53-19-0)  | ug/l | 0.01               | In house                    |
|   | para-para-DDE (CAS 75-55-9)  | ug/l | 0.02               | In house                    |
|   | Endosulfan   | ug/l | 0.02               | in house                    |
|   | Hexachloro-benzene   | ug/l | 0.02               | in house                    |
|   | Hexachloro-butadiene   | ug/l | 0.02               | in house                    |
|   | Hexachloro-cyclohexane   | ug/l | 0.02               | in house                    |
|   | Pentachloro-benzene  | ug/l | 0.007              | in house                    |
|   | Trifluralin  | ug/l | 0.02               | in house                    |
|   | Dicofol  | ug/l | 0.0013             | in house                    |
|   | Heptachlor and heptachlor epoxide  | ug/l | 0.001              | in house                    |
|   | HCH – Gamma isomer   | ug/l | 0.02               | In-house                    |
|   | HCH – Alpha isomer   | ug/l | 0.02               | In-house                    |
|   | HCH – Beta isomer  | ug/l | 0.02               | In-house                    |
|   | HCH – Delta isomer   | ug/l | 0.02               | In-house                    |
|   | Methoxychlor   | ug/l | 0.02               | In-house                    |
|   | Dichlorobenil  | ug/l | 0.02               | In-house                    |
|   | Chlordane  | ug/l | 0.02               | In-house                    |
|   | Tecnazene  | ug/l | 0.02               | In house                    |
| Triallate   | ug/l   | 0.02 | in house           |                             |
|   | Cyclodiene pesticides – total aldrin, dieldrin, endrin and isodrin                     |      |                    | in house                    |
| Polyaromatic hydrocarbons PAH Suite                     | Polyaromatic hydrocarbons (PAH) Total  | ug/l | see individual RLs | UKWIR Validated             |
|   | Naphthalene  | ug/l | 0.02               | in house                    |
|   | Fluoranthene   | ug/l | 0.0009             | UKWIR Validated             |
|   | Anthracene   | ug/l | 0.02               | in house                    |
|   | Benzo(a)pyrene   | ug/l | 0.00017            | UKWIR Validated             |
|   | Benzo(b)fluoranthene   | ug/l | 0.0001             | UKWIR Validated             |
|   | Benzo(k)fluoranthene   | ug/l | 0.0001             | UKWIR Validated             |
|   | Benzo(g,h,i)-perylene  | ug/l | 0.0003             | UKWIR Validated             |
|   | Indeno(1,2,3-cd)-pyrene  | ug/l | 0.0003             | UKWIR Validated             |
| Triazine suite  | Atrazine   | ug/l | 0.02               | in house                    |
|   | Simazine   | ug/l | 0.02               | in house                    |
|   | Terbutryn  | ug/l | 0.02               | in house                    |
|   | Desethyl Atrazine  | ug/l | 0.02               | In house                    |
|   | Tebuthiuron  | ug/l | 0.02               | In house                    |
|   | Propazine  | ug/l | 0.02               | In house                    |
|   | Promethryn   | ug/l | 0.02               | In house                    |
| Phthalates  | Di(2-ethylhexyl)-phthalate (DEHP)  | ug/l | 0.15               | UKWIR Validated             |
|   | Benzyl butyl phthalate   | ug/l | 0.2                | in house                    |
|   | D butyl phthalate  | ug/l | 0.02               | in house                    |
|   | Diethyl phthalate  | ug/l | 0.02               | in house                    |
|   | Dimethyl phthalate   | ug/l | 0.02               | in house                    |
|   | Dioctyl phthalate  | ug/l | 0.02               | in house                    |
| Other WFD parameters                                    | Brominated diphenylethers Total (sum of BDE penta congeners 28,47,99,100,153,154, 183) | ug/l | 0.0005             | UKWIR Validated             |
|   | BDE 28   | ug/l | 0.0001             | UKWIR Validated             |
|   | BDE 47   | ug/l | 0.0001             | UKWIR Validated             |
|   | BDE 99   | ug/l | 0.0001             | UKWIR Validated             |
|   | BDE 100  | ug/l | 0.0001             | UKWIR Validated             |
|   | BDE 153  | ug/l | 0.0001             | UKWIR Validated             |
|   | BDE 154  | ug/l | 0.0001             | UKWIR Validated             |
|   | BDE 183  | ug/l | 1.0001             | UKWIR Validated             |



| SUITE 9 – WFD + EQSD + DWSP + Emerging Subs + Olfactory | Parameter   | Unit | LOD <sup>12</sup>                            | Accreditation <sup>13</sup>       |
|---|---|------|--|-----------------------------------|
|   | C10-13 Chloroalkanes (total)  | ug/l | 0.4  | UKWIR Validated                   |
|   | Triclosan   | ug/l | 0.01   | UKAS and UKWIR Validated          |
|   | Nonylphenols (4-Nonylphenol Technical Mix)                                | ug/l | 0.04   | UKWIR Validated submitted to UKAS |
|   | 4-n-nonylphenol (104-40-5)  | ug/l | 0.04   |                                   |
|   | Nonylphenol ethoxylates (sum of NPEO 1-3)                                 | ug/l | 0.12   | UKWIR Validated submitted to UKAS |
|   | Nonylphenol monoethoxylate NPEO1  | ug/l | 0.04   | UKWIR Validated submitted to UKAS |
|   | Nonylphenol diethoxylate NPEO2  | ug/l | 0.04   | UKWIR Validated submitted to UKAS |
|   | Nonylphenol triethoxylate NPEO3   | ug/l | 0.04   | UKWIR Validated submitted to UKAS |
|   | Octylphenols ((4-(1,1', 3,3'-tetramethylbutyl)-phenol))                   | ug/l | 0.01   | UKWIR Validated                   |
|   | Octylphenol ethoxylates (Sum OPEO 1-3)                                    | ug/l | 0.06   | UKWIR Validated                   |
|   | Octylphenol monoethoxylate (OPEO1)  | ug/l | 0.02   | UKWIR Validated                   |
|   | Octylphenol diethoxylate (OPEO2)  | ug/l | 0.02   | UKWIR Validated                   |
|   | Octylphenol triethoxylate (OPEO3)   | ug/l | 0.02   | UKWIR Validated                   |
|   | Tributyltin compounds (as Tributyltin cation)                             | ug/l | 0.00002                                      | UKAS and UKWIR validated          |
|   | Triphenyltin compounds (as triphenyltin cation)                           | ug/l | 0.002  | in house                          |
|   | PFAS List of 54 drinking water level                                      | ug/l | 0.0001–0.005                                 | in-house                          |
|   | Perfluorooctane sulfonic acid and its derivatives (PFOS & PFOA) WFD level | ug/l | 0.0002                                       | UKAS and UKWIR validated          |
|   | Bisphenol A (already in GUC)  | ug/l | 0.01   | UKWIR Validation                  |
|   | Bisphenol F   | ug/l | 0.01   | in house                          |
|   | Bisphenol S   | ug/l | 0.01   | UKWIR Validation                  |
|   | Hexabromocyclododecane (HBCDD)  | ug/l | 0.00014 total and 0.00004 individual isomers | UKAS and UKWIR validated          |
|   | Phenol  | ug/l | 1  | UKWIR Validated                   |
| Steroids and pharmaceuticals                            | Oesterone (E1)  | ug/l | 0.001  | UKWIR Validated                   |
|   | 17β oestradiol (E2)   | ug/l | 0.0003                                       | UKWIR Validated                   |
|   | 17α ethinyloestradiol (EE2)   | ug/l | 0.00003                                      | UKWIR Validated                   |
|   | Trenbolone  | ug/l | 0.1  | in house                          |
|   | 19-norethindron   | ug/l | 0.1  | in house                          |
|   | Levonorgesterel   | ug/l | 0.5  | in house                          |
|   | Ibuprofen   | ug/l | 0.01   | UKWIR Validation                  |
|   | Chlorophene   | ug/l | 0.02   | in-house                          |
|   | Flutamide   | ug/l | 0.1  | in-house                          |
|   | Raloxifene  | ug/l | 0.5  | in-house                          |
|   | Viclozolin metabolite M2  | ug/l | 1  | in-house                          |
| PCBs  | PCB 28  | ug/l | 0.005  | in house                          |
|   | PCB 52  | ug/l | 0.005  | in house                          |
|   | PCB 101   | ug/l | 0.005  | in house                          |
|   | PCB 118   | ug/l | 0.005  | in house                          |
|   | PCB 136   | ug/l | 0.005  | in house                          |
|   | PCB 153   | ug/l | 0.005  | in house                          |
|   | PCB 180   | ug/l | 0.005  | in house                          |
| VOC Suite   | 3, 4 Dichloroaniline  | ug/l | 1  | in house                          |
|   | Tetrachloroethane   | ug/l | 0.1  | in house                          |
|   | 1,2-Dichloroethane  | ug/l | 1  | in house                          |
|   | Dichloromethane   | ug/l | 1  | in house                          |
|   | Tetrachloroethylene   | ug/l | 1  | in house                          |
|   | Trichloroethylene   | ug/l | 1  | in house                          |
|   | Trichlorobenzenes   | ug/l | 0.4  | in house                          |
|   | Trichloromethane  | ug/l | 1  | in house                          |
|   | 1,2-Dibromoethane   | ug/l | 1  | in house                          |
|   | Carbon tetrachloride or Tethachloromethane                                | ug/l | 1  | in house                          |
|   | D bromochloromethane  | ug/l | 1  | In house                          |
|   | Dichlorobenzene – total dichlorobenzene isomers                           | ug/l | 0.1  | in house                          |
|   | Styrene   |      | 0.1  | in house                          |
|   | Vinyl Chloride  | ug/l | 0.1  | in house                          |

| SUITE 9 – WFD + EQSD + DWSP + Emerging Subs + Olfactory | Parameter  | Unit | LOD <sup>12</sup> | Accreditation <sup>13</sup> |
|---|--|------|-------------------|-----------------------------|
| <b>THMs</b>   | Bromodichloromethane                                       | ug/l | 1                 | In house                    |
|   | Bromoform  | ug/l | 1                 | In house                    |
|   | Chloroform   | ug/l | 1                 | In house                    |
|   | Tetrachloroethane  | ug/l | 1                 | In house                    |
|   | Trichloroethane (1 1 1)                                    | ug/l | 1                 | In house                    |
|   | Trichloroethane (1 1 2)                                    | ug/l | 1                 | In house                    |
|   | Tetra & Trichloroethane TOTAL                              | ug/l | 1                 | In house                    |
|   | THM TOTAL  | ug/l |                   | In house                    |
| <b>MTBE</b>   | MTBE   | ug/l | 1                 | in house                    |
| <b>BTEX</b>   | BTEX total (Benzene, Toluene, Ethylbenzene & o,p -Xylenes) | ug/l | 1                 | in house                    |
|   | Benzene  | ug/l | 0.1               | in house                    |
|   | Toluene  | ug/l | 0.1               | in house                    |
|   | Ethylbenzene   | ug/l | 0.1               | in house                    |
|   | m,p-Xylene   | ug/l | 0.1               | in-house                    |
|   | O-Xylene   | ug/l | 0.1               | in-house                    |
| <b>1,4-Dioxane</b>                                      | 1,4-dioxane  | ug/l | 1                 | in-house                    |
| <b>Quinolines</b>                                       | Quinoxifen   | ug/l | 0.1               | in house                    |
|   | Aclonifen  | ug/l | 0.1               | in house                    |
| <b>Algicides and other herbicides</b>                   | BifenoX  | ug/l | 0.012             | in house                    |
|   | Cybutryne (irgarol)  | ug/l | 0.0025            | in house                    |
|   | Pendimethalin  | ug/l | 0.02              | in house                    |
|   | Glyphosate   | ug/l | 0.1               | UKAS and UKWIR Validated    |
|   | AMPA   | ug/l | 0.1               | UKAS and UKWIR Validated    |
| <b>Fungicides</b>                                       | Chlorothalonil   | ug/l | 0.035             | in house                    |
| <b>Insecticides</b>                                     | Permethrin   | ug/l | 0.001             | in house                    |
|   | Cyfluthrin   | ug/l | 0.1               | in house                    |
|   | Cypermethrin   | ug/l | 0.00008           | UKAS and UKWIR validated    |
| <b>Acid hebicide precursor</b>                          | 2,4-Dichlorophenol   | ug/l | 0.02              | in house                    |
| <b>Growth regulator</b>                                 | 2,3,6-Trichlorobenzoic acid (2,3,6-TBA)                    | ug/l |                   | in house                    |
| <b>Phenol Suite 4</b>                                   | 2-METHYL PHENOL  | ug/l | 0.02              | In house                    |
|   | 3-METHYL PHENOL  | ug/l | 0.02              | In house                    |
|   | 4-METHYL PHENOL  | ug/l | 0.02              | In house                    |
|   | TRICHLOROPHENOL (2 4 5)                                    | ug/l | 0.02              | In house                    |
|   | TRICHLOROPHENOL (2 4 6)                                    | ug/l | 0.02              | In house                    |
|   | DIMETHYLPHENOL (2 4)                                       | ug/l | 0.02              | In house                    |
|   | DIMETHYLPHENOL (2 5)                                       | ug/l | 0.02              | In house                    |
|   | DIMETHYLPHENOL (3 5)                                       | ug/l | 0.02              | In house                    |
|   | 4-CHLORO-3-METHYLPHENOL                                    | ug/l | 0.02              | In house                    |
|   | CHLOROMETHYLPHENOL (4 3)                                   | ug/l | 0.02              | In house                    |
|   | CHLOROPHENOL (2)   | ug/l | 0.02              | In house                    |
|   | CHLOROPHENOL (3)   | ug/l | 0.02              | In house                    |
|   | CHLOROPHENOL (4)   | ug/l | 0.02              | In house                    |
| <b>EDD/EMD</b>  | 2 EDD  | ug/l | 0.1               | in house                    |
|   | 2 EMD  | ug/l | 0.1               | in house                    |
| <b>DTCs</b>   | Mancozeb   | ug/l | 0.1               | in house                    |
|   | Maneb  | ug/l | 0.1               | in house                    |
| <b>Mectins</b>  | Abamectin  | ug/l | 5                 | in house                    |
|   | Doramectin   | ug/l | 5                 | in house                    |
|   | Ivermectin   | ug/l | 5                 | in house                    |
| <b>Mitins</b>   | Flucofuron   | ug/l | 0.05              | in house                    |
|   | Sulcofuron   | ug/l | 0.05              | in house                    |
| <b>Imadazoles</b>                                       | Pirimicarb   | ug/l | 1                 | in house                    |
|   | Prochloraz   | ug/l | 0.1               | in house                    |
|   | Thiabendazole  | ug/l | 0.1               | in house                    |
| <b>Chelating agents</b>                                 | EDTA   | ug/l | 100               | in house                    |
|   | Nitriloacetic acid (NTA)                                   | ug/l | 100               | in house                    |
| <b>DHC VOCs</b>   | DHC BENZENE*   | ug/l | 0.1               | in house                    |
|   | DHC CUMENE*  | ug/l | 0.1               | in house                    |
|   | DHC DECANE*  | ug/l | 0.1               | in house                    |
|   | DHC ETHYL BENZENE*   | ug/l | 0.1               | in house                    |
|   | DHC HEPTANE*   | ug/l | 0.1               | in house                    |
|   | DHC NAPHTHALENE*   | ug/l | 0.1               | in house                    |



| SUITE 9 – WFD + EQSD + DWSP + Emerging Subs + Olfactory  | Parameter  | Unit               | LOD <sup>12</sup> | Accreditation <sup>13</sup> |
|--|--|--------------------|-------------------|-----------------------------|
|  | DHC OCTANE*                                      | ug/l               | 0.1               | in house                    |
|  | DHC PHENANTHRACENE*                              | ug/l               | 0.1               | in house                    |
|  | DHC TETRADECANE*                                 | ug/l               | 0.1               | in house                    |
|  | DHC TOLUENE*                                     | ug/l               | 0.1               | in house                    |
| <b>Alkylbenzene-sulfonates</b> Including : Branched sodium Dodecylbenzene sulfonate; Linear sodium Dodecylbenzene sulfonate; calcium dodecylbenzene sulfonate; sodium tridecylbenzene sulfonate; triethanolammonium dodecylbenzene sulfonate | sum of C10–C14 alkyl benzene sulfonic acids      | mg/l               | 0.1               | in house                    |
|  | C10 alkyl benzene sulfonic acids                 | mg/l               | 0.02              | in house                    |
|  | C11 alkyl benzene sulfonic acids                 | mg/l               | 0.02              | in house                    |
|  | C12 alkyl benzene sulfonic acids                 | mg/l               | 0.02              | in house                    |
|  | C13 alkyl benzene sulfonic acids                 | mg/l               | 0.02              | in house                    |
|  | C14 alkyl benzene sulfonic acids                 | mg/l               | 0.02              | in house                    |
|  | p-Toluenesulfonic acid                           | ug/l               | 0.02              | in house                    |
| <b>Diamines</b>  | 1,6-hexanediamine                                | ug/l               | 10                | in house                    |
| <b>Quaternary Ammonium Compounds</b>   | Benza konium chlorides (as BAC 10,12,14 and 16)  | ug/l               | 10                | in house                    |
|  | Dodecylammonium chloride                         | ug/l               | 10                | in house                    |
|  | Quaternium 18 (cas 61789-80-8)                   | ug/l               | 10                | in house                    |
|  | Stearyl dimethylbenzyl ammonium chloride (BAC18) | ug/l               | 10                | in house                    |
| <b>Haloacetic acids</b>  | bromoacetic acid                                 | ug/l               | 1                 | in house                    |
|  | bromochloroacetic acid                           | ug/l               | 1                 | in house                    |
|  | chloroacetic acid                                | ug/l               | 1                 | in house                    |
|  | dibromochloroacetic acid                         | ug/l               | 1                 | in house                    |
|  | dibromoacetic acid                               | ug/l               | 1                 | in house                    |
|  | dichlorobromoacetic acid                         | ug/l               | 1                 | in house                    |
|  | dichloroacetic acid                              | ug/l               | 1                 | in house                    |
|  | tribromoacetic acid                              | ug/l               | 1                 | in house                    |
|  | trichloroacetic acid                             | ug/l               | 1                 | in house                    |
| <b>Nitrosamines</b>  | NDMA   | ug/l               | 0.001             | in house                    |
|  | NMEA   | ug/l               | 0.001             | in house                    |
|  | NDEA   | ug/l               | 0.001             | in house                    |
|  | NDPA   | ug/l               | 0.001             | in house                    |
|  | NDBA   | ug/l               | 0.001             | in house                    |
|  | NPIP   | ug/l               | 0.001             | in house                    |
|  | NPYR   | ug/l               | 0.001             | in house                    |
|  | NMOR   | ug/l               | 0.001             | in house                    |
| <b>Phosphonates</b>  | ATMP   | ug/l               | 1                 | in house                    |
|  | DTPMP  | ug/l               | 1                 | in house                    |
| <b>Others</b>  | Azoxystrobin                                     | ug/l               | 0.05              | in house                    |
|  | Boscalid   | ug/l               | 0.1               | in house                    |
|  | Epichlorohydrin                                  | ug/l               | 0.1               | in house                    |
|  | Metribuzin                                       | ug/l               | 0.05              | In-house                    |
|  | Metamitron                                       | ug/l               | 0.02              | in house                    |
|  | tert-Amyl methyl ether (TAME)                    | ug/l               | 0.5               | In-house                    |
|  | Metalddehyde                                     | ug/l               | 0.02              | In-house                    |
|  | Metazachlor                                      | ug/l               | 0.1               | In-house                    |
|  | Diflufenican                                     | ug/l               | 0.1               | In-house                    |
|  | Ethofumesate                                     | ug/l               | 0.05              | In-house                    |
|  | Flufenacet                                       | ug/l               | 0.02              | In-house                    |
|  | Ametryne   | ug/l               | 0.02              | In-house                    |
|  | Carbetamide                                      | ug/l               | 0.01              | In-house                    |
|  | Carbophenothion                                  | ug/l               | 0.02              | In-house                    |
|  | Chlorotoluron                                    | ug/l               | 0.05              | In-house                    |
|  | Oxadixyl   | ug/l               | 0.05              | In-house                    |
|  | Oxamyl   | ug/l               | 0.05              | In-house                    |
|  | Tebuconazole                                     | ug/l               | 0.05              | In-house                    |
| Biphenyl   | ug/l   | 0.02               | in house          |                             |
| Geosmin  | ng/l   | 1 – drinking water | In-house          |                             |

| SUITE 9 – WFD + EQSD + DWSP + Emerging Subs + Olfactory | Parameter  | Unit | LOD <sup>12</sup>  | Accreditation <sup>13</sup> |
|---|--|------|--------------------|-----------------------------|
|   | 2-Methylisoborneol (MIB)                                     | ng/l | 1 – drinking water | In-house                    |
|   | Microcystin LR   | ug/l | 5                  | In-house                    |
|   | Benzotriazole  | ug/l | 0.1                | UKWIR validated             |
|   | Acrylamide   | ug/l | 0.1                | in house                    |
|   | Linear A ky benzene Sulphonate (LAS)                         | mg/l | 0.1                | in house                    |
|   | CAPB as Lauroylamide propylbetaine                           | TBC  | TBC                | in house                    |
|   | DEGBE  | mg/l | 10                 | in house                    |
|   | Specific ABS 245nm   | abs  | n/a                | in house                    |
|   | Transmission % at 245nm                                      | %    | n/a                | in house                    |
|   | Chloronitrotoluenes  | ug/l | 0.02               | in house                    |
|   | Tolytriazole   | ug/l | 0.1                | UKWIR validated             |
|   | Propiconazole  | ug/l | 0.1                | In-house                    |
|   | Soluble methane  | mg/l | 0.1                | in house                    |
|   | Diclofenac   | ug/l | 0.1                | UKWIR validated             |
|   | Triclocarban   | ug/l | 0.1                | in house                    |
|   | Tri-(2-chloroethyl) phosphate                                | ug/l | 0.01               | in house                    |
|   | Bifenthrin   | ug/l | 0.02               | In-house                    |
|   | Chlorpropham   | ug/l | 0.1                | in house                    |
|   | Triazaphos   | ug/l | 0.02               | in house                    |
|   | Malachite green  | ug/l | 1                  | in house                    |
|   | Formaldehyde   | ug/l | 50                 | in house                    |
|   | polychloro chloromethyl sulphonamido diphenyl ethers (PCSDs) | ug/l | 0.2                | in house                    |

# Appendix C. Suite A

| GUC Suite A – WFD1                         | Parameter                                       | Unit  | LOD <sup>14</sup>          | Accreditation <sup>15</sup> |
|--|---|-------|----------------------------|-----------------------------|
| <b>General Parameters</b>                  | pH  | pH    | 0.1 pH unit                | in house                    |
|  | BOD 5   | mg/l  | 1                          | UKAS (sub) UKWIR Validated  |
|  | Chemical Oxygen Demand (COD)                    | mg/l  | 5                          | UKAS                        |
|  | Reactive phosphorus                             | mg/l  | 0.01                       | UKAS (sub) UKWIR Validated  |
|  | Total phosphorus                                | mg/l  | 0.01                       | UKAS (sub) UKWIR Validated  |
|  | Salinity @ 20°C                                 | uS/cm | 1                          | UKAS (sub)                  |
|  | Conductivity @ 20°C                             | uS/cm |                            | in house                    |
|  | Ammoniacal Nitrogen as N                        | mg/l  | 0.015                      | UKAS                        |
|  | Ammonia (as N)                                  | mg/l  | 0.1                        | UKAS (sub) UKWIR Validated  |
|  | Nitrate (as NO <sub>3</sub> )                   | mg/l  | 0.1                        | UKAS (sub) UKWIR Validated  |
|  | Nitrate as N                                    | mg/l  | calc                       | calc from above             |
|  | Nitrite (as NO <sub>2</sub> )                   | mg/l  | 0.1                        | UKAS (sub) UKWIR Validated  |
|  | Nitrite as N                                    | mg/l  | calc                       | calc from above             |
|  | Total nitrogen (oxidised as N)                  | mg/l  | 0.054                      | calculation                 |
|  | Keldhal nitrogen                                | mg/l  | 0.2                        | UKAS                        |
|  | Organic nitrogen                                | mg/l  | calc                       | calc from above             |
|  | Sulphide  | ug/l  | 10                         | UKAS                        |
|  | Alkalinity as CaCO <sub>3</sub>                 | mg/l  | 5                          | UKAS (sub)                  |
|  | Acid Neutralisation Capacity (ANC) (unfiltered) | mg/l  | 5                          | UKAS (sub)                  |
|  | Hardness as CaCO <sub>3</sub>                   | mg/l  | 0.1                        | UKAS (sub)                  |
|  | Dissolved organic carbon* if on its own         | mg/l  | 0.5                        | UKAS (sub) UKWIR Validated  |
|  | Total organic carbon                            | mg/l  | 0.5                        | UKAS (sub) UKWIR Validated  |
|  | Solids, Suspended @ 105°C                       | mg/l  | 2                          | UKAS                        |
| Chlorophyll                                | ug/l  | 20    | in house                   |                             |
| Phaeophytin                                | ug/l  | 20    | in house                   |                             |
| <b>Metals</b>                              | Antimony Total                                  | ug/l  | 0.17                       | sub                         |
|  | Antimony Dissolved*                             | ug/l  | 0.17                       | sub                         |
|  | Aluminium Total                                 | ug/l  | 10                         | UKWIR Validated (sub)       |
|  | Aluminium Dissolved*                            | ug/l  | 10                         | UKAS (sub) UKWIR Validated  |
|  | Aluminium Reactive                              | ug/l  | 4                          | UKWIR Validated (sub)       |
|  | Arsenic Total                                   | ug/l  | 0.16                       | UKWIR Validated (sub)       |
|  | Arsenic Dissolved *                             | ug/l  | 0.16                       | UKAS (sub) UKWIR Validated  |
|  | Cadmium Total                                   | ug/l  | 0.02                       | UKWIR Validated (sub)       |
|  | Cadmium Dissolved *                             | ug/l  | 0.02                       | UKAS (sub) UKWIR Validated  |
|  | Calcium Total                                   | mg/l  | 0.09                       | UKWIR Validated (sub)       |
|  | Calcium Dissolved                               | mg/l  | 0.09                       | UKWIR Validated (sub)       |
|  | Copper Total                                    | ug/l  | 0.4                        | UKWIR Validated (sub)       |
|  | Copper Dissolved                                | ug/l  | 0.4                        | UKAS (sub) UKWIR Validated  |
|  | Chromium Total                                  | ug/l  | 0.25                       | UKWIR Validated (sub)       |
|  | Chromium Dissolved*                             | ug/l  | 0.25                       | UKAS (sub) UKWIR Validated  |
|  | Iron Total                                      | ug/l  | 5.5                        | UKWIR Validated (sub)       |
|  | Iron Dissolved*                                 | ug/l  | 5.5                        | UKAS (sub) UKWIR Validated  |
|  | Lead Total                                      | ug/l  | 0.09                       | UKWIR Validated (sub)       |
|  | Lead Dissolved*                                 | ug/l  | 0.09                       | UKAS (sub) UKWIR Validated  |
|  | Mercury Total                                   | ug/l  | 0.001                      | UKWIR Validated (sub)       |
|  | Mercury Dissolved*                              | ug/l  | 0.001                      | UKAS (sub) UKWIR Validated  |
|  | Manganese Total                                 | ug/l  | 10                         | UKWIR Validated (sub)       |
|  | Manganese Dissolved*                            | ug/l  | 0.22                       | UKAS UKWIR Validated        |
| Nickel Total                               | ug/l  | 0.5   | UKWIR Validated (sub)      |                             |
| Nickel Dissolved*                          | ug/l  | 0.5   | UKAS (sub) UKWIR Validated |                             |
| Zinc Total                                 | ug/l  | 0.5   | UKWIR Validated (sub)      |                             |
| Zinc Dissolved*                            | ug/l  | 0.5   | UKAS (sub) UKWIR Validated |                             |
| <b>Polyaromatic hydrocarbons PAH Suite</b> | Fluoranthene                                    | ug/l  | 0.0009                     | UKWIR Validated             |
|  | Benzo(a)pyrene                                  | ug/l  | 0.00017                    | UKWIR Validated             |
|  | Polyaromatic hydrocarbons (PAH) Total           | ug/l  | see individual RLs         | UKWIR Validated             |
|  | Naphthalene                                     | ug/l  | 0.02                       | in house                    |
|  | Anthracene                                      | ug/l  | 0.02                       | in house                    |

<sup>14</sup> The LOD will be raised if the sample needs diluting during analysis

<sup>15</sup> Indicates UKAS ISO 17025 accreditation / UKWIR validation for testing and calibration laboratories. 'In house' and 'sub' indicates an unaccredited test..



| GUC Suite A – WFD1          | Parameter  | Unit | LOD <sup>14</sup> | Accreditation <sup>15</sup> |
|-----------------------------|--|------|-------------------|-----------------------------|
|                             | Benzo(b)fluoranthene   | ug/l | 0.0001            | UKWIR Validated             |
|                             | Benzo(k)fluoranthene   | ug/l | 0.0001            | UKWIR Validated             |
|                             | Benzo(g,h,i)-perylene  | ug/l | 0.0003            | UKWIR Validated             |
|                             | Indeno(1,2,3-cd)-pyrene  | ug/l | 0.0003            | UKWIR Validated             |
| <b>Phthalates</b>           | Di(2-ethylhexyl)-phthalate (DEHP)  | ug/l | 0.15              | UKWIR Validated             |
| <b>Other WFD parameters</b> | Brominated diphenylethers Total ( sum of BDE penta congeners 28,47,99,100,153,154) | ug/l | 0.0005            | UKWIR Validated             |
|                             | BDE 28   | ug/l | 0.0001            | UKWIR Validated             |
|                             | BDE 47   | ug/l | 0.0001            | UKWIR Validated             |
|                             | BDE 99   | ug/l | 0.0001            | UKWIR Validated             |
|                             | BDE 100  | ug/l | 0.0001            | UKWIR Validated             |
|                             | BDE 153  | ug/l | 0.0001            | UKWIR Validated             |
|                             | BDE 154  | ug/l | 0.0001            | UKWIR Validated             |
|                             | Triclosan  | ug/l | 0.01              | UKAS and UKWIR Validated    |
|                             | Nonylphenols. (4-Nonylphenol Technical Mix)  | ug/l | 0.04              | UKWIR Validated             |
|                             | 4-n-Nonylphenol  | ug/l | 0.04              |                             |
|                             | Nonylphenol ethoxylates (sum of NPEO 1-3)  | ug/l | 0.12              | UKWIR Validated             |
|                             | Nonylphenol monoethoxylate NPEO1   | ug/l | 0.04              | UKWIR Validated             |
|                             | Nonylphenol diethoxylate NPEO2   | ug/l | 0.04              | UKWIR Validated             |
|                             | Nonylphenol triethoxylate NPEO3  | ug/l | 0.04              | UKWIR Validated             |
|                             | Octylphenols ((4-(1,1', 3,3'- tetramethylbutyl)-phenol))                           | ug/l | 0.01              | UKWIR Validated             |
|                             | Octylphenol ethoxylates (Sum OPEO 1-3)   | ug/l | 0.06              | UKWIR Validated             |
|                             | Octylphenol monoethoxylate (OPEO1)   | ug/l | 0.02              | UKWIR Validated             |
|                             | Octylphenol diethoxylate (OPEO2)   | ug/l | 0.02              | UKWIR Validated             |
|                             | Octylphenol triethoxylate (OPEO3)  | ug/l | 0.02              | UKWIR Validated             |
|                             | Tributyltin compounds (as Tributyltin cation)                                      | ug/l | 0.00002           | UKAS and UKWIR validated    |
|                             | PFOS & PFOA low level  | ug/l | 0.00065           | UKAS and UKWIR validated    |
|                             | PFAS List of 54  | ug/l | 0.0001–0.005      | in-house                    |
|                             | Hexabromocyclododecane (HBCDD) Total   | ug/l | 0.00014           | UKAS and UKWIR validated    |
|                             | alpha -Hexabromocyclododecane (α-HBCDD)  | ug/l | 0.00004           | UKAS and UKWIR validated    |
|                             | beta -Hexabromocyclododecane (β-HBCDD)   | ug/l | 0.00004           | UKAS and UKWIR validated    |
|                             | gamma -Hexabromocyclododecane (γ-HBCDD)  | ug/l | 0.00004           | UKAS and UKWIR validated    |
| <b>VOCs</b>                 | Trichloroethylene  | ug/l | 1                 | in house                    |
| <b>THMs</b>                 | Chloroform   | ug/l | 1                 | In house                    |
|                             | Trichloroethane (1 1 1)  | ug/l | 1                 | In house                    |
|                             | Trichloroethane (1 1 2)  | ug/l | 1                 | In house                    |
| <b>Insecticides</b>         | Cypermethrin   | ug/l | 0.00008           | UKAS and UKWIR validated    |

# Appendix D. Suite B

| GUC Suite B<br>WFD + EQSD +<br>Emerging Subs | Parameter   | Unit                | LOD <sup>16</sup> | Accreditation <sup>17</sup> |     |
|--|---|---------------------|-------------------|-----------------------------|-----|
| General<br>Parameters                        | pH  | pH                  | 0.1 pH unit       | in house                    |     |
|  | BOD 5   | mg/l                | 1                 | UKAS (sub) UKWIR Validated  |     |
|  | Chemical Oxygen Demand (COD)                        | mg/l                | 5                 | UKAS                        |     |
|  | ORP   | mV                  | -500              | in house                    |     |
|  | Salinity @ 20°C                                     | uS/cm               | 1                 | UKAS (sub)                  |     |
|  | Conductivity @ 20°C                                 | uS/cm               |                   | in house                    |     |
|  | Total phosphorus                                    | mg/l                | 0.01              | UKAS (sub) UKWIR Validated  |     |
|  | Reactive phosphorus as PO4                          | mg/l                | 0.01              | UKAS (sub) UKWIR Validated  |     |
|  | Ammoniacal Nitrogen as N                            | mg/l                | 0.015             | UKAS                        |     |
|  | Ammonia (as N)                                      | mg/l                | 0.1               | UKAS (sub) UKWIR Validated  |     |
|  | Ammonia (un-ionised)                                | mg/l                | 0.02              | in house                    |     |
|  | Nitrate (as NO3)                                    | mg/l                | 0.1               | UKAS (sub) UKWIR Validated  |     |
|  | Nitrate as N  | mg/l                | calc              | calc from above             |     |
|  | Nitrite (as NO2)                                    | mg/l                | 0.1               | UKAS (sub) UKWIR Validated  |     |
|  | Nitrite as N  | mg/l                | calc              | calc from above             |     |
|  | Total nitrogen (oxidised as N)                      | mg/l                | 0.054             | calculation                 |     |
|  | Keldhal nitrogen                                    | mg/l                | 0.2               | UKAS                        |     |
|  | Organic nitrogen                                    | mg/l                | calc              | calc from above             |     |
|  | Bromate   | ug/l                | 2-10              | in-house                    |     |
|  | Bromide   | mg/l                | 0.008             | UKAS                        |     |
|  | Bromine – total residual oxidant                    | mg/l                | 0.05              | in house                    |     |
|  | Chlorine total                                      | mg/l                | 0.01              | in house                    |     |
|  | Chlorine free                                       | mg/l                | 0.01              | in house                    |     |
|  | Bromine – total residual oxidant                    | mg/l                | 0.05              | in house                    |     |
|  | Fluoride  | mg/l                | 0.01              | in house                    |     |
|  | Chlorate  | mg/l                | 0.7               | in house                    |     |
|  | Chlorite  | mg/l                | 0.01              | in house                    |     |
|  | Chloride as CL                                      | mg/l                | 0.1               | UKAS                        |     |
|  | Sulphate as SO4                                     | mg/l                | 0.1               | UKAS                        |     |
|  | Total anions (sum of Br, Cl, F, NO2, NO3, PO4, SO4) | mg/l                |                   | in house                    |     |
|  | Cyanide Free (easily liberable)                     | ug/l                | 0.1               | UKAS                        |     |
|  | Cyanide Total                                       | ug/l                | 0.1               | UKAS (sub)                  |     |
|  | Sulphide  | ug/l                | 10                | UKAS                        |     |
|  | Alkalinity as CaCO3                                 | mg/l                | 5                 | UKAS (sub)                  |     |
|  | Acid Neutralisation Capacity (ANC) (unfiltered)     | mg/l                | 5                 | UKAS (sub)                  |     |
|  | Hardness as CaCO3                                   | mg/l                | 0.1               | UKAS (sub)                  |     |
|  | Dissolved organic carbon* if on its own             | mg/l                | 0.5               | UKAS (sub) UKWIR Validated  |     |
|  | Total organic carbon                                | mg/l                | 0.5               | UKAS (sub) UKWIR Validated  |     |
|  | Solids, Suspended @ 105°C                           | mg/l                | 2                 | UKAS                        |     |
|  | Chlorophyll   | ug/l                | 20                | in house                    |     |
|  | Phaeophytin   | ug/l                | 20                | in house                    |     |
|  | Metals  | Antimony Total      | ug/l              | 0.17                        | sub |
|  |   | Antimony Dissolved* | ug/l              | 0.17                        | sub |
| Aluminium Total                              |   | ug/l                | 10                | UKWIR Validated (sub)       |     |
| Aluminium Dissolved*                         |   | ug/l                | 10                | UKAS (sub) UKWIR Validated  |     |
| Aluminium Reactive                           |   | ug/l                | 4                 | UKWIR Validated (sub)       |     |
| Arsenic Total                                |   | ug/l                | 0.16              | in-house UKWIR Validated    |     |
| Arsenic Dissolved *                          |   | ug/l                | 0.16              | UKAS (sub) UKWIR Validated  |     |
| Barium Dissolved                             |   | ug/l                | 0.26              | UKAS                        |     |
| Boron Total                                  |   | ug/l                | 12                | in-house                    |     |
| Boron Dissolved                              |   | ug/l                | 12                | in-house                    |     |
| Cadmium Total                                |   | ug/l                | 0.02              | UKWIR Validated (sub)       |     |
| Cadmium Dissolved *                          |   | ug/l                | 0.02              | UKAS (sub) UKWIR Validated  |     |
| Calcium Total                                |   | mg/l                | 0.09              | UKWIR Validated (sub)       |     |
| Calcium Dissolved                            |   | mg/l                | 0.09              | UKWIR Validated (sub)       |     |
| Cobalt Total                                 |   | ug/l                | 0.16              | in-house                    |     |
| Cobalt Dissolved                             |   | ug/l                | 0.16              | UKAS                        |     |
| Copper Total                                 |   | ug/l                | 0.4               | in-house UKWIR Validated    |     |

<sup>16</sup> The LOD will be raised if the sample needs diluting during analysis

<sup>17</sup> Indicates UKAS ISO 17025 accreditation / UKWIR validation for testing and calibration laboratories. 'In house' and 'sub' indicates an unaccredited test.



| GUC Suite B<br>WFD + EQSD +<br>Emerging Subs | Parameter  | Unit | LOD <sup>16</sup>  | Accreditation <sup>17</sup> |
|--|--|------|--------------------|-----------------------------|
|  | Copper Dissolved   | ug/l | 0.4                | UKAS UKWIR Validated        |
|  | Chromium Total   | ug/l | 0.25               | UKWIR Validated (sub)       |
|  | Chromium Dissolved*  | ug/l | 0.25               | UKAS                        |
|  | Chromium(VI) Dissolved*  | ug/l | 0.5                | in house                    |
|  | Chromium(III) Dissolved*   | ug/l | 1                  | UKAS                        |
|  | Iron Total   | ug/l | 5.5                | in-house UKWIR Validated    |
|  | Iron Dissolved   | ug/l | 5.5                | UKAS UKWIR Validated        |
|  | Lead Total   | ug/l | 0.09               | UKWIR Validated (sub)       |
|  | Lead Dissolved*  | ug/l | 0.09               | UKAS (sub) UKWIR Validated  |
|  | Manganese Total  | ug/l | 10                 | UKWIR Validated (sub)       |
|  | Manganese Dissolved*   | ug/l | 0.22               | UKAS UKWIR Validated        |
|  | Mercury Total  | ug/l | 0.001              | UKWIR Validated (sub)       |
|  | Mercury Dissolved*   | ug/l | 0.001              | UKAS (sub) UKWIR Validated  |
|  | Molybdenum Total   | ug/l | 1.1                | sub                         |
|  | Molybdenum Dissolved*  | ug/l | 1.1                | UKAS                        |
|  | Nickel Total   | ug/l | 0.5                | UKWIR Validated (sub)       |
|  | Nickel Dissolved*  | ug/l | 0.5                | UKAS (sub) UKWIR Validated  |
|  | Selenium Total   | ug/l | 0.25               | sub                         |
|  | Silver Total   | ug/l | 1                  | sub                         |
|  | Silver Dissolved*  | ug/l | 1                  | UKAS                        |
|  | Sodium Dissolved*  | mg/l | 0.07               | UKAS                        |
|  | Tin Total  | ug/l | 0.4                | sub                         |
|  | Tin Dissolved*   | ug/l | 0.4                | UKAS                        |
|  | Uranium Total  | ug/l | 10                 | sub                         |
|  | Vanadium Total   | ug/l | 10                 | in-house                    |
|  | Vanadium Dissolved*  | ug/l | 10                 | UKAS                        |
|  | Zinc Total   | ug/l | 0.5                | in-house UKWIR Validated    |
|  | Zinc Dissolved*  | ug/l | 0.5                | UKAS UKWIR Validated        |
| <b>Microbiology</b>                          | Somatic Coliphages   |      |                    | sub                         |
|  | Legionella   |      |                    | sub                         |
| <b>Polyaromatic hydrocarbons PAH Suite</b>   | Polyaromatic hydrocarbons (PAH) Total                                  | ug/l | see individual RLs | UKWIR Validated             |
|  | Naphthalene  | ug/l | 0.02               | in house                    |
|  | Fluoranthene   | ug/l | 0.0009             | UKWIR Validated             |
|  | Anthracene   | ug/l | 0.02               | in house                    |
|  | Benzo(a)pyrene   | ug/l | 0.00017            | UKWIR Validated             |
|  | Benzo(b)fluoranthene   | ug/l | 0.0001             | UKWIR Validated             |
|  | Benzo(k)fluoranthene   | ug/l | 0.0001             | UKWIR Validated             |
|  | Benzo(g,h,i)-perylene  | ug/l | 0.0003             | UKWIR Validated             |
|  | Indeno(1,2,3-cd)-pyrene  | ug/l | 0.0003             | UKWIR Validated             |
| <b>Triazine suite</b>                        | Atrazine   | ug/l | 0.02               | in house                    |
|  | Simazine   | ug/l | 0.02               | in house                    |
|  | Terbutryn  | ug/l | 0.02               | in house                    |
|  | Desethyl Atrazine  | ug/l | 0.02               | In house                    |
|  | Tebuthiuron  | ug/l | 0.02               | In house                    |
|  | Propazine  | ug/l | 0.02               | In house                    |
|  | Promethryn   | ug/l | 0.02               | In house                    |
| <b>Organo Phosphorous Pesticide Suite</b>    | Diazinon   | ug/l | 0.01               | in house                    |
|  | Dimethoate   | ug/l | 0.02               | in house                    |
|  | Chlorfenvinphos  | ug/l | 0.02               | in house                    |
|  | Chlorpyrifos (Chlorpyrifosethyl)                                       | ug/l | 0.02               | in house                    |
|  | Dichlorvos   | ug/l | 0.001              | in house                    |
|  | Propetamphos   | ug/l | 0.02               | In house                    |
|  | Parathion  | ug/l | 0.02               | In house                    |
|  | Cyanazine  | ug/l | 0.02               | In house                    |
|  | Tributyl phosphate   | ug/l | 0.02               | in house                    |
|  | Coumaphos  | ug/l | 0.02               | in house                    |
|  | Demetons   | ug/l | 0.02               | in house                    |
|  | Fenclorphos  | ug/l | 0.02               | in house                    |
|  | Fenitrothion   | ug/l | 0.01               | in house                    |
|  | Mevinphos  | ug/l | 0.02               | in house                    |
|  | Omethoate  | ug/l | 0.01               | in house                    |
|  | Pirimiphos-methyl  | ug/l | 0.01               | in house                    |
|  | Malathion  | ug/l | 0.02               | In-house                    |
|  | Azinphos methyl (dissolved) this needs separate run after filtration * | ug/l | 0.02               | in house                    |
|  | 2, 4 Dichlorophenoxyacetic acid (2, 4 D)                               | ug/l | 0.02               | UKAS                        |



| GUC Suite B<br>WFD + EQSD +<br>Emerging Subs | Parameter  | Unit | LOD <sup>16</sup> | Accreditation <sup>17</sup> |
|--|--|------|-------------------|-----------------------------|
| <b>Acid Herbicide Suite</b>                  | Mecoprop   | ug/l | 0.02              | UKAS                        |
|  | Pentachloro-phenol   | ug/l | 0.02              | UKAS                        |
|  | MCPA   | ug/l | 0.02              | UKAS                        |
|  | Bentazone  | ug/l | 0.02              | UKAS                        |
|  | Bromoxynil   | ug/l | 0.02              | In-house                    |
|  | loxynil  | ug/l | 0.02              | In-house                    |
|  | Propyzamide  | ug/l | 0.01              | In house                    |
| <b>Carbamate pesticide</b>                   | Carbendazim  | ug/l | 0.1               | in house                    |
| <b>Fungicide</b>                             | Methiocarb   | ug/l | 0.1               | in house                    |
| <b>Uron Herbicide Suite</b>                  | Linuron  | ug/l | 0.01              | in house                    |
|  | Diuron   | ug/l | 0.05              | UKWIR Validated             |
|  | Isoproturon  | ug/l | 0.002             | in house                    |
|  | Monuron  | ug/l | 0.05              | In-house                    |
|  | Diflubenzuron  | ug/l | 0.001             | in house                    |
| <b>OCL Insecticide Suite</b>                 | Alachor  | ug/l | 0.02              | in house                    |
|  | Aldrin   | ug/l | 0.02              | in house                    |
|  | Dieldrin   | ug/l | 0.02              | in house                    |
|  | Endrin   | ug/l | 0.02              | in house                    |
|  | Isodrin  | ug/l | 0.02              | in house                    |
|  | DDT total  | ug/l | 0.025             | in house                    |
|  | para-para-DDT (CAS 50-29-3)  | ug/l | 0.01              | in house                    |
|  | ortho-para-DDT (CAS 789-02-6)  | ug/l | 0.01              | in house                    |
|  | TDE OP' or p'p'-DDD (CAS 72-54-8)  | ug/l | 0.01              | In house                    |
|  | TDE PP' or o'p'-DDD (CAS 53-19-0)  | ug/l | 0.01              | In house                    |
|  | para-para-DDE (CAS 72-55-9)  | ug/l | 0.02              | In house                    |
|  | Endosulfan   | ug/l | 0.02              | in house                    |
|  | Hexachloro-benzene   | ug/l | 0.02              | in house                    |
|  | Hexachloro-butadiene   | ug/l | 0.02              | in house                    |
|  | Hexachloro-cyclohexane   | ug/l | 0.02              | in house                    |
|  | Pentachloro-benzene  | ug/l | 0.007             | in house                    |
|  | Trifluralin  | ug/l | 0.02              | in house                    |
|  | Dicofol  | ug/l | 0.0013            | in house                    |
|  | Heptachlor and heptachlor epoxide  | ug/l | 0.001             | in house                    |
|  | HCH – Gamma isomer   | ug/l | 0.02              | In-house                    |
|  | HCH – Alpha isomer   | ug/l | 0.02              | In-house                    |
|  | HCH – Beta isomer  | ug/l | 0.02              | In-house                    |
|  | HCH – Delta isomer   | ug/l | 0.02              | In-house                    |
|  | Methoxychlor   | ug/l | 0.02              | In-house                    |
|  | Dichlorobenil  | ug/l | 0.02              | In-house                    |
|  | Chlordane  | ug/l | 0.02              | In-house                    |
|  | Tecnazene  | ug/l | 0.02              | In house                    |
|  | Triallate  | ug/l | 0.02              | in house                    |
|  | Cyclodiene pesticides – total aldrin, dieldrin, endrin and isodrin                     |      |                   | in house                    |
| <b>Phthalates</b>                            | Benzyl butyl phthalate   | ug/l | 0.2               | in house                    |
|  | D butyl phthalate  | ug/l | 0.02              | in house                    |
|  | Diethyl phthalate  | ug/l | 0.02              | in house                    |
|  | Dimethyl phthalate   | ug/l | 0.02              | in house                    |
|  | Dioctyl phthalate  | ug/l | 0.02              | in house                    |
| <b>PCBs</b>                                  | PCB 28   | ug/l | 0.005             | in house                    |
|  | PCB 52   | ug/l | 0.005             | in house                    |
|  | PCB 101  | ug/l | 0.005             | in house                    |
|  | PCB 118  | ug/l | 0.005             | in house                    |
|  | PCB 136  | ug/l | 0.005             | in house                    |
|  | PCB 153  | ug/l | 0.005             | in house                    |
|  | PCB 180  | ug/l | 0.005             | in house                    |
| <b>Other WFD parameters</b>                  | Di(2-ethylhexyl)-phthalate (DEHP)  | ug/l | 0.15              | UKWIR Validated             |
|  | Brominated diphenylethers Total ( sum of BDE penta congeners 28,47,99,100,153,154,183) | ug/l | 0.0005            | UKWIR Validated             |
|  | BDE 28   | ug/l | 0.0001            | UKWIR Validated             |
|  | BDE 47   | ug/l | 0.0001            | UKWIR Validated             |
|  | BDE 99   | ug/l | 0.0001            | UKWIR Validated             |
|  | BDE 100  | ug/l | 0.0001            | UKWIR Validated             |
|  | BDE 153  | ug/l | 0.0001            | UKWIR Validated             |

| GUC Suite B<br>WFD + EQSD +<br>Emerging Subs | Parameter  | Unit | LOD <sup>16</sup> | Accreditation <sup>17</sup> |
|--|--|------|-------------------|-----------------------------|
|  | BDE 154  | ug/l | 0.0001            | UKWIR Validated             |
|  | BDE 183  | ug/l | 0.0001            | in-house                    |
|  | C10-13 Chloroalkanes (total)                               | ug/l | 0.4               | UKWIR Validated             |
|  | Triclosan  | ug/l | 0.01              | UKAS and UKWIR Validated    |
|  | Tributyltin compounds (as Tributyltin cation)              | ug/l | 0.00002           | UKAS and UKWIR validated    |
|  | Triphenyltin compounds (as triphenyltin cation)            | ug/l | 0.002             | in house                    |
|  | PFOS & PFOA low level                                      | ug/l | 0.00065           | UKAS and UKWIR validated    |
|  | PFAS List of 54 drinking water level                       | ug/l | 0.0001-0.005      | in-house                    |
|  | Hexabromocyclododecane (HBCDD) Total                       | ug/l | 0.00014           | UKAS and UKWIR validated    |
|  | alpha -Hexabromocyclododecane (α-HBCDD)                    | ug/l | 0.00004           | UKAS and UKWIR validated    |
|  | beta -Hexabromocyclododecane (β-HBCDD)                     | ug/l | 0.00004           | UKAS and UKWIR validated    |
|  | gamma -Hexabromocyclododecane (γ-HBCDD)                    | ug/l | 0.00004           | UKAS and UKWIR validated    |
|  | Nonylphenols. (4-Nonylphenol Technical Mix)                | ug/l | 0.04              | UKWIR Validated             |
|  | 4-n-Nonylphenol  | ug/l | 0.04              |                             |
|  | Nonylphenol ethoxylates (sum of NPEO 1-3)                  | ug/l | 0.12              | UKWIR Validated             |
|  | Nonylphenol monoethoxylate NPEO1                           | ug/l | 0.04              | UKWIR Validated             |
|  | Nonylphenol diethoxylate NPEO2                             | ug/l | 0.04              | UKWIR Validated             |
|  | Nonylphenol triethoxylate NPEO3                            | ug/l | 0.04              | UKWIR Validated             |
|  | Octylphenols ((4-(1,1', 3,3'- tetramethylbutyl)-phenol))   | ug/l | 0.01              | UKWIR Validated             |
|  | Octylphenol ethoxylates (Sum OPEO 1-3)                     | ug/l | 0.06              | UKWIR Validated             |
|  | Octylphenol monoethoxylate (OPEO1)                         | ug/l | 0.02              | UKWIR Validated             |
|  | Octylphenol diethoxylate (OPEO2)                           | ug/l | 0.02              | UKWIR Validated             |
|  | Octylphenol triethoxylate (OPEO3)                          | ug/l | 0.02              | UKWIR Validated             |
|  | Bisphenol A  | ug/l | 0.01              | UKWIR Validation            |
|  | Phenol   | ug/l | 1                 | UKWIR Validated             |
| <b>Steroids</b>                              | Oosterone (E1)   | ug/l | 0.001             | UKWIR Validated             |
|  | 17β oestradiol (E2)  | ug/l | 0.0003            | UKWIR Validated             |
|  | 17α ethinyloestradiol (EE2)                                | ug/l | 0.00003           | UKWIR Validated             |
| <b>VOC Suite</b>                             | Dichloromethane  | ug/l | 1                 | in house                    |
|  | D bromochloromethane                                       | ug/l | 1                 | In house                    |
|  | 3, 4 Dichloroaniline                                       | ug/l | 1                 | in house                    |
|  | 1,2-Dichloroethane   | ug/l | 1                 | in house                    |
|  | Trichloroethylene  | ug/l | 1                 | in house                    |
|  | Trichlorobenzenes  | ug/l | 0.4               | in house                    |
|  | Trichloromethane   | ug/l | 1                 | in house                    |
|  | Tetrachloroethylene  | ug/l | 1                 | in house                    |
|  | Carbon-tetrachloride or Tethachloromethane                 | ug/l | 1                 | in house                    |
|  | Dichlorobenzene – total dichlorobenzene isomers            | ug/l | 0.1               | in house                    |
|  | Styrene  |      | 0.1               | in house                    |
|  | Vinyl Chloride   | ug/l | 0.1               | in house                    |
| <b>THMs</b>                                  | Bromodichloromethane                                       | ug/l | 1                 | In house                    |
|  | Chloroform   | ug/l | 1                 | In house                    |
|  | Tetrachloroethane  | ug/l | 1                 | In house                    |
|  | Trichloroethane (1 1 1)                                    | ug/l | 1                 | In house                    |
|  | Trichloroethane (1 1 2)                                    | ug/l | 1                 | In house                    |
|  | Tetra & Trichloroethane TOTAL                              | ug/l | 1                 | In house                    |
| <b>BTEX</b>                                  | BTEX total (Benzene, Toluene, Ethylbenzene & o,p -Xylenes) | ug/l | 1                 | in house                    |
|  | Benzene  | ug/l | 0.1               | in house                    |
|  | Toluene  | ug/l | 0.1               | in house                    |
|  | Ethylbenzene   | ug/l | 0.1               | in house                    |
|  | m,p-Xylene   | ug/l | 0.1               | in-house                    |
|  | O-Xylene   | ug/l | 0.1               | in-house                    |
| <b>Quinolines</b>                            | Quinoxifen   | ug/l | 0.1               | in house                    |
|  | Aclonifen  | ug/l | 0.1               | in house                    |
| <b>Algicides and other herbicides</b>        | Bifenox  | ug/l | 0.012             | in house                    |
|  | Cybutryne (irgarol)  | ug/l | 0.0025            | in house                    |
|  | Pendimethalin  | ug/l | 0.02              | in house                    |
|  | Glyphosate   | ug/l | 0.1               | UKAS and UKWIR Validated    |
|  | AMPA   | ug/l | 0.1               | UKAS and UKWIR Validated    |
| <b>Fungicides</b>                            | Chlorothalonil   | ug/l | 0.035             | in house                    |
| <b>Insecticides</b>                          | Permethrin   | ug/l | 0.001             | in house                    |
|  | Cyfluthrin   | ug/l | 0.1               | in house                    |



| GUC Suite B<br>WFD + EQSD +<br>Emerging Subs | Parameter  | Unit | LOD <sup>16</sup> | Accreditation <sup>17</sup>          |
|--|--|------|-------------------|--------------------------------------|
|  | Cypermethrin   | ug/l | 0.00008           | UKAS and UKWIR validated             |
| Acid hebicide precursor                      | 2, 4 Dichlorophenol  | ug/l | 0.02              | in house                             |
| Phenol Suite 4                               | 3-METHYL PHENOL  | ug/l | 0.02              | In house                             |
|  | 4-METHYL PHENOL  | ug/l | 0.02              | In house                             |
|  | 4-CHLORO-3-METHYLPHENOL                                      | ug/l | 0.02              | In house                             |
|  | CHLOROPHENOL (2)   | ug/l | 0.02              | In house                             |
|  | CHLOROPHENOL (3)   | ug/l | 0.02              | In house                             |
|  | CHLOROPHENOL (4)   | ug/l | 0.02              | In house                             |
| DTCs   | Mancozeb   | ug/l | 0.1               | in house                             |
|  | Maneb  | ug/l | 0.1               | in house                             |
| Mectins                                      | Abamectin  | ug/l | 5                 | in house                             |
|  | Doramectin   | ug/l | 5                 | in house                             |
|  | Ivermectin   | ug/l | 5                 | in house                             |
| Mitins                                       | Fulcofuron   | ug/l | 0.05              | in house                             |
|  | Sulcofuron   | ug/l | 0.05              | in house                             |
| Haloacetic acids                             | bromoacetic acid   | ug/l | 1                 | in house                             |
|  | bromochloroacetic acid                                       | ug/l | 1                 | in house                             |
|  | chloroacetic acid  | ug/l | 1                 | in house                             |
|  | dibromochloroacetic acid                                     | ug/l | 1                 | in house                             |
|  | dibromoacetic acid   | ug/l | 1                 | in house                             |
|  | dichlorobromoacetic acid                                     | ug/l | 1                 | in house                             |
|  | dichloroacetic acid  | ug/l | 1                 | in house                             |
|  | tribromoacetic acid  | ug/l | 1                 | in house                             |
|  | trichloroacetic acid   | ug/l | 1                 | in house                             |
| Nitrosamines                                 | NDMA   | ug/l | 0.001             | in house                             |
|  | NMEA   | ug/l | 0.001             | in house                             |
|  | NDEA   | ug/l | 0.001             | in house                             |
|  | NDPA   | ug/l | 0.001             | in house                             |
|  | NDBA   | ug/l | 0.001             | in house                             |
|  | NPIP   | ug/l | 0.001             | in house                             |
|  | NPYR   | ug/l | 0.001             | in house                             |
|  | NMOR   | ug/l | 0.001             | in house                             |
|  | Primicarb  | ug/l | 1                 | in house                             |
|  | Prochloraz   | ug/l | 0.1               | in house                             |
|  | Thiobendazole  | ug/l | 0.1               | in house                             |
|  | EDTA   | ug/l | 100               | in house                             |
|  | Nitriloacetic acid (NTA)                                     | ug/l | 100               | in house                             |
| Others                                       | Chlorotoluron  | ug/l | 0.05              | In-house                             |
|  | Biphenyl   | ug/l | 0.02              | in house                             |
|  | Tolytriazole   | ug/l | 0.1               | UKWIR validated                      |
|  | Chloronitrotoluenes  | ug/l | 0.02              | in house                             |
|  | Chloroprofarm  | ug/l | 0.1               | in house                             |
|  | Epichlorohydrin  | ug/l | 0.1               | in house                             |
|  | Triazaphos   | ug/l | 0.02              | in house                             |
|  | Microcystin LR   | ug/l | 5                 | In-house                             |
|  | Linear A kylbenzene Sulphonate (LAS)                         | mg/l | 0.1               | in house                             |
|  | Propiconazole  | ug/l | 0.1               | in house                             |
|  | Soluble methane  | mg/l | 0.1               | in house (based on min on 3 samples) |
|  | Diclofenac   | ug/l | 0.1               | UKWIR validated                      |
|  | Acrylamide   | ug/l | 0.1               | In-house                             |
|  | Malachite green  | ug/l | 1                 | in house                             |
|  | Formaldehyde   | ug/l | 50                | in house                             |
|  | Triclocarban   | ug/l | 0.1               | in house                             |
|  | Tri-(2-chloroethyl) phosphate (TCEP)                         | ug/l | 0.01              | in house                             |
|  | polychloro chloromethyl sulphonamido diphenyl ethers (PCSDs) | ug/l | 0.2               | in house                             |

# Appendix E. Suite C

| GUC Suite C – WFD + DWSP + Emerging Subs | Parameter   | Unit      | LOD <sup>18</sup> | Accreditation <sup>19</sup> |
|--|---|-----------|-------------------|-----------------------------|
| General Parameters                       | pH  | pH        | 0.1 pH unit       | in house                    |
|  | BOD 5   | mg/l      | 1                 | UKAS (sub) UKWIR Validated  |
|  | Chlorine total  | mg/l      | 0.1               | sub                         |
|  | Chlorine free   | mg/l      | 0.1               | sub                         |
|  | ORP   | mV        | -500              | in house                    |
|  | Chemical Oxygen Demand (COD)  | mg/l      | 5                 | UKAS                        |
|  | Reactive phosphorus   | mg/l      | 0.01              | UKAS (sub) UKWIR Validated  |
|  | Total phosphorus  | mg/l      | 0.01              | UKAS (sub) UKWIR Validated  |
|  | Silica Reactive (SiO <sub>2</sub> )   | mg/l      | 0.1               | UKAS                        |
|  | Salinity @ 20°C   | uS/cm     | 1                 | UKAS (sub)                  |
|  | Conductivity @ 20°C   | uS/cm     | 1                 | UKAS (sub)                  |
|  | Bromate   | ug/l      | 0.8               | in-house                    |
|  | Bromide   | mg/l      | 0.008             | UKAS (sub)                  |
|  | Fluoride  | mg/l      | 0.01              | in house                    |
|  | Chloride as CL  | mg/l      | 0.1               | UKAS                        |
|  | Chlorite  | ug/L      | 3                 | UKAS (sub)                  |
|  | Chlorate  | mg/l      | 0.7               | in house                    |
|  | Sulphate as SO <sub>4</sub>   | mg/l      | 0.1               | UKAS                        |
|  | Ammonium as NH <sub>4</sub>   | mg/l      | 0.1               | UKAS                        |
|  | Ammonia (as N)  | mg/l      | 0.1               | UKAS (sub) UKWIR Validated  |
|  | Ammoniacal Nitrogen as N  | mg/l      | 0.015             | UKAS                        |
|  | Nitrate (as NO <sub>3</sub> )   | mg/l      | 0.1               | UKAS (sub) UKWIR Validated  |
|  | Nitrite (as NO <sub>2</sub> )   | mg/l      | 0.1               | UKAS (sub) UKWIR Validated  |
|  | Nitrite as N  | mg/l      | 0.0306            | calculation                 |
|  | Nitrate as N  | mg/l      | 0.0227            | calculation                 |
|  | Nitrite & Nitrate calculation   | mg/l      | 1.0227            | calculation                 |
|  | Total nitrogen (oxidised as N)  | mg/l      | 0.054             | calculation                 |
|  | Keldhal nitrogen  | mg/l      | 0.2               | UKAS                        |
|  | Organic nitrogen  | mg/l      | calc              | calc from above             |
|  | Total anions (sum of Br, Cl, F, NO <sub>2</sub> , NO <sub>3</sub> , SO <sub>4</sub> ) | mg/l      |                   | in house                    |
|  | Cyanide Free (easily liberable)   | ug/l      | 0.1               | UKAS                        |
|  | Cyanide Total   | ug/l      | 0.1               | UKAS (sub)                  |
|  | Sulphide  | ug/l      | 10                | UKAS                        |
|  | Acid Neutralisation Capacity (ANC) (unfiltered)                                       | mg/l      | 5                 | UKAS (sub)                  |
|  | Alkalinity as CaCO <sub>3</sub>   | mg/l      | 5                 | UKAS (sub)                  |
|  | Alkalinity as HCO <sub>3</sub>  | mg/l      |                   | calculation                 |
|  | Hardness as CaCO <sub>3</sub>   | mg/l      | 0.1               | UKAS (sub)                  |
|  | Hardness Total as CA  | mg/l      | 0.04              | UKAS (sub)                  |
|  | Dissolved organic carbon  | mg/l      | 0.5               | UKAS (sub) UKWIR Validated  |
|  | Total organic carbon  | mg/l      | 0.5               | UKAS (sub) UKWIR Validated  |
|  | Particulate Organic Carbon (calculated from TOC and DOC results)                      | ug/l      | –                 | in house                    |
|  | Turbidity (NTU)   | NTU       | 1                 | UKAS                        |
|  | Solids, Suspended @ 105°C   | mg/l      | 2                 | UKAS                        |
|  | Total Dry Solids @ 180°C  | mg/l      | 2                 | UKAS                        |
|  | Dissolved solids  | mg/l      | 2                 | calculation                 |
|  | Colour  | mg/IPT/Co | 1                 | UKAS                        |
|  | Chlorophyll   | ug/l      | 20                | in house                    |
| Phaeophytin                              | ug/l  | 20        | in house          |                             |
| Microbiology                             | Algae cell count (total algal cells)  | no/ml     | n/a               | sub                         |
|  | Algal speciation (diatoms/blue-green cyanobacteria etc)                               | n/a       | n/a               |                             |
|  | Somatic Coliphages  |           |                   | sub                         |
|  | Legionella  |           |                   | sub                         |
|  | 22C PC NEAT (PLATE COUNT)   | no/ml     | /ml               | UKAS (sub)                  |
|  | 37C PC NEAT (PLATE COUNT)   | no/ml     | /ml               | UKAS (sub)                  |
|  | Odour   | coded     |                   | UKAS                        |

<sup>18</sup> The LOD will be raised if the sample needs diluting during analysis

<sup>19</sup> Indicates UKAS ISO 17025 accreditation / UKWIR validation for testing and calibration laboratories. 'In house' and 'sub' indicates an unaccredited test.

| GUC Suite C – WFD + DWSP + Emerging Subs | Parameter                                  | Unit      | LOD <sup>18</sup> | Accreditation <sup>19</sup> |
|--|--|-----------|-------------------|-----------------------------|
|  | CL. PERFRINGENS-VEG & SPORES CONFIRMED     | no/100ml  | /100ml            | UKAS (sub)                  |
|  | CRYPTOSPORIDIUM                            | no/litre  | /10 Litres        | UKAS (sub)                  |
|  | number of crypto like bodies 3-4um         | /10L      | /10L              |                             |
|  | number of crypto like bodies 4-6um         | /10L      | /10L              |                             |
|  | Giardia                                    | no/litre  | /10 Litres        | UKAS (sub)                  |
|  | Oocyst Count included in other micro tests | Number    |                   | UKAS (sub)                  |
|  | Enterococci Confirmed                      | no/100ml  | /100ml            | UKAS (sub)                  |
|  | Coliform Total                             | MPN/100ml | /100ml            | UKAS (sub)                  |
|  | E. coli included in other micro tests      | MPN/100ml |                   | UKAS (sub)                  |
|  | PSEUDOMONAS CONFIRMED                      | no/100ml  | /100ml            | UKAS (sub)                  |
| Radioactivity                            | ALPHA ACTIVITY – TOTAL                     | Bq/l      | 0.02              | UKAS (sub)                  |
|  | BETA ACTIVITY – TOTAL                      | Bq/l      | 0.04              | UKAS (sub)                  |
|  | RADON                                      | Bq/l      | 10                | UKAS (sub)                  |
|  | TRITIUM                                    | Bq/l      | 10                | UKAS (sub)                  |
| Metals                                   | Aluminium Total                            | ug/l      | 10                | in-house UKWIR Validated    |
|  | Aluminium Dissolved*                       | ug/l      | 10                | UKAS                        |
|  | Aluminium Reactive                         | ug/l      | 4                 | UKWIR Validated (sub)       |
|  | Antimony Total                             | ug/l      | 0.17              | in-house                    |
|  | Antimony Dissolved*                        | ug/l      | 0.17              | UKAS                        |
|  | Arsenic Total                              | ug/l      | 0.16              | in-house UKWIR Validated    |
|  | Arsenic Dissolved *                        | ug/l      | 0.16              | UKAS (sub) UKWIR Validated  |
|  | Barium Total                               | ug/l      | 0.26              | in-house                    |
|  | Barium Dissolved*                          | ug/l      | 0.26              | UKAS                        |
|  | Beryllium Total                            | ug/l      | 0.1               | in-house                    |
|  | Beryllium Dissolved                        | ug/l      | 0.1               | in-house                    |
|  | Boron Total                                | ug/l      | 12                | in-house                    |
|  | Boron Dissolved*                           | ug/l      | 12                | in-house                    |
|  | Cadmium Total                              | ug/l      | 0.02              | in-house UKWIR Validated    |
|  | Cadmium Dissolved *                        | ug/l      | 0.02              | UKAS UKWIR Validated        |
|  | Cobalt Total                               | ug/l      | 0.16              | in-house                    |
|  | Cobalt Dissolved*                          | ug/l      | 0.16              | UKAS                        |
|  | Calcium Total                              | mg/l      | 0.09              | in-house                    |
|  | Calcium Dissolved*                         | mg/l      | 0.09              | UKAS                        |
|  | Copper Total                               | ug/l      | 0.4               | in-house UKWIR Validated    |
|  | Copper Dissolved                           | ug/l      | 0.4               | UKAS UKWIR Validated        |
|  | Chromium(III) Dissolved*                   | ug/l      | 1                 | UKAS                        |
|  | Chromium Dissolved*                        | ug/l      | 0.25              | UKAS                        |
|  | Chromium(VI) Dissolved*                    | ug/l      | 0.5               | in-house                    |
|  | Chromium Total                             | ug/l      | 0.25              | in-house UKWIR Validated    |
|  | Iron Total                                 | ug/l      | 5.5               | in-house UKWIR Validated    |
|  | Iron Dissolved*                            | ug/l      | 5.5               | UKAS UKWIR Validated        |
|  | Lead Total                                 | ug/l      | 0.09              | in-house UKWIR Validated    |
|  | Lead Dissolved*                            | ug/l      | 0.09              | UKAS UKWIR Validated        |
|  | Magnesium Total                            | mg/l      | 0.02              | in-house                    |
|  | Magnesium Dissolved*                       | mg/l      | 0.02              | UKAS                        |
|  | Manganese Total                            | ug/l      | 10                | in-house UKWIR Validated    |
|  | Manganese Dissolved*                       | ug/l      | 0.22              | UKAS UKWIR Validated        |
|  | Mercury Total                              | ug/l      | 0.001             | in-house UKWIR Validated    |
|  | Mercury Dissolved*                         | ug/l      | 0.001             | UKAS UKWIR Validated        |
|  | Molybdenum Total                           | ug/l      | 1.1               | in-house                    |
|  | Molybdenum Dissolved*                      | ug/l      | 1.1               | UKAS                        |
|  | Nickel Total                               | ug/l      | 0.5               | in-house UKWIR Validated    |
|  | Nickel Dissolved*                          | ug/l      | 0.5               | UKAS UKWIR Validated        |
|  | Potassium Total                            | mg/l      | 0.08              | in-house                    |
|  | Potassium Dissolved*                       | mg/l      | 0.08              | UKAS                        |
|  | Selenium Total                             | ug/l      | 0.25              | in-house                    |
|  | Selenium Dissolved*                        | ug/l      | 0.25              | UKAS                        |
|  | Silver Total                               | ug/l      | 1                 | in-house                    |
|  | Silver Dissolved*                          | ug/l      | 1                 | UKAS                        |
|  | Sodium Total                               | mg/l      | 0.07              | in-house                    |
|  | Sodium Dissolved*                          | mg/l      | 0.07              | UKAS                        |
| Strontium Total                          | mg/l                                       | 0.4       | in-house          |                             |
| Strontium Dissolved*                     | mg/l                                       | 0.4       | UKAS              |                             |
| Tin Total                                | ug/l                                       | 0.4       | in-house          |                             |
| Tin Dissolved*                           | ug/l                                       | 0.4       | UKAS              |                             |
| Titanium Total                           | ug/l                                       | 0.3       | in-house          |                             |
| Titanium Dissolved*                      | ug/l                                       | 0.3       | UKAS              |                             |

| GUC Suite C – WFD + DWSP + Emerging Subs  | Parameter  | Unit | LOD <sup>18</sup> | Accreditation <sup>19</sup> |
|---|--|------|-------------------|-----------------------------|
|   | Tungsten Total   | ug/l | 10                | in-house                    |
|   | Tungsten Dissolved*  | ug/l | 10                | in-house                    |
|   | Vanadium Total   | ug/l | 10                | in-house                    |
|   | Vanadium Dissolved*  | ug/l | 10                | UKAS                        |
|   | Zinc Total   | ug/l | 0.5               | in-house UKWIR Validated    |
|   | Zinc Dissolved*  | ug/l | 0.5               | UKAS UKWIR Validated        |
|   | Zinc Dissolved*  | ug/l | 0.5               | UKAS UKWIR Validated        |
|   | Uranium Total  | ug/l | 10                | in-house                    |
| <b>Organo Phosphorous Pesticide Suite</b> | Diazinon   | ug/l | 0.01              | in house                    |
|   | Dimethoate   | ug/l | 0.02              | in house                    |
|   | Chlorfenvinphos  | ug/l | 0.02              | in house                    |
|   | Chlorpyrifos (Chlorpyrifosethyl)                                       | ug/l | 0.02              | in house                    |
|   | Dichlorvos   | ug/l | 0.001             | in house                    |
|   | Propetamphos   | ug/l | 0.02              | In house                    |
|   | Parathion  | ug/l | 0.02              | In house                    |
|   | Cyanazine  | ug/l | 0.02              | In house                    |
|   | Tributyl phosphate   | ug/l | 0.02              | in house                    |
|   | Coumaphos  | ug/l | 0.02              | in house                    |
|   | Demetons   | ug/l | 0.02              | in house                    |
|   | Fenchlorphos   | ug/l | 0.02              | in house                    |
|   | Fenitrothion   | ug/l | 0.01              | in house                    |
|   | Mevinphos  | ug/l | 0.02              | in house                    |
|   | Omethoate  | ug/l | 0.01              | in house                    |
|   | Pirimiphos-methyl  | ug/l | 0.01              | in house                    |
|   | Malathion  | ug/l | 0.02              | In-house                    |
|   | Azinphos methyl (dissolved) this needs separate run after filtration * | ug/l | 0.02              | in house                    |
| <b>Organo Phosphorous Pesticide Suite</b> | Diazinon   | ug/l | 0.01              | in house                    |
|   | Propetamphos   | ug/l | 0.02              | In house                    |
|   | Parathion  | ug/l | 0.02              | In house                    |
|   | Malathion  | ug/l | 0.02              | In-house                    |
|   | Cyanazine  | ug/l | 0.02              | In house                    |
| <b>Acid Herbicide Suite</b>               | 2, 4 Dichlorophenoxyacetic acid (2, 4 D)                               | ug/l | 0.02              | UKAS                        |
|   | Mecoprop   | ug/l | 0.02              | UKAS                        |
|   | Pentachloro-phenol   | ug/l | 0.02              | UKAS                        |
|   | 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)                            | ug/l | 0.02              | UKAS                        |
|   | 4-(2,4-dichlorophenoxy)butanoic acid (2,4-DB)                          | ug/l | 0.02              | UKAS                        |
|   | MCPA   | ug/l | 0.02              | UKAS                        |
|   | MCPB   | ug/l | 0.02              | In-house                    |
|   | Bentazone  | ug/l | 0.02              | UKAS                        |
|   | Bromoxynil   | ug/l | 0.02              | In-house                    |
|   | Clopyralid   | ug/l | 0.02              | UKAS                        |
|   | Dicamba  | ug/l | 0.02              | In-house                    |
|   | Dalapon  | ug/l | 0.02              | In-house                    |
|   | Ioxynil  | ug/l | 0.02              | In-house                    |
|   | Dichloprop   | ug/l | 0.02              | UKAS                        |
|   | Fenprop  | ug/l | 0.02              | UKAS                        |
|   | Fluroxypyr   | ug/l | 0.02              | In-house                    |
|   | Triclopyr  | ug/l | 0.02              | In house                    |
|   | Picloram   | ug/l | 0.02              | In house                    |
|   | Propyzamide  | ug/l | 0.01              | In house                    |
|   | Quimerac   | ug/l | 0.02              | In house                    |
|   | Benazolin  | ug/l | 0.025             | In-house                    |
| <b>Carbamate pesticide</b>                | Carbendazim  | ug/l | 0.1               | in house                    |
| <b>Fungicide</b>                          | Methiocarb   | ug/l | 0.1               | in house                    |
| <b>Uron Herbicide Suite</b>               | Linuron  | ug/l | 0.01              | in house                    |
|   | Diuron   | ug/l | 0.05              | UKWIR Validated             |
|   | Isoproturon  | ug/l | 0.002             | in house                    |
|   | Monuron  | ug/l | 0.05              | In-house                    |
| <b>OCL Insecticide Suite</b>              | Alachor  | ug/l | 0.02              | in house                    |
|   | Aldrin   | ug/l | 0.02              | in house                    |
|   | Dieldrin   | ug/l | 0.02              | in house                    |
|   | Endrin   | ug/l | 0.02              | in house                    |
|   | Isodrin  | ug/l | 0.02              | in house                    |

| GUC Suite C – WFD + DWSP + Emerging Subs | Parameter   | Unit   | LOD <sup>18</sup>  | Accreditation <sup>19</sup>       |
|--|---|--------|--------------------|-----------------------------------|
|  | DDT total   | ug/l   | 0.025              | in house                          |
|  | para-para-DDT (CAS 50-29-3)   | ug/l   | 0.01               | in house                          |
|  | ortho-para-DDT (CAS 789-02-6)   | ug/l   | 0.01               | in house                          |
|  | TDE OP' or p'p'-DDD (CAS 72-54-8)   | ug/l   | 0.01               | In house                          |
|  | TDE PP' or o'p'-DDD (CAS 53-19-0)   | ug/l   | 0.01               | In house                          |
|  | para-para-DDE (CAS 72-55-9)   | ug/l   | 0.02               | In house                          |
|  | Endosulfan  | ug/l   | 0.02               | in house                          |
|  | Hexachloro-benzene  | ug/l   | 0.02               | in house                          |
|  | Hexachloro-butadiene  | ug/l   | 0.02               | in house                          |
|  | Hexachloro-cyclohexane  | ug/l   | 0.02               | in house                          |
|  | Pentachloro-benzene   | ug/l   | 0.007              | in house                          |
|  | Trifluralin   | ug/l   | 0.02               | in house                          |
|  | Dicofol   | ug/l   | 0.0013             | in house                          |
|  | Heptachlor and heptachlor epoxide   | ug/l   | 0.001              | in house                          |
|  | HCH – Gamma isomer  | ug/l   | 0.02               | In-house                          |
|  | HCH – Alpha isomer  | ug/l   | 0.02               | In-house                          |
|  | HCH – Beta isomer   | ug/l   | 0.02               | In-house                          |
|  | HCH – Delta isomer  | ug/l   | 0.02               | In-house                          |
|  | Methoxychlor  | ug/l   | 0.02               | In-house                          |
|  | Dichlorobenzil  | ug/l   | 0.02               | In-house                          |
|  | Chlordane   | ug/l   | 0.02               | In-house                          |
|  | Tecnazene   | ug/l   | 0.02               | In house                          |
|  | Triallate   | ug/l   | 0.02               | in house                          |
|  | Cyclodiene pesticides – total aldrin, dieldrin, endrin and isodrin                      |        |                    |                                   |
| Polyaromatic hydrocarbons PAH Suite      | Polyaromatic hydrocarbons (PAH) Total   | ug/l   | see individual RLs | sum from below                    |
|  | Total 4 PAH (BBF, BKF, BGHIP, I123CDP)  | ug/l   | 0.0008             | sum from below                    |
|  | Naphthalene   | ug/l   | 0.02               | in house                          |
|  | Fluoranthene  | ug/l   | 0.0009             | UKWIR Validated                   |
|  | Anthracene  | ug/l   | 0.02               | UKWIR Validated                   |
|  | Benzo(a)pyrene  | ug/l   | 0.00017            | UKWIR Validated                   |
|  | Benzo(b)fluoranthene  | ug/l   | 0.0001             | UKWIR Validated                   |
|  | Benzo(k)fluoranthene  | ug/l   | 0.0001             | UKWIR Validated                   |
|  | Benzo(g,h,i)-perylene   | ug/l   | 0.0003             | UKWIR Validated                   |
| Indeno(1,2,3-cd)-pyrene                  | ug/l  | 0.0003 | UKWIR Validated    |                                   |
| Triazine suite                           | Atrazine  | ug/l   | 0.02               | in house                          |
|  | Simazine  | ug/l   | 0.02               | in house                          |
|  | Terbutryn   | ug/l   | 0.02               | in house                          |
|  | Desethyl Atrazine   | ug/l   | 0.02               | In house                          |
|  | Tebuthiuron   | ug/l   | 0.02               | In house                          |
|  | Propazine   | ug/l   | 0.02               | In house                          |
|  | Promethryn  | ug/l   | 0.02               | In house                          |
| Phthalates                               | Di(2-ethylhexyl)-phthalate (DEHP)   | ug/l   | 0.15               | UKAS and UKWIR Validated          |
|  | Benzyl butyl phthalate  | ug/l   | 0.2                | in house                          |
|  | Brominated diphenylethers Total ( sum of BDE penta congeners 28,47,99,100,153,154, 183) | ug/l   | 0.0005             | UKWIR Validated                   |
|  | BDE 28  | ug/l   | 0.0001             | UKWIR Validated                   |
|  | BDE 47  | ug/l   | 0.0001             | UKWIR Validated                   |
|  | BDE 99  | ug/l   | 0.0001             | UKWIR Validated                   |
|  | BDE 100   | ug/l   | 0.0001             | UKWIR Validated                   |
|  | BDE 153   | ug/l   | 0.0001             | UKWIR Validated                   |
|  | BDE 154   | ug/l   | 0.0001             | UKWIR Validated                   |
|  | BDE 183   | ug/l   | 0.0001             | UKWIR Validated                   |
|  | C10-13 Chloroalkanes (total)  | ug/l   | 0.4                | UKWIR Validated                   |
|  | Triclosan   | ug/l   | 0.01               | UKAS and UKWIR Validated          |
|  | Nonylphenols. (4-Nonylphenol Technical Mix)   | ug/l   | 0.04               | UKWIR Validated submitted to UKAS |
|  | 4-n-Nonylphenol   | ug/l   | 0.04               |                                   |
|  | Nonylphenol ethoxylates (sum of NPEO 1-3)   | ug/l   | 0.12               | UKWIR Validated submitted to UKAS |
|  | Nonylphenol monoethoxylate NPEO1  | ug/l   | 0.04               | UKWIR Validated submitted to UKAS |
|  | Nonylphenol diethoxylate NPEO2  | ug/l   | 0.04               | UKWIR Validated submitted to UKAS |
|  | Nonylphenol triethoxylate NPEO3   | ug/l   | 0.04               | UKWIR Validated submitted to UKAS |

| GUC Suite C – WFD + DWSP + Emerging Subs | Parameter  | Unit | LOD <sup>18</sup> | Accreditation <sup>19</sup> |
|--|--|------|-------------------|-----------------------------|
|  | Octylphenols ((4-(1,1', 3,3'-tetramethy butyl)-phenol))    | ug/l | 0.01              | UKWIR Validated             |
|  | Octylphenol ethoxylates (Sum OPEO 1-3)                     | ug/l | 0.06              | UKWIR Validated             |
|  | Octylphenol monoethoxylate (OPEO1)                         | ug/l | 0.02              | UKWIR Validated             |
|  | Octylphenol diethoxylate (OPEO2)                           | ug/l | 0.02              | UKWIR Validated             |
|  | Octylphenol triethoxylate (OPEO3)                          | ug/l | 0.02              | UKWIR Validated             |
|  | Tributyltin compounds (as Tributyltin cation)              | ug/l | 0.00002           | UKAS and UKWIR validated    |
|  | PFOS & PFOA low level                                      | ug/l | 0.00065           | UKAS and UKWIR validated    |
|  | PFAS List of 54 drinking water level                       | ug/l | 0.0001–0.005      | in-house                    |
|  | Hexabromocyclododecane (HBCDD) Total                       | ug/l | 0.00014           | UKAS and UKWIR validated    |
|  | alpha -Hexabromocyclododecane (α-HBCDD)                    | ug/l | 0.00004           | UKAS and UKWIR validated    |
|  | beta -Hexabromocyclododecane (β-HBCDD)                     | ug/l | 0.00004           | UKAS and UKWIR validated    |
|  | gamma -Hexabromocyclododecane (γ-HBCDD)                    | ug/l | 0.00004           | UKAS and UKWIR validated    |
|  | Phenol   | ug/l | 1                 | UKWIR Validated             |
| <b>Steroids</b>                          | Oesterone (E1)   | ug/l | 0.001             | UKWIR Validated             |
|  | 17β oestradiol (E2)  | ug/l | 0.0003            | UKWIR Validated             |
|  | 17α ethinyloestradiol (EE2)                                | ug/l | 0.00003           | UKWIR Validated             |
|  | Phenol   | ug/l | 1                 | UKWIR Validated             |
| <b>PCBs</b>                              | PCB 28   | ug/l | 0.005             | in house                    |
|  | PCB 52   | ug/l | 0.005             | in house                    |
|  | PCB 101  | ug/l | 0.005             | in house                    |
|  | PCB 118  | ug/l | 0.005             | in house                    |
|  | PCB 136  | ug/l | 0.005             | in house                    |
|  | PCB 153  | ug/l | 0.005             | in house                    |
|  | PCB 180  | ug/l | 0.005             | in house                    |
| <b>VOCs</b>                              | 1,2-Dichloroethane   | ug/l | 1                 | in house                    |
|  | 3, 4 Dichloroaniline                                       | ug/l | 1                 | in house                    |
|  | Dichloromethane  | ug/l | 1                 | in house                    |
|  | Trichloroethylene  | ug/l | 1                 | in house                    |
|  | Tetrachloroethylene  | ug/l | 1                 | in house                    |
|  | Trichlorobenzenes  | ug/l | 0.4               | in house                    |
|  | Trichloromethane   | ug/l | 1                 | in house                    |
|  | 1,2-Dibromoethane  | ug/l | 1                 | in house                    |
|  | Carbon-tetrachloride or Tethachloromethane                 | ug/l | 1                 | in house                    |
|  | D bromochloromethane                                       | ug/l | 1                 | In house                    |
| Vinyl Chloride                           | ug/l   | 0.1  |                   |                             |
| <b>THMs</b>                              | Bromodichloromethane                                       | ug/l | 1                 | In house                    |
|  | Bromoform  | ug/l | 1                 | In house                    |
|  | Chloroform   | ug/l | 1                 | In house                    |
|  | Tetrachloroethane  | ug/l | 1                 | In house                    |
|  | Trichloroethane (1 1 1)                                    | ug/l | 1                 | In house                    |
|  | Trichloroethane (1 1 2)                                    | ug/l | 1                 | In house                    |
|  | Tetra & Trichloroethane TOTAL                              | ug/l | 1                 | In house                    |
|  | THM TOTAL  | ug/l |                   | In house                    |
| <b>MTBE</b>                              | MTBE   | ug/l | 1                 | in house                    |
| <b>BTEX</b>                              | BTEX total (Benzene, Toluene, Ethylbenzene & o,p -Xylenes) | ug/l | 1                 | in house                    |
|  | Benzene  | ug/l | 0.1               | in house                    |
|  | Toluene  | ug/l | 0.1               | in house                    |
|  | Ethylbenzene   | ug/l | 0.1               | in house                    |
|  | m,p-Xylene   | ug/l | 0.1               | in-house                    |
|  | o-Xylene   | ug/l | 0.1               | in-house                    |
| <b>1,4-Dioxane</b>                       | 1,4-dioxane  | ug/l | 1                 | in-house                    |
| <b>Quinolines</b>                        | Quinoxifen   | ug/l | 0.1               | in house                    |
|  | Aclonifen  | ug/l | 0.1               | in house                    |
| <b>Algicides and other herbicides</b>    | Bifenox  | ug/l | 0.012             | in house                    |
|  | Cybutryne (irgarol)  | ug/l | 0.0025            | in house                    |
|  | Pendimethalin  | ug/l | 0.02              | in house                    |
|  | Glyphosate   | ug/l | 0.1               | UKAS and UKWIR Validated    |
|  | AMPA   | ug/l | 0.1               | UKAS and UKWIR Validated    |
| <b>Fungicides</b>                        | Chlorothalonil   | ug/l | 0.035             | in house                    |

| GUC Suite C – WFD + DWSP + Emerging Subs | Parameter  | Unit  | LOD <sup>18</sup> | Accreditation <sup>19</sup> |
|--|--|-------|-------------------|-----------------------------|
| Acid hebicide precursor                  | 2, 4 Dichlorophenol                                      | ug/l  | 0.02              | in house                    |
| Growth regulator                         | 2,3,6-Trichlorobenzoic acid (2,3,6-TBA)                  | ug/l  | 0.02              | in house                    |
| Phenol Suite 4                           | 2-METHYL PHENOL  | ug/l  | 0.02              | In house                    |
|  | 3-METHYL PHENOL  | ug/l  | 0.02              | In house                    |
|  | 4-METHYL PHENOL  | ug/l  | 0.02              | In house                    |
|  | TRICHLOROPHENOL (2 4 5)                                  | ug/l  | 0.02              | In house                    |
|  | TRICHLOROPHENOL (2 4 6)                                  | ug/l  | 0.02              | In house                    |
|  | DIMETHYLPHENOL (2 4)                                     | ug/l  | 0.02              | In house                    |
|  | DIMETHYLPHENOL (2 5)                                     | ug/l  | 0.02              | In house                    |
|  | DIMETHYLPHENOL (3 5)                                     | ug/l  | 0.02              | In house                    |
|  | 4-CHLORO-3-METHYLPHENOL                                  | ug/l  | 0.02              | In house                    |
|  | CHLOROMETHYLPHENOL (4 3)                                 | ug/l  | 0.02              | In house                    |
|  | CHLOROPHENOL (2)   | ug/l  | 0.02              | In house                    |
|  | CHLOROPHENOL (3)   | ug/l  | 1.02              | In house                    |
|  | CHLOROPHENOL (4)   | ug/l  | 0.02              | In house                    |
| EDD/EMD                                  | 2 EDD  | ug/l  | 0.1               | in house                    |
|  | 2 EMD  | ug/l  | 0.1               | in house                    |
| DHC VOCs                                 | DHC BENZENE*   | ug/l  | 0.1               | in house                    |
|  | DHC CUMENE*  | ug/l  | 0.1               | in house                    |
|  | DHC DECAENE*   | ug/l  | 0.1               | in house                    |
|  | DHC ETHYL BENZENE*                                       | ug/l  | 0.1               | in house                    |
|  | DHC HEPTANE*   | ug/l  | 0.1               | in house                    |
|  | DHC NAPHTHALENE*   | ug/l  | 0.1               | in house                    |
|  | DHC OCTANE*  | ug/l  | 0.1               | in house                    |
|  | DHC PHENANTHACENE*                                       | ug/l  | 0.1               | in house                    |
|  | DHC TETRADECANE*   | ug/l  | 0.1               | in house                    |
| DHC TOLUENE*                             | ug/l   | 0.1   | in house          |                             |
| Haloacetic acids                         | bromoacetic acid   | ug/l  | 1                 | in house                    |
|  | bromochloroacetic acid                                   | ug/l  | 1                 | in house                    |
|  | chloroacetic acid  | ug/l  | 1                 | in house                    |
|  | dibromochloroacetic acid                                 | ug/l  | 1                 | in house                    |
|  | dibromoacetic acid                                       | ug/l  | 1                 | in house                    |
|  | dichlorobromoacetic acid                                 | ug/l  | 1                 | in house                    |
|  | dichloroacetic acid                                      | ug/l  | 1                 | in house                    |
|  | tribromoacetic acid                                      | ug/l  | 1                 | in house                    |
| trichloroacetic acid                     | ug/l   | 1     | in house          |                             |
| Nitrosamines                             | NDMA   | ug/l  | 0.001             | in house                    |
|  | NMEA   | ug/l  | 0.001             | in house                    |
|  | NDEA   | ug/l  | 0.001             | in house                    |
|  | NDPA   | ug/l  | 0.001             | in house                    |
|  | NDBA   | ug/l  | 0.001             | in house                    |
|  | NPIP   | ug/l  | 0.001             | in house                    |
|  | NPYR   | ug/l  | 0.001             | in house                    |
| NMOR                                     | ug/l   | 0.001 | in house          |                             |
| Insecticides                             | Permethrin   | ug/l  | 0.001             | in house                    |
|  | Cyfluthrin   | ug/l  | 0.1               | in house                    |
|  | Cypermethrin   | ug/l  | 0.00008           | UKAS and UKWIR validated    |
| Phosphonates                             | ATMP   | ug/l  | 1                 | in house                    |
|  | DTPMP  | ug/l  | 1                 | in house                    |
| others                                   | Metalddehyde   | ug/l  | 0.02              | In-house                    |
|  | Metazachlor  | ug/l  | 0.1               | In-house                    |
|  | Flufenacet   | ug/l  | 0.02              | In-house                    |
|  | Ametryne   | ug/l  | 0.02              | In-house                    |
|  | Metamitron   | ug/l  | 0.02              | in house                    |
|  | Boscalid   | ug/l  | 0.1               | in house                    |
|  | Epichlorohydrin  | ug/l  | 0.1               | in house                    |
|  | Ethofumesate   | ug/l  | 0.05              | In-house                    |
|  | Azoxystrobin   | ug/l  | 0.05              | in house                    |
|  | Chlorotoluron  | ug/l  | 0.05              | In-house                    |
|  | Carbophnothion   | ug/l  | 0.02              | In-house                    |
|  | Carbetamide  | ug/l  | 0.01              | In-house                    |
|  | Diflufenican   | ug/l  | 0.1               | In-house                    |
|  | Methyl Tertiary Amyl Ether (tert-amyl methyl ether TAME) | ug/l  | 0.5               | In-house                    |



| GUC Suite C – WFD + DWSP + Emerging Subs | Parameter  | Unit | LOD <sup>18</sup>  | Accreditation <sup>19</sup>          |
|--|--|------|--------------------|--------------------------------------|
|  | Metribuzin   | ug/l | 0.05               | In-house                             |
|  | Oxadixyl   | ug/l | 0.05               | In-house                             |
|  | Oxamyl   | ug/l | 0.05               | In-house                             |
|  | Tebuconazole   | ug/l | 0.05               | In-house                             |
|  | Tolytriazole   | ug/l | 0.1                | UKWIR validated                      |
|  | Propiconazole  | ug/l | 0.1                | In-house                             |
|  | Soluble methane  | mg/l | 0.1                | in house (based on min on 3 samples) |
|  | Diclofenac   | ug/l | 0.1                | UKWIR validated                      |
|  | Bisphenol A  | ug/l | 0.01               | UKWIR Validation                     |
|  | Geosmin  | ng/l | 1 –drinking water  | In-house                             |
|  | 2-Methylisoborneol (MIB)                                     | ng/l | 1 – drinking water | In-house                             |
|  | Microcystin LR   | ug/l | 5                  | In-house                             |
|  | Benzotriazole  | ug/l | 0.1                | UKWIR validated                      |
|  | Acrylamide   | ug/l | 0.1                | in house                             |
|  | Linear A kylbenzene Sulphonate (LAS)                         | mg/l | 0.1                | in house                             |
|  | CAPB as Lauroylamide propylbetaine                           | ug/l | 1                  | in house                             |
|  | DEGBE  | mg/l | 10                 | in house                             |
|  | Triclocarban   | ug/l | 0.1                | in house                             |
|  | Tri-(2-chloroethyl) phosphate                                | ug/l | 0.01               | in house                             |
|  | Specific ABS 245nm   | abs  | n/a                | in house                             |
|  | Transmission % at 245nm                                      | %    | n/a                | in house                             |
| <b>Others</b>                            | Malachite green  | ug/l | 1                  | in house                             |
|  | polychloro chloromethyl sulphonamido diphenyl ethers (PCSDs) | ug/l | 0.2                | in house                             |
|  | Triazaphos   | ug/l | 0.02               | in house                             |
|  | Formaldehyde   | ug/l | 50                 | in house                             |
| <b>DTCs</b>                              | Mancozeb   | ug/l | 0.1                | in house                             |
|  | Maneb  | ug/l | 0.1                | in house                             |
| <b>Mectins</b>                           | Abamectin  | ug/l | 5                  | in house                             |
|  | Doramectin   | ug/l | 5                  | in house                             |
|  | Ivermectin   | ug/l | 5                  | in house                             |

# Appendix F. Suite D

| GUC Suite D – WFD + EQSD | Parameter   | Unit  | LOD <sup>20</sup> | Accreditation <sup>21</sup> |
|--------------------------|---|-------|-------------------|-----------------------------|
| General Parameters       | pH  | pH    | 0.1 pH unit       | in house                    |
|                          | BOD 5   | mg/l  | 1                 | UKAS (sub) UKWIR Validated  |
|                          | Chemical Oxygen Demand (COD)                        | mg/l  | 5                 | UKAS                        |
|                          | Chlorine total                                      | mg/l  | 0.1               | sub                         |
|                          | Chlorine free                                       | mg/l  | 0.1               | sub                         |
|                          | ORP   | mV    | -500              | in house                    |
|                          | Reactive phosphorus                                 | mg/l  | 0.01              | UKAS (sub) UKWIR Validated  |
|                          | Total phosphorus                                    | mg/l  | 0.01              | UKAS (sub) UKWIR Validated  |
|                          | Salinity @ 20°C                                     | uS/cm | 1                 | UKAS (sub)                  |
|                          | Conductivity @ 20°C                                 | uS/cm |                   | in house                    |
|                          | Bromide   | mg/l  | 0.01              | in house                    |
|                          | Bromine – total residual oxidant                    | mg/l  | 0.05              | in house                    |
|                          | Fluoride  | mg/l  | 0.01              | in house                    |
|                          | Chloride as CL                                      | mg/l  | 0.1               | UKAS                        |
|                          | Ortho Phosphate as PO4                              | mg/l  | 0.01              | UKAS                        |
|                          | Sulphate as SO4                                     | mg/l  | 0.1               | UKAS                        |
|                          | Ammonia (un-ionised)                                | mg/l  | 0.02              | in house                    |
|                          | Ammoniacal Nitrogen as N                            | mg/l  | 0.015             | UKAS                        |
|                          | Ammonia (as N)                                      | mg/l  | 0.1               | UKAS (sub) UKWIR Validated  |
|                          | Nitrate (as NO3)                                    | mg/l  | 0.1               | UKAS (sub) UKWIR Validated  |
|                          | Nitrate as N  | mg/l  | calc              | calc from above             |
|                          | Nitrite (as NO2)                                    | mg/l  | 0.1               | UKAS (sub) UKWIR Validated  |
|                          | Nitrite as N  | mg/l  | calc              | calc from above             |
|                          | Total anions (sum of Br, Cl, F, NO2, NO3, SO4, PO4) | mg/l  |                   | in house                    |
|                          | Total nitrogen (oxidised as N)                      | mg/l  | 0.054             | calculation                 |
|                          | Kjeldahl nitrogen                                   | mg/l  | 0.2               | UKAS                        |
|                          | Organic nitrogen                                    | mg/l  | calc              | calc from above             |
|                          | Cyanide Free (easily liberable)                     | ug/l  | 0.1               | UKAS                        |
|                          | Cyanide Total                                       | ug/l  | 0.1               | UKAS                        |
|                          | Sulphide  | ug/l  | 10                | UKAS                        |
|                          | Alkalinity as CaCO3                                 | mg/l  | 5                 | UKAS (sub)                  |
|                          | Acid Neutralisation Capacity (ANC) (unfiltered)     | mg/l  | 5                 | UKAS (sub)                  |
|                          | Hardness as CaCO3                                   | mg/l  | 0.1               | UKAS (sub)                  |
|                          | Dissolved organic carbon* if on its own             | mg/l  | 0.5               | UKAS (sub) UKWIR Validated  |
|                          | Total organic carbon                                | mg/l  | 0.5               | UKAS (sub) UKWIR Validated  |
|                          | Solids, Suspended @ 105°C                           | mg/l  | 2                 | UKAS                        |
| Chlorophyll              | ug/l  | 20    | in house          |                             |
| Phaeophytin              | ug/l  | 20    | in house          |                             |
| Metals                   | Antimony Total                                      | ug/l  | 0.17              | sub                         |
|                          | Antimony Dissolved*                                 | ug/l  | 0.17              | sub                         |
|                          | Aluminium Total                                     | ug/l  | 10                | UKWIR Validated (sub)       |
|                          | Aluminium Dissolved*                                | ug/l  | 10                | UKAS (sub) UKWIR Validated  |
|                          | Aluminium Reactive                                  | ug/l  | 4                 | UKWIR Validated (sub)       |
|                          | Arsenic Total                                       | ug/l  | 0.16              | UKWIR Validated (sub)       |
|                          | Arsenic Dissolved *                                 | ug/l  | 0.16              | UKAS (sub) UKWIR Validated  |
|                          | Boron Total   | ug/l  | 12                | in-house                    |
|                          | Boron Dissolved*                                    | ug/l  | 12                | in-house                    |
|                          | Cadmium Total                                       | ug/l  | 0.02              | UKWIR Validated (sub)       |
|                          | Cadmium Dissolved *                                 | ug/l  | 0.02              | UKAS (sub) UKWIR Validated  |
|                          | Calcium Total                                       | mg/l  | 0.09              | UKWIR Validated (sub)       |
|                          | Calcium Dissolved                                   | mg/l  | 0.09              | UKWIR Validated (sub)       |
|                          | Cobalt Total  | ug/l  | 0.16              | in-house                    |
|                          | Cobalt Dissolved*                                   | ug/l  | 0.16              | UKAS                        |
|                          | Copper Total  | ug/l  | 0.4               | UKWIR Validated (sub)       |
|                          | Copper Dissolved                                    | ug/l  | 0.4               | UKAS (sub) UKWIR Validated  |
|                          | Chromium(III) Dissolved*                            | ug/l  | 1                 | UKAS                        |
|                          | Chromium(VI) Dissolved*                             | ug/l  | 0.05              | in-house                    |
|                          | Chromium Total                                      | ug/l  | 0.25              | UKWIR Validated (sub)       |
|                          | Chromium Dissolved*                                 | ug/l  | 0.25              | UKAS (sub) UKWIR Validated  |

<sup>20</sup> The LOD will be raised if the sample needs diluting during analysis

<sup>21</sup> Indicates UKAS ISO 17025 accreditation / UKWIR validation for testing and calibration laboratories. 'In house' and 'sub' indicates an unaccredited test.



| GUC Suite D – WFD + EQSD   | Parameter                                     | Unit  | LOD <sup>20</sup>          | Accreditation <sup>21</sup> |
|--|---|-------|----------------------------|-----------------------------|
|  | Iron Total                                    | ug/l  | 5.5                        | UKWIR Validated (sub)       |
|  | Iron Dissolved*                               | ug/l  | 5.5                        | UKAS (sub) UKWIR Validated  |
|  | Lead Total                                    | ug/l  | 0.09                       | UKWIR Validated (sub)       |
|  | Lead Dissolved*                               | ug/l  | 0.09                       | UKAS (sub) UKWIR Validated  |
|  | Manganese Total                               | ug/l  | 10                         | in-house UKWIR Validated    |
|  | Manganese Dissolved*                          | ug/l  | 0.22                       | UKAS UKWIR Validated        |
|  | Mercury Total                                 | ug/l  | 0.001                      | UKWIR Validated (sub)       |
|  | Mercury Dissolved*                            | ug/l  | 0.001                      | UKAS (sub) UKWIR Validated  |
|  | Nickel Total                                  | ug/l  | 0.5                        | UKWIR Validated (sub)       |
|  | Nickel Dissolved*                             | ug/l  | 0.5                        | UKAS (sub) UKWIR Validated  |
|  | Silver Total                                  | ug/l  | 1                          | in-house                    |
|  | Silver Dissolved*                             | ug/l  | 1                          | UKAS                        |
|  | Tin Total                                     | ug/l  | 0.4                        | in-house                    |
|  | Tin Dissolved*                                | ug/l  | 0.4                        | UKAS                        |
|  | Vanadium Total                                | ug/l  | 10                         | in-house                    |
|  | Vanadium Dissolved*                           | ug/l  | 10                         | UKAS                        |
|  | Zinc Total                                    | ug/l  | 0.5                        | UKWIR Validated (sub)       |
| Zinc Dissolved*  | ug/l  | 0.5   | UKAS (sub) UKWIR Validated |                             |
| Organo Phosphorous Pesticide Suite                                     | Diazinon                                      | ug/l  | 0.01                       | in house                    |
|  | Dimethoate                                    | ug/l  | 0.02                       | in house                    |
|  | Chlorfenvinphos                               | ug/l  | 0.02                       | in house                    |
|  | Chlorpyrifos (Chlorpyrifosethyl)              | ug/l  | 0.02                       | in house                    |
|  | Dichlorvos                                    | ug/l  | 0.001                      | in house                    |
|  | Propetamphos                                  | ug/l  | 0.02                       | In house                    |
|  | Parathion                                     | ug/l  | 0.02                       | In house                    |
|  | Cyanazine                                     | ug/l  | 0.02                       | In house                    |
|  | Tributyl phosphate                            | ug/l  | 0.02                       | in house                    |
|  | Coumaphos                                     | ug/l  | 0.02                       | in house                    |
|  | Demetons                                      | ug/l  | 0.02                       | in house                    |
|  | Fenclorphos                                   | ug/l  | 0.02                       | in house                    |
|  | Fenitrothion                                  | ug/l  | 0.01                       | in house                    |
|  | Mevinphos                                     | ug/l  | 0.02                       | in house                    |
|  | Omethoate                                     | ug/l  | 0.01                       | in house                    |
|  | Pirimiphos-methyl                             | ug/l  | 0.01                       | in house                    |
|  | Malathion                                     | ug/l  | 0.02                       | In-house                    |
| Azinphos methyl (dissolved) this needs separate run after filtration * | ug/l  | 0.02  | in house                   |                             |
| Acid Herbicide Suite   | 2, 4 Dichlorophenoxyacetic acid (2, 4 D)      | ug/l  | 0.02                       | UKAS                        |
|  | Mecoprop                                      | ug/l  | 0.02                       | UKAS                        |
|  | Pentachloro-phenol                            | ug/l  | 0.02                       | UKAS                        |
|  | 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)   | ug/l  | 0.02                       | UKAS                        |
|  | 4-(2,4-dichlorophenoxy)butanoic acid (2,4-DB) | ug/l  | 0.02                       | UKAS                        |
|  | MCPA  | ug/l  | 0.02                       | UKAS                        |
|  | MCPB  | ug/l  | 0.02                       | In-house                    |
|  | Bentazone                                     | ug/l  | 0.02                       | UKAS                        |
|  | Bromoxynil                                    | ug/l  | 0.02                       | In-house                    |
|  | Clopyralid                                    | ug/l  | 0.02                       | UKAS                        |
|  | Dicamba                                       | ug/l  | 0.02                       | In-house                    |
|  | Dalapon                                       | ug/l  | 0.02                       | In-house                    |
|  | Ioxynil                                       | ug/l  | 0.02                       | In-house                    |
|  | Dichloprop                                    | ug/l  | 0.02                       | UKAS                        |
|  | Fenprop                                       | ug/l  | 0.02                       | UKAS                        |
|  | Fluroxypyr                                    | ug/l  | 0.02                       | In-house                    |
|  | Triclopyr                                     | ug/l  | 0.02                       | In house                    |
|  | Picloram                                      | ug/l  | 0.02                       | In house                    |
|  | Propyzamide                                   | ug/l  | 0.01                       | In house                    |
|  | Quimerac                                      | ug/l  | 0.02                       | In house                    |
| Bromacil   | ug/l  | 0.02  | in house                   |                             |
| Benazolin  | ug/l  | 0.025 | In-house                   |                             |
| Carbamate pesticide  | Carbendazim                                   | ug/l  | 0.1                        | in house                    |
| Fungicide  | Methiocarb                                    | ug/l  | 0.1                        | in house                    |
| Uron Herbicide Suite   | Linuron                                       | ug/l  | 0.01                       | in house                    |
|  | Diuron  | ug/l  | 0.05                       | UKWIR Validated             |
|  | Isoproturon                                   | ug/l  | 0.002                      | in house                    |
|  | Monuron                                       | ug/l  | 0.05                       | In-house                    |

| GUC Suite D – WFD + EQSD   | Parameter  | Unit   | LOD <sup>20</sup>        | Accreditation <sup>21</sup> |
|--|--|--------|--------------------------|-----------------------------|
|  | Diflufenuron   | ug/l   | 0.001                    | in house                    |
| OCL Insecticide Suite  | Alachor  | ug/l   | 0.02                     | in house                    |
|  | Aldrin   | ug/l   | 0.02                     | in house                    |
|  | Dieldrin   | ug/l   | 0.02                     | in house                    |
|  | Endrin   | ug/l   | 0.02                     | in house                    |
|  | Isodrin  | ug/l   | 0.02                     | in house                    |
|  | DDT total  | ug/l   | 0.025                    | in house                    |
|  | para-para-DDT (CAS 50-29-3)  | ug/l   | 0.01                     | in house                    |
|  | ortho-para-DDT (CAS 789-02-6)  | ug/l   | 0.01                     | in house                    |
|  | TDE OP' or p'p'-DDD (CAS 72-54-8)  | ug/l   | 0.01                     | In house                    |
|  | TDE PP' or o'p'-DDD (CAS 53-19-0)  | ug/l   | 0.01                     | In house                    |
|  | para-para-DDE (CAS 72-55-9)  | ug/l   | 0.02                     | In house                    |
|  | Endosulfan   | ug/l   | 0.02                     | in house                    |
|  | Hexachloro-benzene   | ug/l   | 0.02                     | in house                    |
|  | Hexachloro-butadiene   | ug/l   | 0.02                     | in house                    |
|  | Hexachloro-cyclohexane   | ug/l   | 0.02                     | in house                    |
|  | Pentachloro-benzene  | ug/l   | 0.007                    | in house                    |
|  | Trifluralin  | ug/l   | 0.02                     | in house                    |
|  | Dicofol  | ug/l   | 0.0013                   | in house                    |
|  | Heptachlor and heptachlor epoxide  | ug/l   | 0.001                    | in house                    |
|  | HCH – Gamma isomer   | ug/l   | 0.02                     | In-house                    |
|  | HCH – Alpha isomer   | ug/l   | 0.02                     | In-house                    |
|  | HCH – Beta isomer  | ug/l   | 0.02                     | In-house                    |
|  | HCH – Delta isomer   | ug/l   | 0.02                     | In-house                    |
|  | Methoxychlor   | ug/l   | 0.02                     | In-house                    |
|  | Dichlorobenil  | ug/l   | 0.02                     | In-house                    |
|  | Chlordane  | ug/l   | 0.02                     | In-house                    |
| Tecnazene  | ug/l   | 0.02   | In house                 |                             |
| Triallate  | ug/l   | 0.02   | in house                 |                             |
| Cyclodiene pesticides – total aldrin, dieldrin, endrin and isodrin |  |        |                          | in house                    |
| Polyaromatic hydrocarbons PAH Suite                                | Polyaromatic hydrocarbons (PAH) Total  | ug/l   | see individual RLs       | UKWIR Validated             |
|  | Naphthalene  | ug/l   | 0.02                     | in house                    |
|  | Fluoranthene   | ug/l   | 0.0009                   | UKWIR Validated             |
|  | Anthracene   | ug/l   | 0.02                     | in house                    |
|  | Benzo(a)pyrene   | ug/l   | 0.00017                  | UKWIR Validated             |
|  | Benzo(b)fluoranthene   | ug/l   | 0.0001                   | UKWIR Validated             |
|  | Benzo(k)fluoranthene   | ug/l   | 0.0001                   | UKWIR Validated             |
|  | Benzo(g,h,i)-perylene  | ug/l   | 0.0003                   | UKWIR Validated             |
| Indeno(1,2,3-cd)-pyrene  | ug/l   | 0.0003 | UKWIR Validated          |                             |
| Triazine suite   | Atrazine   | ug/l   | 0.02                     | in house                    |
|  | Simazine   | ug/l   | 0.02                     | in house                    |
|  | Terbutryn  | ug/l   | 0.02                     | in house                    |
|  | Desethyl Atrazine  | ug/l   | 0.02                     | In house                    |
|  | Tebuthiuron  | ug/l   | 0.02                     | In house                    |
|  | Propazine  | ug/l   | 0.02                     | In house                    |
| Promethryn   | ug/l   | 0.02   | In house                 |                             |
| Phthalates   | Di(2-ethylhexyl)-phthalate (DEHP)  | ug/l   | 0.15                     | UKAS and UKWIR Validated    |
|  | Benzyl butyl phthalate   | ug/l   | 0.2                      | in house                    |
|  | Dibutyl phthalate  | ug/l   | 0.02                     | in house                    |
|  | Diethyl phthalate  | ug/l   | 0.02                     | in house                    |
|  | Dimethyl phthalate   | ug/l   | 0.02                     | in house                    |
| Diocetyl phthalate   | ug/l   | 0.02   | in house                 |                             |
| Phthalates   | Di(2-ethylhexyl)-phthalate (DEHP)  | ug/l   | 0.15                     | UKWIR Validated             |
| Other WFD parameters   | Brominated diphenylethers Total ( sum of BDE penta congeners 28,47,99,100,153,154) | ug/l   | 0.0005                   | UKWIR Validated             |
|  | BDE 28   | ug/l   | 0.0001                   | UKWIR Validated             |
|  | BDE 47   | ug/l   | 0.0001                   | UKWIR Validated             |
|  | BDE 99   | ug/l   | 0.0001                   | UKWIR Validated             |
|  | BDE 100  | ug/l   | 0.0001                   | UKWIR Validated             |
|  | BDE 153  | ug/l   | 0.0001                   | UKWIR Validated             |
|  | BDE 154  | ug/l   | 0.0001                   | UKWIR Validated             |
|  | C10-13 Chloroalkanes (total)   | ug/l   | 0.4                      | UKWIR Validated             |
| Triclosan  | ug/l   | 0.01   | UKAS and UKWIR Validated |                             |

| GUC Suite D – WFD + EQSD       | Parameter  | Unit | LOD <sup>20</sup> | Accreditation <sup>21</sup> |
|--------------------------------|--|------|-------------------|-----------------------------|
|                                | Nonylphenols. (4-Nonylphenol Technical Mix)                | ug/l | 0.04              | UKWIR Validated             |
|                                | 4-n-Nonylphenol  | ug/l | 0.04              |                             |
|                                | Nonylphenol ethoxylates (sum of NPEO 1-3)                  | ug/l | 0.12              | UKWIR Validated             |
|                                | Nonylphenol monoethoxylate NPEO1                           | ug/l | 0.04              | UKWIR Validated             |
|                                | Nonylphenol diethoxylate NPEO2                             | ug/l | 0.04              | UKWIR Validated             |
|                                | Nonylphenol triethoxylate NPEO3                            | ug/l | 0.04              | UKWIR Validated             |
|                                | Octylphenols ((4-(1,1', 3,3'-tetramethylbutyl)-phenol))    | ug/l | 0.01              | UKWIR Validated             |
|                                | Octylphenol ethoxylates (Sum OPEO 1-3)                     | ug/l | 0.06              |                             |
|                                | Octylphenol monoethoxylate (OPEO1)                         | ug/l | 0.02              |                             |
|                                | Octylphenol diethoxylate (OPEO2)                           | ug/l | 0.02              |                             |
|                                | Octylphenol triethoxylate (OPEO3)                          | ug/l | 0.02              |                             |
|                                | Tributyltin compounds (as Tributyltin cation)              | ug/l | 0.00002           | UKAS and UKWIR validated    |
|                                | Triphenyltin compounds (as triphenyltin cation)            | ug/l | 0.002             | in house method             |
|                                | PFOS & PFOA low level                                      | ug/l | 0.00065           | UKAS and UKWIR validated    |
|                                | PFAS List of 54  | ug/l | 0.0001–0.005      | in-house                    |
|                                | Hexabromocyclododecane (HBCDD) Total                       | ug/l | 0.00014           | UKAS and UKWIR validated    |
|                                | alpha -Hexabromocyclododecane (α-HBCDD)                    | ug/l | 0.00004           | UKAS and UKWIR validated    |
|                                | beta -Hexabromocyclododecane (β-HBCDD)                     | ug/l | 0.00004           | UKAS and UKWIR validated    |
|                                | gamma -Hexabromocyclododecane (γ-HBCDD)                    | ug/l | 0.00004           | UKAS and UKWIR validated    |
| Phenol                         | ug/l   | 1    | UKWIR Validated   |                             |
| VOC Suite                      | 1,2-Dichloroethane   | ug/l | 1                 | in house                    |
|                                | 3, 4 Dichloroaniline                                       | ug/l | 1                 | in house                    |
|                                | Dichloromethane  | ug/l | 1                 | in house                    |
|                                | Tetrachloroethylene  | ug/l | 1                 | in house                    |
|                                | Trichloroethylene  | ug/l | 1                 | in house                    |
|                                | Trichlorobenzenes  | ug/l | 0.4               | in house                    |
|                                | Trichloromethane   | ug/l | 1                 | in house                    |
|                                | 1,2-Dibromoethane  | ug/l | 1                 | in house                    |
|                                | Carbon-tetrachloride or Tethachloromethane                 | ug/l | 1                 | in house                    |
|                                | Dibromochloromethane                                       | ug/l | 1                 | In house                    |
|                                | Dichlorobenzene – total dichlorobenzene isomers            | ug/l | 0.1               | in house                    |
|                                | Styrene  |      | 0.1               | in house                    |
|                                | Vinyl Chloride   | ug/l | 0.1               | in house                    |
| BTEX                           | BTEX total (Benzene, Toluene, Ethylbenzene & o,p -Xylenes) | ug/l | 1                 | in house                    |
|                                | Benzene  | ug/l | 0.1               | in house                    |
|                                | Toluene  | ug/l | 0.1               | in house                    |
|                                | Ethylbenzene   | ug/l | 0.1               | in house                    |
|                                | m,p-Xylene   | ug/l | 0.1               | in-house                    |
|                                | O-Xylene   | ug/l | 0.1               | in-house                    |
| THMs                           | Chloroform   | ug/l | 1                 | In house                    |
|                                | Tetrachloroethane  | ug/l | 1                 | In house                    |
|                                | Trichloroethane (1 1 1)                                    | ug/l | 1                 | In house                    |
|                                | Trichloroethane (1 1 2)                                    | ug/l | 1                 | In house                    |
| Quinolines                     | Quinoxyfen   | ug/l | 0.1               | in house                    |
|                                | Aclofenifen  | ug/l | 0.1               | in house                    |
| Algicides and other herbicides | Bifenox  | ug/l | 0.012             | in house                    |
|                                | Cybutryne (irgarol)  | ug/l | 0.0025            | in house                    |
|                                | Pendimethalin  | ug/l | 0.02              | in house                    |
|                                | Glyphosate   | ug/l | 0.1               | UKAS and UKWIR Validated    |
|                                | AMPA   | ug/l | 0.1               | UKAS and UKWIR Validated    |
| Fungicides                     | Chlorothalonil   | ug/l | 0.035             | in house                    |
| Insecticides                   | Permethrin   | ug/l | 0.001             | in house                    |
|                                | Cyfluthrin   | ug/l | 0.1               | in house                    |
|                                | Cypermethrin   | ug/l | 0.00008           | UKAS and UKWIR validated    |
| Acid hecicide precursor        | 2, 4 Dichlorophenol  | ug/l | 0.02              | in house                    |
| Phenol Suite 4                 | 2-METHYL PHENOL  | ug/l | 0.02              | In house                    |
|                                | 3-METHYL PHENOL  | ug/l | 0.02              | In house                    |

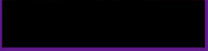


| GUC Suite D – WFD + EQSD | Parameter  | Unit | LOD <sup>20</sup> | Accreditation <sup>21</sup> |
|--------------------------|--|------|-------------------|-----------------------------|
|                          | 4-METHYL PHENOL  | ug/l | 0.02              | In house                    |
|                          | TRICHLOROPHENOL (2 4 5)                                      | ug/l | 0.02              | In house                    |
|                          | TRICHLOROPHENOL (2 4 6)                                      | ug/l | 0.02              | In house                    |
|                          | DIMETHYLPHENOL (2 4)   | ug/l | 0.02              | In house                    |
|                          | DIMETHYLPHENOL (2 5)   | ug/l | 0.02              | In house                    |
|                          | DIMETHYLPHENOL (3 5)   | ug/l | 0.02              | In house                    |
|                          | 4-CHLORO-3-METHYLPHENOL                                      | ug/l | 0.02              | In house                    |
|                          | CHLOROMETHYLPHENOL (4 3)                                     | ug/l | 0.02              | In house                    |
|                          | CHLOROPHENOL (2)   | ug/l | 0.02              | In house                    |
|                          | CHLOROPHENOL (3)   | ug/l | 1.02              | In house                    |
|                          | CHLOROPHENOL (4)   | ug/l | 0.02              | In house                    |
| DTCs                     | Mancozeb   | ug/l | 0.1               | in house                    |
|                          | Maneb  | ug/l | 0.1               | in house                    |
| Mectins                  | Abamectin  | ug/l | 5                 | in house                    |
|                          | Doramectin   | ug/l | 5                 | in house                    |
|                          | Ivermectin   | ug/l | 5                 | in house                    |
| Mitins                   | Flucofuron   | ug/l | 0.05              | in house                    |
|                          | Sulcofuron   | ug/l | 0.05              | in house                    |
| Imadazoles               | Pirimicarb   | ug/l | 1                 | in house                    |
|                          | Prochloraz   | ug/l | 0.1               | in house                    |
|                          | Thiabendazole  | ug/l | 0.1               | in house                    |
| Chelating agents         | EDTA   | ug/l | 100               | in house                    |
|                          | Nitilotriacetic acid (NTA)                                   | ug/l | 100               | in house                    |
| Others                   | Chlorotoluron  | ug/l | 0.05              | In-house                    |
|                          | Biphenyl   | ug/l | 0.02              | in house                    |
|                          | Chloronitrotoluenes  | ug/l | 0.02              | in house                    |
|                          | Chlorpropham   | ug/l | 0.1               | in house                    |
|                          | Triazaphos   | ug/l | 0.02              | in house                    |
|                          | Malachite green  | ug/l | 1                 | in house                    |
|                          | Formaldehyde   | ug/l | 50                | in house                    |
|                          | polychloro chloromethyl sulphonamido diphenyl ethers (PCSDs) | ug/l | 0.2               | in house                    |

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**Water Quality  
Monitoring Report -  
Interim results to  
inform Gate 3  
assessments**

Severn Trent, Affinity Water and the Canal &  
River Trust

31 October 2022

**Gate 3 Water Quality  
Monitoring: Quarter 1  
Results**

Severn Trent, Affinity Water and the Canal &  
River Trust

5204564/7/DG/027

**GRAND  
UNION CANAL  
STRATEGIC  
RESOURCE OPTION**

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# Executive Summary

The Grand Union Canal (GUC) is a Strategic Resource Option (SRO) in which Affinity Water (AfW) and Severn Trent (ST) are working together alongside the Canal & River Trust (The Trust). The scheme looks to transfer water from ST's Minworth Wastewater Recycling Centre (WwRC) in the Midlands to AfW in the South East using the existing GUC network.

## Objectives

The aim of the water quality monitoring programme is to obtain a baseline dataset to allow characterisation of different study reaches in terms of drinking water safety risks (particularly with respect to current and future regulated parameters), Water Framework Directive determinands, and Environment Agency Surface Water Pollution Risk Assessment Parameters, to characterise the baseline risk and to inform modelling. The key drivers for monitoring water quality for this SRO include:

- Drinking Water Safety Planning – the scheme involves utilisation of a new source for public drinking water supply. As such, assessment of the risks to human health from this new source, and development of control measures sufficient to reduce these risks to an acceptable level, is critical to ensuring compliance with the legislative requirements for drinking water quality and safeguarding public health while meeting demand for public water supply of future generations.
- An All Company Working Group (ACWG) treatment water methodology for drinking water risk assessment and water safety planning of all SROs has been developed, which will require water quality data to inform judgements of drinking water risk. This ACWG methodology was updated for the transfer scheme at the end of Phase 1 and has been updated as part of Phase 3 using the available monitoring data.
- Environmental water quality – the scheme would result in changes to the sources of water entering the canal and therefore may impact on the ecological and environmental health of the water body and local environment. Water quality data are key to identifying and mitigating potential environmental impacts of the scheme. In particular, the requirements of the Water Framework Directive determinands, and Environmental Quality Standards Directive have been referred to in the development of this monitoring programme.
- Lastly, this monitoring programme will help inform treatment design at both selected discharge and abstraction location.

Data are presented from a total of 11 sites including those carried forward from previous Phases (Site 1 Minworth, Site 3 Coventry Canal at Atherstone, Site 5 GUC at Welton Lane, Daventry, and Site 6 Grove Lock, Leighton Buzzard), and newly established monitoring locations (Site 10 GUC at Bedworth, Site 11 GUC at Little Heath Long Buckby, Site 12 GUC at Gayton, Site 13 GUC at Stoke Bruen, Site 14 GUC at Cosgrove, Site 15 GUC at Stoke Hammond, and Site 16 GUC at Marsworth).

## Methodology

Under the Phase 1 water quality monitoring programme (May 2020 - March 2021), conducted by ALS analytical testing services, samples were taken at 15 monitoring locations in the upper and lower sections of the canal to characterise baseline water quality at the potential discharge and abstraction locations. Subsequent phases, Phase 2 (April - September 2021) and Phase 3 (October 2021 – March 2022) have been conducted by AtkinsRéalis and RPS, a fully accredited laboratory (UK Accreditation Service ISO 17025) based in Bedford. At the onset of Phase 2, a number of discharge sub-route options and abstraction point sub-options were no longer being progressed as part of the scheme, so it was necessary to adapt the monitoring programme accordingly. For Phase 2 and 3, monitoring was conducted at a total of nine monitoring locations across the GUC Transfer scheme. An additional Phase 3 extension was commissioned to run between April 2022 – June 2022. It is the data collected under the Phase 3 extension that are presented here with water quality monitoring



and analysis conducted at sites where there is a key legislative or design driver. As a result, the water quality analysis suites break down into the following components.

- **Environmental risks as required by the Water Framework Directive (WFD)** – which cover analysis of samples for 83 determinands as previously agreed to be suitable as part of Phase 1, and, set out in the 2015 WFD Directions<sup>1</sup>
- **Environmental permitting risks as required by the Environmental Quality Standards Directive (EQSD)** – which cover analysis of samples for the 95 determinands set out in the surface water pollution risk assessment for environmental permits,<sup>2</sup> at Sites that may require permitting.
- **Drinking Water** – an appropriate list of 263 determinands to characterise the expected raw water quality to be abstracted from the GUC and to inform a water safety planning approach to control measures as required by Drinking Water Inspectorate (DWI).

For Sites 1, 3, 5, and 6, monitored through Phase 2, the first four sampling rounds conducted by AtkinsRéalis and RPS took place at three weekly intervals (20/04/21 – 22/06/21 inclusive), however, following consultation with the Environment Agency and the DWI, samples collected from the start of July 2021 were collected at monthly intervals.

In addition to spot sampling, continuous monitoring sondes were installed at the example discharge location (Site 3, Atherstone), example abstraction location (Site 6, Leighton Buzzard), and at most downstream point of impact (Site 16, Marsworth). This continuous data will, in conjunction with rainfall data, enable determination of landscape pollutant sources and potential transport mechanisms that may impact the quality of water at both example discharge and abstraction locations. Determinands monitored continuously at these sites include temperature, conductivity, dissolved oxygen, ammonium, pH, chlorophyll and turbidity. In addition, a continuous monitoring sonde was installed at the proposed source (Site 1, Minworth WwRC final effluent).

## Conclusions

In total, 91 environmental quality standard exceedances were observed spanning all sampling sites. At present, the following parameters demonstrated the greatest number of exceedances across all sites: acid neutralisation capacity, benzo(a)pyrene and fluoranthene (polycyclic aromatic hydrocarbons), biological oxygen demand (a measure of organic pollution), perfluorooctanesulfonic acid (a synthetic chemical with a number of waterproofing applications), dissolved oxygen and soluble reactive phosphorus (a key limiting nutrient).

Some concentrations in the Minworth WwRC effluent were greater than the Environmental Quality Standards (EQS) in the receiving water (noting these standards do not directly apply to effluent and discharge standards are set through the permitting regime). These include chlorothalonil (an organic fungicide) and cypermethrin (a synthetic pyrethroid), permethrin (an insecticide) and bioavailable zinc. As a result, if Minworth WwRC discharge were diverted into any of the proposed sub discharge routes without additional treatment being applied, additional instream exceedances may occur, resulting in a future WFD compliance risk if the new discharge prevented the receiving body from achieving Good water quality status.

Minworth WwRC treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of these 'high risk' compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permissibility risk (e.g., due to within class deterioration).

---

<sup>1</sup> The Water Framework (Standards and Classification) Directive (England and Wales) 2015 accessed via: [The Water Framework Directive \(Standards and Classification\) Directions \(England and Wales\) 2015 \(legislation.gov.uk\)](https://www.legislation.gov.uk/uk/2015/1000/contents/section/1)

<sup>2</sup> Accessed via: <https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit>



Drinking water safety parameters, assessed through their comparison to Prescribed Concentration or Values (PCVs) are only required to characterise the source water at Minworth WwRC (Site 1) and the potential downstream abstraction location (Site 6, Grove, Leighton Buzzard). There has been a total of 162 PCV exceedances at Site 1 (27 samples due to the inclusion of Phase 1-3 data) and 94 exceedances at Site 6 (17 samples following commencement of Drinking Water Safety Plan (DWSP) sampling in November 2021).

A number of determinands routinely exceed these targets including *Clostridium perfringens* veg & spores, *Escherichia coli*, turbidity, nitrite and iron (total). It should be noted, however, that drinking water safety thresholds apply only to treated drinking water, and not raw source waters, and as such these are included only as guidance to inform treatment options as in some cases the PCV equates to '0' CFU/100ml which is easily exceeded in raw waters.

Data from sampling which occurred on wet weather days resulted in a number of additional exceedances not observed during low flow conditions. These exceedances included iron, nitrate and ammonium. Of particular interest were the presence of tebuconazole, an agricultural triazole fungicide used to treat plant pathogenic fungi, and metribuzin, a synthetic herbicide applied both pre- and post-emergence of vegetable crops, which suggests an agricultural origin and the mobilisation of a larger number of potential pollutants under wet weather conditions. It is therefore recommended that the SRO completes a review of planned mitigations to factor in these additional compounds of concern.

A series of algal blooms, which may pose a risk to water abstraction, were observed in sonde data at Site 6 (potential abstraction location) between March and April 2022 with chlorophyll concentrations peaking at 147 µg/l. Algal blooms could have an impact on water storage as well as within the canal itself, and as such, mitigation for algal blooms should be considered in any treatment designs.

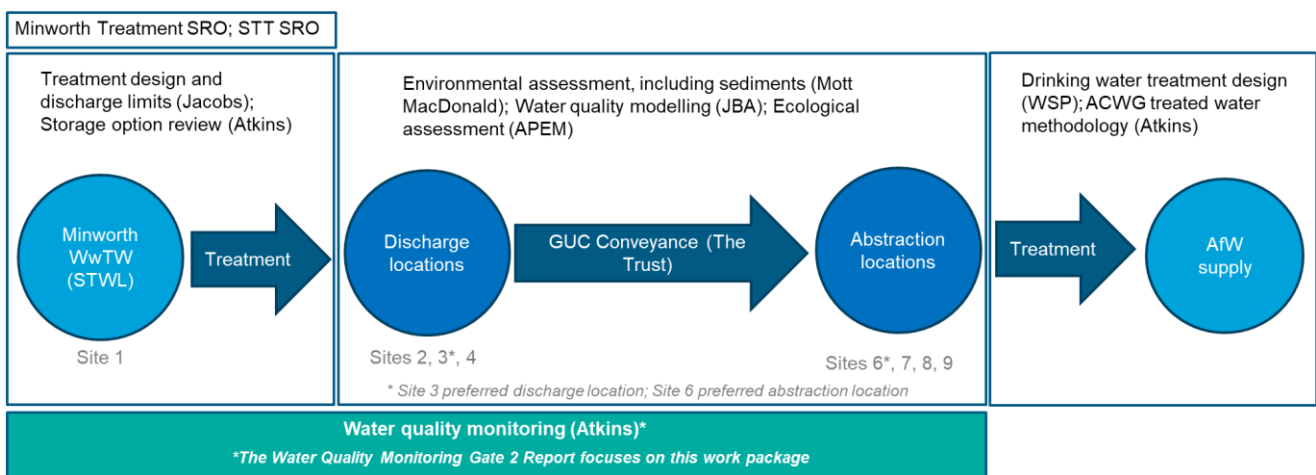
Lastly, the most recent period of monitoring coincides with a period of reduced rainfall. This became more pronounced at the end of the monitoring period. This, however, does not currently result in any additional determinands exceeding AA or MAC EQS values. This will be monitored in future report iterations to determine if a combination of reduced landscape connectivity and/or reduced instream dilution capacity exert a key control on instream parameters and result in any additional EQS/PCV exceedances.



# 1. Introduction

## 1.1 Background

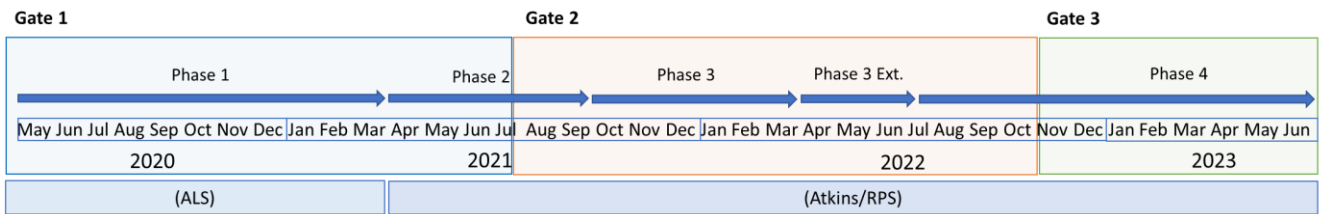
The GUC is an SRO in which AfW and ST are working together alongside The Trust. The scheme looks to transfer water from ST’s Minworth WwRC in the Midlands to AfW in the South East using the existing GUC network. Under the GUC SRO, there are multiple work packages covering the different scheme elements. A schematic diagram conceptualising the different scheme elements and associated work packages is shown in Figure 1-1. There are clear linkages between the scheme and other SROs, for example, the Minworth SRO and the Severn to Thames Transfer (STT) SRO. The purpose of this report is to present the results from the water quality monitoring work package. This work package will feed into other work packages, the results of which will be reported elsewhere.



**Figure 1-1 - Conceptualisation of the GUC scheme and work packages**

Phase 1 water quality monitoring was undertaken by ALS between May 2020 and March 2021 at 15 locations along the transfer route. The sampling programme for Phase 1 involved spot water sampling on a monthly basis. Phase 2, undertaken by AtkinsRéalis and RPS, was commissioned for the 6-month period between April and September 2021, with the view to further investigate changes in water quality along the transfer route and includes a more in-depth investigation into water quality at the abstraction locations to drinking water requirements. The programme included a more in-depth suite of determinands and continuous monitoring sondes. Phase 3 was commissioned (October 2021 – March 2022) to continue the Phase 2 monitoring programme. An additional Phase 3 extension was commissioned to run between April 2022 – June 2022, reported here. Sampling under Phase 4 runs between July 2022 – June 2023 with shifts in sampling site locations as a result of the finalisation of example abstraction and discharge locations; more detail is given on sampling site selection and rational in Section 2.1. The GUC project phases are summarised in Figure 1-2 below.





**Figure 1-2 – Schematic diagram showing the GUC monitoring Phases.**

The key drivers for monitoring water quality for this SRO are:

- Drinking Water Safety Planning – the scheme involves utilisation of a new source for public drinking water supply. As such, assessment of the risks to human health from this new source, and development of control measures sufficient to reduce these risks to an acceptable level, is critical to ensuring compliance with the legislative requirements for drinking water quality and safeguarding public health while meeting demand for public water supply of future generations.
- An All Company Working Group (ACWG) treatment water methodology for drinking water risk assessment and water safety planning of all SROs has been developed, which will require water quality data to inform judgements of drinking water risk. This ACWG methodology was updated for the GUC transfer scheme at the end of Phase 1 and will be revisited as part of Phase 3 using updated monitoring data.
- Environmental water quality – the scheme would result in changes to the sources of water entering the canal and therefore may impact on the ecological and environmental health of the water body and local environment. Water quality data are key to identifying and mitigating potential environmental impacts of the scheme. In particular, the requirements of the Water Framework Directive (WFD) determinands and Environmental Quality Standards Directive (EQSD) have been referred to in the development of this monitoring programme.
- Lastly, this monitoring programme will help inform treatment design at both selected discharge and abstraction locations.

The aim of the water quality monitoring programme is to obtain a recent baseline dataset to allow characterisation of different study reaches in terms of drinking water safety risks (particularly with respect to current and future regulated parameters), the WFD determinands, and Environment Agency Surface Water Pollution Risk Assessment Parameters (referred to as EQSD parameters in this note) to characterise the baseline risk and inform modelling. The Monitoring programme for Phases 1-4 included both water quality spot sampling and continuous monitoring (30-minute resolution data for dissolved oxygen, ammonium, temperature, conductivity, pH, and turbidity).

In this Phase 3 extension report, data collected are used alongside existing GUC water quality monitoring Phase 1 data to inform Drinking Water risk assessment and management (for discussion with the Drinking Water Inspectorate (DWI)) and to inform water quality modelling to ascertain WFD compliance (for discussion with the Environment Agency).

## 1.2 Purpose of this document

The purpose of this document is to provide an update for data collected over the last quarter (April – June 2022) in context of longer-term monitoring data available for the period July 2021 to March 2022, where available.

Data collection is ongoing, and this report provides interested parties with a look at all data collected thus far in the monitoring programme.



## 2. Methodology

### 2.1 Site locations

Under the Phase 1 water quality monitoring programme, samples were taken at 15 monitoring locations in the upper and lower sections of the GUC to characterise baseline water quality at the potential discharge and abstraction locations. At the onset of Phase 2, a number of discharge sub-route options and abstraction point sub-options were no longer being progressed as part of the scheme, so it was necessary to adapt the monitoring programme accordingly. For Phase 2 and 3 monitoring was conducted at a total of nine locations across the canal network. A detailed analysis of monitoring data collected under Phases 1-3 (inclusive of Phase 3 extension data), including an analysis of environmental and drinking water quality standards can be found in the GUC Gate 2 Annex B1.4 Water Quality Monitoring report.

Monitoring conducted during Phase 3 extension of the GUC Transfer Scheme was modified to take account of Sites 3 (Coventry Canal at Atherstone) and 6 (GUC at Grove Lock, Leighton Buzzard) being selected as example discharge and abstraction locations, respectively. Existing Sites 2 (Birmingham & Fazeley Canal at Minworth), 4 (GUC at Leamington Trough Pound), 7 (GUC at Beggars Lane, Tring), 8 (GUC at Little Heath Lane Bridge, Hemel Hempstead) and 9 (GUC at The Grove, Hunton Bridge) were discontinued and an additional seven sites added to monitoring water quality at key instream intersections (e.g., major confluences). A total of 11 sites were monitored during the Phase 3 extension. Sites currently being monitored are summarised in Figure 1-2 with additional details provided in Table 2-1. This monitoring programme was discussed with the Environment Agency and DWI at workshops held on 23/04/2021 and 21/05/2021. They were offered the opportunity to comment on the programme so any required amendments could be incorporated into the programme. We have subsequently engaged with them on a quarterly basis throughout Gate 2.

For the purpose of conceptualising the monitoring programme, the GUC system has been split into three main geographical sections, an overview of which can be seen in Figure 2-1. These are summarised below

- 'Upper section': Covering the discharge from Minworth to the example discharge location (Coventry Canal at Atherstone).
- 'Middle section': GUC from the Braunston Junction to the Aylesbury Arm (Marsworth, North of Tring).
- 'Lower section': GUC from the Aylesbury Arm to Hanwell, London. This section includes the example abstraction location (GUC at Grove Lock, Leighton Buzzard).



Grid references for monitoring locations redacted

Table 2-1 - Monitoring locations

| Section                   | Site no. | Location description         | NGR | Rationale   | Sampling                                | Land access |
|---------------------------|----------|------------------------------|-----|---|---|-------------|
| GUC:<br>Upper<br>Section  | 1.       | Minworth WwRC Final Effluent |     | <p>Official Minworth WwRC final effluent sampling point. To characterise potential future influence on the GUC prior to additional treatment which is likely to be deemed necessary.</p> <p><b><i>This Site is being sampled as part of the Severn to Thames Transfer Scheme (STT) SRO monitoring programme scheme. These data can be used to inform the water quality monitoring programme for the GUC, and thus duplicate sampling is not required. However, a small sub-set of parameters not currently monitored have been added to this suite to ensure that the full Drinking Water suite described for GUC is still sampled. This consists of 39 different parameters. Phases 1-3 data available for analysis.</i></b></p> | Spot sampling + continuous monitoring   | ST          |
|                           | 3.       | Coventry Canal at Atherstone |     | <p>A site to characterise the reach and understand baseline water quality around sub-route 3 discharge point.</p> <p>This site is aligned with the Phase 1 water quality monitoring point for consistency. <b>Phases 1-3 data available for analysis.</b></p>   | Spot sampling + continuous monitoring** | The Trust   |
| GUC:<br>Middle<br>Section | 10.      | GUC at Bedworth****          |     | To understand baseline water quality south of the interaction with the Ashby Canal and Oxford Canal. Spot sampling at this site commenced in April 2022.  | Spot sampling                           | The Trust   |
|                           | 5.       | GUC at Welton Lane, Daventry |     | <p>Site on the GUC east of the point where the GUC and Oxford Canal interlink and before the Leicester Line at Norton Junction to characterise water quality at the upper end of the middle section and to understand baseline of water being 'passed forward' within the middle section.</p> <p>This is a new water quality monitoring location aligned with previous APEM ecological monitoring location in this reach.</p>   | Spot sampling                           | The Trust   |
|                           | 11.      | GUC at Long Buckby****       |     | Added to understand baseline water quality downstream of Norton Junction south of the interaction with the with the Leicester Line. Spot sampling at this site commenced in April 2022.   | Spot sampling                           | The Trust   |



| Section            | Site no. | Location description           | NGR | Rationale   | Sampling                                 | Land access |
|--------------------|----------|--------------------------------|-----|---|--|-------------|
|                    | 12.      | GUC at Gayton****              |     | To understand the baseline water quality upstream of the interaction(s) with the River Nene in order to determine whether there is likely to be any deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.   | Spot sampling                            | The Trust   |
|                    | 13.      | GUC at Stoke Bruen****         |     | To understand the baseline water quality upstream of the interaction(s) with the River Tove in order to determine whether there is likely to be any deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.   | Spot sampling                            | The Trust   |
|                    | 14.      | GUC at Cosgrove****            |     | To understand the baseline water quality upstream of the interaction(s) with the River Great Ouse in order to determine whether there is likely to be any deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.   | Spot sampling                            | The Trust   |
|                    | 15.      | GUC at Stoke Hammond****       |     | To understand the baseline water quality upstream of the interaction(s) with the River Ousel in order to determine whether there is likely to be any deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.  | Spot sampling                            | The Trust   |
| GUC: Lower Section | 6.       | GUC at Grove, Leighton Buzzard |     | A Site to characterise and understand water quality at the lower end of the middle section after interactions with other watercourses.<br>This is a new water quality monitoring location upstream of Tring before the Aylesbury and Wendover Arms converge with the GUC.<br>Continuous monitoring sondes are installed at this proposed abstraction location to give an indication of sub-daily water quality variability, as a result of biological activity discharges and/or tributaries*. <b>Phases 2-3 data available for analysis.</b> | Spot sampling + continuous monitoring*   | The Trust   |
|                    | 16.      | GUC at Marsworth****           |     | To understand baseline water quality at the most downstream influence of the transfer scheme before the Tring summit. Spot sampling at this site commenced in April 2022.   | Spot sampling + continuous monitoring*** |             |

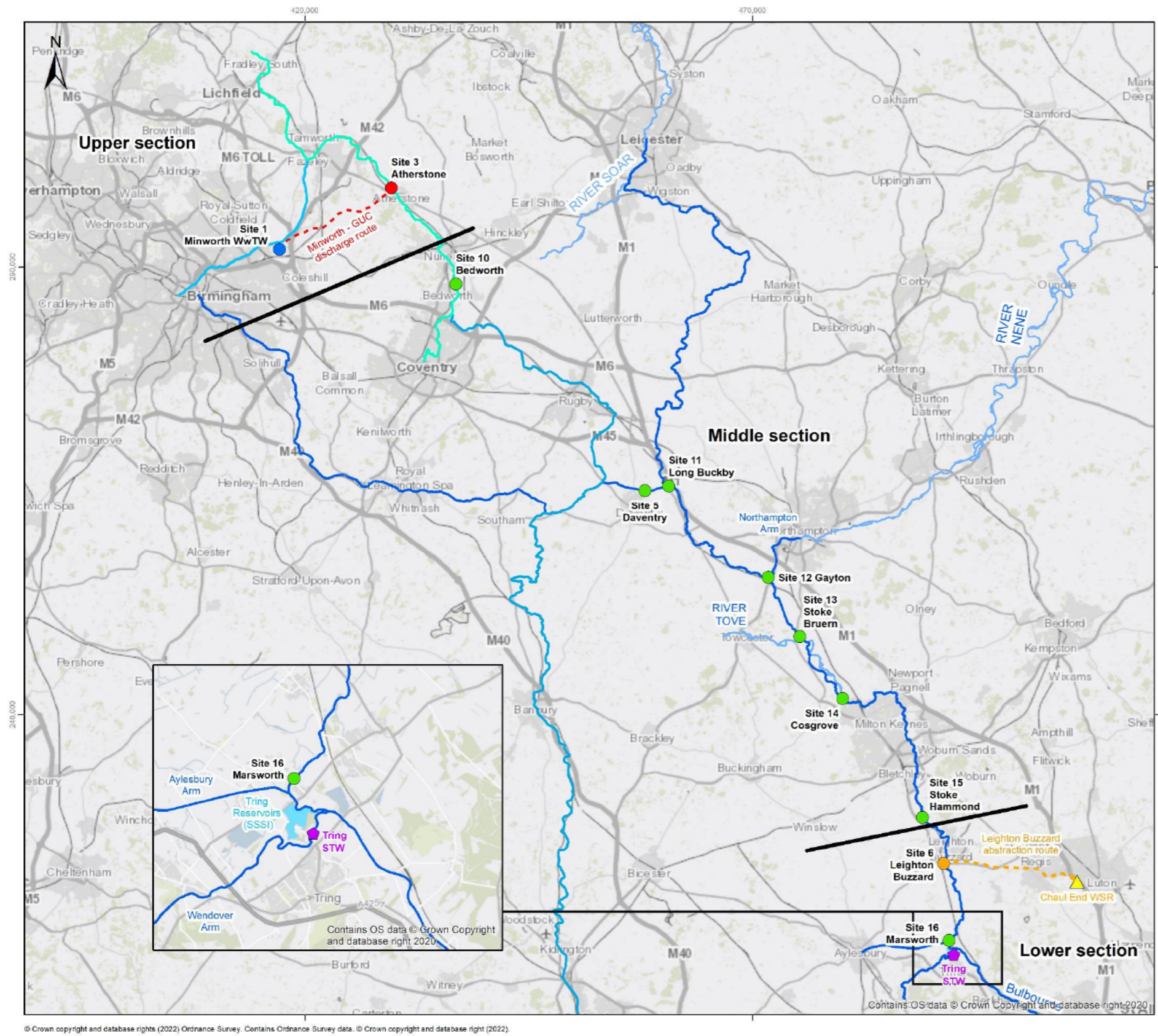
Grid references for monitoring locations redacted

\* Continuous monitoring commenced at Site 6 on 25<sup>th</sup> November 2021.

\*\* A continuous monitoring sonde was installed at this site on 11<sup>th</sup> May 2022.

\*\*\* A continuous monitoring sonde was installed at this site on 24<sup>th</sup> May 2022.





### Grand Union Canal WQ monitoring locations

**Legend**

**Water Quality Monitoring Locations**

- Source - Minworth WwTW Final Effluent
- Discharge Location
- Abstraction Location
- WQ Monitoring Location
- - - Potential Abstraction Route
- - - Potential Discharge Route
- ▲ Water Storage Reservoirs
- Sewage Treatment Works

**Watercourses**

- Grand Union Canal
- Birmingham & Fazeley Canal
- Coventry Canal
- Oxford Canal
- Interacting Main Rivers

Data sources: Environment Agency, Ordnance Survey

0 30 60 120 180 240 300 Km  
Scale (at A3): 1:400,000

**SEVERN**  
**TRENT**

**AffinityWater**  
Taking care of your water

**Canal & River Trust**  
Making life better by water

**ATKINS**  
Member of the SNC-Lavalin Group

|                    |                                    |                     |                        |
|--------------------|------------------------------------|---------------------|------------------------|
| Status: S1         | Purpose of issue: For Coordination | Rev: 2.0            | Model File Identifier: |
| Reference: 6204564 | Drawn: 22/07/2022                  | Checked: 22/07/2022 | Authorised: 22/07/2022 |

Woodcote Grove, Ashley Road, Epsom, Surrey, KT18 5BW  
www.atkinsglobal.com

Author names redacted

Figure 2-1 - Key elements/ reaches of the GUC scheme (black lines notate the upper, middle and lower sections).





AtkinsRéalis have recommended that, where missing from this list, the following core environmental suites comprising determinands that pose a risk to WFD status deterioration were also included:

- Supporting parameters required to do WFD specific calculations such as bioavailable fractions.
- The Minworth final effluent permitted determinands (point source emissions to water) for secondary treated sewage effluent with nutrient removal.

As a result, we included a further nine parameters in this suite: Acid neutralising capacity (ANC), dissolved inorganic carbon, hardness, organic nitrogen, total nitrogen (oxidised), nitrite as NO<sub>2</sub>, ammonia, salinity (conductivity) and trichloroethylene.

This 'WFD suite' therefore consists of a total of 83 different compounds (see Appendix A). This analysis suite was used for all sites to characterise environmental risks. At the end of 12 months of Phase 4 data (June 2023) we will investigate if any parameters can be removed (e.g., where parameters were consistently below the LoD).

## 2.2.2 EQSD suite

The Environment Agency surface pollution risk assessment list includes a total of 95 different parameters which have been set out in Appendix B. For the requirements of discharge permitting, these determinands are included only at sites where discharges are proposed as part of the scheme. Removing duplication of WFD parameters, this results in an additional 87 different compounds to be analysed.

It is noted that due to the GUC being classed as an artificial waterbody, clarity needs to be sought from the Environment Agency on the permitting options and expectations for water quality discharge risk assessments. There may be a view that environmental risks are covered sufficiently by the WFD suite, and this may subsequently reduce the expectations for additional monitoring under EQSD. We will review after sufficient data are collected.

## 2.2.3 Drinking water suite

The 263 different compounds making up the Drinking Water suite have been set out in Appendix C for the source water and the proposed intake / abstraction locations. Removing duplication with WFD / EQSD parameters, this results in a total of 239 additional parameters to be analysed. These will be compared against Permitted Concentration or Values (PCV) obtained following consultation with DWI. It should be noted that PCV's only apply to treated drinking water and not raw water values and have been compared solely as an indicator as to which determinands may be of concern following abstraction. This is discussed further in Section 3.2.

While the Drinking Water suite may appear large, it is important to note that:

- The sampling programme must be comprehensive to secure confidence that the solutions and proposed mitigation will not present a risk to human health – this is particularly important for reuse schemes from both a regulatory and public perspective.
- Monthly sampling to characterise expected parameter envelopes which may be presented to treatment is critical to appropriate sizing of treatment and other control measures, which in turn ensures fulfilment of the two key responsibilities of the water company – the effectiveness of risk management and the availability of water resources when required ('always on and good to drink').
- A targeted approach is recommended – to restrict use of this suite to relevant locations only (proposed abstraction points and discharge from Minworth to allow quantification of new sources / any change to risk in the canal catchment).



## 2.3 Sampling and analysis procedures

### 2.3.1 Continuous sondes

A continuous monitoring sonde was installed at the example abstraction site (Site 6 GUC at Grove, Leighton Buzzard) on 25/11/21. Additional sondes were installed at the example discharge site (Site 3 Coventry canal at Atherstone) and at the base of the catchment (Site 16 GUC at Marsworth) on 16/05/22 and 14/05/22 respectively. A sonde has also already been installed to characterise the source water (Minworth WwRC treated discharge) as part of the STT SRO monitoring programme. Each continuous monitoring location includes:

- A modular system complete with an MCE-ESNET2 telemetry unit and a Xylem EXO2 multiparameter sonde, deployed at approximately 1 metre depth and sensors for temperature, conductivity, dissolved oxygen, ammonium, pH, chlorophyll and turbidity.
- A limited sensor suite (dissolved oxygen, pH, and temperature) was included at Minworth during Phase 2 and 3 installed under the STT scheme, however, this suite was upgraded in April 2022 to include comparable parameters to Sites 3, 6, and 16, with the exception of chlorophyll.
- 20 W solar panel kit allowing autonomous year-round operation.
- 30-minute resolution telemetered data with secure web portal access via the Cloud, using a Tier III secure data centre.
- Daily data integrity checks undertaken via the Cloud.

Dedicated maintenance visits occur around every four to six weeks to proactively clean and calibrate the sensors and check equipment. So far, these have been undertaken at Site 16 (Marsworth) and Site 6 (GUC at Grove, Leighton Buzzard) on 22/06/2021, 13/08/2021, 22/09/2021, 21/10/2021, and 25/11/2021, 20/01/2022, 10/02/2022, 16/03/22, 21/04/22, 24/05/22, 30/06/22. Due to geographical constraints, sonde maintenance is conducted on a different schedule. Site 1 (Minworth WwRC Final Effluent) and Site 3 (Coventry Canal at Atherstone) were recently visited on 11/05/22. When sensors experience drift or fail in between that time, reactive repair and maintenance of the sondes has been undertaken.

### 2.3.2 Spot water quality sampling

It is noted that many of the WFD, EQSD and DWSP parameters have low Environmental Quality Standard (EQS) limits and will therefore require laboratory analysis to a very low level. Appropriate sampling and analysis methods have been used, along with suitably experienced staff, to achieve the required LoD and prevent risk of cross-contamination. Water quality samples have been collected monthly using project-specific Sampling Operating Procedure (SOP), which follows the approach outlined in the Environment Agency Operational Instruction 19-09.<sup>7</sup> Samples have been taken from a site representative of the bulk of water being assessed (the volume of sample taken at each site has been determined by the laboratory to cover the required analysis). In addition to the Environment Agency Operational Instruction, we also adhere to 'best practice' guidance for organic contaminant sampling set out by the US Environment Protection Agency (EPA).<sup>8</sup> It is very important that cross contamination of samples is avoided to make sure no 'false positives' are seen in the data analysis. This is especially important owing to the very low EQS levels for WFD and PCV for DWSP parameters. These additional measures include:

- A sampling pole and food grade stainless steel and plastic sampling buckets have been used to collect water to fill the sampling bottles. These buckets are also used by the Environment Agency and prevent metal leaching. Each bucket will be thoroughly rinsed out downstream or slightly further away from the sampling location before any samples are taken to avoid any cross-contamination issues. One set will be

<sup>7</sup> Environment Agency Operational Instruction 19\_09: Chemical and microbiological sampling of water. Issued 03/02/10

<sup>8</sup> See [www.epa.gov](https://www.epa.gov), <https://www.epa.gov/quality> and <https://www.epa.gov/quality/procedures-collecting-wastewatersamples>. For example, [https://www.epa.gov/sites/production/files/2019-02/documents/pfas\\_methods\\_tech\\_brief\\_28feb19\\_update.pdf](https://www.epa.gov/sites/production/files/2019-02/documents/pfas_methods_tech_brief_28feb19_update.pdf) for PFOS



dedicated to each scheme and not used for other projects, keeping all sampling containers in a dedicated 'clean' bag until used.

- Use of clean / sterile sampling bottles for any sampling round, including discarding any bottles inadvertently opened during transit.
- Use of specialist sampling containers for different analytes, some of which contain preservatives, for which indirect sampling will be used.
- Use of vinyl sampling gloves. Use new clean gloves for each new sample and dirty gloves and other dirty personal protective equipment (PPE) stored in a designated 'dirty' bag.
- With regard to Perfluorooctanesulfonic acid (PFOS), avoiding PFOS-containing PPE and equipment (e.g., Gore-Tex jackets and boots, waterproof notepads), unless required for Health & Safety purposes (e.g., life jackets).

In addition to taking spot water samples for laboratory analysis, the following water quality parameters were measured *in-situ* using a calibrated YSI handheld multiparameter probe: dissolved oxygen (% saturation and mg/l), temperature, conductivity, and pH.

Samples are maintained at a cool temperature during transit by using refrigerated vehicles. The laboratory (RPS) provides temperature data loggers and temperature blanks to record temperature during transit to ensure that the samples have not been exposed to environmental conditions that may adversely affect any analytical test for which they are scheduled. The samples are dropped off at the laboratory's nearest pick up point or collected directly from site by RPS on the same day of collection and delivered to the laboratory overnight, thus maintaining compliance with the UK Accreditation Service (UKAS) Policy on Deviating Samples<sup>9</sup> (e.g., 24 hours for microbiological parameters and Biochemical Oxygen Demand (BOD)).

### 2.3.3 Laboratory analysis suites

Sample analyses were undertaken by RPS laboratories, with the main laboratory located in Bedford. RPS is fully accredited (UKAS ISO 17025) and highly experienced in both WFD and DWSP analysis suites, including through (but not limited to) previous projects involving extensive water company investigation work, as well as the CIP. As a result of this work, which included extensive final effluent as well as main river sampling, RPS offers all WFD and almost all EQSD determinands at or below the associated EQS. The very small number of exceptions include 3,4-dichloroaniline, cyfluthrin, doramectin, formaldehyde, hydrogen sulphide and methiocarb.

Table 2-2 below sets out the analysis suite for each of the eleven monitoring sites. Appendix A-C contains detail on the parameters, EQS and LoD which can be achieved by RPS<sup>10</sup> against the WFD EQS set out in the 2015 Directions and non-statutory EQS for the EQSD parameters. A database has been developed to hold all environmental data.

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<sup>9</sup> [TPS 63 UKAS Policy on Deviating Samples](#)

<sup>10</sup> <https://www.rpsgroup.com/services/laboratories/>



**Table 2-2 - Overview of analysis suites**

| Section             | Sites                             | Continuous Monitoring Sonde | WFD (Appendix A) | EQSD** (Appendix B) | DWSP*** (Appendix C) |
|---------------------|-----------------------------------|-----------------------------|------------------|---------------------|----------------------|
| GUC: Upper Section  | 1. Minworth WwRC Final Effluent*  | ✓                           | ✓                | ✓                   | ✓                    |
|                     | 3. Coventry Canal at Atherstone   | ✓^                          | ✓                | ✓                   | ✗                    |
| GUC: Middle Section | 10. GUC at Bedworth*****          | ✗                           | ✓                | ✗                   | ✗                    |
|                     | 5. GUC at Welton Lane, Daventry   | ✗                           | ✓                | ✗                   | ✗                    |
|                     | 11. GUC at Long Buckby*****       | ✗                           | ✓                | ✗                   | ✗                    |
|                     | 12. GUC at Gayton*****            | ✗                           | ✓                | ✗                   | ✗                    |
|                     | 13. GUC at Stoke Bruen*****       | ✗                           | ✓                | ✗                   | ✗                    |
|                     | 14. GUC at Cosgrove*****          | ✗                           | ✓                | ✗                   | ✗                    |
|                     | 15. GUC at Stoke Hammond*****     | ✗                           | ✓                | ✗                   | ✗                    |
| GUC: Lower Section  | 6. GUC at Grove, Leighton Buzzard | ✓****                       | ✓                | ✗                   | ✓****                |
|                     | 16. GUC at Marsworth*****         | ✓^^                         | ✓                | ✗                   | ✗                    |

\* Minworth WwRC final effluent already being sampled as part of the STT SRO monitoring programme. Only parameters identified in the Drinking Water suite (Appendix C) that are not already being sampled as part of this programme will need to be sampled.

\*\* EQSD parameters are only required to be sampled at discharge sites.

\*\*\* Drinking Water parameters are only required to characterise the source water and to understand baseline conditions at the potential abstraction locations.

\*\*\*\* DWSP parameters were added to the analysis suite at Site 6 in October 2021 and a continuous monitoring sonde was added in November 2021 as a result of this Site being proposed as a potential abstraction location (previous analysis suite consisted of WFD parameters only April-September 2021).

\*\*\*\*\* Data will only start from April 2022 at these new sites.

^ Continuous monitoring sonde installed at this site on 11<sup>th</sup> May 2022.

^^ Continuous monitoring sonde installed at this site on 24<sup>th</sup> May 2022.

## 2.4 Monitoring frequency

Initially, for those sites included in Phase 1 (Site 3, Coventry Canal at Atherstone) monitoring was conducted at three weekly intervals (20/04/21 – 02/06/21 inclusive). However, following consultation with the Environment Agency and the DWI, all samples collected from the start of July 2021 were collected at monthly intervals. All results are reviewed quarterly to inform future monitoring frequency, and suites will be amended where necessary after sufficient data (i.e., 12 months) have been collected. Sessions have been set up with the Environment Agency and DWI on a quarterly basis to discuss findings and get agreement to amend suites where appropriate.



## 2.5 Data analysis

Following data compilation and the completion of standard data quality assurance procedures, descriptive statistical analyses were conducted on data from all Sites, including the generation of mean, maximum, minimum and percentile values (95<sup>th</sup>, 90<sup>th</sup>, and 10<sup>th</sup> percentiles). Samples at the limit of detection were included in the analysis and used at face value to adhere to discharge permitting assessment guidance. Any significant outliers were removed from the analysis. Relevant EQS (relating to both WFD<sup>11</sup> and EQSD<sup>12</sup>) were then obtained following consultation with the Environment Agency against which running mean data have been compared. Sites with potential abstraction applications have been compared against additional drinking water PCVs obtained from the UK's Water Supply (Water Quality) Regulations (2016) Schedule 1<sup>13</sup> with some determinands defined as indicator parameters being found in Schedule 2<sup>14</sup>. Additionally, many of the parameters included are not named within the regulations but fall under the category of 'other pesticides' and so were given a PCV of 0.10 µg/l. In addition, high-resolution sensor data collected from all four sites have been rigorously checked for sensor drop out, instrument drift, and anomalous readings that may impact interpretation.

## 2.6 Rainfall data

Rainfall data were available from the Environment Agency for the entire monitoring period for a single location along the GUC (Dancers End Reservoir, Environment Agency Siation Number: 261602). This site was selected for data interpretation as Dancers End Reservoir is situated at the example abstraction location, Site 6 (Leighton Buzzard) and coincides with the locations of the continuous monitoring sonde. The use of this dataset to infer catchment processes was therefore deemed sufficient for this interpretation. These data are presented in Figure 2-2. There was some notable weather over the monitoring period. Rainfall experienced across the GUC during 2020 peaked in October (212 mm) with the UK experiencing high rainfall totals as a result a number of large storms, namely storm Alex (02/10/2020). May recorded the lowest rainfall totals in 2020 (3.6 mm). In 2021, the UK experienced the 4<sup>th</sup> highest rainfall totals on record for the month of May, as a result, this month experienced the highest rainfall totals (121 mm). April was the driest month of 2021 (lower = 5.7 mm), mirroring a national picture of predominantly dry and sunny weather. The rainfall total for England and Wales up to January 2022 reached 34 mm, less than 40% of the average for this time of year. This national picture is reflected in the data observed in Figure 2-2 with rainfall totals equalling 21.1 mm in 2022 compared with 127 mm in 2021.

Rainfall during the period between February and June 2022 was very low, corresponding with a national picture of reduced rainfall across all regions of England. These data will be used to analyse high frequency sonde and water quality spot sampling data, providing context for shifts in determinand concentrations as a result of weather patterns.

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<sup>11</sup> The Water Framework (Standards and Classification) Directive (England and Wales) 2015 accessed via: [The Water Framework Directive \(Standards and Classification\) Directions \(England and Wales\) 2015 \(legislation.gov.uk\)](https://www.legislation.gov.uk/ukdsi/2016/614/schedule/1)

<sup>12</sup> Environment Agency statutory and operational EQS accessed via <https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit>

<sup>13</sup> <https://www.legislation.gov.uk/uksi/2016/614/schedule/1>

<sup>14</sup> <https://www.legislation.gov.uk/uksi/2016/614/schedule/2>



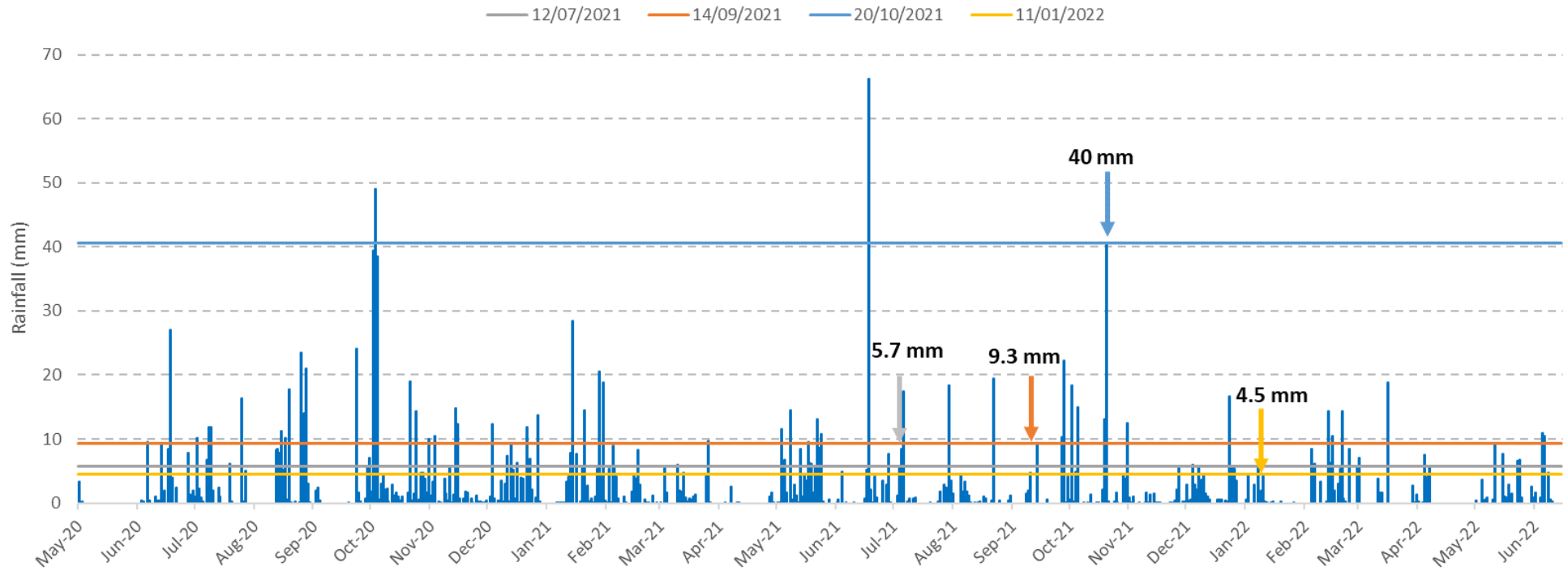


Figure 2-2 – Daily rainfall totals observed at Dancers End Reservoir (Environment Agency Station Number: 261602) for selected location to be used in the analysis of GUC sonde and chemical data series.<sup>15</sup>

<sup>15</sup> Coloured lines represent rainfall totals of days corresponding with sample collection. Corresponding sample collection days are highlighted with corresponding coloured arrows. Rainfall total on sample collection days are also given.



## 3. Results

### 3.1 WFD and EQSD Environmental Quality Standards (EQS)

#### 3.1.1 Overview

In order to determine parameters of risk, values have been compared against the relevant EQS as detailed by the 2015 WFD Directions and the Environment Agency Surface Water Pollution Risk Assessment Parameters EQSD, these include:

- Freshwater specific pollutants and operational environmental quality standards
- Freshwater priority hazardous substances
- Priority substances and other pollutants

It is important to note that standards or condition limits for certain parameters under the WFD (e.g., dissolved oxygen, BOD, ammoniacal nitrogen, and ANC), are determined by categorising the water body by type, dependent on its altitude and alkalinity. ANC standards are determined by annual mean dissolved organic carbon concentrations. In addition, soluble reactive phosphorus (SRP) standards are determined by the water body's altitude and alkalinity, cadmium standards are determined by categorising the water body, by type, dependent on the hardness of the water, and zinc standards are determined by the ambient background concentration (ABC) of dissolved zinc. EA site specific standards (where available) were used (e.g. SRP), Where these were not available, site-specific standards were calculated. Table 3-1 shows the categorisation of each monitoring site in order to determine water body type, and Table 3-2 details the resultant site-specific EQS which were used as part of our analysis. Whilst we have used site-specific EQS or WFD Good standards for the Minworth WwRC final effluent for indicative purposes, it is important to note that these standards should not be routinely applied to final effluent samples as they are in-river standards (EQS compliance does not apply to Minworth as it is not an environmental sample).

Water quality monitoring data collected by ALS during Phase 1 of this monitoring programme have been included in this report. These extra data cover 11 months between May 2020 and March 2021 for Sites 1 (Minworth WwRC final effluent) and 3 (Coventry Canal at Atherstone). These data were not collected by AtkinsRéalis staff or analysed at laboratories recommended by AtkinsRéalis and as such have been included at face value, under the assumption that the data are of good quality and have been previously quality assured following appropriate protocols. This report presents data from the 11-month period of Phase 1 (Sites 1 and 3) alongside the 6-month period of Phase 2 and the 9-month period of Phase 3 (Sites 1, 3, 5, 6). The total number of sampling rounds at Sites 1, 3, 5 and 6 were 28, 27, 16 and 17 respectively. Sites 10 – 16 were added during the Phase 3 extension and cover a 3-month period, represented by three sampling rounds from each site.

For the purpose of this analysis, it should be noted that we have compared all data to annual EQS values, often expressed as either annual averages, 10<sup>th</sup>, 90<sup>th</sup> or 95<sup>th</sup> percentiles or maximum allowable concentrations (MAC). As such these exceedances are likely to change as the dataset expands. The same is true for the site-specific EQS, which uses water quality data gathered as part of this monitoring programme. Based on the data collected thus far, with metal concentrations (copper, zinc, manganese, and nickel) converted to bioavailable concentrations using the M-BAT tool, across all Sites there were 91 EQS exceedances. The distribution of these EQS exceedances is shown in Figure 3-1.



**Table 3-1 - Categorisation of each monitoring Site to determine water body type**

| Site                              | Elevation (m) | Average alkalinity as CaCO <sub>3</sub> (mg/l) | Type (for dissolved oxygen, BOD and ammoniacal nitrogen standards) | Average dissolved organic carbon (mg/l) | Average water hardness as CaCO <sub>3</sub> (mg/l) | Cadmium class | ABC for dissolved zinc (catchment / group of catchments) | ABC for dissolved zinc (µg/l) |
|-----------------------------------|---------------|--|--|---|--|---------------|--|-------------------------------|
| 1. Minworth WwRC final effluent*  | 85            | 91   | 4  | 9.3                                     | 169  | 4             | Humber   | 2.9                           |
| 3. Coventry Canal at Atherstone   | 74            | 118  | 5  | 4.5                                     | 487  | 5             | Humber   | 2.9                           |
| 5. GUC at Welton Lane, Daventry   | 137           | 150  | 6  | 3.7                                     | 242  | 5             | Nene   | 4                             |
| 6. GUC at Grove, Leighton Buzzard | 95            | 175  | 6  | 4.9                                     | 265  | 5             | Great Ouse   | 3.1                           |
| 10. GUC at Bedworth               | 98            | 170  | 6  | 6.0                                     | 266  | 5             | Humber   | 2.9                           |
| 11. GUC at Long Buckby            | 109           | 183  | 6  | 5.6                                     | 290  | 5             | Nene   | 4                             |
| 12. GUC at Gayton                 | 93            | 220  | 7  | 2.5                                     | 349  | 5             | Nene   | 4                             |
| 13. GUC at Stoke Bruen            | 74            | 233  | 7  | 3.1                                     | 315  | 5             | Great Ouse   | 3.1                           |
| 14. GUC at Cosgrove               | 70            | 187  | 5  | 5.0                                     | 303  | 5             | Great Ouse   | 3.1                           |
| 15. GUC at Stoke Hammond          | 79            | 160  | 5  | 4.9                                     | 271  | 5             | Great Ouse   | 3.1                           |
| 16. GUC at Marsworth              | 108           | 157  | 6  | 3.7                                     | 230  | 5             | Great Ouse   | 3.1                           |

\* Waterbody types should not be applied to final effluent. We have used these for indicative purposes only in order to determine and understand the potential effects on the receiving waterbodies



**Table 3-2 - Site specific EQS or WFD Good Status values used**

| Site                              | Dissolved Oxygen (% saturation) (10th percentile) WFD Good status | BOD (mg/l) (90th percentile) WFD Good status | Ammoniacal Nitrogen (mg/l) (90th percentile) WFD Good status | ANC (annual average) WFD Good status | SRP (mg/l) (annual average) WFD Good status | Cadmium (µg/l) (annual average) EQS | Cadmium (µg/l) (maximum allowable concentration) EQS | Zinc bioavailable plus ABC dissolved (µg/l) EQS |
|-----------------------------------|---|--|--|--------------------------------------|---|-------------------------------------|--|---|
| 1. Minworth WwRC final effluent*  | 75  | 4  | 0.3  | 40                                   | 0.054                                       | 0.15                                | 0.9  | 13.8  |
| 3. Coventry Canal at Atherstone   | 60  | 5  | 0.6  | 40                                   | 0.061                                       | 0.25                                | 1.5  | 13.8  |
| 5. GUC at Welton Lane, Daventry   | 75  | 4  | 0.3  | 40                                   | 0.054                                       | 0.25                                | 1.5  | 14.9  |
| 6. GUC at Grove, Leighton Buzzard | 75  | 4  | 0.3  | 40                                   | 0.065                                       | 0.25                                | 1.5  | 14  |
| 10. GUC at Bedworth               | 75  | 4  | 0.3  | 40                                   | 0.064                                       | 0.25                                | 1.5  | 13.8  |
| 11. GUC at Long Buckby            | 75  | 4  | 0.3  | 40                                   | 0.064                                       | 0.25                                | 1.5  | 14.9  |
| 12. GUC at Gayton                 | 60  | 5  | 0.6  | 40                                   | 0.071                                       | 0.25                                | 1.5  | 14.9  |
| 13. GUC at Stoke Bruen            | 60  | 5  | 0.6  | 40                                   | 0.077                                       | 0.25                                | 1.5  | 14  |
| 14. GUC at Cosgrove               | 60  | 5  | 0.6  | 40                                   | 0.073                                       | 0.25                                | 1.5  | 14  |
| 15. GUC at Stoke Hammond          | 60  | 5  | 0.6  | 40                                   | 0.067                                       | 0.25                                | 1.5  | 14  |
| 16. GUC at Marsworth              | 75  | 4  | 0.3  | 40                                   | 0.06  | 0.25                                | 1.5  | 14  |

\* River EQS or WFD Good Status standards should not be routinely applied to final effluent. We have used these for indicative purposes only in order to determine and understand the potential effects on the receiving waterbodies.



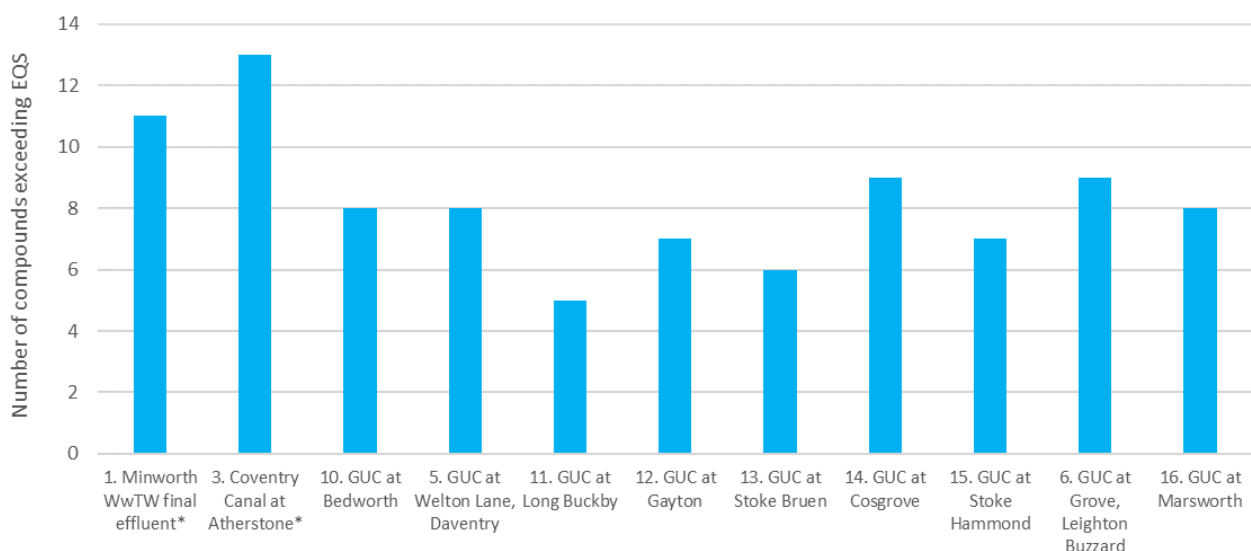


Figure 3-1 - Number of compounds exceeding EQS split by site location.<sup>16</sup>

## 3.1.2 Analysis

### 3.1.2.1 Long term dataset

A list of all compounds that exceeded the quoted EQS split by site is presented in Table 3-3. Of these compounds, those that exceeded the EQS at most sites included two polycyclic aromatic hydrocarbons (PAH) benzo(a)pyrene and fluoranthene. As per the WFD, benzo(a)pyrene is considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water. Benzo(a)pyrene is classed as a priority hazardous substance under both the WFD<sup>17</sup> and EQSD<sup>18</sup> as it has carcinogenic and mutagenic properties, persists in the environment, accumulates in biota and food chains, and has adverse toxic effects on both aquatic and human life. PAHs released to the atmosphere, mainly through emissions from (road) transport and domestic consumption may reach terrestrial and aquatic environments through both wet and dry deposition. Once deposited, for example in terrestrial environments, PAHs can accumulate over long-time scales and can also be transported into adjacent waterbodies, along with other contaminants, following periods of heavy rainfall.<sup>19</sup>

BOD levels resulted in exceedances across all sites except Sites 10 (GUC at Bedworth), 11 (GUC at Long Buckby) and 13 (GUC at Stoke Bruen). BOD (5-day) is an analytical technique which quantifies the oxygen demand exerted by biochemical processes, typically associated with the presence of organic material that may originate from either point or diffuse sources. As a result of microbial decomposition of organic matter, higher biochemical or chemical oxygen demand values are commonly associated with lower dissolved oxygen levels in the water column.

<sup>16</sup> Asterisks indicate inclusion of Phase 1 monitoring data. Mean values for Sites 1 and 3 cover a 26-month period (May 20 – June 22), Sites 6 covers 15-month period (April 21 – June 22), and Sites 10 – 16 cover a 3-month period (April – June 2022).

<sup>17</sup> [The Water Framework Directive \(Standards and Classification\) Directions \(England and Wales\) 2015 \(legislation.gov.uk\)](https://www.legislation.gov.uk)

<sup>18</sup> [Surface water pollution risk assessment for your environmental permit - GOV.UK \(www.gov.uk\)](https://www.gov.uk)

<sup>19</sup> [Microsoft Word - UKSHS 9 final.doc \(publishing.service.gov.uk\)](https://publishing.service.gov.uk)



Elevated PFOS concentrations also resulted in EQS exceedances at all 11 Sites. PFOS is primarily used as a flame retardant, however, has also been used in pesticides and as a surface coating for fabrics such as carpets and waterproof apparel and is becoming increasingly found in a range of aquatic environments.<sup>20</sup>

SRP also exceeded EQS values at 7 Sites including Minworth WwRC. Standards for SRP are site specific, derived as a function of altitude and alkalinity, and can be seen in Table 3-2.

Bromine (total residual oxidant) resulted in EQS exceedances at two sites, as it is only measured as part of the EQSD analysis suite (see Table 2-2). Bromine has been used in the production of fire retardants, hand sanitiser, and also used in agriculture as an insecticide, and as such may enter aquatic environments through point source discharges or through diffuse agricultural pathways. Bromine can occur in a number of oxidation states from -1 to +7 and is oxidised during drinking water treatment, using either ozone or chlorine dioxide, forming bromate, a suspected carcinogen.<sup>21</sup>

Lastly, low 10<sup>th</sup> percentile dissolved oxygen saturation values resulted in EQS exceedances at six sites. It should be noted, however, that only three sampling rounds have been conducted for Sites 10-15 and 16.

Table 3-4 shows the values corresponding to the test statistics for all compounds in exceedance of the EQS. This table highlights compounds that, while not currently exceeding EQS, may, if final effluent from Minworth WwRC were discharged into the GUC without additional treatment, be at risk of exceeding these WFD EQS values in the receiving waterbodies. This may result in a future WFD compliance risk as the new discharge would prevent the water quality of the receiving body from achieving Good Status in the future. These compounds include chlorothalonil (organic fungicide), cypermethrin (synthetic pyrethroid), permethrin (insecticide), and zinc (bioavailable).

Maximum allowable concentration (MAC) values were examined separately and have been applied to individual results and not mean or percentile data. In total there are 135 instances of MAC exceedances across all sites. Overall, four PAH (benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene) accounted for 22% of these exceedances. As discussed above, benzo(a)pyrene can be considered as a marker for the other PAHs and hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water. The three additional hydrocarbons do, however, have a MAC value under WFD. Bromine (total residual oxidant) accounted for 30 exceedances and was most prone to exceedance in the 'upper GUC', Sites 1 and 3. Sulphate (or hydrogen sulphide) exceeded MAC values on 60 occasions. A list of total exceedances split by compound can be seen in Table 3-5.

### 3.1.2.1 Patterns in the last quarter

While it may be expected that prolonged periods of reduced rainfall act to reduce pollutant transport from surrounding catchment sources, a result of poor landscape connectivity, the subsequent reduction in flow may also act to increase, proportionally, the importance of large point sources such as WwRCs within catchments.

No baseline data exist against which to compare data from the newly added sites (Sites 10 - 16). As a result, it is not yet possible with the data available to examine the impact of reduced flows on instream determinand concentrations. With regards Sites 1, 3, 5, and 6, against which such longer-term comparisons can be made, no additional determinands exceed AA or MAC EQS following the inclusion of data from April-June 2022. This suggests that to date, the reduced precipitation experienced has not directly resulted in increases in determinand concentrations instream and concentrations have remained the same.

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<sup>20</sup> [perfluorooctane-sulfonate-and-related-substances-pressure-rbmp-2021.pdf \(environment-agency.gov.uk\)](#)

<sup>21</sup> [Neal bromide.pmd \(copernicus.org\)](#)



Table 3-3 – Number of EQS (WFD and EQSD) exceedances.<sup>22</sup>

| Compound                       | Standard | Unit | Statistic <sup>+</sup> | Upper GUC       |                 | Middle GUC |           |          |          |          |          | Lower GUC |                 |          |   |
|--------------------------------|----------|------|------------------------|-----------------|-----------------|------------|-----------|----------|----------|----------|----------|-----------|-----------------|----------|---|
|                                |          |      |                        | Site 1          | Site 3          | Site 10    | Site 5    | Site 11  | Site 12  | Site 13  | Site 14  | Site 15   | Site 6          | Site 16  |   |
| Acid neutralisation capacity   | 40       | mg/l | AA                     | 16 <sup>#</sup> | 16 <sup>#</sup> | 3          | 16        | 3        | 3        | 3        | 3        | 3         | 3               | 17       | 3 |
| Benzo(a)pyrene                 | 0.00017  | µg/l | AA                     | 28              | 27              | 3          | 16        | 3        | 3        | 3        | 3        | 3         | 3               | 17       | 3 |
| BOD (5 day)                    | *        | mg/l | 90 <sup>th</sup>       | 5               | 5               | 0          | 3         | 0        | 1        | 0        | 1        | 2         | 6               | 1        |   |
| Bromine                        | 0.002    | mg/l | AA                     | 15              | 15 <sup>#</sup> |            |           |          |          |          |          |           |                 |          |   |
| Chlorothalonil                 | 0.035    | µg/l | AA                     | 1 <sup>#</sup>  | 0               |            |           |          |          |          |          |           |                 |          |   |
| Cobalt - dissolved             | 3        | µg/l | AA                     | 0 <sup>#</sup>  | 12 <sup>#</sup> |            |           |          |          |          |          |           |                 | 0        |   |
| Dissolved oxygen               | *        | %    | 10 <sup>th</sup>       | 10              | 1 <sup>#</sup>  | 2          | 5         | 0        | 0        | 0        | 1        | 0         | 2 <sup>#</sup>  | 0        |   |
| Cypermethrin                   | 0.00008  | µg/l | AA                     | 19              | 2               | 2          | 1         | 0        | 0        | 0        | 1        | 2         | 3               | 1        |   |
| Fluoranthene                   | 0.0063   | µg/l | AA                     | 0               | 26              | 3          | 5         | 3        | 3        | 3        | 3        | 3         | 16              | 3        |   |
| Manganese - bioavailable**     | 123      | µg/l | AA                     | 0 <sup>#</sup>  | 25              |            |           |          |          |          |          |           | 0 <sup>##</sup> |          |   |
| Nickel - bioavailable**        | 4        | µg/l | AA                     | 4               | 20              | 0          | 0         | 0        | 0        | 0        | 0        | 0         | 0               | 0        |   |
| Perfluorooctane sulfonic acid  | 0.00065  | µg/l | AA                     | 27              | 27              | 3          | 16        | 3        | 3        | 3        | 3        | 3         | 13              | 3        |   |
| Permethrin                     | 0.001    | µg/l | AA                     | 9 <sup>#</sup>  | 1               |            |           |          |          |          |          |           |                 |          |   |
| Soluble reactive phosphorus    | *        | mg/l | AA                     | 20              | 4               | 3          | 5         | 1        | 0        | 2        | 2        | 0         | 14              | 2        |   |
| Sulphide or hydrogen sulphide  | 0.25     | µg/l | AA                     | 6               | 17              | 3          | 8         | 2        | 2        | 3        | 3        | 2         | 11              | 3        |   |
| Total anions                   | 250      | mg/l | AA                     | 5 <sup>#</sup>  | 14 <sup>#</sup> |            |           |          |          |          |          |           | 1               |          |   |
| Tributyltin compounds          | 0.0002   | µg/l | AA                     | 1               | 1               | 0          | 0         | 0        | 2        | 0        | 3        | 0         | 1               | 0        |   |
| Zinc - bioavailable**          | *        | µg/l | AA                     | 12              | 9               | 0          | 0         | 0        | 0        | 0        | 0        | 0         | 0               | 0        |   |
| <b>Total number of samples</b> | -        | -    | -                      | <b>28</b>       | <b>27</b>       | <b>3</b>   | <b>16</b> | <b>3</b> | <b>3</b> | <b>3</b> | <b>3</b> | <b>3</b>  | <b>17</b>       | <b>3</b> |   |

<sup>+</sup>AA = Annual Average. Numbers of exceedances are shown for illustrative purposes only and reflect individual samples being compared to an AA or percentile derived EQS.

\* Site specific EQS determined, see Table 3-2 for details.

\*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT)<sup>23</sup>

<sup>#</sup> Total number of samples collected = 16 (not included in Phase 1 dataset).

<sup>##</sup> Drinking water suite parameters added to this site in October 2021 so total number of samples = 9.

<sup>22</sup> Blue shading indicates EQS (WFD and EQSD) exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. For further detail relating to analysis suites see Table 2-2. The count of individual EQS exceedances are also given<sup>+</sup>.

<sup>23</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktag](#)



Table 3-4 – Concentrations of compounds responsible for EQS (WFD and EQSD) exceedance.<sup>24</sup>

| Compound                       | Standard <sup>+</sup> | Unit | Statistic <sup>+</sup> | Upper GUC |         | Middle GUC |         |         |         |          |          | Lower GUC |          |          |
|--------------------------------|-----------------------|------|------------------------|-----------|---------|------------|---------|---------|---------|----------|----------|-----------|----------|----------|
|                                |                       |      |                        | Site 1    | Site 3  | Site 10    | Site 5  | Site 11 | Site 12 | Site 13  | Site 14  | Site 15   | Site 6   | Site 16  |
| Acid neutralisation capacity   | 40                    | mg/l | AA                     | 1906      | 2406    | 3400       | 3006    | 3700    | 4500    | 4667     | 3767     | 3200      | 3535     | 3133     |
| Benzo(a)pyrene                 | 0.00017               | µg/l | AA                     | 0.0013    | 0.01500 | 0.0435     | 0.0041  | 0.0137  | 0.0191  | 0.0196   | 0.0191   | 0.0550    | 0.0220   | 0.0166   |
| BOD (5 day)                    | *                     | mg/l | 90 <sup>th</sup>       | 4.54      | 5.66    | 3.54       | 5.10    | 3.96    | 5.52    | 3.92     | 7.12     | 5.34      | 9.68     | 4.76     |
| Bromine                        | 0.002                 | mg/l | AA                     | 0.19      | 2.45    |            |         |         |         |          |          |           |          |          |
| Chlorothalonil                 | 0.035                 | µg/l | AA                     | 0.05      | 0.03    |            |         |         |         |          |          |           |          |          |
| Cobalt - dissolved             | 3                     | µg/l | AA                     | 1.84      | 11.5    |            |         |         |         |          |          |           | 0.468    |          |
| Dissolved oxygen               | *                     | %    | 10 <sup>th</sup>       | 56.8      | 74.0    | 60.3       | 65.5    | 87.5    | 98.3    | 109      | 65.8     | 84.1      | 74.6     | 99.7     |
| Cypermethrin                   | 0.00008               | µg/l | AA                     | 0.0002    | 0.00005 | 0.00009    | 0.00008 | 0.00008 | 0.00004 | 0.000080 | 0.000090 | 0.000117  | 0.000085 | 0.000107 |
| Fluoranthene                   | 0.0063                | µg/l | AA                     | 0.0023    | 0.0185  | 0.0251     | 0.0053  | 0.0252  | 0.0110  | 0.0120   | 0.0157   | 0.0480    | 0.0191   | 0.0210   |
| Manganese - bioavailable**     | 123                   | µg/l | AA                     | 15.3      | 1475    |            |         |         |         |          |          |           | 14.92    |          |
| Nickel - bioavailable**        | 4                     | µg/l | AA                     | 3.07      | 9.6     | 0.70       | 1.02    | 0.82    | 1.08    | 0.70     | 0.58     | 0.93      | 0.76     | 0.45     |
| Perfluorooctane sulfonic acid  | 0.00065               | µg/l | AA                     | 0.0198    | 0.00761 | 0.00464    | 0.0181  | 0.00165 | 0.0304  | 0.0455   | 0.0131   | 0.00100   | 0.00172  | 0.00289  |
| Permethrin                     | 0.001                 | µg/l | AA                     | 0.00253   | 0.0010  |            |         |         |         |          |          |           |          |          |
| Soluble reactive phosphorus    | *                     | mg/l | AA                     | 0.236     | 0.128   | 0.103      | 0.089   | 0.037   | 0.013   | 0.120    | 0.070    | 0.020     | 0.176    | 0.090    |
| Sulphide or hydrogen sulphide  | 0.25                  | µg/l | AA                     | 6.94      | 15.81   | 14.3       | 13.2    | 13.7    | 11.7    | 17.3     | 19.3     | 17.3      | 27.1     | 15.0     |
| Total anions                   | 250                   | mg/l | AA                     | 249       | 466     |            |         |         |         |          |          |           | 213      |          |
| Tributyltin compounds          | 0.0002                | µg/l | AA                     | 0.00005   | 0.00009 | 0.00012    | 0.00004 | 0.00006 | 0.00025 | 0.000050 | 0.000393 | 0.000150  | 0.000149 | 0.000070 |
| Zinc - bioavailable**          | *                     | µg/l | AA                     | 14.9      | 9.44    | 3.73       | 2.92    | 1.05    | 1.43    | 1.01     | 1.79     | 1.68      | 3.01     | 1.73     |
| <b>Total number of samples</b> | -                     | -    | -                      | 28        | 27      | 3          | 16      | 3       | 3       | 3        | 3        | 3         | 17       | 3        |

\*AA = Annual Average.

\* Site specific EQS determined, see Table 3-2 for details.

\*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT).<sup>25</sup>

<sup>24</sup> Blue shading indicates EQS exceedance and grey shading indicates where failures relate to EQSD target compounds (not monitored at all sites, and as such not directly comparable across all sites). Concentrations corresponding to test statistic are also shown. For further detail relating to analysis suites see Table 2-2.

<sup>25</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktag](#)



Table 3-5 - Number of WFD and EQSD MAC exceedances.<sup>26</sup>

| Compound                         | Standard | Unit | Statistic | Upper GUC |           | Middle GUC |           |          |          |          |          | Lower GUC |          |           |          |
|----------------------------------|----------|------|-----------|-----------|-----------|------------|-----------|----------|----------|----------|----------|-----------|----------|-----------|----------|
|                                  |          |      |           | Site 1    | Site 3    | Site 10    | Site 5    | Site 11  | Site 12  | Site 13  | Site 14  | Site 15   | Site 6   | Site 16   |          |
| Benzo(a)pyrene                   | 0.027    | ug/l | MAC       | 0         | 4         | 2          | 0         | 0        | 0        | 0        | 1        | 1         | 2        | 5         | 0        |
| Benzo(b)fluoranthene*            | 0.017    | ug/l | MAC       | 0#        |           |            |           |          |          |          |          |           |          | 5##       |          |
| Benzo(g,h,i)perylene*            | 0.0082   | ug/l | MAC       | 0#        |           |            |           |          |          |          |          |           |          | 8##       |          |
| Benzo(k)fluoranthene*            | 0.017    | ug/l | MAC       | 0#        |           |            |           |          |          |          |          |           |          | 2##       |          |
| Bromine - total residual oxidant | 0.005    | mg/l | MAC       | 15#       | 15        |            |           |          |          |          |          |           |          |           |          |
| Cypermethrin                     | 0.0006   | ug/l | MAC       | 2         | 0         | 0          | 0         | 0        | 0        | 0        | 0        | 0         | 0        | 0         | 0        |
| Nickel - dissolved               | 34       | ug/l | MAC       | 2         | 11        | 0          | 0         | 0        | 0        | 0        | 0        | 0         | 0        | 0         | 0        |
| Sulphide or hydrogen sulphide    | 1        | ug/l | MAC       | 6         | 17        | 3          | 8         | 2        | 2        | 3        | 3        | 3         | 2        | 11        | 3        |
| <b>Total number of samples</b>   | -        | -    | -         | <b>28</b> | <b>27</b> | <b>3</b>   | <b>16</b> | <b>3</b> | <b>3</b> | <b>3</b> | <b>3</b> | <b>3</b>  | <b>3</b> | <b>17</b> | <b>3</b> |

\* While these determinands have a MAC, as per the WFD there is no corresponding AA statistic as benzo(a)pyrene should be considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water.

# Total number of samples collected = 16 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 9.

<sup>26</sup> Blue shading indicates MAC EQS exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of exceedances also given.



## 3.2 Drinking Water Quality Standards

### 3.2.1 Overview

Drinking water parameters, assessed through their comparison to PCVs are only required to characterise the source water at Minworth WwRC (Site 1) and the downstream abstraction location (Site 6 Leighton Buzzard). It is important to note, that specific drinking water parameters were only added to the analysis suite at Site 6 in October 2021, prior to which, only WFD parameters were analysed. As a result, nine months of DWSP parameter data are reported, compared to Site 1, for which data from Phases 1-3 are available (26-months). The exception to this is where a determinand has a comparable PCV and is present in the WFD analysis suite (e.g., iron). In these instances, all monitoring data are compared to the relevant drinking water standard.

Across both sites where drinking water PCVs apply, to date there have been a total of 256 instances of PCV exceedances (Site 1 = 162 exceedances, Site 6 = 94 exceedances). The distribution of these exceedances across the sites can be seen in Figure 3-2, with a detailed breakdown in Table 3-6. Several determinands exceeded PCVs in every, or almost every, sampling round. These determinands, along with the number of exceedances observed at Site 6 (example abstraction location), are given below and discussed in turn in the following section.

- Benzo(a)pyrene (total exceedances = 9)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 9)
- *Escherichia coli* (E.coli, total exceedances = 9)
- Iron - total (total exceedances = 14)
- Nitrite (total exceedances = 8)
- Turbidity (total exceedances = 9)

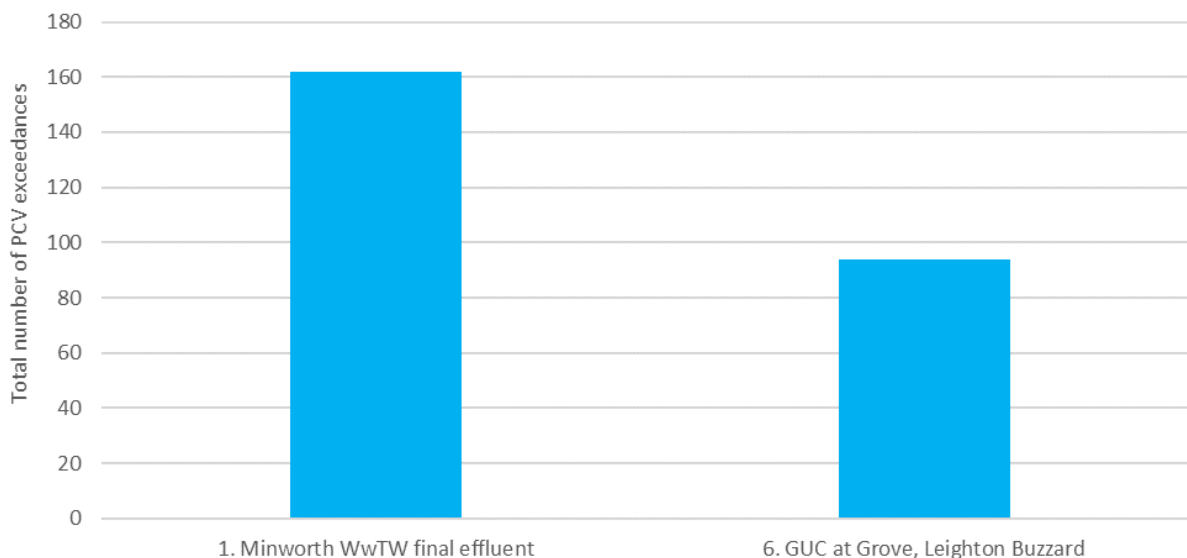


Figure 3-2 - Total number of PCV exceedances split by site location<sup>27</sup>

<sup>27</sup> Site 1 includes data from all phases covering May 20 – June 22, a 26-month period, sampling for the DWSP suite at Site 6 covers the period October 21 – June 22, a 9-month period.

*C. perfringens* (a sulphite-reducing species commonly associated with faecal contamination) is widely distributed in the environment and is regularly evaluated with the aim of understanding the microbiological safety of drinking water supplies. *C. perfringens* is responsible for gastrointestinal disease, the spores of which persist longer than other indicators of contamination, such as Coliforms (which also demonstrated exceedances at all sites and is also an important indicator of faecal contamination). Sources of bacterial contamination can range from the input of animal manures from farmyard runoff and the discharge of untreated, and even treated, sewage effluent.<sup>28</sup> *Cryptosporidium* was not detected at either site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward.

Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores. However, as canal networks often has shallow depths (<6ft), short lived events may be a result of localised disturbance such as boats but also dogs and other wildlife swimming in the vicinity of the sensor location, disturbing shallow sediment depositions.

## 3.2.2 Rainfall events

### 3.2.2.1 Analysis of historic rainfall events

A number of rainfall events were captured during the monitoring period. Rainfall events coincided with sampling on 14/09/21 (daily rainfall total = 9.3 mm), 07/12/21 (daily rainfall total = 5.7 mm), and 11/01/22 (daily rainfall total = 4.5 mm). Exceedances in both nitrite (1.2 = mg/l NO<sub>2</sub>, PCV = 0.5 mg/l NO<sub>2</sub>) and iron (total = 230 µg/l, PCV = 200 µg/l) were observed during the rainfall event that occurred on 14/09/21. DWSP were only added to Site 6 in November 2021 and as such none of these determinands can be assessed. During the second rainfall event that coincided with sampling on 07/12/21, additional PCV exceedances in ammonium (1.88 mg/l NH<sub>4</sub>, PCV = 0.5 mg/l NH<sub>4</sub>), nitrate (53 mg/l NO<sub>3</sub>, PCV = 50 mg/l NO<sub>3</sub>) and colour (24 mg/lPt/Co, PCV = 20 mg/lPt/Co) were observed. Although cell counts for *E.coli* regularly exceed PCVs (as this is set to 0 MPM/100 ml) these were elevated during the rainfall event. Cell counts of 1730 MPM/100ml were observed on 07/12/21, compared to the preceding dry sample value of 687 MPM/100ml (09/11/21).

A number of exceedances were also observed for an additional sample collected on 20/10/2021 which coincided with a period of intense rainfall relative to the other storms captured (see Figure 2-2). October 2021 experienced 120 mm total rainfall compared to 55 mm in the preceding month with a daily total on 20/10/2021 of 40 mm (see Figure 2-2). Of the additional exceedances observed, of note are the presence of tebuconazole, an agricultural triazole fungicide used to treat plant pathogenic fungi, and metribuzin, a synthetic herbicide applied both pre- and post-emergence of vegetable crops. It is likely these are of agricultural origin, leached by the heavy rainfall experienced during the month, with each rainstorm increasing ground saturation and further facilitating additional losses. The Ledburn Book has its confluence with the GUC directly south (upstream) of Site 6. Ledburn Book is a heavily modified water body which lists poor agricultural land management as one of its contributing factors for not achieving good status under WFD. The presence of a ditch upstream of Site 6 was also observed with a visually elevated suspended sediment loading. It is therefore likely that these catchment areas may be responsible for the delivery of these additional compounds during periods of heavy rainfall.

This storm event also resulted in additional exceedances of PAH, aluminium (dissolved), and iron (dissolved), which were not regularly experienced under base flow conditions. A subsequent rainfall event which occurred on 11/01/22 (daily rainfall total = 4.5 mm) demonstrated no additional exceedances of tebuconazole or metribuzin. Antecedent conditions for this month, however, were considerably different from those experienced in October 2021. As discussed in Section 2.6, national rainfall totals for January 2022 were on average 40% lower than the preceding year (January 2022 = 21.2 mm, January 2021 = 127 mm). Reduced rainfall, leading to

<sup>28</sup> [final\\_jrc\\_tech\\_report\\_dwd\\_06.04.20\\_final\\_pdf\(4\).pdf](#)



drier soil conditions may have resulted in a lower rate of pollutant transport, and as such, there were no additional exceedances of the agricultural biproducts observed during the last period of rainfall that coincided with sample collection.

While these determinands are useful indicators of compounds that may be of concern following abstraction (depending on their relative drinking water treatment removal efficiencies) PCVs apply only to treated drinking water, and not raw source waters, which helps to explain why these numbers are considerably higher than the number of EQS failures. They do however, aid in future planning helping to ensure treatment facilities are tailored towards the chemicals of concern. Table 3-7 shows the maximum concentrations observed across four of the potential abstraction locations. Based on maximum concentrations discharged from Minworth WwRC, the following parameters have the potential to result in additional instream breaches of PCVs: colour, nitrate and PAH (sum).

### **3.2.2.2 Rainfall events during the last quarter**

Rainfall during April 2022 was low (17.9 mm) when compared to both the regional long-term (RLT) mean (1991-2020, UK Met Office Climate Station: Oxford, 59.9 mm) and data collected from Dancers End Reservoir (DER) in 2021 (5.67 mm). A similar story was observed for both May (RLT = 56.9 mm, DER 2021 = 122 mm, DER 2022 = 47 mm) and June (RLT = 49.7 mm, DER 2021 = 99 mm, DER 2022 = 11.2 mm). As a result of these lower-than-average monthly rainfall totals, no sampling conducted in the last three sampling rounds coincided with a rainfall event.



Table 3-6 - Number of drinking water PCV exceedances.

| Compound   | PCV  | Unit                 | Source          | Abstraction site |
|--|------|----------------------|-----------------|------------------|
|  |      |                      | Site 1**        | Site 6**         |
| Aluminium - total  | 200  | µg/l                 | 0               | 6                |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l                 | 1 <sup>#</sup>  | 1 <sup>##</sup>  |
| Benzo(a)pyrene   | 0.01 | µg/l                 | 0               | 9                |
| Bisphenol A  | 2.5  | µg/l                 | 9 <sup>#</sup>  | 0 <sup>##</sup>  |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml             | 16 <sup>#</sup> | 9 <sup>##</sup>  |
| Chlorate   | 0.25 | mg/l                 | 4 <sup>#</sup>  | 0 <sup>##</sup>  |
| Chloride   | 250  | mg/l                 | 1 <sup>#</sup>  | 0 <sup>##</sup>  |
| Chlorite   | 0.25 | µg/l                 | 0 <sup>#</sup>  | 1                |
| Chromium - total   | 50   | µg/l                 | 1               | 0                |
| Clopyralid   | 0.1  | µg/l                 | 1               | 0                |
| Coliform - total   | 0    | MPN/100ml            | 16              | 9 <sup>##</sup>  |
| Colour   | 20   | mg/l/Pt/Co           | 15 <sup>#</sup> | 2 <sup>##</sup>  |
| <i>E. coli</i>   | 0    | MPN/100ml            | 16 <sup>#</sup> | 9 <sup>##</sup>  |
| Iron - dissolved   | 200  | µg/l                 | 0               | 1                |
| Iron - total   | 200  | µg/l                 | 5               | 14               |
| Manganese - dissolved  | 50   | µg/l                 | 16 <sup>#</sup> | 1 <sup>##</sup>  |
| Manganese - total  | 50   | µg/l                 | 16 <sup>#</sup> | 2 <sup>##</sup>  |
| Metribuzin   | 0.1  | µg/l                 | 0 <sup>#</sup>  | 1 <sup>##</sup>  |
| Nickel - dissolved   | 20   | µg/l                 | 4               | 0                |
| Nickel - total   | 20   | µg/l                 | 4               | 0                |
| Nitrate  | 50   | mg/l NO <sub>3</sub> | 9               | 2                |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub> | 15 <sup>#</sup> | 8                |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                 | 0 <sup>#</sup>  | 2 <sup>##</sup>  |
| PAH sum*   | 0.1  | µg/l                 | 0 <sup>#</sup>  | 5 <sup>##</sup>  |
| Propyzamide  | 0.1  | µg/l                 | 1 <sup>#</sup>  | 0 <sup>##</sup>  |
| Sulphate   | 250  | mg/l SO <sub>4</sub> | 0 <sup>#</sup>  | 1 <sup>##</sup>  |
| Tebuconazole   | 0.1  | µg/l                 | 0 <sup>#</sup>  | 1 <sup>##</sup>  |
| Turbidity  | 1    | NTU                  | 12 <sup>#</sup> | 9 <sup>##</sup>  |
| Vinyl chloride   | 0.5  | µg/l                 | 0               | 1 <sup>##</sup>  |
| <b>Total number of samples</b>   | -    | -                    | 27              | 17               |

Blue shading indicates PCV exceedance, with the number of exceedances provided.

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

\*\* Data at Site 1 covers May 20 - June 22 and data at Site 6 covers April 21 - June 22.

# Total number of samples collected = 16 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 9.



Table 3-7 – Concentrations of compounds responsible for drinking water PCV exceedances.<sup>29</sup>

| Compound   | Source |                         | Abstraction sites |        |
|--|--------|-------------------------|-------------------|--------|
|  | PCV    | Unit                    | Site 1            | Site 6 |
| Aluminium - total  | 200    | µg/l                    | 125               | 230    |
| Ammonium as NH <sub>4</sub>  | 0.5    | mg/l as NH <sub>4</sub> | 1.4               | 1.88   |
| Benzo(a)pyrene   | 0.01   | µg/l                    | 0.00302           | 0.134  |
| Bisphenol A  | 2.5    | µg/l                    | 137               | <10    |
| <i>C. perfringens</i> veg & spores, confirmed  | 0      | No/100ml                | >100              | >100   |
| Chlorate   | 0.25   | mg/l                    | 2                 | 0.7    |
| Chloride   | 250    | mg/l                    | 610               | 75     |
| Chlorite   | 0.25   | µg/l                    | <3                | 15     |
| Chromium - total   | 50     | µg/l                    | 140               | 8.6    |
| Clopyralid   | 0.1    | µg/l                    | 0.19              | 0.03   |
| Coliform - total   | 0      | MPN/100ml               | >2420             | >2420  |
| Colour   | 20     | mg/lPt/Co               | 40                | 26     |
| <i>E. coli</i>   | 0      | MPN/100ml               | >2420             | >2420  |
| Iron - dissolved   | 200    | µg/l                    | 100               | 1700   |
| Iron - total   | 200    | µg/l                    | 310               | 2600   |
| Manganese - dissolved  | 50     | µg/l                    | 130               | 120    |
| Manganese - total  | 50     | µg/l                    | 160               | 150    |
| Metribuzin   | 0.1    | µg/l                    | <0.05             | 0.22   |
| Nickel - dissolved   | 20     | µg/l                    | 61                | 7.1    |
| Nickel - total   | 20     | µg/l                    | 61                | 9.4    |
| Nitrate  | 50     | mg/l NO <sub>3</sub>    | 120               | 100    |
| Nitrite  | 0.5    | mg/l NO <sub>2</sub>    | 3.6               | 2.5    |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1    | µg/l                    | -                 | 0.374  |
| PAH sum*   | 0.1    | µg/l                    | <0.05             | 0.62   |
| Propyzamide  | 0.1    | µg/l                    | 0.32              | 0.1    |
| Sulphate   | 250    | mg/l SO <sub>4</sub>    | 180               | 690    |
| Tebuconazole   | 0.1    | µg/l                    | 0.05              | 0.2    |
| Turbidity  | 1      | NTU                     | 14                | 210    |
| Vinyl chloride   | 0.5    | µg/l                    | 0.50              | 1.00   |

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

<sup>29</sup> Dark blue shading indicates PCV exceedance, light blue shading indicates this substance is of future concern as it is within 20% of the PCV. Maximum observed values are also given.



## 3.2.3 Analysis

### 3.2.3.1 Long term data records

In this section temporal patterns in key determinand concentrations are explored. For data compilation and the completion of standard data quality assurance procedures, descriptive statistical analyses were conducted on data from all sites, including the generation of mean, maximum, minimum statistics in addition to percentile values including the 95<sup>th</sup>, 90<sup>th</sup>, and 10<sup>th</sup> percentiles. Samples at the limit of detection were included in the analysis and used at face value to adhere to discharge permitting assessment guidance. Any significant outliers were removed from the analysis.

Only 4 sites have data spanning >12 months, these include Site 1 Minworth (27 months), Site 3 Coventry Canal at Atherstone (27 months), Site 5 GUC at Welton Lane, Daventry (16 months) and Site 6 Grove Lock, Leighton Buzzard (17 months) and as such discussion around temporal trends are reserved for these sites. The remaining sites including Site 10 GUC at Bedworth, Site 11 GUC at Little Heath Long Buckby, Site 12 GUC at Gayton, Site 13 GUC at Stoke Bruen, Site 14 GUC at Cosgrove, Site 15 GUC at Stoke Hammond and Site 16 GUC at Marsworth all have three months of data. The addition and removal of sites to the programme has resulted in site numbers no longer being in numerical order correlating with distance downstream. As a result, sites are plotted below in order of distance downstream to aid interpretation, rather than by site number. Temporal plots of the four most common determinands to breach EQS values (benzo(a)pyrene, PFOS, soluble reactive phosphorus, and BOD) across all sites can be seen in Figure 3-3 to Figure 3-13. These determinands are discussed in turn below.

#### Benzo(a)pyrene

Site 3 exhibits the most striking temporal pattern in benzo(a)pyrene concentrations. Increases in benzo(a)pyrene concentration were observed through mid/late summer peaking in September at 0.0695 µg/l and 0.042 µg/l for 2020 and 2021 respectively. This may have been the result of an increase in fossil fuel combustion resulting from increasing usage of the canal network for transport and recreation during the summer months. A reduction in dilution capacity caused by a lower frequency of rainfall events may have acted to further exacerbate this trend. Additionally, a marginal increase was observed in December 2020 and may have been the result of a sudden increase in the inefficient burning of fuel for heating (during the winter months) such as log burning stoves, common on house boats and barges, prevalent across the canal network. This trend of increasing PAH discharge in riverine systems has been observed across the scientific literature.<sup>30</sup> Data from Minworth final effluent demonstrated no obvious seasonal trends, with peak concentrations occurring in December 2020 and October 2021. Benzo(a)pyrene concentration at Site 6 peaked in October 2021 in the sample collected to coincide with wet weather conditions. This peak in concentration (0.134 µg/l) is considerably higher than all other concentrations observed during this record and may be related to the flushing of land directly adjacent to the canal used predominantly for parking.

#### Soluble reactive phosphorus

Differences in concentration patterns between sites suggest a complex assortment of phosphorus source areas across landscape scales. No clear seasonal trend was evident; however, concentrations were elevated during the autumn and winter months, encompassing October through February. Phosphorus is commonly leached from a number of sources (predominantly agricultural) under intense rainfall conditions due to a combination of its charge, and its affinity for sediment. As a result, it is likely that peaks in phosphorus concentrations outside any observable seasonal pattern were the result of catchment delivery from diffuse sources. The considerable peak in phosphorus concentration that occurred at Site 3 in December 2020 did not correlate with a large rainfall event, suggesting either a more local, flow independent source may be responsible or a localised rainfall

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<sup>30</sup> [Seasonal and long-term trends in atmospheric PAH concentrations: evidence and implications - ScienceDirect](#)



event. Peak phosphorus concentrations at Site 6 were observed coinciding with an intense period of rainfall, suggesting flushing of local sources, which are commonly soil phosphorus stores. Patterns in data from Minworth treated effluent were highly variable, peaking during Phase 1 between September and February 2020. This was a considerable increase and may be related to operational issues taking place at the works as concentrations remain below 0.4 mg/l from March 2021 to the end of the reporting period.

## PFOS

Although most uses of PFOS and related substances are now heavily restricted, landscape sources still exist due to its historical use in products such as carpets and other textiles. As a result, 'legacy emissions' relating to the washing of these products and subsequent release to the environment through WwRC or indirectly through the land application of biosolids are common. A weak seasonal pattern was observed in PFOS data with concentrations experiencing a maximum during the late summer months and a minimum during the winter months. This was likely due to the changing dilution capacity of the canal between seasons. As inputs from point sources (e.g., WwRC or septic tanks) are relatively consistent across the year, a seasonal signal is often superimposed on synthetic chemicals as winter dilution from higher baseflow input decreases instream concentrations. This has been found with a number of chemicals of emerging concern including the brominated flame retardant hexabromocyclododecane (HBCDD).<sup>31</sup>

## BOD

Results from the analysis of BOD were more variable and likely reflect local conditions and nutrient sources. Increases in BOD are commonly associated with increases in organic loading (due to the increased oxygen required to break down the organic material). Although no clear seasonal trend exists, BOD broadly peaks during the summer months (June, July, August). This pattern is consistent with instream bacterial breakdown of a point source input of organic matter, as instream dilution capacity drops during the summer months, increasing instream nutrient concentrations and BOD. Significant peaks in BOD occurred at Site 3 on between July – September 2021. While no rainfall events were observed in either July or August, there was a considerable rainfall event corresponding with September sampling (9.3 mm). This rainfall event may have delivered an organic load from a proximal source sufficient to deteriorate local conditions resulting in an increased BOD value. As observed with the other determinands discussed above, no seasonality was evident in final effluent samples collected from Minworth.

### 3.2.3.2 Patterns in the last quarter

Data collected from April-June (Section 3.1) for sites where baseline data were available (Sites 1, 3, 5, and 6) show no variations from patterns established during previous monitoring phases as a result of the reduced rainfall experienced in spring 2022.

Marked reductions in phosphorus concentrations were observed at Sites 11, 13, 14, and 16 for samples collected during April 2022 when compared to samples collected during June/May 2022. As discussed in Section 3.2.2, rainfall during April 2022 (17.9 mm) was particularly low when compared to the RLT mean (59.9 mm). Reduced rainfall will reduce landscape connectivity and as such reduce phosphorus loading.

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<sup>31</sup> [Seasonal variation of contaminant concentrations in wastewater Recycling Center effluents and river waters: Environmental Technology: Vol 41, No 21 \(tandfonline.com\)](https://www.tandfonline.com/doi/abs/10.1080/10916344.2012.704444)



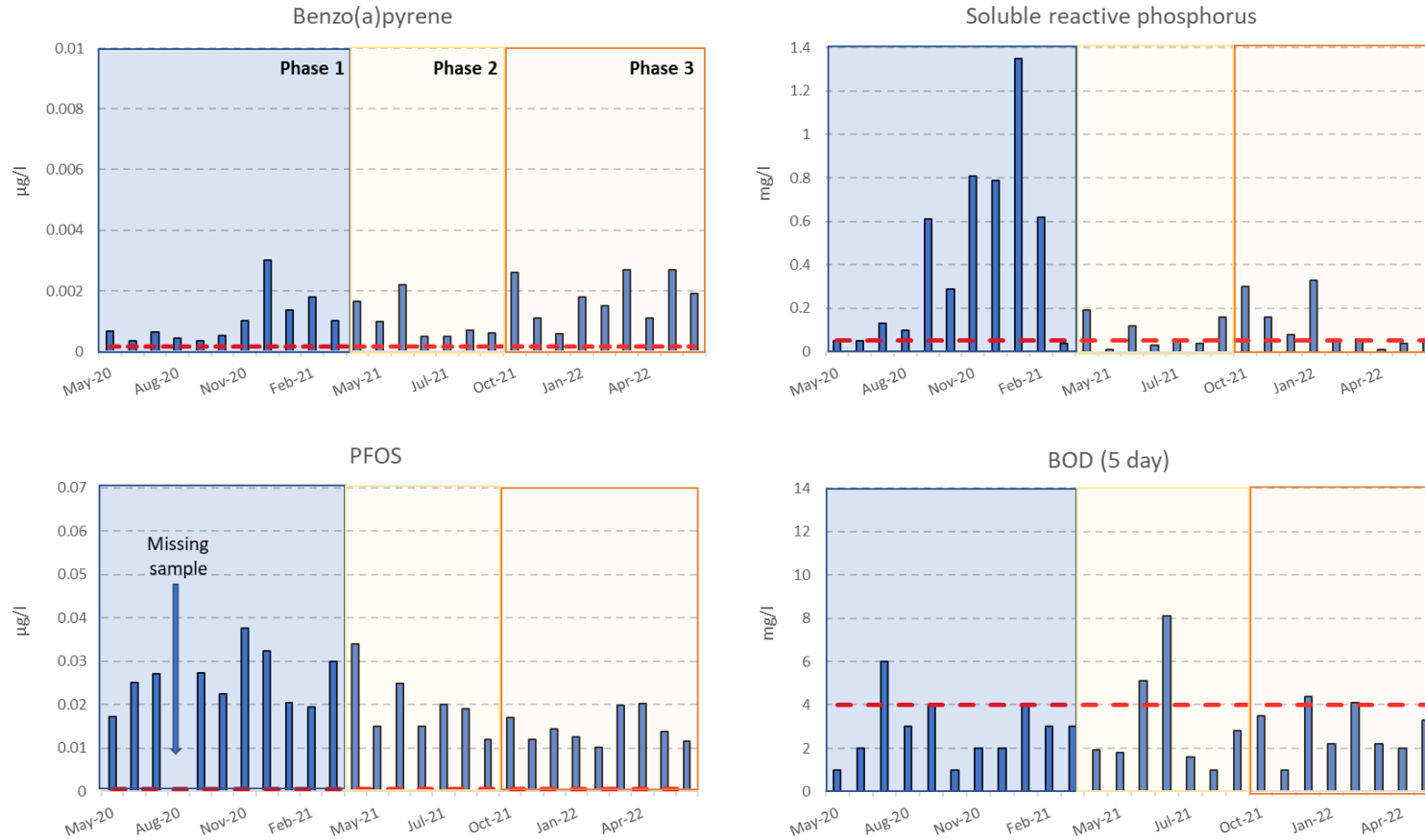


Figure 3-3 - Temporal trends in for key determinands at Site 1 Minworth WwRC final effluent (May 2020 - June 2022).<sup>32</sup>

<sup>32</sup> Red dashed line indicates the EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Note: this EQS is applicable to raw water samples and has been included as a visual guide only. Blue shading indicates Phase 1 data, yellow Phase 2, and orange Phase 3. Values <LoD have been plotted at the LoD. Note: a different y-axis is used at this site for benzo(a)pyrene and soluble reactive phosphorus as the data reflect treated final effluent and not canal water samples.



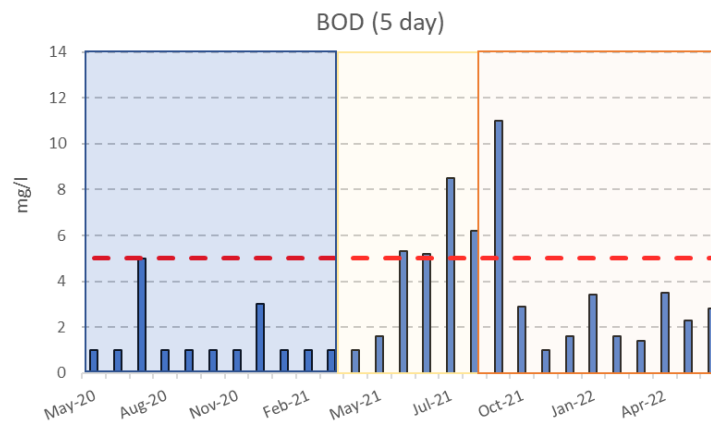
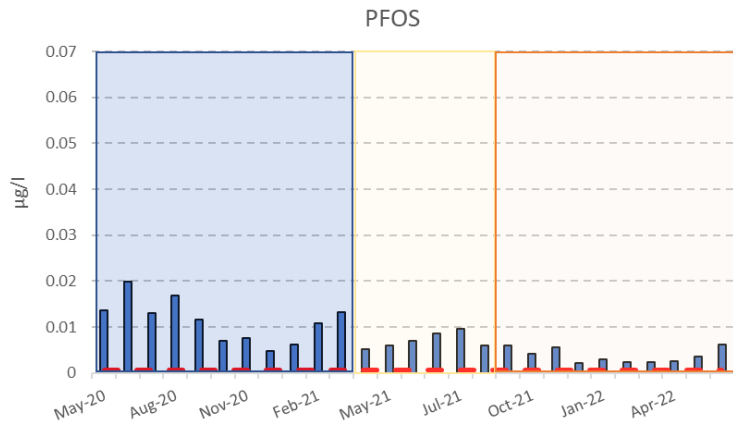
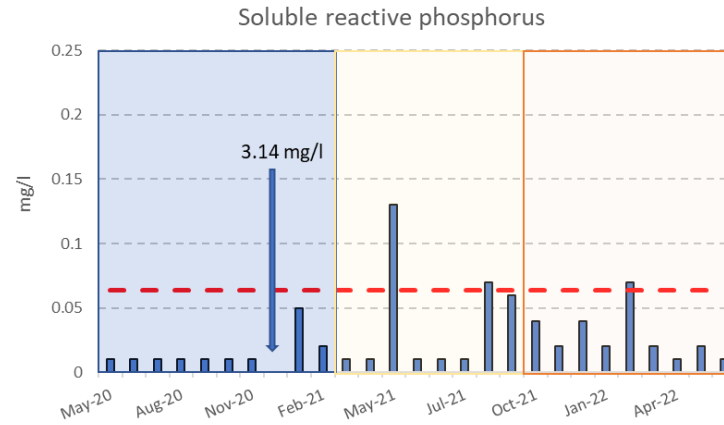
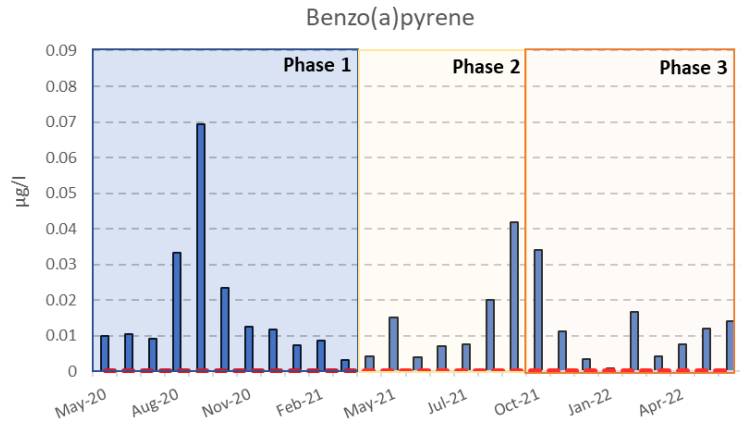


Figure 3-4 - Temporal trends in for key determinands at Site 3 Coventry Canal at Atherstone (May 2020 - June 2022).<sup>33</sup>

<sup>33</sup> Red dashed line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.064 mg/l, BOD = 5 mg/l). Blue shading indicates Phase 1 data, yellow Phase 2, and orange Phase 3. Phase 1 analyses were conducted at a different analytical laboratory. Values <LoD have been plotted at the LoD.



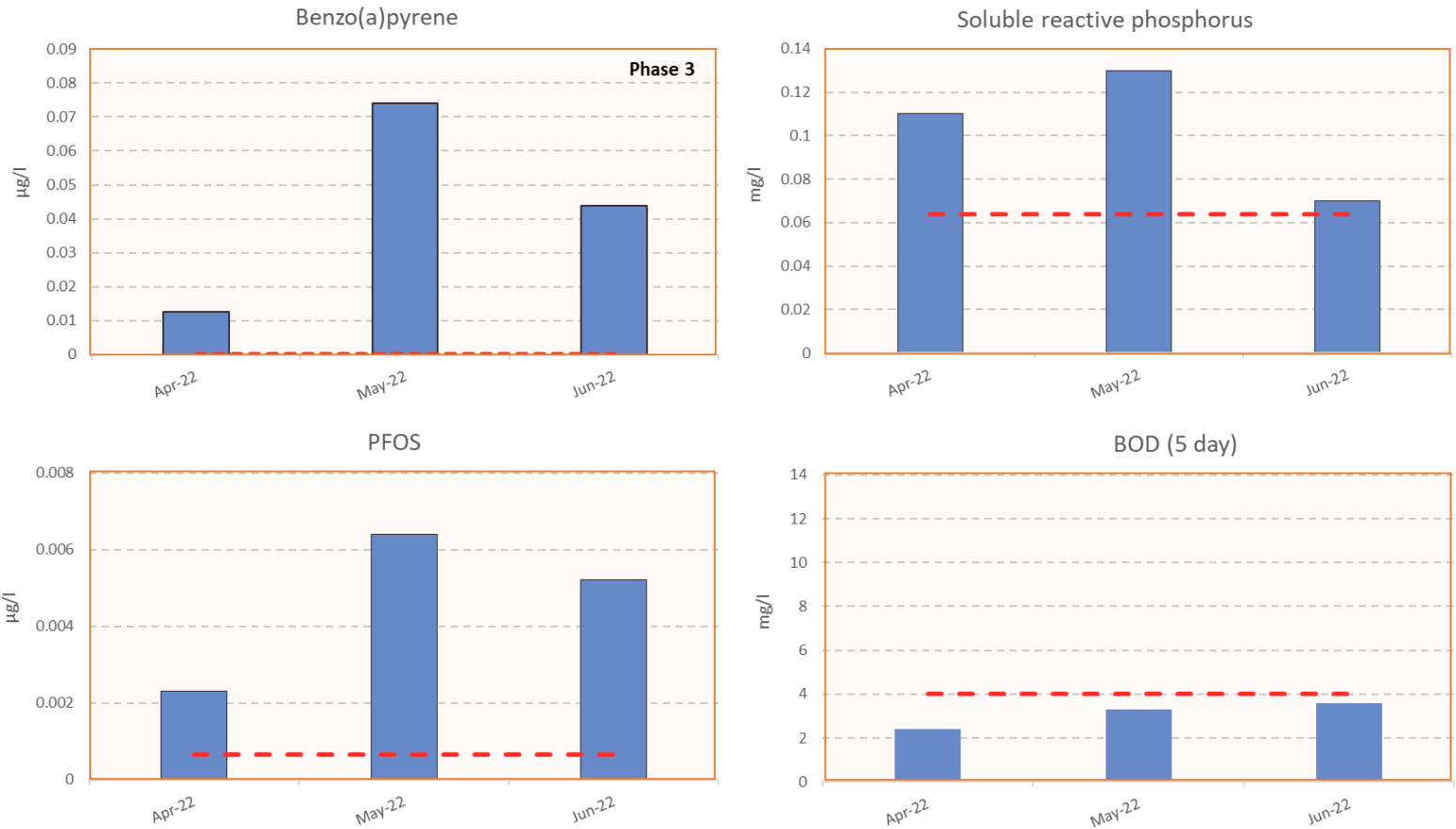


Figure 3-5 - Temporal trends in for key determinands at Site 10 GUC at Bedworth, Tring (April 2022 – June 2022).<sup>34</sup>

<sup>34</sup> Red dashed line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.064 mg/l, BOD = 4 mg/l). Orange shading indicates Phase 3 data. Values <LoD have been plotted at the LoD. Note: a different y-axis is used for PFOS due to the range of values observed at this site



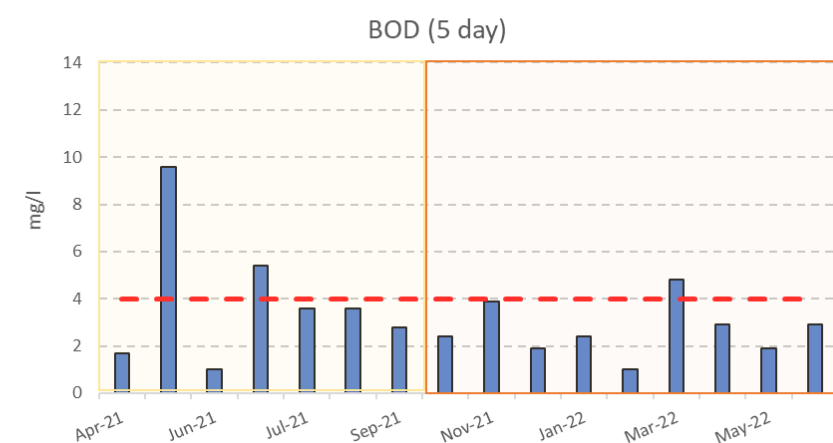
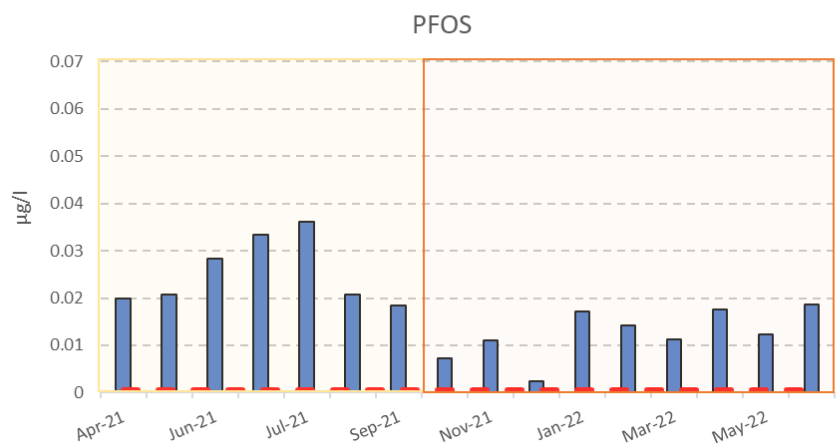
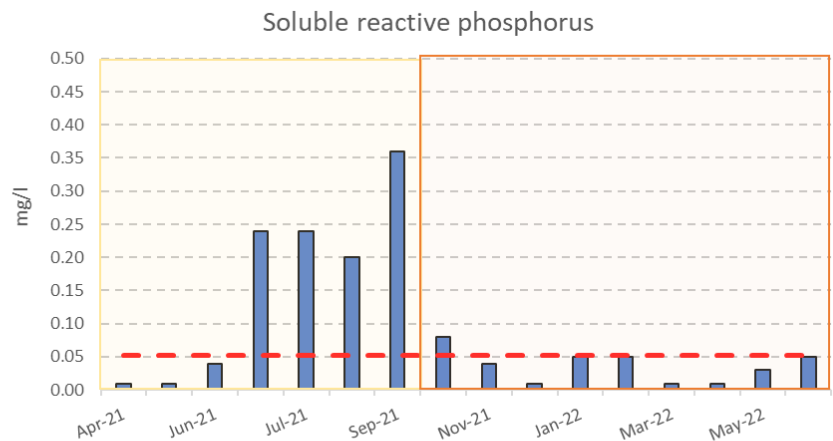
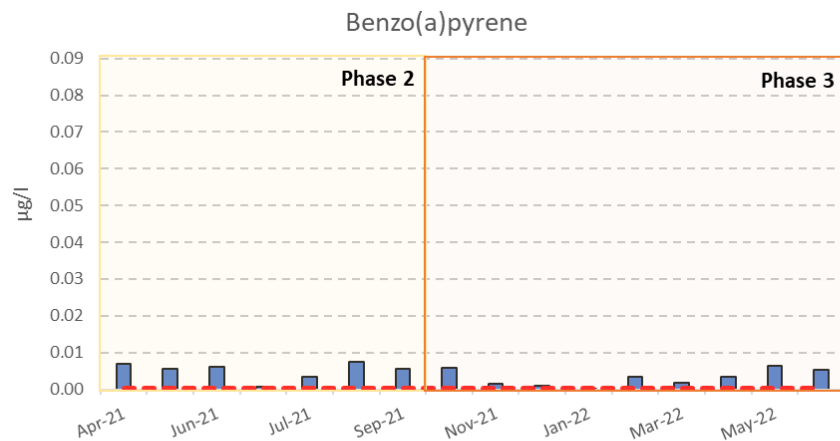


Figure 3-6 - Temporal trends in for key determinands at Site 5 GUC at Welton Lane, Daventry (April 2021 - June 2022).<sup>35</sup>

<sup>35</sup> Red dashed line indicated EQS value (see Table 3-2 for details). Yellow shading indicated Phase 2 data and orange Phase 3 data. Values <LoD have been plotted at the LoD (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.052 mg/l, BOD = 4 mg/l). Note: a different y-axis is used for soluble reactive phosphorus due to the range of values observed at this site.



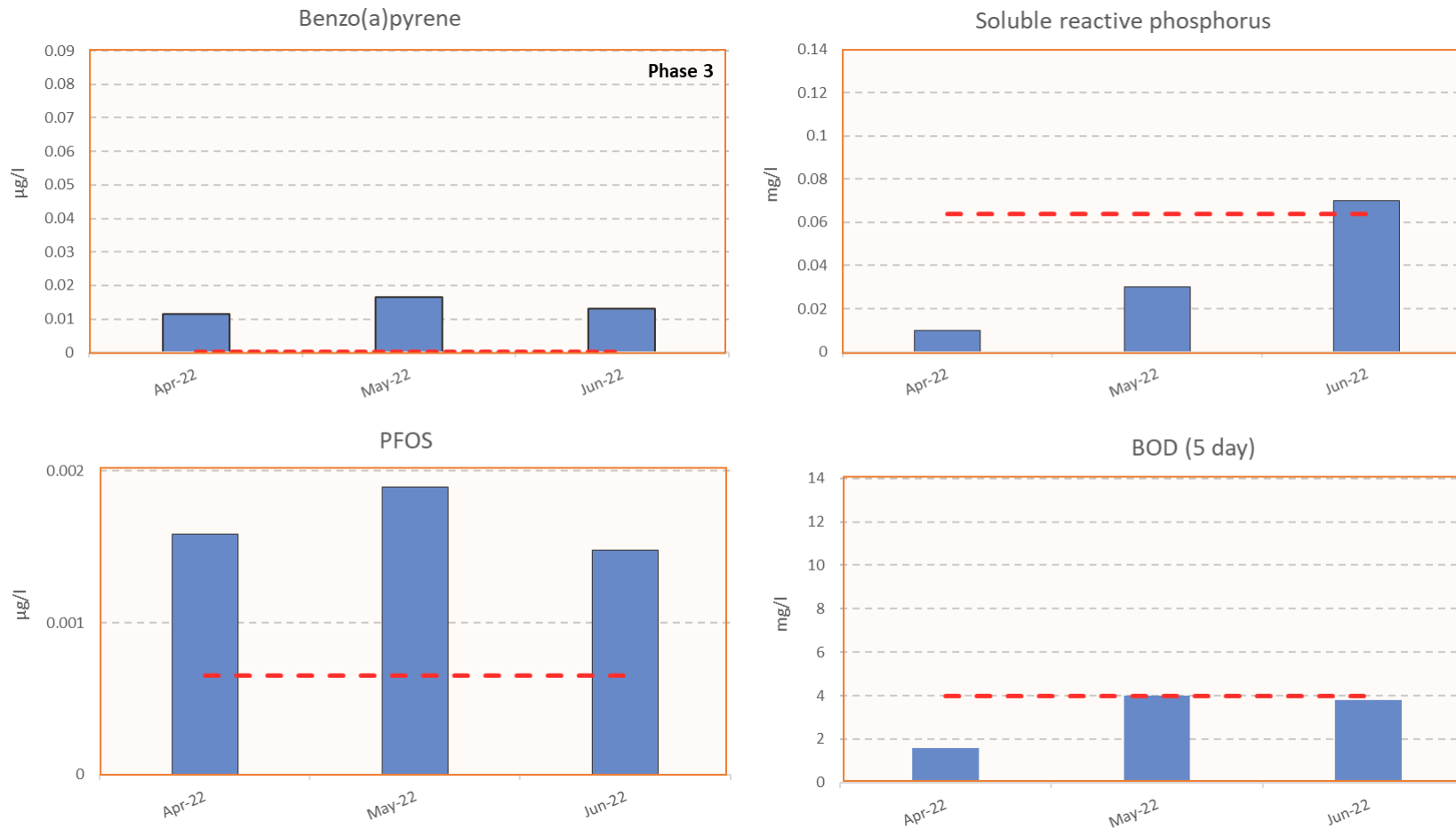


Figure 3-7 - Temporal trends in for key determinands at Site 11 GUC at Little Heath Long Buckby (April 2022 - June 2022).<sup>36</sup>

<sup>36</sup> Red dashed line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.064 mg/l, BOD = 4 mg/l). Orange shading indicates Phase 3 data. Values <LoD have been plotted at the LoD. Note: a different y-axis is used for PFOS due to the range of values observed at this site.



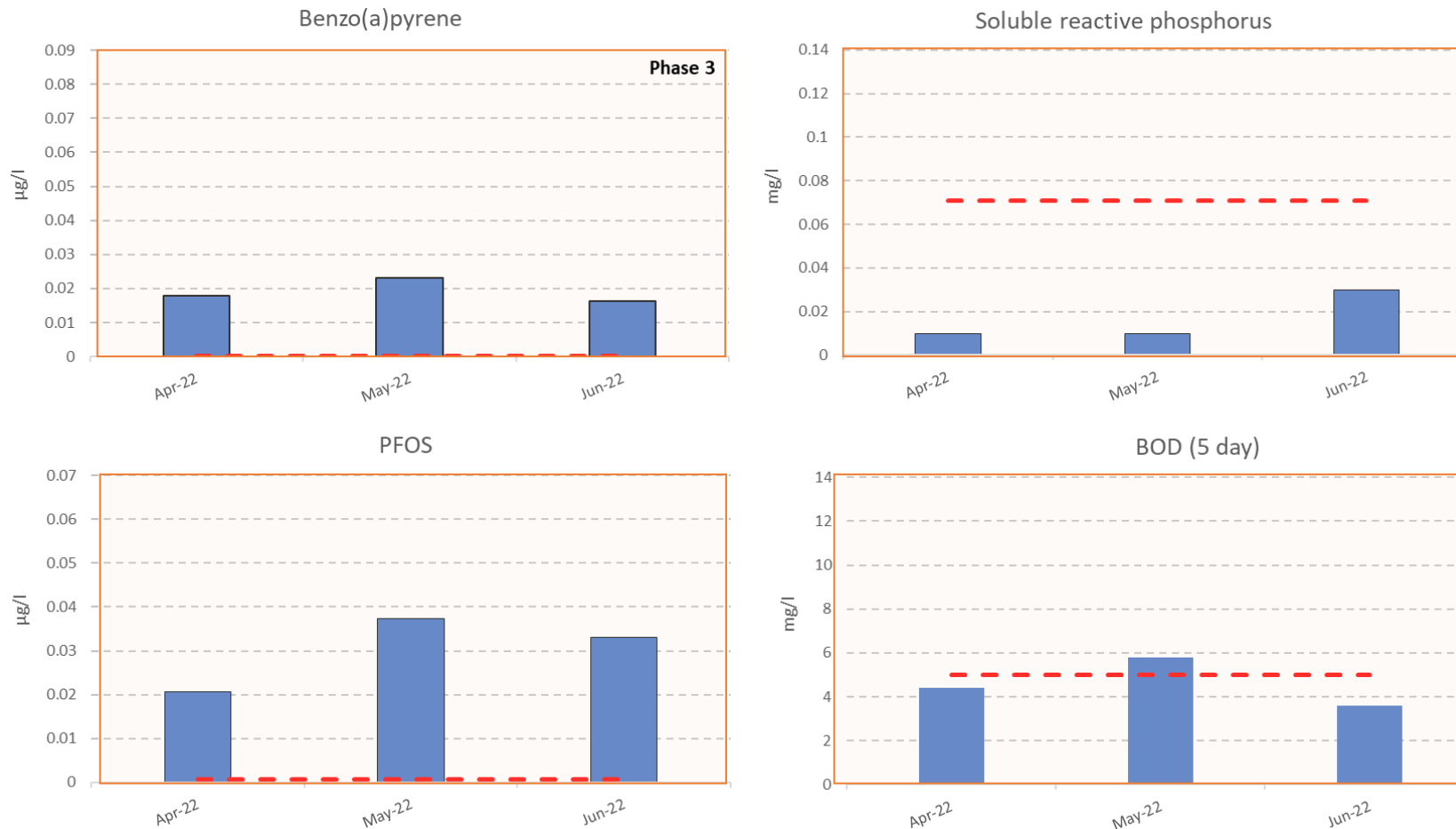


Figure 3-8 - Temporal trends in for key determinands at Site 12 GUC at Gayton (April 2022 – June 2022).<sup>37</sup>

<sup>37</sup> Red line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.071 mg/l, BOD = 5 mg/l). Orange shading indicates Phase 3 data. Values <LoD have been plotted at the LoD.



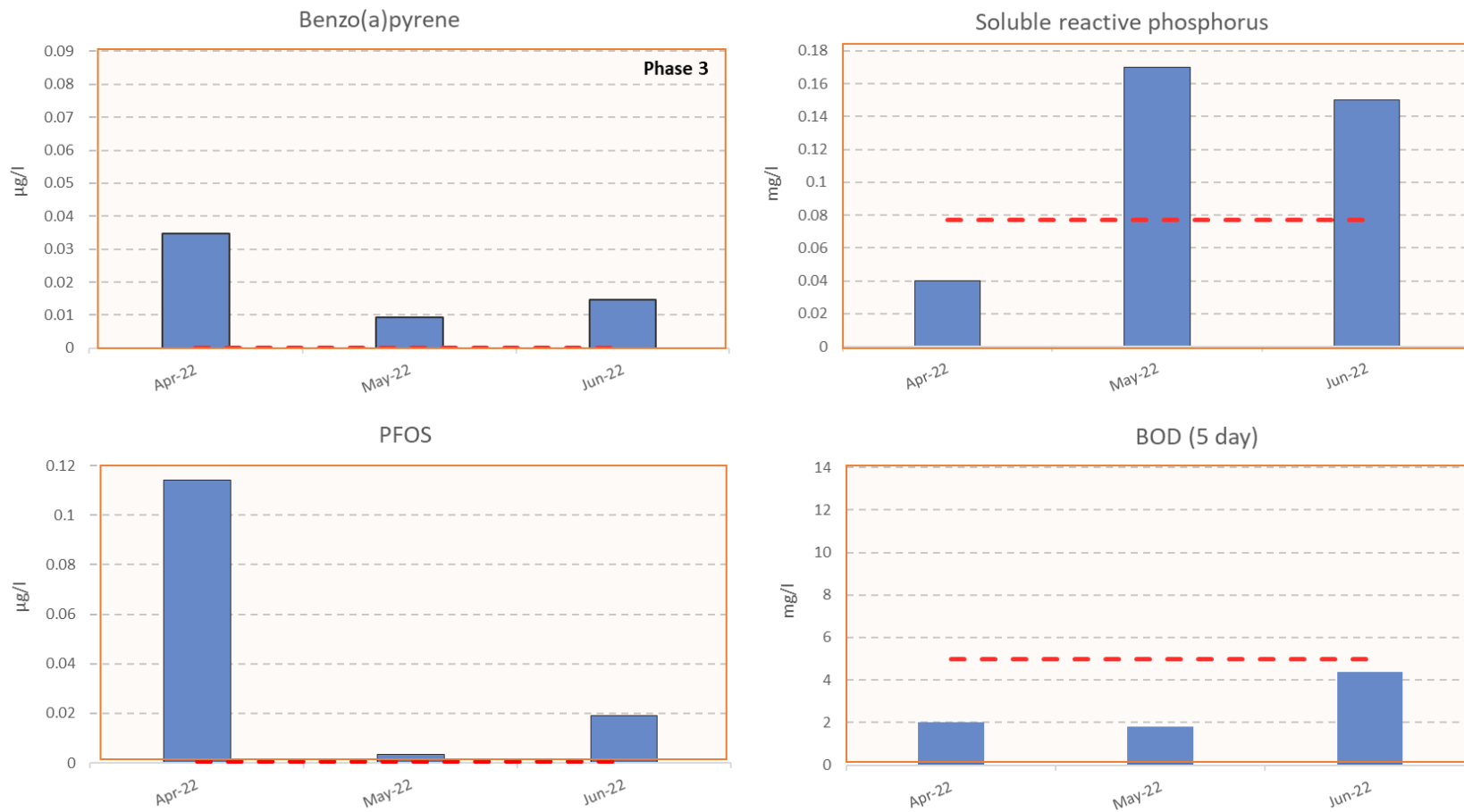


Figure 3-9 - Temporal trends in for key determinands at Site 13 GUC at Stoke Bruen (April 2022 – June 2022).<sup>38</sup>

<sup>38</sup> Red line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.077 mg/l, BOD = 5 mg/l). Orange shading indicates Phase 3 data. Values <LoD have been plotted at the LoD. Concentrations that exceeded the y-axis range are indicated by an arrow with their concentration also given. Note: a different y-axis is used for PFOS due to the range of values observed at this site.



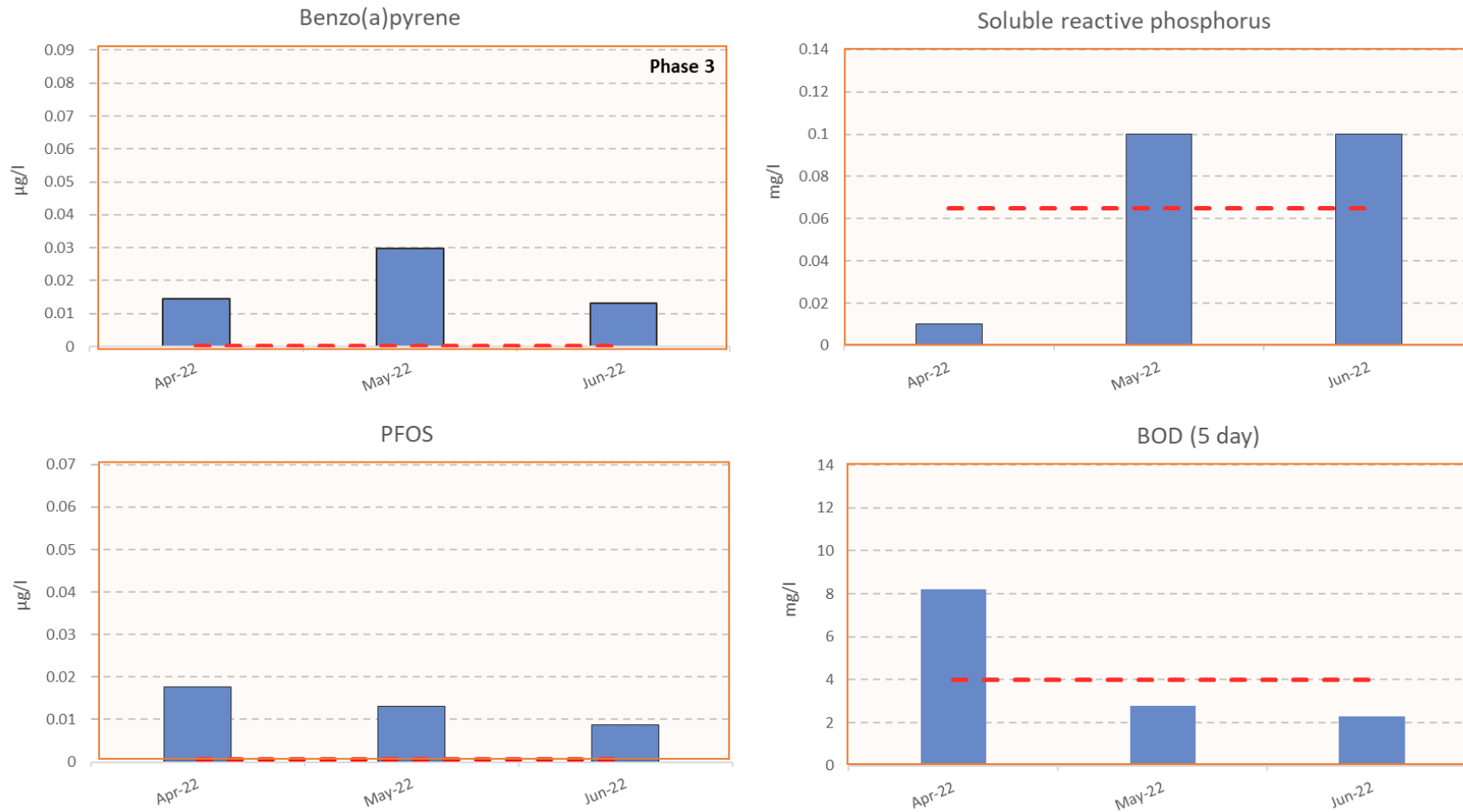


Figure 3-10 - Temporal trends in for key determinands at Site 14 GUC at Cosgrove (April 2022 – June 2022).<sup>39</sup>

<sup>39</sup> Red line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Orange shading indicates Phase 3 data. Values <LoD have been plotted at the LoD.



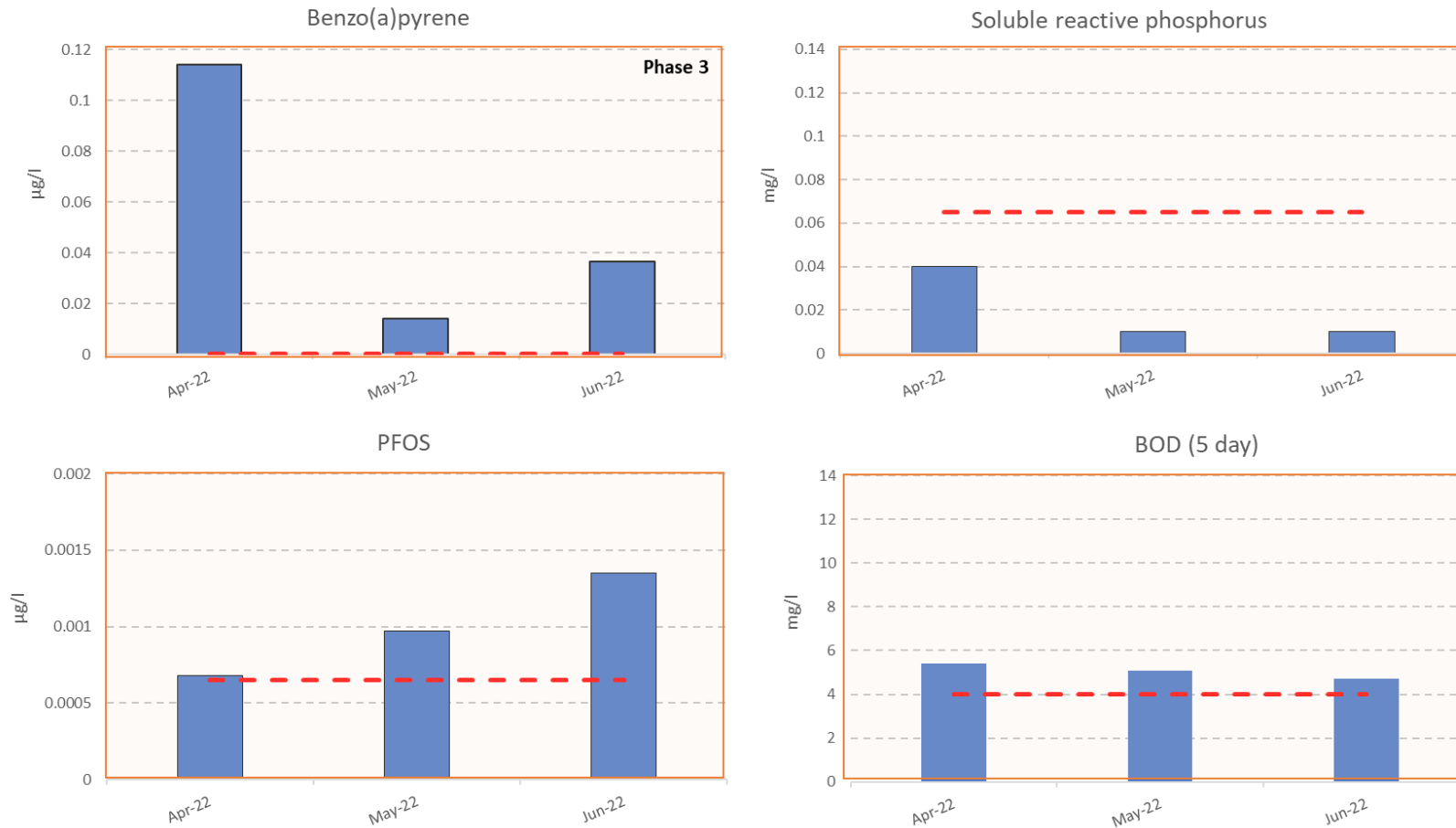


Figure 3-11 - Temporal trends in for key determinands at Site 15 GUC at Stoke Hammond (April 2022 – June 2022).<sup>40</sup>

<sup>40</sup> Red line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Orange shading indicates Phase 3 data. Values <LoD have been plotted at the LoD. Concentrations that exceeded the y-axis range are indicated by an arrow with their concentration also given. Note: a different y-axis is used for PFOS due to the range of values observed at this site.



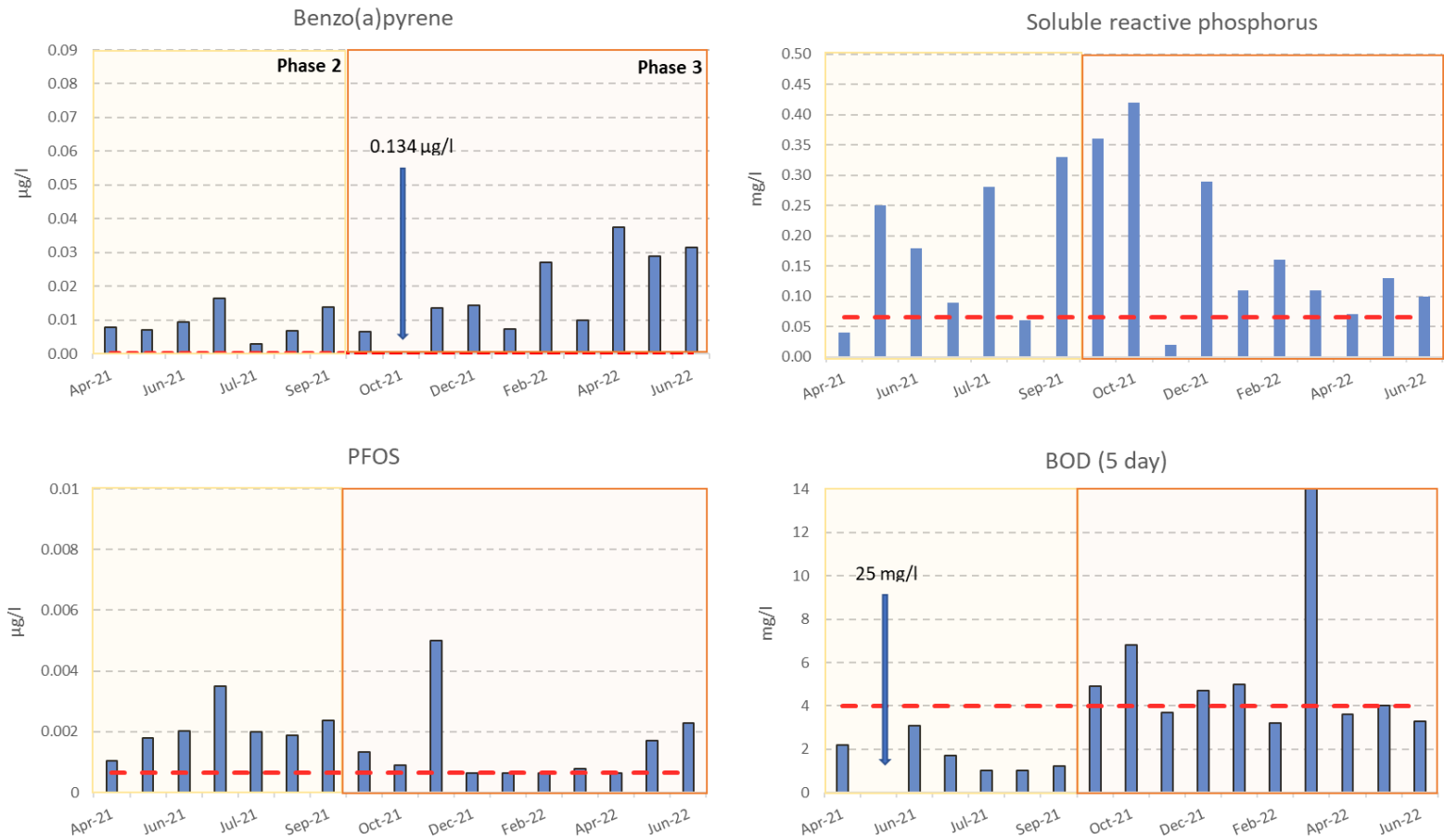


Figure 3-12 - Temporal trends in for key determinands at Site 6 Grove Lock, Leighton Buzzard (April 2021 - June 2022).<sup>41</sup>

<sup>41</sup> Red dashed line indicated EQS value (see Table 3-2 for details). Yellow shading indicated Phase 2 data and orange Phase 3 data. Values <LoD have been plotted at the LoD (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Note: a different y-axis is used for soluble reactive phosphorus and PFOS due to the range of values observed at this site. Concentrations that exceeded the y-axis range are indicated by an arrow with their concentration also given.



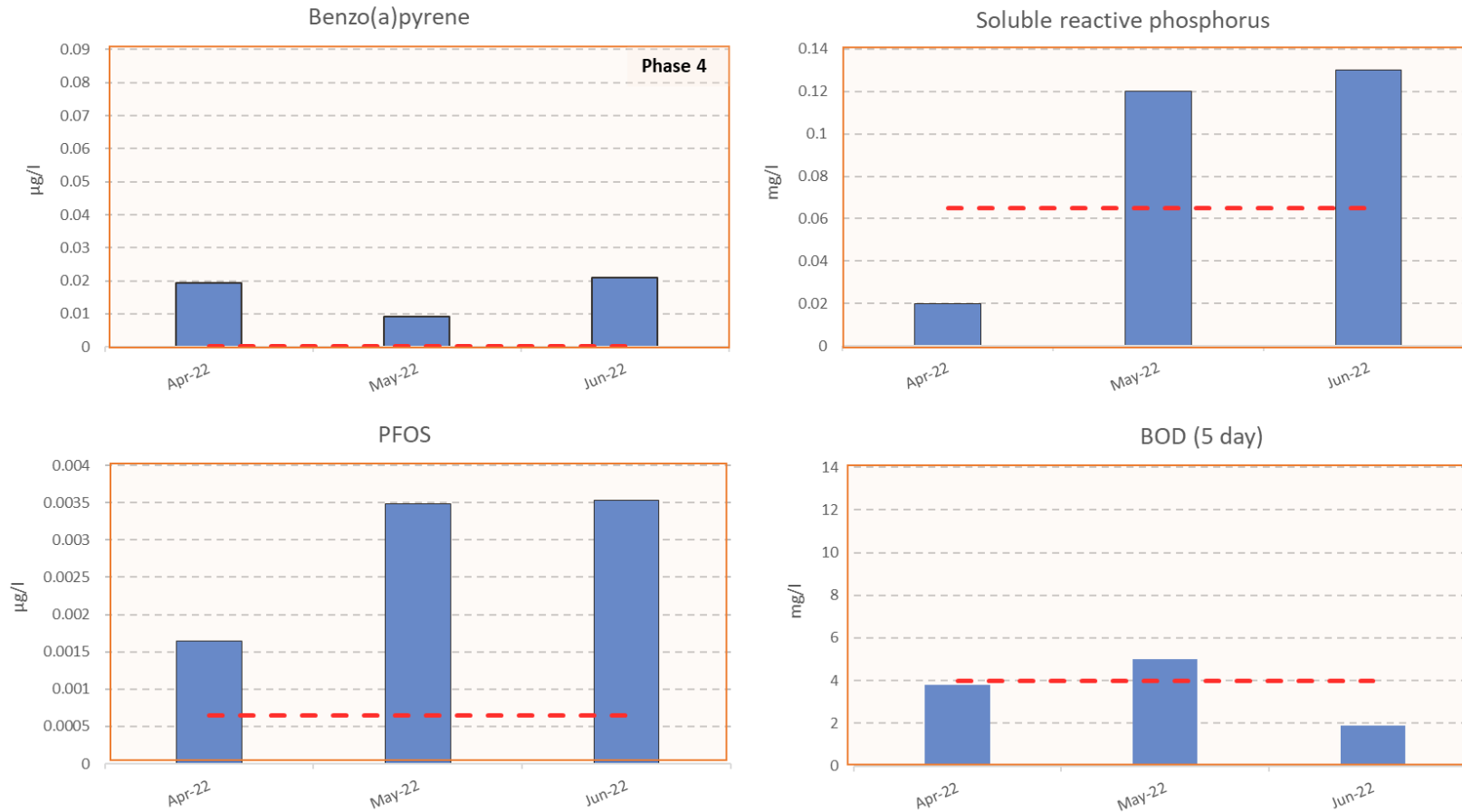


Figure 3-13 - Temporal trends in for key determinands at Site 16 GUC at Marsworth (April 2022 – June 2022).<sup>42</sup>

<sup>42</sup> Red line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Orange shading indicates Phase 3 data. Values <LoD have been plotted at the LoD. Note: a different y-axis is used for PFOS due to the range of values observed at this site.



## 3.3 Continuous Monitoring Data

In the following sections, sonde data are discussed from each continuous monitoring location in turn, comparing relative changes in parameter values with catchment conditions (i.e., rainfall), in order to make inferences regarding nutrient source areas and potential transport pathways. Typical instream responses to storm events, often responsible for the delivery of pollutant material, include a reduction in conductivity, as instream material is diluted by the receiving rainwater, and increases in the flux of suspended solids, inferred using turbidity as a proxy. The inclusion of ammonium sensors within the monitoring suites allows the differentiation of material that is potentially detrimental to aquatic ecosystems. A spike in ammonium concentration for example, may also indicate the mobilisation of not only ammonium, but associated organics that may result in environmental degradation (e.g., reducing BOD following instream mineralisation of any organic material present). It should also be noted that ammonium sensors are good at representing qualitative patterns (i.e., peaks in the data) but not at quantifying absolute values, typically over-estimating concentrations when compared with laboratory derived data. As such ammonium data are considered in conjunction with other parameters such as conductivity or turbidity for interpretation.

### 3.3.1 Site 1, Minworth WwRC

Temporal variability in the sensor data collected from Minworth WwRC final effluent can be seen in Figure 3-14 with corresponding descriptive statistics in Table 3-8. Dissolved oxygen concentrations during the monitoring period were low, ranging between 40.8% and 70.0% (mean = 54.7%) and are indicative of treated final effluent with elevated organic matter concentrations. Diurnal variability in conductivity was also observed. Conductivity represents the ability of water to conduct an electrical charge and is a general indicator of how much ionic material is in the water. This is often elevated in the discharge of treated effluent, and this can be affected by many factors including influent loading and the addition of chemicals during the treatment process.

Ammonium, Turbidity, and pH channels were added to the Minworth suite on 05/04/2022. Initial data collected between this installation date and the end of the current reporting period show a high degree of variability in these data. Spikes observed in both turbidity and ammonium do not correlate with shifts in other parameters e.g., conductivity. It is likely that this is driven by variations in influent loading and fluctuations in treatment efficacies. pH data (mean = 6.8) are relatively stable throughout the most recent monitoring period ranging between 6.6 - 7.0, this range is within expected limits.

### 3.3.2 Site 3, GUC Atherstone

This site is newly added to the monitoring suite (installed 11/05/2022).

Driven by regional differences in underlying geology and soil type, considerable differences in both pH and electrical conductivity were observed at this site when compared to the other sites with continuous monitoring. pH values are lower at this site (mean = 7.47) than those observed at Sites 6 (mean = 8.01) and 16 (mean = 8.04) reflecting the enhanced capacity for instream buffering provided by the calcareous geology in the lower reaches of the canal system. In contrast, electrical conductivity was elevated at Site 3 (mean = 1531  $\mu\text{S cm}^{-1}$ ) when compared to downstream sites (Site 6 mean = 671  $\mu\text{S cm}^{-1}$ , Site 16 mean = 538  $\mu\text{S cm}^{-1}$ ).

Increases in conductivity between the end of May and start of June correspond to local (i.e., Warwickshire County Council) school holiday times encompassing the June bank holiday (30/05/22 – 03/06/22). This short-lived ramp up in conductivity values may be the result of increased holiday traffic during this period putting excess strain on local sewerage infrastructure.

Regular spikes in turbidity (e.g., 02/06/22) that don't correlate with other monitored parameters (specifically conductivity) indicate a flow independent sediment source. Satellite imagery of this site confirms elevated boat



traffic when compared to other monitored sites. High usage of the canal network and shallow sedimented channel beds are likely to result in regular sediment resuspension and be responsible for the corresponding elevated turbidity values.

### 3.3.3 Site 6 - GUC at Grove, Leighton Buzzard

The sonde at Site 6 (Leighton Buzzard) was installed on 25/11/2021, as such these data do not span an annual cycle. Available data, seen in Figure 3-16 show clear catchment responses to both small (a) and large (b) precipitation events, with sharp increases in turbidity as sediment is mobilised from catchment sources. Sudden reductions in conductivity values are also observed in response to dilution and marginal reductions in pH following the flushing of soil horizons. When precipitation events occur in series (b), moisture falling on already saturated ground has the potential to increase pollutant transport by decreasing the proportion of subsurface flow in favour of the much more efficient overland flow pathways. This increases the distance over which pollutants may be transported. Both temperature and pH values were in line with seasonal expectations. Mean dissolved oxygen was ~90%. A steady increase in oxygen saturation was observed across the monitoring period as colder temperatures during the winter gave way to the warmer summer months. Colder temperatures impact photosynthesis–respiration diurnal dynamics which lead to reductions in both % oxygen saturation and its diurnal variability.

A series of algal blooms, that may pose a risk for abstraction, were observed between March and May 2022 (spring) with chlorophyll concentrations peaking at 147 µg/l on 03/05/22. Algal blooms occur when light becomes available and thermal stratification starts to occur, which inhibits vertical mixing and results in a high light high nutrient environment.

Two large pulses were observed in ammonium concentrations toward the end of the reporting period (25/05/22, peak concentration = 0.82 mg/l and 01/06/2022, peak concentration = 0.99 mg/l). While these correlated with the occurrence of two relatively small rainfall events, the lack of an observed dilution of instream conductivity data (as observed in Figure 3-16) suggest a localised event mobilising a bank side source of ammonium.

A sonde change on 20/01/22, evident in Figure 3-16 resulted in a sudden increase in a number of recorded determinands including dissolved oxygen, pH, chlorophyll, and ammonium. This is a common issue when reporting long-term sensor data. Sondes commonly experience “drift”, which, as discussed in section 2.3.1, is why dedicated maintenance site visits are scheduled every four to six weeks to proactively clean and calibrate the sensors and check equipment. When additional cleaning or maintenance is required, sondes are replaced.

### 3.3.4 Site 16, GUC at Marsworth

This site is newly added to the monitoring suite and was installed on 24/05/2022.

A monitoring window of three weeks is reported here for Site 16, Marsworth, and as a result, no seasonal or long-term patterns are observed. Temperature, pH, and dissolved oxygen are all within the normal range that would be expected. Oxygen super saturation (saturation above 100%) is observed with high signal amplitude. This is to be expected during the summer months in a well oxygenated system with considerable instream vegetation. Mean dissolved oxygen saturation at this site is 112%, the highest saturation of all sites monitored, and there is a large data range (minimum value = 76.1%, maximum = 185%). Chlorophyll concentrations remain low at this site, with a mean of 14.8 µg/l observed and no considerable algal bloom events recorded. In contrast to other upstream sites no obvious causation between rainfall data, instream turbidity and conductivity measurements can be inferred. This is not uncommon for a canal system where shallow waters and intensive usage for navigation result in flow independent turbidity sources.



**Table 3-8 - Mean sensor data. All data presented to 3 significant figures.**

| Determinand      | Unit     | 1. Minworth WwRC Final Effluent* | 3. GUC at Atherstone** | 6. GUC at Grove, Leighton Buzzard*** | 16. GUC at Marsworth** |
|------------------|----------|----------------------------------|------------------------|--------------------------------------|------------------------|
| Temperature      | °C       | 16.0                             | 16.3                   | 9.43                                 | 17.2                   |
| Conductivity     | µS/cm    | 796                              | 1531                   | 671                                  | 538                    |
| Dissolved Oxygen | %        | 54.7                             | 81.0                   | 91.1                                 | 112                    |
| pH               | pH units | 6.83                             | 7.47                   | 8.01                                 | 8.04                   |
| Ammonium         | mg N/l   | 2.03                             | 0.930                  | 0.431                                | 0.424                  |
| Turbidity        | NTU      | 13.9                             | 14.0                   | 20.2                                 | 5.82                   |
| Chlorophyll      | µg/l     | -                                | 13.5                   | 22.9                                 | 14.8                   |

\* Site 1 (Minworth WwRC) sonde data monitoring for conductivity, temperature, and dissolved oxygen commenced at the start of Phase 2 monitoring on 18/05/2022. Additional parameters including pH, ammonium, and turbidity were added on 05/04/2022.

\*\* Site 3 (GUC at Atherstone) and Site 16 (GUC at Marsworth) sondes were deployed on 11/05/22 and 24/05/22 respectively.

\*\*\* Site 6 (Grove, Leighton Buzzard) sonde was deployed on 25/11/21



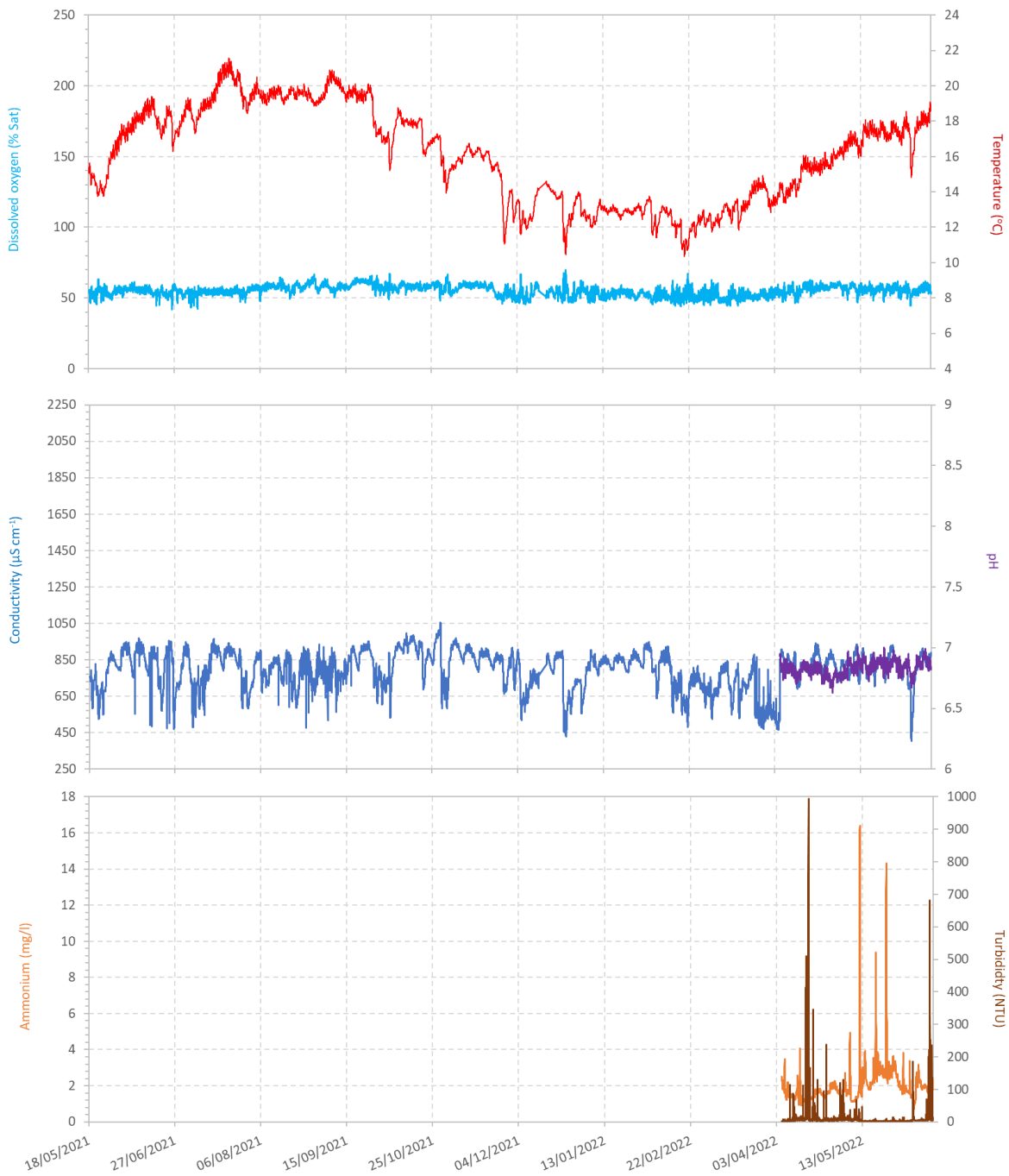


Figure 3-14 - Instream data at Site 1, Minworth WwRC Final Effluent (May 2021 – June 2022)<sup>43</sup>

<sup>43</sup> Additional channels for pH, ammonium, and turbidity were added to monitoring on 05/04/2022.



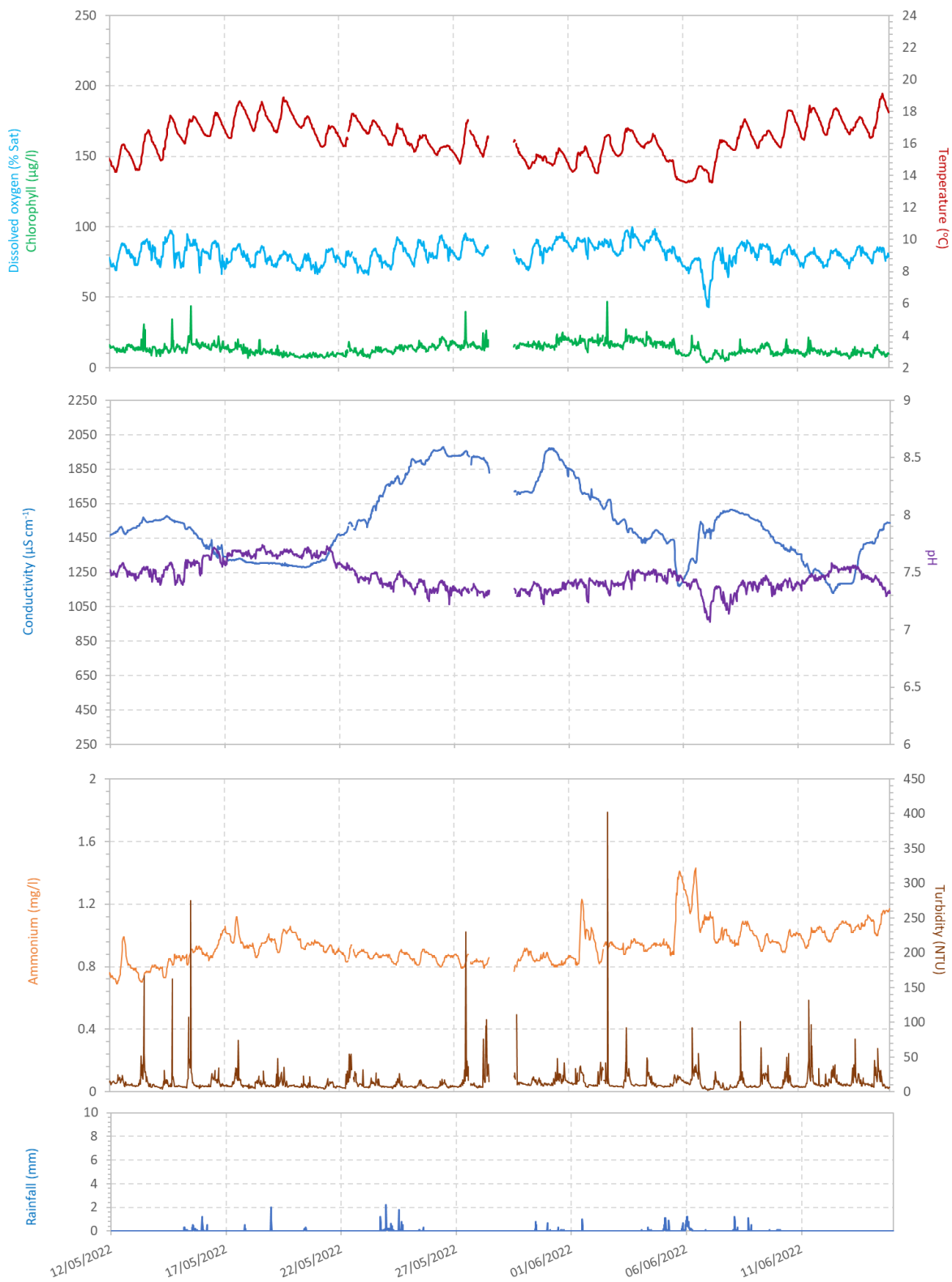
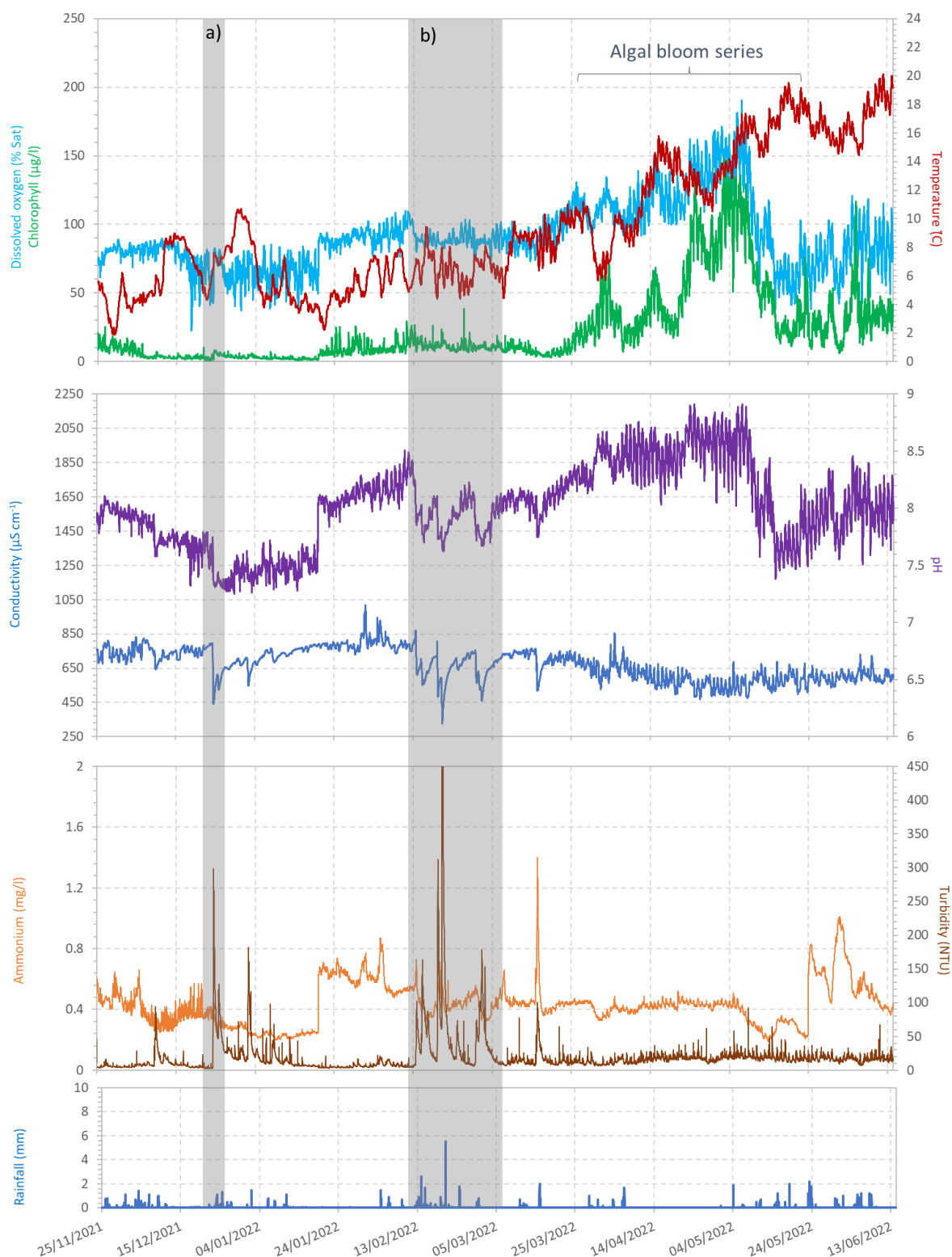


Figure 3-15 – Instream sensor data at Site 3, GUC Atherstone (May 2022 – June 2022).<sup>44</sup>

<sup>44</sup> Rainfall data source: Environment Agency (Station number: 261602TP).





**Figure 3-16 - Instream sensor data at Site 6, GUC at Grove, Leighton Buzzard (November 2021 – June 2022).**<sup>45</sup>

<sup>45</sup> Letters a and b indicate example storm event responses. Rainfall data source: Environment Agency (Station number: 261602TP)..



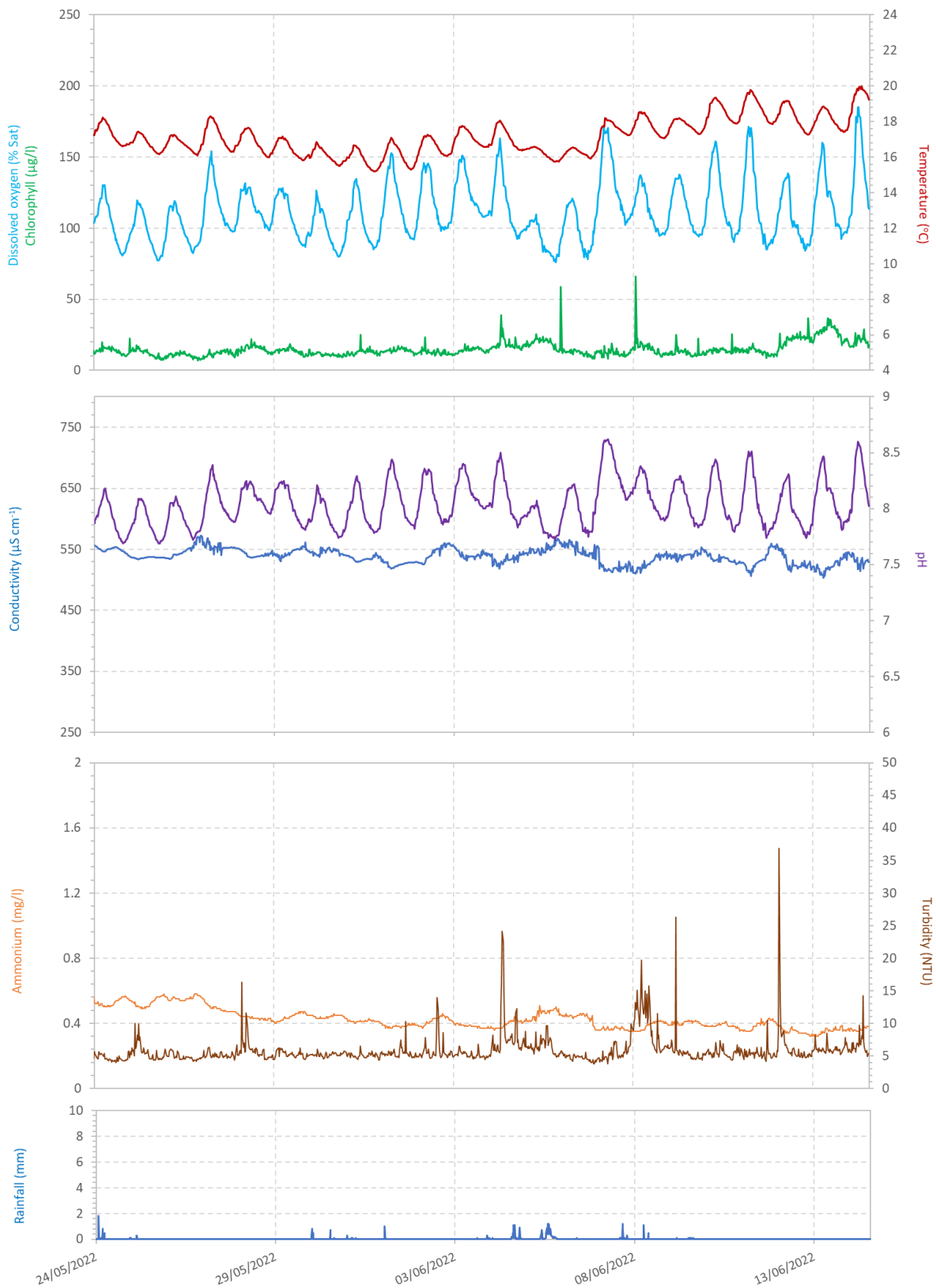


Figure 3-17 - Instream sensor data at Site 16, GUC at Marsworth (May 2022 - June 2022).<sup>46</sup>

<sup>46</sup> Rainfall data source: Environment Agency (Station number: 261602TP).



## 4. Conclusions

At present, the following determinands demonstrated the greatest number of WFD EQS exceedances on an individual sample basis:

- ANC (11 sites, a total of 86 individual occurrences)
- Benzo(a)pyrene (11 sites, a total of 109 individual occurrences)
- BOD - 5-day (8 sites, a total of 24 individual occurrences)
- Dissolved Oxygen (6 sites, a total of 21 individual occurrences)
- Fluoranthene (8 sites, a total of 68 individual occurrences)
- PFOS (11 sites, a total of 104 individual occurrences)
- SRP (7 sites, a total of 53 individual occurrences)
- Sulphide or hydrogen sulphide (10 sites, a total of 60 individual occurrences)

In addition, the following determinands exceeded WFD / EQSD MAC values:

- Sulphide or hydrogen sulphide (total individual exceedances across all sites = 60)
- Bromine - total residual oxidant (total individual exceedances across all sites = 30)
- Benzo(a)pyrene (total residual oxidant, total individual exceedances across all sites = 15)
- Nickel - dissolved (total individual exceedances across all sites = 13)
- Benzo(g,h,i)perylene (total individual exceedances across all sites = 8)
- Benzo(b)fluoranthene (total individual exceedances across all sites = 5)
- Benzo(k)fluoranthene (total individual exceedances across all sites = 2)
- Cypermethrin (total individual exceedances across all sites = 2)

Some concentrations in the Minworth WwRC effluent were greater than the EQS in the receiving water at Site 3, Coventry Canal, Atherstone (noting these standards do not directly apply to effluent and discharge standards are set through the permitting regime). These include chlorothalonil (an organic fungicide), cypermethrin (a synthetic pyrethroid), permethrin (an insecticide) and bioavailable zinc. As a result, if Minworth WwRC discharge were diverted into any of the proposed sub discharge routes without additional treatment applied, additional instream exceedances may occur, resulting in a future WFD compliance risk as the new discharge would prevent the water quality of the receiving body from achieving Good Status. Current mean bioavailable zinc concentration at Site 3 is 9.44 µg/l against a site specific EQS of 13.9 µg/l. The addition of the discharge of final effluent from Minworth may take concentrations at Site 3 closer to its EQS. Further assessment is required to determine the level of confidence if this is indeed the case (e.g., through modelling or pairwise assessment of samples once a full year of data is collected). Treatment or other removal at works will be required in order to provide a resolution to this issue.

Minworth WwRC treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of these 'high risk' compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permissibility risk (e.g., due to within class deterioration).

As discussed in Section 3.2, PCVs apply only to treated drinking water, and not raw source waters. However, the monitoring of these determinands and regular comparison with drinking water standards enables a threshold for screening out determinands that may be considerably elevated in raw water, thus helping to inform treatment design at the example abstraction location. With that in mind, the following determinands are currently routinely exceeding PCV targets at Site 6.

- Benzo(a)pyrene (total exceedances = 9)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 9)
- *Escherichia coli* (E.coli, total exceedances = 9)
- Iron - total (total exceedances = 14)



- Nitrite (total exceedances = 8)
- Turbidity (total exceedances = 9)

*C. perfringens* exceeded at all sites as it is widely distributed across the environment and as such, is regularly evaluated to monitor the microbiological safety of drinking water supplies. Sources of bacterial contamination can range from the input of animal manures from farmyard runoff to discharge from untreated or treated sewage effluent. *Cryptosporidium* was not detected at any site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores or localised disturbance events.

A water sample collected at Site 6 on 20/10/2021 captured a period of heavy rainfall resulting in a number of additional exceedances not observed during lower flow conditions. These additional exceedances included PAHs, aluminium (dissolved), and iron (dissolved). However, of particular interest were the presence of tebuconazole, an agricultural triazole fungicide used to treat plant pathogenic fungi, and metribuzin, a synthetic herbicide applied both pre- and post-emergence of vegetable crops suggesting an agricultural origin. The heavily modified, and agricultural Ledburn brook, located approximately <20 m south (upstream) of the monitoring location may be the source of these additional exceedances. Wet weather sampling captured a number of additional PCV exceedances common across abstraction locations, including nitrate and ammonium. It is recommended that AfW update their DWSP and complete a review of planned mitigation to factor in these additional determinands. Rainfall events also coincided with sampling on 14/09/21 (daily rainfall total = 9.3 mm), 07/12/21 (daily rainfall total = 5.7 mm) and 11/01/22 (daily rainfall total = 4.5 mm). Exceedances in both nitrite and iron were observed during the rainfall event that occurred on 14/09/21 with exceedances in ammonium, nitrate and colour observed following rainfall on 07/12/21. *E.coli* counts were also observed to be elevated during rainfall events.

All sensor data appear to be within ranges typical of freshwater environments. A series of large spring algal blooms, that may pose a risk for abstraction, were observed in the data at Site 6 between March and April 2022 with chlorophyll concentrations peaking at 147 µg/l. No algal blooms were observed at other continuous monitoring locations. A number of large storm events were also observed at this site, resulting in considerable increases in both turbidity and ammonium, most probably flushed from adjacent land. Regular spikes in turbidity observed at Site 3 do not correlate with rainfall or any other measures parameter, suggesting a flow independent source such as heavy boat traffic leading to sediment resuspension.

Only 3 months of continuous sonde data were available within this reporting period at Sites 3 and 16 and as such no temporal patterns can be observed. Similarly, at Site 6 regular large spikes in turbidity are also observed at Site 16 and show no correlation to other measured parameters or rainfall data.

Lastly, we continue to report on compounds that breach both EQS and PCV targets as requested by the regulatory bodies. A detailed review of substances regularly below analytical levels for Sites 1 and 6 can be seen in the Grand Union Canal Strategic Resource Option Water Quality Monitoring Gate 2 Report (Document Reference: 5204564/1.5/021). An updated analysis of determinands regularly below analytical LoD will be conducted in June 2023, when a minimum of 12 months of data will have been collected at all newly added sites.

The most recent three months of monitoring (April – June 2022) have captured a period of reduced rainfall (see Section 2.6 for discussion). To date, this reduced rainfall, and resultant reduction of instream dilution capacity, has not resulted in additional determinands exceeding AA or MAC EQS values. Any influence of the onset of drought conditions as experienced in summer 2022 will be discussed in the next report.



# APPENDICES



# Appendix A. WFD analysis suite

| Group                     | Parameter                                       | Unit  | Annual<br>average EQS | 90 <sup>th</sup><br>percentile | 95 <sup>th</sup><br>percentile | MAC | LoD         |
|---------------------------|---|-------|-----------------------|--------------------------------|--------------------------------|-----|-------------|
| <b>General parameters</b> | Dissolved oxygen*                               | mg/l  | ***                   | -                              | -                              | -   | -           |
|                           | Temperature**                                   | °C    | 28                    | -                              | -                              | -   | -           |
|                           | pH  | pH    | ***                   | -                              | -                              | -   | 0.1 pH unit |
|                           | BOD 5   | mg/l  | -                     | ***                            | -                              | -   | 1           |
|                           | Chemical oxygen demand                          | mg/l  | -                     | -                              | -                              | -   | 5           |
|                           | Reactive phosphorus                             | mg/l  | ***                   | -                              | -                              | -   | 0.01        |
|                           | Total phosphorus                                | mg/l  | -                     | -                              | -                              | -   | 0.01        |
|                           | Salinity (at 20°C)                              | µS/cm | -                     | -                              | -                              | -   | 1           |
|                           | Conductivity (at 20°C)                          | µS/cm | -                     | -                              | -                              | -   | -           |
|                           | Ammoniacal Nitrogen (as N)                      | mg/l  | ***                   | -                              | -                              | -   | 0.015       |
|                           | Ammonia (as N)                                  | mg/l  | -                     | -                              | -                              | -   | 0.1         |
|                           | Nitrate (as NO <sub>3</sub> )                   | mg/l  | -                     | -                              | -                              | -   | 0.1         |
|                           | Nitrate (as N)                                  | mg/l  | -                     | -                              | -                              | -   | calc        |
|                           | Nitrite (as NO <sub>2</sub> )                   | mg/l  | -                     | -                              | -                              | -   | 0.1         |
|                           | Nitrite (as N)                                  | mg/l  | -                     | -                              | -                              | -   | calc        |
|                           | Total nitrogen (oxidised as N)                  | mg/l  | -                     | -                              | -                              | -   | 5           |
|                           | Keldhal nitrogen                                | mg/l  | -                     | -                              | -                              | -   | 0.2         |
|                           | Organic nitrogen                                | mg/l  | -                     | -                              | -                              | -   | calc        |
|                           | Sulphide or hydrogen sulphide                   | µg/l  | 0.25                  | -                              | -                              | 1   | 10          |
|                           | Alkalinity (as CaCO <sub>3</sub> )              | mg/l  | -                     | -                              | -                              | -   | 5           |
|                           | Acid Neutralisation Capacity (ANC) (unfiltered) | mg/l  | 40                    | -                              | -                              | -   | 5           |
|                           | Hardness as (CaCO <sub>3</sub> )                | mg/l  | -                     | -                              | -                              | -   | 0.1         |
|                           | Dissolved organic carbon                        | mg/l  | -                     | -                              | -                              | -   | 0.5         |
|                           | Total organic carbon                            | mg/l  | -                     | -                              | -                              | -   | 0.5         |
|                           | Solids, Suspended (at 105°C)                    | mg/l  | -                     | -                              | -                              | -   | 2           |
|                           | Chlorophyll                                     | µg/l  | -                     | -                              | -                              | -   | 20          |
|                           | Phaeophytin                                     | µg/l  | -                     | -                              | -                              | -   | 20          |
| <b>Metals</b>             | Antimony - total                                | µg/l  | -                     | -                              | -                              | -   | 0.17        |
|                           | Antimony - dissolved                            | µg/l  | -                     | -                              | -                              | -   | 0.17        |
|                           | Aluminium - total                               | µg/l  | -                     | -                              | -                              | -   | 10          |
|                           | Aluminium - dissolved                           | µg/l  | -                     | -                              | -                              | -   | 10          |
|                           | Aluminium - reactive                            | µg/l  | -                     | -                              | -                              | -   | 4           |
|                           | Arsenic - total                                 | µg/l  | 50                    | -                              | -                              | -   | 0.16        |
|                           | Arsenic - dissolved                             | µg/l  | -                     | -                              | -                              | -   | 0.16        |
|                           | Cadmium - total                                 | µg/l  | 0.25                  | -                              | -                              | 1.5 | 0.02        |



|                             |   |      |         |      |   |       |         |
|-----------------------------|---|------|---------|------|---|-------|---------|
|                             | Cadmium - dissolved   | µg/l | 0.25    | -    | - | 1.5   | 0.02    |
|                             | Calcium - total   | mg/l | -       | -    | - | -     | 0.09    |
|                             | Copper - total  | µg/l | -       | -    | - | -     | 0.4     |
|                             | Copper - bioavailable   | µg/l | 1       | -    | - | -     | 0.4     |
|                             | Chromium - total  | µg/l | -       | -    | - | -     | 0.25    |
|                             | Chromium - dissolved  | ug/l | -       | -    | - | -     | 0.25    |
|                             | Iron - total  | µg/l | 1,000   | -    | - | -     | 5.5     |
|                             | Iron - dissolved  | µg/l | 1,000   | -    | - | -     | 5.5     |
|                             | Lead - total  | µg/l | 1.2     | -    | - | -     | 0.09    |
|                             | Lead - dissolved*   | µg/l | 1.2     | -    | - | 14    | 0.09    |
|                             | Mercury - total   | µg/l | 0.07    | -    | - | 0.07  | 0.001   |
|                             | Mercury - dissolved   | µg/l | 0.07    | -    | - | 0.07  | 0.001   |
|                             | Nickel - total  | µg/l | 4       | -    | - | -     | 0.5     |
|                             | Nickel - dissolved*   | µg/l | 4       | -    | - | 34    | 0.5     |
|                             | Zinc - total  | µg/l | -       | -    | - | -     | 0.5     |
|                             | Zinc - dissolved*   | µg/l | ***     | -    | - | -     | 0.5     |
| <b>PAH Suite</b>            | Fluoranthene  | µg/l | 0.0063  | -    | - | 0.12  | 0.0009  |
|                             | Benzo(a)pyrene  | µg/l | 0.00017 | -    | - | 0.027 | 0.00017 |
| <b>Phthalates</b>           | Di(2-ethylhexyl)-phthalate (DEHP)   | µg/l | 1.3     | -    | - | -     | 0.15    |
| <b>Other WFD parameters</b> | Brominated diphenylethers Total (sum of BDE penta congeners 28,47,99,100,153,154) | µg/l | -       | -    | - | 0.14  | 0.0005  |
|                             | BDE-28  | µg/l | -       | -    | - | -     | 0.0001  |
|                             | BDE-47  | µg/l | -       | -    | - | -     | 0.0001  |
|                             | BDE-99  | µg/l | -       | -    | - | -     | 0.0001  |
|                             | BDE-100   | µg/l | -       | -    | - | -     | 0.0001  |
|                             | BDE-153   | µg/l | -       | -    | - | -     | 0.0001  |
|                             | BDE-154   | µg/l | -       | -    | - | -     | 0.0001  |
|                             | Triclosan   | µg/l | 0.1     | 0.28 | - | -     | 0.01    |
|                             | Nonylphenols. (4-Nonylphenol Technical Mix)                                       | µg/l | 0.3     | -    | - | 2     | 0.04    |
|                             | 4-n-Nonylphenol   | µg/l | 0.3     | -    | - | 2     | 0.04    |
|                             | Nonylphenol ethoxylates (sum)   | µg/l | -       | -    | - | -     | 0.12    |
|                             | Nonylphenol monoethoxylate NPEO1  | µg/l | -       | -    | - | -     | 0.04    |
|                             | Nonylphenol diethoxylate NPEO2  | µg/l | -       | -    | - | -     | 0.04    |
|                             | Nonylphenol triethoxylate NPEO3   | µg/l | -       | -    | - | -     | 0.04    |
|                             | Octylphenols ((4-(1,1', 3,3'-tetramethylbutyl)-phenol))                           | µg/l | 0.1     | -    | - | -     | 0.01    |
|                             | Octylphenol ethoxylates (Sum OPEO 1-3)  | µg/l | -       | -    | - | -     | 0.06    |
|                             | Octylphenol monoethoxylate (OPEO1)  | µg/l | -       | -    | - | -     | 0.02    |



|                     |   |      |         |   |   |        |         |
|---------------------|---|------|---------|---|---|--------|---------|
|                     | Octylphenol diethoxylate (OPEO2)              | µg/l | -       | - | - | -      | 0.02    |
|                     | Octylphenol triethoxylate (OPEO3)             | µg/l | -       | - | - | -      | 0.02    |
|                     | Tributyltin compounds (as Tributyltin cation) | µg/l | 0.0002  | - | - | 0.0015 | 0.00002 |
|                     | Perfluorooctane sulfonic acid PFOS            | µg/l | 0.00065 | - | - | 36     | 0.00065 |
|                     | Perfluorooctanoic acid (PFOA)                 | µg/l | -       | - | - | -      | 0.00065 |
|                     | HexabromocycLoDodecane (HBCDD) Total          | µg/l | -       | - | - | -      | 0.00014 |
|                     | alpha - HexabromocycLoDodecane (α-HBCDD)      | µg/l | -       | - | - | -      | 0.00004 |
|                     | beta - HexabromocycLoDodecane (β-HBCDD)       | µg/l | -       | - | - | -      | 0.00004 |
|                     | gamma - HexabromocycLoDodecane (γ-HBCDD)      | µg/l | -       | - | - | -      | 0.00004 |
| <b>VOCs</b>         | Trichloroethylene                             | µg/l | -       | - | - | -      | 1       |
| <b>THMs</b>         | Chloroform                                    | µg/l | 2.5     | - | - | -      | 1       |
|                     | Trichloroethane (1 1 1)                       | µg/l | 100     | - | - | -      | 1       |
|                     | Trichloroethane (1 1 2)                       | µg/l | 400     | - | - | -      | 1       |
| <b>Insecticides</b> | Cypermethrin                                  | µg/l | 0.00008 | - | - | 0.0006 | 0.00008 |

\*Dissolved oxygen EQS refers to a 10<sup>th</sup> percentile.

\*\*Temperature EQS refers to a 98<sup>th</sup> percentile.

\*\*\*It is noted that some WFD EQS are different for different river types (e.g. upland, lowland, salmonid, cyprinid). Each SRO assessment will use different EQS depending on the local context, see

Table 3-2 for further detail.

+EQS refers to bioavailable concentration.

Red numbers indicate where LoD>EQS.



## Appendix B. EQSD analysis suite

| Parameter                              | Unit | Annual average EQS | 90th percentile | 95th percentile | MAC  | RL <sup>47</sup> |
|--|------|--------------------|-----------------|-----------------|------|------------------|
| 1,1,1-trichloroethane                  | µg/l | 100                | -               | -               | -    | 1                |
| 1,1,2-trichloroethane                  | µg/l | 400                | -               | -               | -    | 1                |
| 2,4-dichlorophenol                     | µg/l | 4.2                | -               | -               | 140  | 0.02             |
| 2,4-dichlorophenoxyacetic acid (2,4-D) | µg/l | 0.3                | -               | 1.3             | -    | 0.02             |
| 2-chlorophenol                         | µg/l | 50                 | -               | -               | -    | 0.02             |
| 3,4-dichloroaniline                    | µg/l | 0.2                | -               | 5.4             | -    | 1                |
| 4-chloro-3-methylphenol                | µg/l | 40                 | -               | -               | -    | 0.02             |
| Abamectin                              | µg/l | 0.01               | -               | -               | 0.03 | 5                |
| Ammonia (un-ionised)                   | µg/l | -                  | -               | -               | -    | 0.1              |
| Arsenic - dissolved                    | µg/l | 50                 | -               | -               | -    | 0.16             |
| Azinphos-methyl - dissolved            | µg/l | 0.01               | -               | -               | -    | 0.01             |
| Bentazone                              | µg/l | 500                | -               | -               | -    | 0.02             |
| Benzyl butyl phthalate                 | µg/l | 7.5                | -               | 51              | -    | 0.2              |
| Biphenyl                               | µg/l | 25                 | -               | -               | -    | 0.02             |
| Boron - total                          | µg/l | 2,000              | -               | -               | -    | 12               |
| Bromine - total residual oxidant       | mg/l | 0.002              | -               | -               | 5    | 1                |
| Bromoxynil                             | µg/l | 100                | -               | -               | 1000 | 0.02             |
| Carbendazim                            | µg/l | 0.15               | -               | -               | 0.7  | 0.1              |
| Chloride                               | µg/l | 250,000            | -               | -               | -    | 0.1              |
| Chlorine - total residual oxidant      | µg/l | 2                  | -               | -               | 5    | 0.1              |
| Chloronitro toluenes                   | µg/l | 10                 | -               | -               | -    | 0.02             |
| Chlorothalonil                         | µg/l | 0.035              | -               | -               | 1.2  | 0.035            |
| Chlorotoluron                          | µg/l | 2                  | -               | -               | 20   | 0.05             |
| Chlorpropham                           | µg/l | 10                 | -               | -               | 40   | 0.1              |
| Chromium (III) - dissolved             | µg/l | 4.7                | -               | 32              | -    | 0.25             |
| Chromium (VI) - dissolved              | µg/l | 3.4                | -               | -               | -    | 7                |

<sup>47</sup> Instrumental LoD may be lower but Reporting Limit (RL) is set by validation in real matrix based on 11 batches in duplicate and calculated as per MCERTS water definition.



|  |      |         |   |       |        |         |
|--|------|---------|---|-------|--------|---------|
| Cobalt - dissolved                                 | µg/l | 3       | - | -     | 100    | 0.16    |
| Copper - dissolved*                                | µg/l | 1       | - | -     | -      | 0.4     |
| Coumaphos  | µg/l | 0.03    | - | -     | 0.1    | 0.02    |
| Cyanide - total                                    | µg/l | 1       | - | -     | -      | 40      |
| Cyfluthrin   | µg/l | 0.001   | - | 0.001 | -      | 0.1     |
| Cypermethrin                                       | µg/l | 0.00008 | - | -     | 0.0006 | 0.00008 |
| Demetons   | µg/l | 0.5     | - | -     | -      | 0.02    |
| Diazinon (sheep dip)                               | µg/l | 0.01    | - | 0.02  | -      | 0.01    |
| Dibutyl phthalate                                  | µg/l | 8       | - | -     | 40     | 0.02    |
| Dichlorobenzene - total<br>dichlorobenzene isomers | µg/l | 20      | - | -     | 200    | 0.1     |
| Dichlorvos   | µg/l | 0.0006  | - | -     | 0.0007 | 0.01    |
| Diethyl phthalate                                  | µg/l | 200     | - | -     | 1000   | 0.02    |
| Diflubenzuron                                      | µg/l | 0.001   | - | -     | 0.015  | 0.001   |
| Dimethoate   | µg/l | 0.48    | - | 4     | -      | 0.02    |
| Dimethyl phthalate                                 | µg/l | 800     | - | -     | 4000   | 0.02    |
| Diocetyl phthalate                                 | µg/l | 20      | - | -     | 40     | 0.02    |
| Doramectin   | µg/l | 0.001   | - | -     | 0.01   | 5       |
| EDTA   | µg/l | 400     | - | -     | 4000   | 100     |
| Fenchlorphos                                       | µg/l | 0.03    | - | -     | 0.1    | 0.02    |
| Fenitrothion                                       | µg/l | 0.01    | - | -     | -      | 0.01    |
| Flucofuron   | µg/l | -       | - | 1     | -      | 0.05    |
| Fluoride – dissolved <50mg/l<br>CaCO3              | µg/l | 1000    | - | -     | -      | 10      |
| Fluoride - dissolved >50mg/l<br>CaCO3              | µg/l | 5000    | - | -     | 15,000 | 10      |
| Formaldehyde                                       | µg/l | 5       | - | -     | 50     | 50      |
| Glyphosate   | µg/l | 196     | - | 398   | -      | 0.1     |
| Hydrogen sulphide                                  | µg/l | 0.25    | - | -     | -      | 10      |
| Ioxynil  | µg/l | 10      | - | -     | 100    | 0.02    |
| Iron - dissolved                                   | µg/l | 1,000   | - | -     | -      | 5.5     |
| Ivermectin   | µg/l | 0.0001  | - | -     | 0.001  | 5       |
| Linuron  | µg/l | 0.5     | - | 0.9   | -      | 0.01    |
| Malachite green                                    | µg/l | 0.5     | - | -     | 100    | 1       |
| Malathion  | µg/l | 0.01    | - | -     | -      | 0.02    |
| Mancozeb   | µg/l | 2       | - | -     | 20     | 0.1     |



|  |             |         |   |      |        |       |
|--|-------------|---------|---|------|--------|-------|
| Maneb  | µg/l        | 3       | - | -    | 30     | 0.1   |
| Manganese - dissolved*   | µg/l        | 123     | - | -    | -      | 0.22  |
| MCPA pH <7   | µg/l        | 12      | - | -    | 80     | 0.02  |
| MCPA pH >7   | µg/l        | 80      | - | -    | 100    | 0.02  |
| Mecoprop   | µg/l        | 18      | - | 187  | -      | 0.02  |
| Methiocarb   | µg/l        | 0.01    | - | 0.77 | -      | 0.1   |
| Mevinphos  | µg/l        | -       | - | -    | 0.02   | 0.02  |
| Nitrilotriacetic acid (NTA)  | µg/l        | 1,000   | - | -    | 10,000 | 100   |
| Omethoate  | µg/l        | 0.01    | - | -    | -      | 0.01  |
| PCSDs (polychloro<br>chloromethyl sulphonamido<br>diphenyl ethers) | µg/l        | -       | - | -    | -      | 0.2   |
| Pendimethalin  | µg/l        | 0.3     | - | 0.58 | -      | 0.02  |
| Permethrin   | µg/l        | 0.01    | - | 0.01 | -      | 0.001 |
| pH   | pH<br>units | 6 to 9  | - | -    | -      | 0.01  |
| Phenol   | µg/l        | 7.7     | - | 46   | -      | 1     |
| Pirimicarb   | µg/l        | 1       | - | -    | 5      | 0.1   |
| Pirimiphos-methyl  | µg/l        | 0.015   | - | -    | 0.05   | 0.01  |
| Prochloraz   | µg/l        | 4       | - | -    | 40     | 0.1   |
| Propetamphos   | µg/l        | 0.03    | - | -    | 0.1    | 0.02  |
| Propyzamide  | µg/l        | 100     | - | -    | 1000   | 0.01  |
| Silver - dissolved   | µg/l        | 0.05    | - | -    | 0.1    | 1     |
| Styrene  | µg/l        | 50      | - | -    | 500    | 0.1   |
| Sulcofuron   | µg/l        | -       | - | 25   | -      | 0.05  |
| Sulphate   | µg/l        | 400,000 | - | -    | -      | 0.1   |
| Tecnazene - total  | µg/l        | 1       | - | -    | 10     | 0.02  |
| Tetrachloroethane  | µg/l        | 140     | - | 1848 | -      | 0.1   |
| Thiabendazole  | µg/l        | 5       | - | -    | 50     | 0.1   |
| Tin (inorganic) - total  | µg/l        | 25      | - | -    | -      | 0.4   |
| Toluene  | µg/l        | 74      | - | 380  | -      | 0.1   |
| Total anions   | µg/l        | 250,000 | - | -    | -      | <1000 |
| Triallate  | µg/l        | 0.25    | - | -    | 5      | 0.02  |
| Triazaphos   | µg/l        | 0.005   | - | -    | -      | 0.02  |
| Tributyl phosphate   | µg/l        | 50      | - | -    | 500    | 0.02  |
| Triclosan  | µg/l        | 0.1     | - | 0.28 | -      | 0.01  |



|                              |      |    |   |   |      |       |
|------------------------------|------|----|---|---|------|-------|
| Triphenyltin and derivatives | µg/l | -  | - | - | 0.02 | 0.002 |
| Vanadium <200mg/l CaCO3      | µg/l | 20 | - | - | -    | 0.6   |
| Vanadium >200mg/l CaCO3      | µg/l | 60 | - | - | -    | 0.6   |
| Xylene                       | µg/l | 30 | - | - | -    | 1     |
| Zinc - dissolved*            | µg/l | ** | - | - | -    | 0.5   |

\*EQS refers to bioavailable concentration.

\*\*It is noted that some WFD EQS are different for different river types (e.g. upland, lowland, salmonid, cyprinid). Each SRO assessment will use different EQS depending on the local context, see

Table 3-2 for further detail.

Red numbers indicate where LOD>EQS.



## Appendix C. Drinking water analysis suites

| Parameter <sup>48</sup>                                 | Unit  | PCV  | Source <sup>49, 50</sup>                  | LoD    |
|---|-------|------|---|--------|
| 1, 2, 3-Benzotriazole                                   | µg/l  | -    |   | 0.1    |
| 1,4-Dioxane   | µg/l  | -    |   | 1      |
| 1, 2 Dibromoethane                                      | µg/l  | -    |   | 1      |
| 17β Oestradiol  | µg/l  | -    |   | 0.0003 |
| 1H-Benzotriazole, 4 (or 5)-methyl                       | µg/l  | -    |   | 0.1    |
| 2 3 6-TBA   | µg/l  | -    |   | 0.02   |
| 2 4 5-T   | µg/l  | -    |   | 0.02   |
| 2 4-D   | µg/l  | -    |   | 0.02   |
| 2 4-DB  | µg/l  | -    |   | 0.02   |
| 2 EDD   | µg/l  | -    |   | 0.1    |
| 2 EMD   | µg/l  | -    |   | 0.1    |
| 2-(2-Butoxyethoxy) ethanol (DEGBE)                      | mg/l  | -    |   | 10     |
| 22C PC Neat (plate count)                               | µg/l  | -    |   | 300    |
| 2-Methylphenol  | µg/l  | -    |   | 0.02   |
| 2-Methylisoborneol (MIB)                                | ng/l  | -    |   | -      |
| 37C PC Neat (plate count)                               | No/ml | -    |   | 300    |
| 3-Methylphenol  | µg/l  | -    |   | 0.02   |
| 4-Methylphenol  | µg/l  | -    |   | 0.02   |
| Acrylamide  | µg/l  | 0.1  | Water Supply Regulations 2016, schedule 1 | 0.1    |
| Adenovirus  | -     | -    |   | -      |
| Aldrin  | µg/l  | 0.03 | Drinking Water Directive, 2021            | 0.02   |
| Algae cell count  | No/ml | -    |   | -      |
| Algal speciation (diatoms/blue-green cyanobacteria etc) | -     | -    |   | -      |
| Alkalinity AS CaCO <sub>3</sub>                         | mg/l  | -    |   | 5      |
| Alkalinity as HCO <sub>3</sub>                          | mg/l  | -    |   | -      |
| Alpha activity - total                                  | Bq/l  | -    |   | 0.02   |

<sup>49</sup> <https://www.legislation.gov.uk/uksi/2016/614/schedule/1>

<sup>50</sup> <https://www.legislation.gov.uk/uksi/2016/614/schedule/2>



|  |           |      |   |         |
|--|-----------|------|---|---------|
| Aluminium - total and dissolved              | µg/l      | 200  | Water Supply Regulations 2016, Schedule 1                                 | 10      |
| Ametryne                                     | µg/l      | 0.1  | Water Supply Regulations 2016, Schedule 1                                 | 0.02    |
| Amino tris(methylene phosphonic acid) (ATMP) | µg/l      | -    |   | 1       |
| Ammoniacal nitrogen                          | mg/l      | -    |   | 0.015   |
| Ammonium as NH4                              | mg/l      | 0.5  | Water Supply Regulations 2016, Schedule 2                                 | 0.02    |
| Antimony - total and dissolved               | µg Sb/l   | 5    | Water Supply Regulations 2016, Schedule 1                                 | 0.017   |
| Arsenic - total and dissolved                | µg/l      | 10   | Water Supply Regulations 2016, Schedule 1                                 | 0.16    |
| Atrazine                                     | µg/l      | 0.1  | Water Supply Regulations 2016, Schedule 1                                 | 0.02    |
| Azoxystrobin                                 | µg/l      | -    |   | 0.05    |
| Barium - total and dissolved                 | µg/l      | -    |   | -       |
| Benazolin                                    | µg/l      | -    |   | 0.02    |
| Bentazone                                    | µg/l      | -    |   | 0.02    |
| Benzene                                      | µg/l      | 1    | Water Supply Regulations 2016, Schedule 1                                 | 0.1     |
| Benzo(a)pyrene                               | µg/l      | 0.01 | Water Supply Regulations 2016, Schedule 1                                 | 0.00017 |
| Benzo(b)fluoranthene                         | µg/l      | -    |   | -       |
| Benzo(k)fluoranthene                         | µg/l      | -    |   | -       |
| Benzo(g,h,i)perylene                         | µg/l      | -    |   | -       |
| Beryllium - total and dissolved              | µg/l      | -    |   | 0.1     |
| Beta - estradiol                             | µg/l      | -    | Added to the Drinking Water Directive watch list- no regulatory value yet | 0.0003  |
| Beta activity - total                        | Bq/l      | -    |   | -       |
| Bisphenol A                                  | µg/l      | 2.5  | Drinking Water Directive, 2021  | 10      |
| BOD  | mg/l      | -    |   | 1       |
| Boron - total and dissolved                  | µg/l-B    | 1000 | Water Supply Regulations 2016, Schedule 1                                 | 12      |
| Boscalid                                     | µg/l      | 0.1  | Water Supply Regulations 2016, Schedule 1                                 | 0.1     |
| Bromate                                      | µg BrO3/l | 10   | Water Supply Regulations 2016, Schedule 1                                 | 2       |
| Bromide                                      | mg/l      | -    |   | 0.1     |
| Bromodichloromethane                         | µg/l      | 60   |   | 1       |
| Bromoform                                    | µg/l      | 100  |   | 1       |
| Bromoxynil                                   | µg/l      | 0.1  | Water Supply Regulations 2016, Schedule 1                                 | 0.02    |
| Cadmium - total and dissolved                | µg Cd/l   | 5    | Water Supply Regulations 2016, Schedule 1                                 | 0.02    |



|  |            |       |   |      |
|--|------------|-------|---|------|
| Calcium - total and dissolved          | mg/l       | -     |   | 0.09 |
| Carbendazim                            | µg/l       | 0.1   | Water Supply Regulations 2016, Schedule 1     | 0.1  |
| Carbetamide                            | µg/l       | 0.1   | Water Supply Regulations 2016, Schedule 1     | 0.01 |
| Carbon tetrachloride                   | µg/l       | -     |   | 1    |
| Carbon, dissolved organic              | mg/l       | -     |   | 2    |
| Carbon, total organic                  | mg/l       | -     |   | 1    |
| Carbophenothion                        | µg/l       | 0.1   | Water Supply Regulations 2016, Schedule 1     | 0.02 |
| Chemical oxygen demand                 | mg/l       | -     |   | 10   |
| Chlorate                               | mg/l       | 0.25  | Drinking Water Directive, 2021                | 0.7  |
| Chlordane                              | µg/l       | -     |   | 0.02 |
| Chloride (as Cl)                       | mg/l       | 250   | Water Supply Regulations 2016, Schedule 2     | -    |
| Chlorite                               | mg/l       | 0.25  | Drinking Water Directive, 2021                | 3    |
| Chloroform                             | µg/l       | -     |   | 1    |
| Chloromethylphenol (4, 3)              | -          | -     |   | -    |
| Chlorophenol (2)                       | µg/l       | -     |   | 0.02 |
| Chlorophenol (4)                       | µg/l       | -     |   | 0.02 |
| Chlorophyll                            | µg/l       | -     |   | 20   |
| Chlortoluron                           | µg/l       | 0.1   | Water Supply Regulations 2016, Schedule 1     | -    |
| Chromium - total and dissolved         | µg/l       | 50    | Water Supply Regulations 2016, Schedule 1     | 0.25 |
| Cl. Perfringens-veg & spores confirmed | No/100ml   | 0     | Drinking Water Directive, 2021                | -    |
| Clopyralid                             | µg/l       | 0.1   | Water Supply Regulations 2016, Schedule 1     | 0.02 |
| Clostridium perfringens                | No/100ml   | 0     | Water Supply Regulations 2016, Schedule 2     | -    |
| Cobalt - total and dissolved           | µg/l       | -     |   | 0.16 |
| Cocamidopropyl betaine (CAPB)          | -          | -     |   | 1    |
| Coliform - total                       | No/100ml   | 0     | Water Supply Regulations 2016, Schedule 1 & 2 | -    |
| Colour                                 | mg/l Pt/Co | 20    | Water Supply Regulations 2016, Schedule 1     | 1    |
| Conductivity (at 20°C)                 | µS/cm-1    | 2,500 | Water Supply Regulations 2016, Schedule 2     | -    |
| Copper - total and dissolved           | µg/l       | 2,000 | Water Supply Regulations 2016, Schedule 1     | 0.4  |
| Cryptosporidium                        | µg/l       | -     |   | -    |
| Cyanazine                              | µg/l       | -     |   | 0.02 |



|  |          |      |   |        |
|--|----------|------|---|--------|
| Cyanide Total  | µg/l     | 50   | Water Supply Regulations 2016, Schedule 1 | 40     |
| Dalapon  | µg/l     | -    |   | 0.02   |
| DDE PP'  | µg/l     | -    |   | 0.02   |
| DDT OP'  | -        | -    |   | -      |
| DDT PP'  | µg/l     | -    |   | 0.025  |
| Desethyl Atrazine  | µg/l     | -    |   | 0.02   |
| DHC Benzene  | µg/l     | -    |   | 0.1    |
| DHC Cumene   | µg/l     | -    |   | 0.0025 |
| DHC Decane   | µg/l     | -    |   | 0.1    |
| DHC Ethyl benzene  | µg/l     | -    |   | 0.1    |
| DHC Heptane  | µg/l     | -    |   | 0.1    |
| DHC Octane   | µg/l     | -    |   | 0.1    |
| DHC Phenanthracene   | µg/l     | -    |   | -      |
| DHC Tetradecane  | µg/l     | -    |   | 0.1    |
| DHC Toluene  | µg/l     | -    |   | 0.1    |
| Diazinon   | µg/l     | -    |   | 0.01   |
| Dibromochloromethane   | µg/l     | -    |   | 1      |
| Dicamba  | µg/l     | -    |   | 0.02   |
| Dichlobenil  | µg/l     | -    |   | 0.02   |
| Dichloprop   | µg/l     | -    |   | 0.02   |
| Dichloroethane (1, 2)  | µg/l     | 3    | Water Supply Regulations 2016, Schedule 1 | 1      |
| Dichlorophenol (2, 4)  | µg/l     | -    |   | 1      |
| Dieldrin   | µg/l     | 0.03 | Drinking Water Directive, 2021            | 0.02   |
| Diethylenetriamine penta (methylene phosphonic acid) (DTPMP) | µg/l     | -    |   | 1      |
| Diflufenican   | µg/l     | -    |   | 0.1    |
| Dimethylphenol (2, 4)  | µg/l     | -    |   | 0.02   |
| Dimethylphenol (2, 5)  | µg/l     | -    |   | 0.02   |
| Dimethylphenol (3, 5)  | µg/l     | -    |   | 0.02   |
| Dissolved oxygen (on Site)                                   | %        | -    |   | -      |
| Diuron   | µg/l     | -    |   | 0.05   |
| E.coli   | No/100ml | 0    | Water Supply Regulations 2016, Schedule 1 | -      |
| Endosulfan A   | µg/l     | -    |   | 0.02   |
| Endrin   | µg/l     | -    |   | 0.02   |
| Enterococci confirmed  | No/100ml | 0    | Water Supply Regulations 2016, Schedule 1 | -      |



|  |      |      |   |        |
|--|------|------|---|--------|
| Enterovirus                              | -    | -    |   | -      |
| Epichlorohydrin                          | µg/l | 0.1  | Water Supply Regulations 2016, Schedule   | 0.1    |
| Ethofumesate                             | µg/l | -    |   | 0.05   |
| Ethylbenzene                             | µg/l | -    |   | 1      |
| Fenoprop                                 | µg/l | -    |   | 0.02   |
| Flufenacet                               | µg/l | -    |   | 0.02   |
| Fluoranthene                             | µg/l | -    |   | 0.0009 |
| Fluoride                                 | mg/l | 1.5  | Water Supply Regulations 2016, Schedule 1 | -      |
| Fluoroanthene                            | µg/l | -    |   | 0.0009 |
| Fluroxypyr                               | µg/l | -    |   | 0.02   |
| Geosmin                                  | ng/l | -    |   | -      |
| Giardia                                  | No/l | -    |   | -      |
| Glyphosate                               | µg/l | -    |   | 0.1    |
| Haloacetic Acids (HAAs)                  | µg/l | 60   | Drinking Water Directive, 2021            | -      |
| Hardness - total (as Ca)                 | mg/l | -    |   | 0.1    |
| Hardness - total (as CaCO <sub>3</sub> ) | mg/l | -    |   | -      |
| HCH Alpha                                | µg/l | -    |   | 0.02   |
| HCH Beta                                 | µg/l | -    |   | 0.02   |
| HCH Delta                                | µg/l | -    |   | 0.02   |
| HCH Gamma                                | µg/l | -    |   | 0.02   |
| Heptachlor                               | µg/l | 0.03 | Drinking Water Directive, 2021            | 0.001  |
| Heptachlor epoxide                       | µg/l | 0.03 | Drinking Water Directive, 2021            | 0.001  |
| Hexachlorobenzene                        | µg/l | -    |   | 0.02   |
| Indeno(1,2,3-cd)pyrene                   | µg/l | -    |   | -      |
| loxynil                                  | µg/l | -    |   | 0.02   |
| Iron - total and dissolved               | µg/l | 200  | Water Supply Regulations 2016, Schedule 1 | 5.5    |
| Isodrin                                  | µg/l | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.02   |
| Isoproturon                              | µg/l | -    |   | 0.002  |
| Lead - total and dissolved               | µg/l | 10   | Water Supply Regulations 2016             | 0.09   |
| Linear alkylbenzene sulphonate (LAS)     | µg/l | -    |   | 0.1    |
| Linuron                                  | µg/l | -    |   | 0.01   |
| Magnesium - total and dissolved          | mg/l | -    |   | -      |
| Malathion                                | µg/l | -    |   | 0.02   |



|                                       |        |      |   |      |
|---------------------------------------|--------|------|---|------|
| Manganese - total and dissolved       | µg/l   | 50   | Water Supply Regulations 2016, Schedule 1 | -    |
| MCPA                                  | µg/l   | -    |   | 0.02 |
| MCPB                                  | µg/l   | -    |   | 0.02 |
| Mecoprop                              | µg/l   | -    |   | 0.02 |
| Mercury - total and dissolved         | µg/l   | 0.07 | Water Supply Regulations 2016, Schedule 1 | 1    |
| Meta & Para-xylene                    | µg/l   | -    |   | 0.1  |
| Metaldehyde                           | µg/l   | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.02 |
| Metamitron                            | µg/l   | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.02 |
| Metazachlor                           | µg/l   | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.1  |
| Methoxychlor                          | µg/l   | -    |   | 0.02 |
| Methyl tertiary amyl ether            | µg/l   | -    |   | -    |
| Metribuzin                            | µg/l   | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.05 |
| Microcystin-LR (algal toxin)          | µg/l   | 1    | Drinking Water Directive, 2021            | 5    |
| Molybdenum - total and dissolved      | µg/l   | -    |   | 1.1  |
| Monuron                               | µg/l   | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.05 |
| MTBE                                  | µg/l   | -    |   | 1    |
| Nickel - total and dissolved          | µg/l   | 20   | Water Supply Regulations 2016, Schedule 1 | 0.5  |
| Nitrate as N                          | µg/l   | 11.4 | Water Supply Regulations 2016, Schedule 1 | -    |
| Nitrate as NO3                        | mg/l   | 50   | Water Supply Regulations 2016, Schedule 1 | -    |
| Nitrite & nitrate (calculation)       | mg/l   | -    |   | -    |
| Nitrite as N                          | mg/l   | -    |   | -    |
| Nitrite as NO2                        | mg/l   | 0.5  | Water Supply Regulations 2016, Schedule 1 | -    |
| Nitrosamines                          | -      | -    |   | -    |
| N-Nitrosodimethylamine (NDMA)         | µg/l   | -    |   | 0.1  |
| Non coliforms                         | -      | -    |   | -    |
| Nonylphenol                           | µg/l   | -    |   | 0.04 |
| Number of crypto like bodies (4-6 µm) | /10l   | -    |   | -    |
| Odour                                 | -      | -    |   | -    |
| Oocyst Count                          | Number | -    |   | -    |
| Ortho-xylene                          | µg/l   | -    |   | 1    |
| Oxadixyl                              | µg/l   | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.05 |
| Oxamyl                                | µg/l   | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.05 |



|                                     |          |         |  |         |
|-------------------------------------|----------|---------|--|---------|
| O-xylene                            | µg/l     | -       |  | 0.1     |
| P soluble reactive                  | mg/l     | -       |  | 0.01    |
| PAH (total of 4 in new reg 200)     | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.05    |
| PAH                                 | µg/l     | 0.1     | Drinking Water Directive, 2021             | 0.05    |
| Parathion                           | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.02    |
| Particulate Organic Carbon          | mg/l     | -       |  | 2       |
| PCP (phenols method)                | µg/l     | -       |  | -       |
| Pendimethalin                       | µg/l     | -       |  | 0.02    |
| Pentachlorophenol                   | µg/l     | -       |  | 0.02    |
| Perfluorooctane sulfonate (PFOS)    | µg/l     | -       |  | 0.00065 |
| Perfluorooctanoic acid (PFOA)       | µg/l     | -       |  | 0.005   |
| Pesticides - total                  | µg/l     | 0.5     | Water Supply Regulations 2016, Schedule 1. | 0.1     |
| PFAS - total                        | µg/l     | 0.5     | Drinking Water Directive, 2021             | -       |
| pH value                            | pH units | 6.5-9.5 | Water Supply Regulations 2016, Schedule 2  | 0.1     |
| Phenol                              | µg/l     | -       |  | 1       |
| Phenols - total                     | µg/l     | -       |  | 1       |
| Phosphorus - total inorganic (as P) | mg/l     | -       |  | 0.01    |
| Picloram                            | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.02    |
| Potassium - total and dissolved     | mg/l     | -       |  | 0.08    |
| Prometryn                           | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | -       |
| Propazine                           | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.02    |
| Propetamphos                        | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.02    |
| Propyzamide                         | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.01    |
| Pseudomonas (confirmed)             | No/100ml | -       |  | 100     |
| Quinmerac                           | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | -       |
| Radon                               | Bq/l     | -       |  | 10      |
| Selenium - total and dissolved      | µg/l     | 10      | Water Supply Regulations 2016, Schedule 1  | 0.25    |
| Silica reactive (SiO2)              | mg/l     | -       |  | -       |
| Silver - total and dissolved        | µg/l     | -       |  | 1       |
| Simazine                            | µg/l     | 2       |  | 0.02    |



|                                 |      |     |   |         |
|---------------------------------|------|-----|---|---------|
| Sodium - total and dissolved    | mg/l | 200 | Water Supply Regulations 2016, Schedule 1 | -       |
| Solids, suspended (105°C)       | mg/l | -   |   | 5       |
| Somatic coliphages              | -    | -   |   | -       |
| Specific abs (254 nm)           | abs  | -   |   | -       |
| Strontium - total and dissolved | mg/l | -   |   | 0.4     |
| Sulphate as SO4                 | mg/l | 250 | Water Supply Regulations 2016, Schedule 2 | -       |
| Sulphide                        | µg/l | -   |   | 10      |
| TDE OP'                         | -    | -   |   | -       |
| TDE PP'                         | -    | -   |   | -       |
| Tebuconazole                    | µg/l | 0.1 | Water Supply Regulations 2016, Schedule 1 | 0.1     |
| Tebuthiuron                     | µg/l | 0.1 | Water Supply Regulations 2016, Schedule 1 | 0.1     |
| Tecnazine                       | µg/l | 0.1 | Water Supply Regulations 2016, Schedule 1 | -       |
| Temp (on Site)                  | °C   | -   |   | -       |
| Terbutryn                       | µg/l | 0.1 | Water Supply Regulations 2016, Schedule 1 | 0.02    |
| Tetra & trichloroethane (total) | µg/l | 10  | Water Supply Regulations 2016, Schedule 1 | 1       |
| Tetrachloroethene               | µg/l | 40  |   | 1       |
| THM (total)                     | µg/l | 100 | Water Supply Regulations 2016, Schedule 1 | 4       |
| Tin - total and dissolved       | µg/l | -   |   | 0.4     |
| Titanium - total and dissolved  | µg/l | -   |   | 0.3     |
| Toluene                         | -    | -   |   | 1       |
| Total dissolved solids (TDS)    | mg/l | -   |   | -       |
| Total dry solids (at 180°C)     | mg/l | -   |   | -       |
| Total oxidised nitrogen         | mg/l | -   |   | -       |
| Transmission (at 254 nm)        | %    | -   |   | -       |
| Tributyltin compounds (TBT)     | µg/l | -   |   | 0.00003 |
| Trichloroethane (1, 1, 1)       | µg/l | -   |   | -       |
| Trichloroethene                 | -    | -   |   | 1       |
| Trichlorophenol (2, 4, 5)       | µg/l | -   |   | -       |
| Trichlorophenol (2, 4, 6)       | µg/l | 200 | Water Supply Regulations 2016, Schedule 1 | -       |
| Tricopyr                        | µg/l | 0.1 | Water Supply Regulations 2016, Schedule 1 | 0.02    |
| Triclosan                       | µg/l | -   |   | 0.01    |
| Trifluralin                     | µg/l | -   |   | 0.02    |



|   |      |     |   |     |
|---|------|-----|---|-----|
| Trihalomethanes (THM) Formation Potential | µg/l | 100 | Water Supply Regulations 2016, Schedule 1 | -   |
| Tritium                                   | Bq/l | 100 | Water Supply Regulations 2016, Schedule 2 | 10  |
| Tungsten - total and dissolved            | µg/l | -   |   | 10  |
| Turbidity                                 | NTU  | 1   | Water Supply Regulations 2016             | -   |
| Uranium (as U)                            | µg/l | 30  | Drinking Water Directive, 2021            | 10  |
| Vanadium - total and dissolved            | µg/l | -   |   | -   |
| Vinyl chloride                            | µg/l | 0.5 | Water Supply Regulations 2016, Schedule 1 | 0.1 |
| Xylene                                    | µg/l | 500 | Water Supply Regulations 2016, Schedule 1 | 1   |
| Zinc - total and dissolved                | µg/l | -   |   | 0.5 |

*Red numbers indicate where LOD > EQS.*



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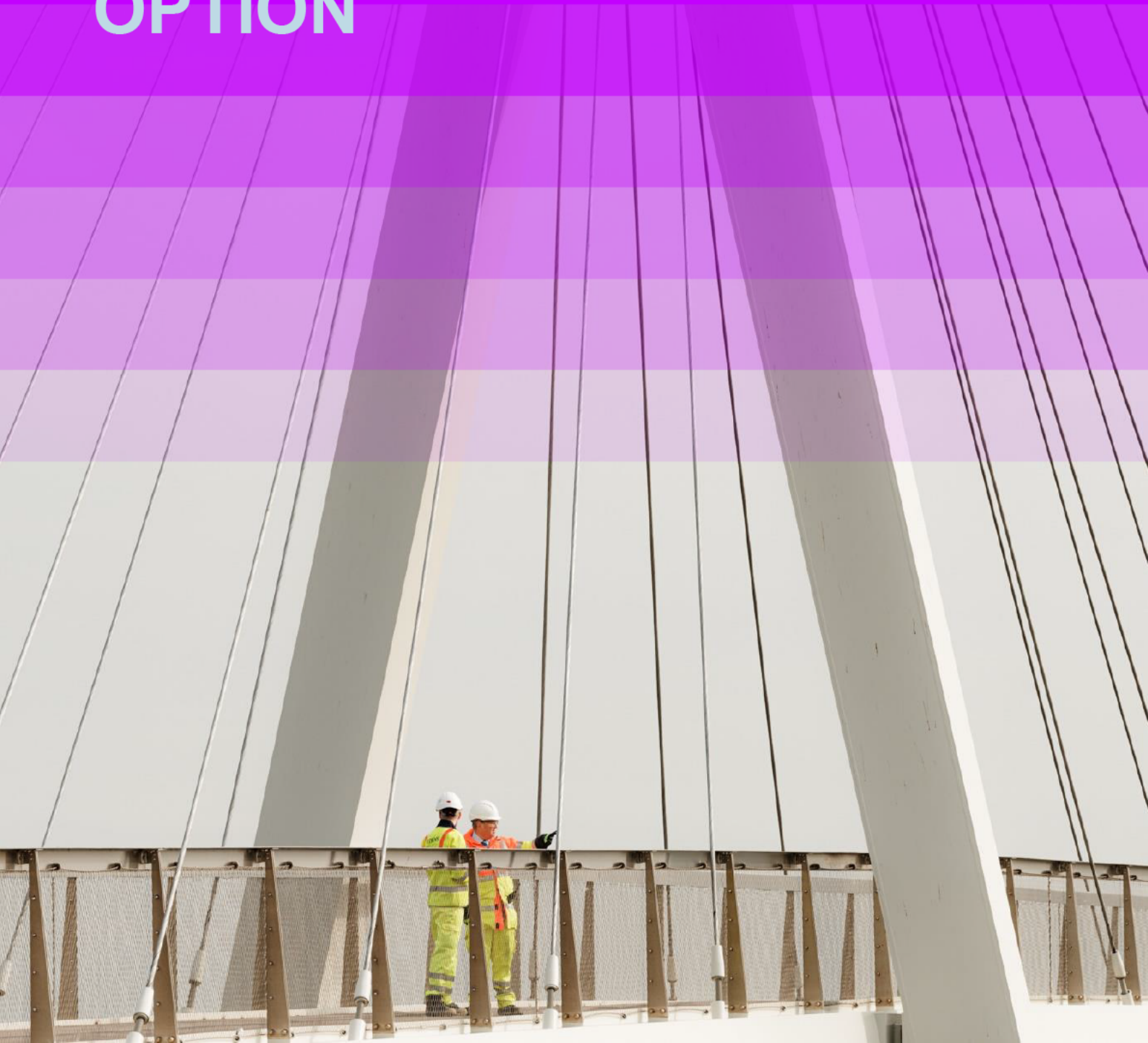


# Gate 3 Water Quality Monitoring: Quarter 2 Results

Severn Trent, Affinity Water and the Canal & River  
Trust

16 December 2022

# GRAND UNION CANAL STRATEGIC RESOURCE OPTION



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# INTRODUCTION



# Executive Summary

The Grand Union Canal (GUC) is a Strategic Resource Option (SRO) in which Affinity Water (AfW) and Severn Trent (ST) are working together alongside the Canal & River Trust (The Trust). This water resources scheme looks to transfer water from ST's Minworth Wastewater Recycling Centre (WwRC) in the Midlands to AfW in the South East using the existing GUC network.

## Objectives

The aim of the water quality monitoring programme is to obtain a baseline dataset to allow characterisation of different study reaches in terms of drinking water safety risks (particularly with respect to current and future regulated parameters), Water Framework Directive (WFD) determinands, and EA (EA) Surface Water Pollution Risk Assessment Parameters, to characterise the baseline risk and to inform modelling. The key drivers for monitoring water quality for this SRO include:

- Drinking Water Safety Planning – the scheme involves utilisation of a new source for public drinking water supply. As such, assessment of the risks to human health from this new source, and development of control measures sufficient to reduce these risks to an acceptable level, is critical to ensuring compliance with the legislative requirements for drinking water quality and safeguarding public health while meeting demand for public water supply of future generations.
- An All Company Working Group (ACWG) treatment water methodology for drinking water risk assessment and water safety planning of all SROs (across the country) has been developed, which will require water quality data to inform judgements of drinking water risk. This ACWG methodology was updated for the transfer scheme at the end of Phase 1 and has been updated as part of Phase 3 using the available monitoring data.
- Environmental water quality – the scheme would result in changes to the sources of water entering the canal and therefore may impact on the ecological and environmental health of the water body and local environment. Water quality data are key to identifying and mitigating potential environmental impacts of the scheme. In particular, the requirements of the WFD determinands, and Environmental Quality Standards Directive (EQSD) have been referred to in the development of this monitoring programme.
- Lastly, this monitoring programme will help inform treatment design at both selected discharge and abstraction location.

Data are presented from a total of 11 sites including those carried forward to Phase 4 from previous Phases, these are shown below.

| Existing Sites                        | New Sites                                 |
|---------------------------------------|---|
| Site 1 - Minworth WwRC Final Effluent | Site 10 - GUC at Bedworth                 |
| Site 3 - Coventry Canal at Atherstone | Site 11 - GUC at Little Heath Long Buckby |
| Site 5 - GUC at Welton Lane, Daventry | Site 12 - GUC at Gayton                   |
| Site 6 - Grove Lock, Leighton Buzzard | Site 13 - GUC at Stoke Bruerne            |
|                                       | Site 14 - GUC at Cosgrove                 |
|                                       | Site 15 - GUC at Stoke Hammond            |
|                                       | Site 16 - GUC at Marsworth                |



# Methodology

Under the Phase 1 water quality monitoring programme (May 2020 - March 2021), conducted by ALS analytical testing services, samples were taken at 15 monitoring locations in the upper and lower sections of the canal to characterise baseline water quality at the potential discharge and abstraction locations. Subsequent phases, Phase 2 (April - September 2021) and Phase 3 (October 2021 – June 2022) have been conducted by AtkinsRéalis (environmental consultant) and RPS, a fully accredited laboratory (UK Accreditation Service ISO 17025) based in Bedford. At the onset of Phase 2, a number of discharge sub-route options and abstraction point sub-options were no longer being progressed as part of the scheme, so it was necessary to adapt the monitoring programme accordingly. For Phase 2 and 3, monitoring was conducted at a total of nine monitoring locations across the GUC Transfer scheme. Phase 4 of the monitoring programme is scheduled to run between July 2022 – June 2023. It is the initial data collected under the Phase 4 that are presented here with water quality monitoring and analysis conducted at sites where there is a key legislative or design driver. As a result, the water quality analysis suites break down into the following components.

- **Environmental risks as required by the WFD** – which cover analysis of samples for 83 determinands as previously agreed to be suitable as part of Phase 1, and, set out in the 2015 WFD Directions<sup>1</sup>
- **Environmental permitting risks as required by the EQSD** – which cover analysis of samples for the 95 determinands set out in the surface water pollution risk assessment for environmental permits,<sup>2</sup> at Sites that may require permitting.
- **Drinking Water** – an appropriate list of 263 determinands to characterise the expected raw water quality to be abstracted from the GUC and to inform a water safety planning approach to control measures as required by Drinking Water Inspectorate (DWI).
- **Emerging substances** – This suite covers 152 substances identified as emerging in a review conducted by AtkinsRéalis.<sup>3</sup> Analysis of these substances will determine whether there is any deterioration in environmental risks associated with the transfer scheme. This suite was added to the monitoring programme in September 2022.

For Sites 1, 3, 5, and 6, monitored through Phase 2, the first four sampling rounds conducted by AtkinsRéalis and RPS took place at three weekly intervals (20/04/21 – 22/06/21 inclusive), however, following consultation with the EA and the DWI, samples collected from the start of July 2021 were collected at monthly intervals.

In addition to spot sampling, continuous water quality monitoring sondes were installed at the example discharge location (Site 3, Atherstone), example abstraction location (Site 6, Leighton Buzzard), and at furthest downstream point of impact (Site 16, Marsworth). This continuous data will, in conjunction with rainfall data, enable determination of landscape pollutant sources and potential transport mechanisms that may impact the quality of water at both example discharge and abstraction locations. Determinands monitored continuously at these sites include temperature, conductivity, dissolved oxygen, ammonium, pH, chlorophyll and turbidity. In addition, a continuous monitoring sonde had already been installed at the proposed source (Site 1, Minworth WwRC final effluent).

## Conclusions

In total, 96 environmental quality standard (EQS) exceedances were observed spanning all sampling sites. At present, the following parameters demonstrated the greatest number of exceedances across all sites: acid

---

<sup>1</sup> The Water Framework (Standard and Classification Directive) (England and Wales 2015) accessed via: [The Water Framework \(Standard and Classification Directive\) \(England and Wales\) 2015 \(legislation.gov.uk\)](https://www.legislation.gov.uk/ukdsi/2015/01/01/5150100001000001/1-1)

<sup>2</sup> Accessed via: <https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit>

<sup>3</sup> Report GUC Gate 2 Annex B1.6



neutralisation capacity, benzo(a)pyrene and fluoranthene (polycyclic aromatic hydrocarbons), biological oxygen demand (a measure of organic pollution), perfluorooctanesulfonic acid (a synthetic chemical with a number of waterproofing applications), dissolved oxygen, soluble reactive phosphorus (a key limiting nutrient), and sulphide.

Some concentrations in the Minworth WwRC effluent were greater than the Environmental Quality Standards (EQS) in the receiving water (noting these standards do not directly apply to effluent and discharge standards are set through the permitting regime). These include chlorothalonil (an organic fungicide), cypermethrin (a synthetic pyrethroid), bioavailable zinc, and dissolved oxygen. As a result, if Minworth WwRC discharge were diverted into any of the proposed sub-discharge routes without additional treatment being applied, additional instream exceedances may occur, resulting in a future WFD compliance risk if the new discharge prevented the receiving body from achieving Good water quality status.

Minworth WwRC treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of these 'high risk' compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permitting risk (e.g., due to within class deterioration).

Drinking water safety parameters, assessed through their comparison to Prescribed Concentration or Values (PCVs) are only required to characterise the source water at Minworth WwRC (Site 1) and the potential downstream abstraction location (Site 6, Grove, Leighton Buzzard). There has been a total of 189 PCV exceedances at Site 1 (30 samples due to the additional Phase 1-3 data) and 120 exceedances at Site 6 (20 samples following commencement of Drinking Water Safety Plan (DWSP) sampling in November 2021).

A number of determinands routinely exceed these targets including *Clostridium perfringens* veg & spores, *Escherichia coli*, turbidity, nitrite and iron (total). It should be noted, however, that drinking water safety thresholds apply only to treated drinking water, and not raw source waters, and as such these are included only as guidance to inform treatment options as in some cases the PCV equates to '0' colony-forming unit (CFU)/100ml which is easily exceeded in raw waters.

Data from sampling which occurred on wet weather days resulted in a number of additional exceedances not observed during low flow conditions. These exceedances included iron, nitrate and ammonium. Of particular interest were the presence of tebuconazole (an agricultural triazole fungicide used to treat plant pathogenic fungi), and metribuzin (a synthetic herbicide applied both pre- and post-emergence of vegetable crops), which suggests an agricultural origin and the mobilisation of a larger number of potential pollutants under wet weather conditions. It is therefore recommended that the SRO completes a review of planned mitigations to factor in these additional compounds of concern.

During the summer of 2022 the UK experienced a prolonged period of dry weather culminating in a severe summer heatwave. Additional MAC exceedances of mercury (both total and dissolved) were observed with concentrations increasing considerably across all sites during the last three months, however, no additional substances were found to exceed EQS values that were not already in exceedance prior to the onset of drought conditions. This is perhaps unsurprising as canal systems are heavily modified systems and are largely controlled by stored sources of water and 'topped up' to ensure they are navigable at all times. As a result, with the exception of the absence of high flow events acting to transport large quantities of potential pollutants during high rainfall, their source water remains largely constant during periods of low flow.

A series of algal blooms, which may pose a risk to water abstraction, were observed in sonde data at Site 6 (potential abstraction location) between March and April 2022 with chlorophyll concentrations peaking at 147 µg/l. A series of smaller blooms were observed in the data from Site 16 between July and August, however, no spring bloom is observed in the data for Site 16, unless it occurred prior to the commencement of monitoring on 24/05/2022. Algal blooms could have an impact on water storage as well as within the canal itself



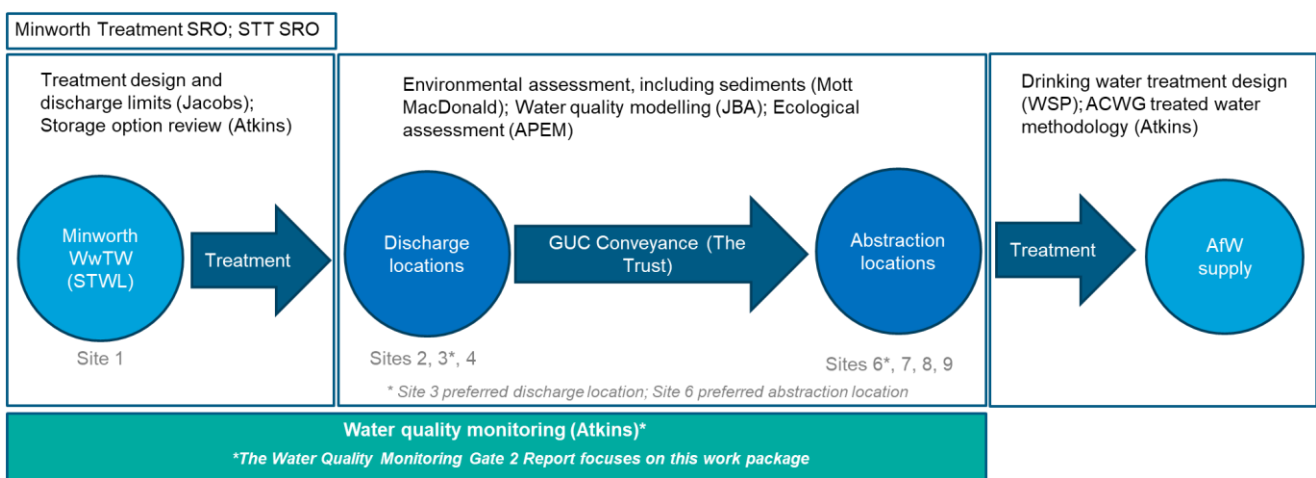
due to the potent toxins they can produce, and as such, mitigation for algal and cyanobacteria blooms should be considered in any treatment designs.



# 1. Introduction

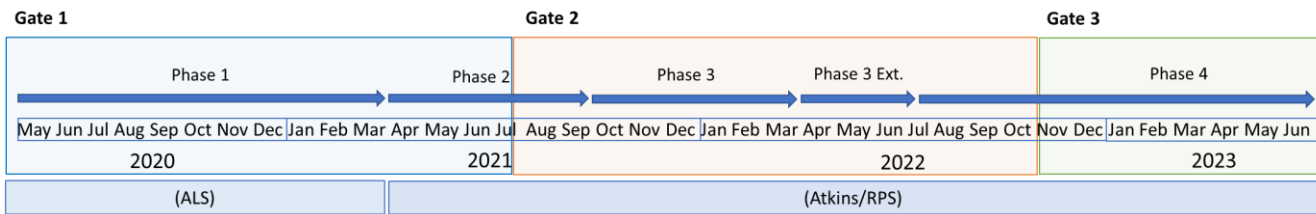
## 1.1 Background

The GUC is an SRO in which AfW and ST are working together alongside The Trust. The scheme looks to transfer water from ST’s Minworth Wastewater Recycling Centre (WwRC) in the Midlands to AfW in the South East using the existing GUC network. Under the GUC SRO, there are multiple work packages covering the different scheme elements. A schematic diagram conceptualising the different scheme elements and associated work packages is shown in Figure 1-1. There are clear linkages between the scheme and other SROs, for example, the Minworth SRO and the Severn to Thames Transfer (STT) SRO. The purpose of this report is to present the results from the water quality monitoring work package. This work package will feed into other work packages, the results of which will be reported elsewhere.



**Figure 1-1 - Conceptualisation of the GUC scheme and work packages**

Phase 1 water quality monitoring was undertaken by ALS between May 2020 and March 2021 at 15 locations along the transfer route. The sampling programme for Phase 1 involved spot water sampling on a monthly basis. Phase 2, undertaken by AtkinsRéalis and RPS, was commissioned for the 6-month period between April and September 2021, with the view to further investigate changes in water quality along the transfer route and includes a more in-depth investigation into water quality at the abstraction locations to drinking water requirements. The programme included a more in-depth suite of determinands and continuous monitoring sondes. Phase 3 was commissioned (October 2021 – March 2022) to continue the Phase 2 monitoring programme. An additional Phase 3 extension was commissioned to run between April 2022 – June 2022, reported here. Sampling under Phase 4 runs between July 2022 – June 2023 with shifts in sampling site locations. More detail is given on sampling site selection and rationale in Section 2.1. The GUC project phases are summarised in Figure 1-2 below.



**Figure 1-2 – Schematic diagram showing the GUC monitoring Phases.**

The key drivers for monitoring water quality for this SRO are:

- Drinking Water Safety Planning – the scheme involves utilisation of a new source for public drinking water supply. As such, assessment of the risks to human health from this new source, and development of control measures sufficient to reduce these risks to an acceptable level, is critical to ensuring compliance with the legislative requirements for drinking water quality and safeguarding public health while meeting demand for public water supply of future generations.
- An All Company Working Group (ACWG) treatment water methodology for drinking water risk assessment and water safety planning of all SROs has been developed, which will require water quality data to inform judgements of drinking water risk. This ACWG methodology was updated for the GUC transfer scheme at the end of Phase 1 and was revisited as part of Phase 3 using updated monitoring data.
- Environmental water quality – the scheme would result in changes to the sources of water entering the canal and therefore may impact on the ecological and environmental health of the water body and local environment. Water quality data are key to identifying and mitigating potential environmental impacts of the scheme. In particular, the requirements of the Water Framework Directive (WFD) determinands and Environmental Quality Standards Directive (EQSD) have been referred to in the development of this monitoring programme.
- Lastly, this monitoring programme will help inform treatment design at both selected discharge and abstraction locations.

The aim of the water quality monitoring programme is to obtain a recent baseline dataset to allow characterisation of different study reaches in terms of drinking water safety risks (particularly with respect to current and future regulated parameters), the WFD determinands, and EA Surface Water Pollution Risk Assessment Parameters (referred to as EQSD parameters here) to characterise the baseline risk and inform modelling. The Monitoring programme for Phases 1-4 included both water quality spot sampling and continuous monitoring (30-minute resolution data for dissolved oxygen, ammonium, temperature, conductivity, pH, and turbidity).

In this Phase 4 report, data collected are used alongside existing datasets (e.g. GUC water quality monitoring Phase 1) to inform Drinking Water risk assessment and management (for discussion with the Drinking Water Inspectorate (DWI)) and to inform water quality modelling to ascertain WFD compliance (for discussion with the EA).

## 1.2 Purpose of this document

The purpose of this document is to provide an update for data collected over the most recent monitoring period (July – September 2022) in the context of longer-term monitoring data available, where available. Data collection is ongoing, and this report provides interested parties with a look at all data collected thus far in the monitoring programme.



## 2. Methodology

### 2.1 Site locations

Under the Phase 1 water quality monitoring programme, samples were taken at 15 monitoring locations in the upper and lower sections of the GUC to characterise baseline water quality at the potential discharge and abstraction locations. At the onset of Phase 2, a number of discharge sub-route options and abstraction point sub-options were no longer being progressed as part of the scheme, so it was necessary to adapt the monitoring programme accordingly. For Phase 2 and 3 monitoring was conducted at a total of nine locations across the canal network. A detailed analysis of monitoring data collected under Phases 1-3 including an analysis of environmental and drinking water quality standards can be found in the GUC Gate 2 Annex B1.4 Water Quality Monitoring report.

Monitoring conducted during Phase 3 extension of the GUC Transfer Scheme was modified to take account of Sites 3 (Coventry Canal at Atherstone) and 6 (GUC at Grove Lock, Leighton Buzzard) being selected as example discharge and abstraction locations, respectively. Existing Sites 2 (Birmingham & Fazeley Canal at Minworth), 4 (GUC at Leamington Trough Pound), 7 (GUC at Beggars Lane, Tring), 8 (GUC at Little Heath Lane Bridge, Hemel Hempstead) and 9 (GUC at The Grove, Hunton Bridge) were discontinued and an additional seven sites added to monitoring water quality at key instream intersections (e.g., major confluences). A total of 11 sites were monitored during Phase 4. Sites currently being monitored are summarised in Table 2-1. This monitoring programme was discussed with the EA and DWI at workshops held on 23/04/2021 and 21/05/2021. They were offered the opportunity to comment on the programme so any required amendments could be incorporated into the programme. We have subsequently engaged with them on a quarterly basis throughout Gate 2.

For the purpose of conceptualising the monitoring programme, the GUC system has been split into three main geographical sections, an overview of which can be seen in Figure 2-1. These are summarised below:

- **Upper section** - Covering the discharge from Minworth to the example discharge location (Coventry Canal at Atherstone).
- **Middle section** - GUC from the Braunston Junction to the Aylesbury Arm (Marsworth, North of Tring).
- **Lower section** - GUC from the Aylesbury Arm to Hanwell, London. This section includes the example abstraction location (GUC at Grove Lock, Leighton Buzzard).



Table 2-1 - Monitoring locations

Grid references for monitoring locations redacted

| Section             | Site no. | Location description         | NGR | Rationale  | Sampling                                | Land access |
|---------------------|----------|------------------------------|-----|--|---|-------------|
| GUC: Upper Section  | 1.       | Minworth WwRC Final Effluent |     | <p>Official Minworth WwRC final effluent sampling point. To characterise potential future influence on the GUC prior to additional treatment which is likely to be deemed necessary.</p> <p><b><i>This Site is being sampled as part of the STT SRO monitoring programme scheme. These data can be used to inform the water quality monitoring programme for the GUC, and thus duplicate sampling is not required. However, a small sub-set of parameters not currently monitored have been added to this suite to ensure that the full Drinking Water suite described for GUC is still sampled. This consists of 39 different parameters. Phases 1-4 data available for analysis.</i></b></p> | Spot sampling + continuous monitoring   | ST          |
|                     | 3.       | Coventry Canal at Atherstone |     | <p>A site to characterise the reach and understand baseline water quality around sub-route 3 discharge point.</p> <p>This site is aligned with the Phase 1 water quality monitoring point for consistency. <b>Phases 1-4 data available for analysis.</b></p>  | Spot sampling + continuous monitoring** | The Trust   |
| GUC: Middle Section | 10.      | GUC at Bedworth              |     | To understand baseline water quality south of the interaction with the Ashby Canal and Oxford Canal. Spot sampling at this site commenced in April 2022.   | Spot sampling                           | The Trust   |
|                     | 5.       | GUC at Welton Lane, Daventry |     | <p>Site on the GUC east of the point where the GUC and Oxford Canal interlink and before the Leicester Line at Norton Junction to characterise water quality at the upper end of the middle section and to understand baseline of water being 'passed forward' within the middle section.</p> <p>This is a new water quality monitoring location aligned with previous APEM ecological monitoring location in this reach.</p>  | Spot sampling                           | The Trust   |
|                     | 11.      | GUC at Long Buckby           |     | Added to understand baseline water quality downstream of Norton Junction south of the interaction with the with the Leicester Line. Spot sampling at this site commenced in April 2022.  | Spot sampling                           | The Trust   |



| Section            | Site no. | Location description           | NGR | Rationale  | Sampling                                 | Land access |
|--------------------|----------|--------------------------------|-----|--|--|-------------|
|                    | 12.      | GUC at Gayton                  |     | To understand the baseline water quality upstream of the interactions with the River Nene in order to determine whether there is likely to be any deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.  | Spot sampling                            | The Trust   |
|                    | 13.      | GUC at Stoke Bruerne           |     | To understand the baseline water quality upstream of the interactions with the River Tove in order to determine whether there is likely to be any deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.  | Spot sampling                            | The Trust   |
|                    | 14.      | GUC at Cosgrove                |     | To understand the baseline water quality upstream of the interactions with the River Great Ouse in order to determine whether there is likely to be any deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.  | Spot sampling                            | The Trust   |
|                    | 15.      | GUC at Stoke Hammond           |     | To understand the baseline water quality upstream of the interactions with the River Ouzel in order to determine whether there is likely to be any deterioration of the connected waterbody. Spot sampling at this site commenced in April 2022.   | Spot sampling                            | The Trust   |
| GUC: Lower Section | 6.       | GUC at Grove, Leighton Buzzard |     | A site to characterise and understand water quality at the lower end of the middle section after interactions with other watercourses.<br>This is a new water quality monitoring location upstream of Tring before the Aylesbury and Wendover Arms converge with the GUC.<br>Continuous monitoring sondes are installed at this example abstraction location to give an indication of sub-daily water quality variability, as a result of biological activity discharges and/or tributaries*. <b>Phases 2-4 data available for analysis.</b> | Spot sampling + continuous monitoring*   | The Trust   |
|                    | 16.      | GUC at Marsworth               |     | To understand baseline water quality at the most downstream influence of the transfer scheme before the Tring summit. Spot sampling at this site commenced in April 2022.  | Spot sampling + continuous monitoring*** | The Trust   |

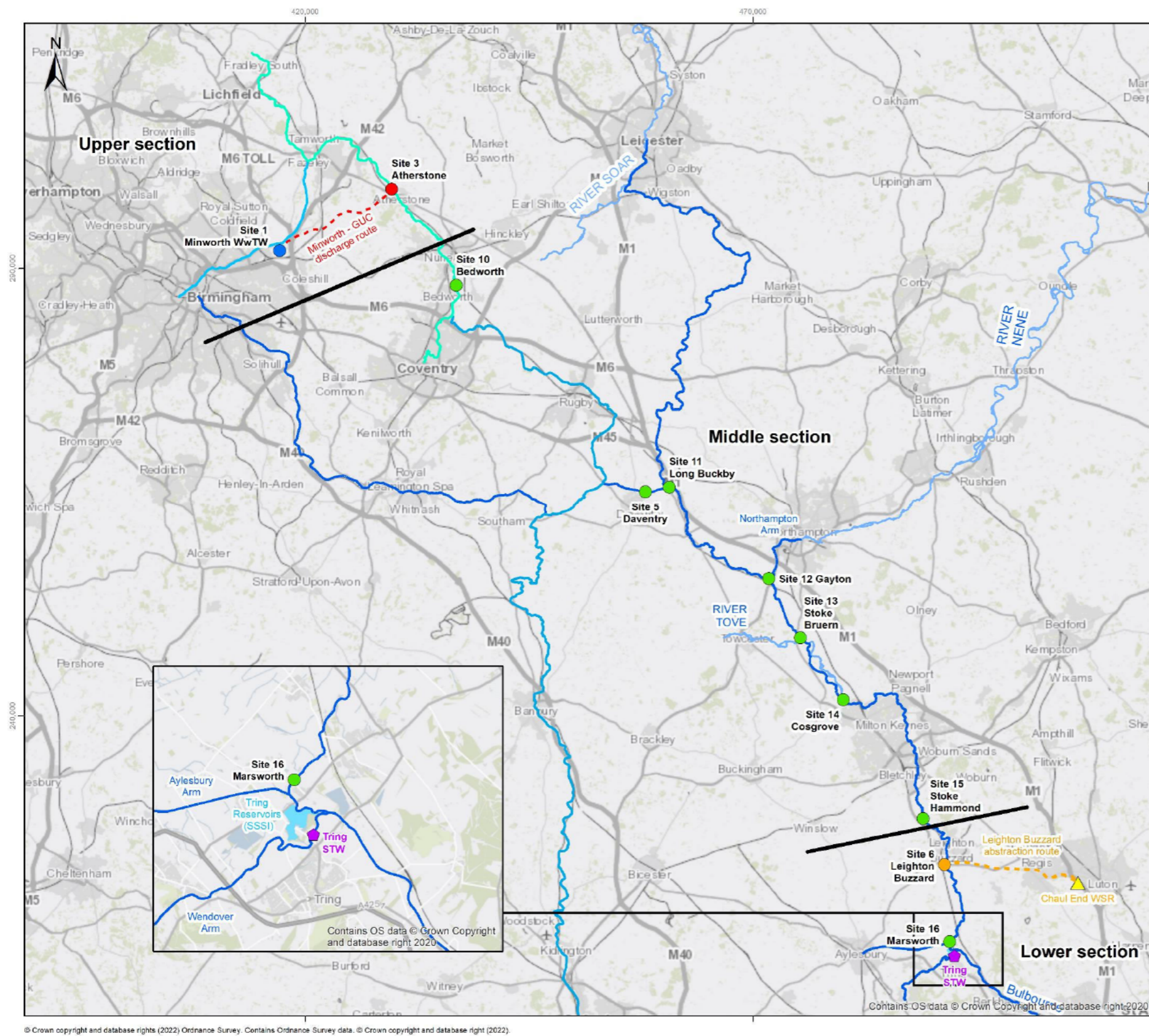
\* Continuous monitoring commenced at Site 6 on 25<sup>th</sup> November 2021.

\*\* A continuous monitoring sonde was installed at this site on 11<sup>th</sup> May 2022.

\*\*\* A continuous monitoring sonde was installed at this site on 24<sup>th</sup> May 2022.

Grid references for monitoring locations redacted





### Grand Union Canal WQ monitoring locations

**Legend**

**Water Quality Monitoring Locations**

- Source - Minworth WwTW Final Effluent
- Discharge Location
- Abstraction Location
- WQ Monitoring Location
- - - Potential Abstraction Route
- - - Potential Discharge Route
- ▲ Water Storage Reservoirs
- ◆ Sewage Treatment Works

**Watercourses**

- Grand Union Canal
- Birmingham & Fazeley Canal
- Coventry Canal
- Oxford Canal
- Interacting Main Rivers

Data sources: Environment Agency, Ordnance Survey

Scale (at A3): 1:400,000

SEVERN  
TRENT

**AffinityWater**  
Taking care of your water

**Canal & River Trust**  
Making life better by water

**ATKINS**  
Member of the SNC-Lavalin Group

|                    |                                    |                     |                        |
|--------------------|------------------------------------|---------------------|------------------------|
| Status: S1         | Purpose of issue: For Coordination | Rev: 2.0            | Model File Identifier: |
| Reference: 6201564 | Drawn: 12/07/2022                  | Checked: 12/07/2022 | Authorised:            |

Woodcote Grove, Ashley Road, Epsom, Surrey, KT18 5BW  
www.atkinsglobal.com

Author names redacted

Figure 2-1 - Key elements/ reaches of the GUC scheme (black lines notate the upper, middle and lower sections).





parameters were agreed between ST, AfW and the EA to cover determinands of relevance and to allow a characterisation of environmental risk.

The Phase 4 monitoring programme has continued to include these 74 parameters. These were included at the start of the Phase 2 programme and were communicated to the EA and the DWI.

AtkinsRéalis have recommended that, where missing from this list, the following core environmental suites comprising determinands that pose a risk to WFD status deterioration were also included:

- Supporting parameters required to do WFD specific calculations such as bioavailable fractions.
- The Minworth final effluent permitted determinands (point source emissions to water) for secondary treated sewage effluent with nutrient removal.

As a result, we included a further nine parameters in this suite: ANC, dissolved inorganic carbon, hardness, organic nitrogen, total nitrogen (oxidised), nitrite, ammonia, salinity (conductivity) and trichloroethylene.

This 'WFD suite' therefore consists of a total of 83 different compounds (see Appendix A). This analysis suite was used for all sites to characterise environmental risks. At the end of 12 months of Phase 4 data (June 2023) we will investigate if any parameters can be removed (e.g., where parameters were consistently below the limit of detection (LoD)).

## 2.2.2 EQSD suite

The EA surface pollution risk assessment list includes a total of 95 different parameters which have been set out in Appendix B. For the requirements of discharge permitting, these determinands are included only at sites where discharges are proposed as part of the scheme. Removing duplication of WFD parameters results in an additional 87 different compounds to be analysed.

It is noted that due to the GUC being classed as an artificial waterbody, clarity needs to be sought from the EA on the permitting options and expectations for water quality discharge risk assessments. There may be a view that environmental risks are covered sufficiently by the WFD suite, and this may subsequently reduce the expectations for additional monitoring under EQSD. AtkinsRéalis will review after sufficient data are collected.

## 2.2.3 Drinking water suite

The 263 different compounds making up the Drinking Water suite have been set out in Appendix C for the source water and the proposed intake / abstraction locations. Removing duplication with WFD / EQSD parameters, this results in a total of 239 additional parameters to be analysed. These will be compared against Prescribed Concentration or Values (PCVs) obtained following consultation with DWI. It should be noted that PCVs only apply to treated drinking water and not raw water values and have been compared solely as an indicator as to which determinands may be of concern following abstraction. This is discussed further in Section 3.2.

While the Drinking Water suite may appear large, it is important to note that:

- The sampling programme must be comprehensive to secure confidence that the solutions and proposed mitigation will not present a risk to human health – this is particularly important for reuse schemes from both a regulatory and public perspective.
- Monthly sampling to characterise expected parameter envelopes which may be presented to treatment is critical to appropriate sizing of treatment and other control measures, which in turn ensures fulfilment of the



two key responsibilities of the water company – the effectiveness of risk management and the availability of water resources when required ('always on and good to drink').

- A targeted approach is recommended – to restrict use of this suite to relevant locations only (example abstraction points and discharge from Minworth to allow quantification of new sources / any change to risk in the canal catchment).

## 2.2.4 Emerging substances

Under Phase 4 of the GUC monitoring programme AtkinsRéalis were commissioned to conduct a review of emerging substances associated with Minworth WwRC.<sup>8</sup> This review identified 152 emerging substances classified as either 'Foreseeable Protection Measures' or 'Potential Protection Measures'. This agreed list of substances can be seen in Appendix D. In addition to their inclusion at Minworth WwRC, to determine whether there is any deterioration in environmental risks associated with the transfer scheme, these were added at the example discharge location (Site 3 Coventry Canal, Atherstone) and to determine the drinking water risks associated with the scheme, these substances were also added at the example abstraction location (Site 6 Leighton Buzzard).

## 2.3 Sampling and analysis procedures

### 2.3.1 Continuous water quality monitoring sondes

A continuous monitoring sonde was installed at the example abstraction site (Site 6 GUC at Grove, Leighton Buzzard) on 25/11/21. Additional sondes were installed at the example discharge site (Site 3 Coventry canal at Atherstone) and at the base of the catchment (Site 16 GUC at Marsworth) on 16/05/22 and 14/05/22 respectively. A sonde has also already been installed to characterise the source water (Minworth WwRC treated discharge) as part of the STT SRO monitoring programme. Each continuous monitoring location includes:

- A modular system complete with an MCE-ESNET2 telemetry unit and a Xylem EXO2 multiparameter sonde, deployed at approximately 1 metre depth and sensors for temperature, conductivity, dissolved oxygen, ammonium, pH, chlorophyll and turbidity.
- A limited sensor suite (dissolved oxygen, pH, and temperature) was included at Minworth during Phase 2 and 3 installed under the STT scheme, however, this suite was upgraded in April 2022 to include comparable parameters to Sites 3, 6, and 16, with the exception of chlorophyll.
- 20 W solar panel kit allowing autonomous year-round operation.
- 30-minute resolution telemetered data with secure web portal access via the Cloud, using a Tier III secure data centre.
- Daily data integrity checks undertaken via the Cloud.

Dedicated maintenance visits occur around every four to six weeks to proactively clean and replace equipment with newly calibrated sondes, when necessary. So far, these checks have been undertaken at Site 16 (Marsworth) and Site 6 (GUC at Grove, Leighton Buzzard) on 22/06/2021, 13/08/2021, 22/09/2021, 21/10/2021, and 25/11/2021, 20/01/2022, 10/02/2022, 16/03/22, 21/04/22, 24/05/22, 30/06/22, 08/08/22, 16/09/22. Due to geographical constraints, sonde maintenance is conducted on a different schedule at selected sites. Site 1 (Minworth WwRC Final Effluent) and Site 3 (Coventry Canal at Atherstone) were recently visited

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<sup>8</sup> GUC Gate 2 Annex B1.6 Emerging Substances.



on, 11/05/22, 16/06/22, 28/07/22, 31/08/22. When sensors experience drift or fail in between that time, reactive repair and maintenance of the sondes has been undertaken.

## 2.3.2 Spot water quality sampling

It is noted that many of the WFD, EQSD and DWSP parameters have low EQS limits and will therefore require laboratory analysis to a very low level. Appropriate sampling and analysis methods have been used, along with suitably experienced staff, to achieve the required LoD and prevent risk of cross-contamination. Water quality samples have been collected monthly using project-specific Sampling Operating Procedure (SOP), which follows the approach outlined in the EA Operational Instruction 19-09.<sup>9</sup> Samples have been taken from a site representative of the bulk of water being assessed (the volume of sample taken at each site has been determined by the laboratory to cover the required analysis). In addition to the EA Operational Instruction, we also adhere to 'best practice' guidance for organic contaminant sampling set out by the US Environment Protection Agency (EPA).<sup>10</sup> It is very important that cross contamination of samples is avoided to make sure no 'false positives' are seen in the data analysis. This is especially important owing to the very low EQS levels for WFD and PCV for DWSP parameters. These additional measures include:

- A sampling pole and food grade stainless steel and plastic sampling buckets have been used to collect water to fill the sampling bottles. These buckets are also used by the EA and prevent metal leaching. Each bucket will be thoroughly rinsed out downstream or slightly further away from the sampling location before any samples are taken to avoid any cross-contamination issues. One set will be dedicated to each scheme and not used for other projects, keeping all sampling containers in a dedicated 'clean' bag until used.
- Use of clean / sterile sampling bottles for any sampling round, including discarding any bottles inadvertently opened during transit.
- Use of specialist sampling containers for different analytes, some of which contain preservatives, for which indirect sampling will be used.
- Use of vinyl sampling gloves. Use new clean gloves for each new sample and dirty gloves and other dirty personal protective equipment (PPE) stored in a designated 'dirty' bag.
- With regard to Perfluorooctanesulfonic acid (PFOS), avoiding PFOS-containing PPE and equipment (e.g., Gore-Tex jackets and boots, waterproof notepads), unless required for Health & Safety purposes (e.g., life jackets).

In addition to taking spot water samples for laboratory analysis, the following water quality parameters were measured *in-situ* using a calibrated YSI handheld multiparameter probe: dissolved oxygen (% saturation and mg/l), temperature, conductivity, and pH.

Samples are maintained at a cool temperature during transit by using refrigerated vehicles. The laboratory (RPS) provides temperature data loggers and temperature blanks to record temperature during transit to ensure that the samples have not been exposed to environmental conditions that may adversely affect any analytical test for which they are scheduled. The samples are dropped off at the laboratory's nearest pick up point or collected directly from site by RPS on the same day of collection and delivered to the laboratory overnight, thus maintaining compliance with the UK Accreditation Service (UKAS) Policy on Deviating Samples<sup>11</sup> (e.g., 24 hours for microbiological parameters and Biochemical Oxygen Demand (BOD)).

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<sup>9</sup> Environment Agency Operational Instruction 19\_09: Chemical and microbiological sampling of water. Issued 03/02/10

<sup>10</sup> See [www.epa.gov/quality](https://www.epa.gov/quality) and <https://www.epa.gov/quality/procedures-collecting-wastewatersamples>. For example, [https://www.epa.gov/sites/production/files/2019-02/documents/pfas\\_methods\\_tech\\_brief\\_28feb19\\_update.pdf](https://www.epa.gov/sites/production/files/2019-02/documents/pfas_methods_tech_brief_28feb19_update.pdf) for PFOS

<sup>11</sup> [TPS 63 UKAS Policy on Deviating Samples](#)



### 2.3.3 Laboratory analysis suites

Sample analyses were undertaken by RPS laboratories, with the main laboratory located in Bedford. RPS is fully accredited (UKAS ISO 17025) and highly experienced in both WFD and DWSP analysis suites, including through (but not limited to) previous projects involving extensive water company investigation work, as well as the CIP. As a result of this work, which included extensive final effluent as well as main river sampling, RPS offers all WFD and almost all EQSD determinands at or below the associated EQS. The very small number of exceptions include 3,4-dichloroaniline, cyfluthrin, doramectin, formaldehyde, hydrogen sulphide and methiocarb.

Table 2-2 below sets out the analysis suite for each of the eleven monitoring sites. Appendix A-D contains detail on the parameters, EQS and LoD which can be achieved by RPS<sup>12</sup> against the WFD EQS set out in the 2015 Directions and non-statutory EQS for the EQSD parameters. A database has been developed to hold all environmental data.

**Table 2-2 - Overview of analysis suites**

| Section             | Sites                             | Continuous Monitoring Sonde | WFD (Appendix A) | EQSD** (Appendix B) | DWSP*** (Appendix C) | Emerging substances (Appendix D) |
|---------------------|-----------------------------------|-----------------------------|------------------|---------------------|----------------------|----------------------------------|
| GUC: Upper Section  | 1. Minworth WwRC Final Effluent*  | ✓                           | ✓                | ✓                   | ✓                    | ✓+                               |
|                     | 3. Coventry Canal at Atherstone   | ✓^                          | ✓                | ✓                   | ✗                    | ✓+                               |
|                     | 10. GUC at Bedworth*****          | ✗                           | ✓                | ✗                   | ✗                    | ✗                                |
| GUC: Middle Section | 5. GUC at Welton Lane, Daventry   | ✗                           | ✓                | ✗                   | ✗                    | ✗                                |
|                     | 11. GUC at Long Buckby*****       | ✗                           | ✓                | ✗                   | ✗                    | ✗                                |
|                     | 12. GUC at Gayton*****            | ✗                           | ✓                | ✗                   | ✗                    | ✗                                |
|                     | 13. GUC at Stoke Bruerne*****     | ✗                           | ✓                | ✗                   | ✗                    | ✗                                |
|                     | 14. GUC at Cosgrove*****          | ✗                           | ✓                | ✗                   | ✗                    | ✗                                |
|                     | 15. GUC at Stoke Hammond*****     | ✗                           | ✓                | ✗                   | ✗                    | ✗                                |
| GUC: Lower Section  | 6. GUC at Grove, Leighton Buzzard | ✓****                       | ✓                | ✗                   | ✓****                | ✓+                               |
|                     | 16. GUC at Marsworth*****         | ✓^^                         | ✓                | ✗                   | ✗                    | ✗                                |

\* Minworth WwRC final effluent already being sampled as part of the STT SRO monitoring programme. Only parameters identified in the Drinking Water suite (Appendix C) that are not already being sampled as part of this programme will need to be sampled.

\*\* EQSD parameters are only required to be sampled at discharge sites.

\*\*\* Drinking Water parameters are only required to characterise the source water and to understand baseline conditions at the potential abstraction locations.

\*\*\*\* DWSP parameters were added to the analysis suite at Site 6 in October 2021 and a continuous monitoring sonde was added in November 2021 as a result of this Site being proposed as a potential abstraction location (previous analysis suite consisted of WFD parameters only April-September 2021).

\*\*\*\*\* Data will only start from April 2022 at these new sites.

^ Continuous monitoring sonde installed at this site on 11<sup>th</sup> May 2022.

^^ Continuous monitoring sonde installed at this site on 24<sup>th</sup> May 2022.

+ Emerging substances added to sites on 12<sup>th</sup> September 2022.

<sup>12</sup> <https://www.rpsgroup.com/services/laboratories/>



## 2.4 Monitoring frequency

Initially, for those sites included in Phase 1 (Site 3, Coventry Canal at Atherstone) monitoring was conducted at three weekly intervals (20/04/21 – 02/06/21 inclusive). However, following consultation with the EA and the DWI, all samples collected from the start of July 2021 were collected at monthly intervals. Sessions have been set up with the EA and DWI on a quarterly basis to discuss findings and get agreement to amend suites where appropriate.

## 2.5 Data analysis

Following data compilation and the completion of standard data quality assurance procedures, descriptive statistical analyses were conducted on data from all Sites, including the generation of mean, maximum, minimum and percentile values (95<sup>th</sup>, 90<sup>th</sup>, and 10<sup>th</sup> percentiles). Samples at the limit of detection were included in the analysis and used at face value to adhere to discharge permitting assessment guidance. Any significant outliers were removed from the analysis. Relevant EQS (relating to both WFD<sup>13</sup> and EQSD<sup>14</sup>) were then obtained following consultation with the EA against which running mean data have been compared. Sites with potential abstraction applications have been compared against additional drinking water PCVs obtained from the UK's Water Supply (Water Quality) Regulations (2016) Schedule 1<sup>15</sup> with some determinands defined as indicator parameters being found in Schedule 2.<sup>16</sup> Additionally, many of the parameters included are not named within the regulations but fall under the category of 'other pesticides' and so were given a PCV of 0.10 µg/l. In addition, high-resolution sensor data collected from all four sites have been rigorously checked for sensor drop out, instrument drift, and anomalous readings that may impact interpretation.

Not all substances included following the addition of the emerging substances suite in September 2022 have an associated EQS or PCV. It is therefore proposed that where EQS values are not available that Predicted No-Effect Concentrations (PNEC) be used as an environmental benchmark against which to facilitate a comparison between sites. These will be selected for inclusion in the next quarterly report following consultation with Southern Trent, the EA and DWI.

## 2.6 Rainfall data

Rainfall data were available from the EA for the entire monitoring period for a single location along the GUC (Dancers End Reservoir, EA Station Number: 261602). This site was selected for data interpretation as Dancers End Reservoir is situated at the example abstraction location, Site 6 (Leighton Buzzard), and coincides with the locations of the continuous monitoring sonde. The use of this dataset to infer catchment processes was therefore deemed sufficient for this interpretation. These data are presented in Figure 2-2. Notable weather events have occurred over the total monitoring period to date.

- Rainfall experienced across the GUC during 2020 peaked in October (212 mm) with the UK experiencing high rainfall totals as a result a number of large storms, namely storm Alex (02/10/2020).

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<sup>13</sup> The Water Framework (Standards and Classification) Directive (England and Wales) 2015 accessed via: [The Water Framework Directive \(Standards and Classification\) Directions \(England and Wales\) 2015 \(legislation.gov.uk\)](#)

<sup>14</sup> Environment Agency statutory and operational EQS accessed via <https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit>

<sup>15</sup> <https://www.legislation.gov.uk/uksi/2016/614/schedule/1>

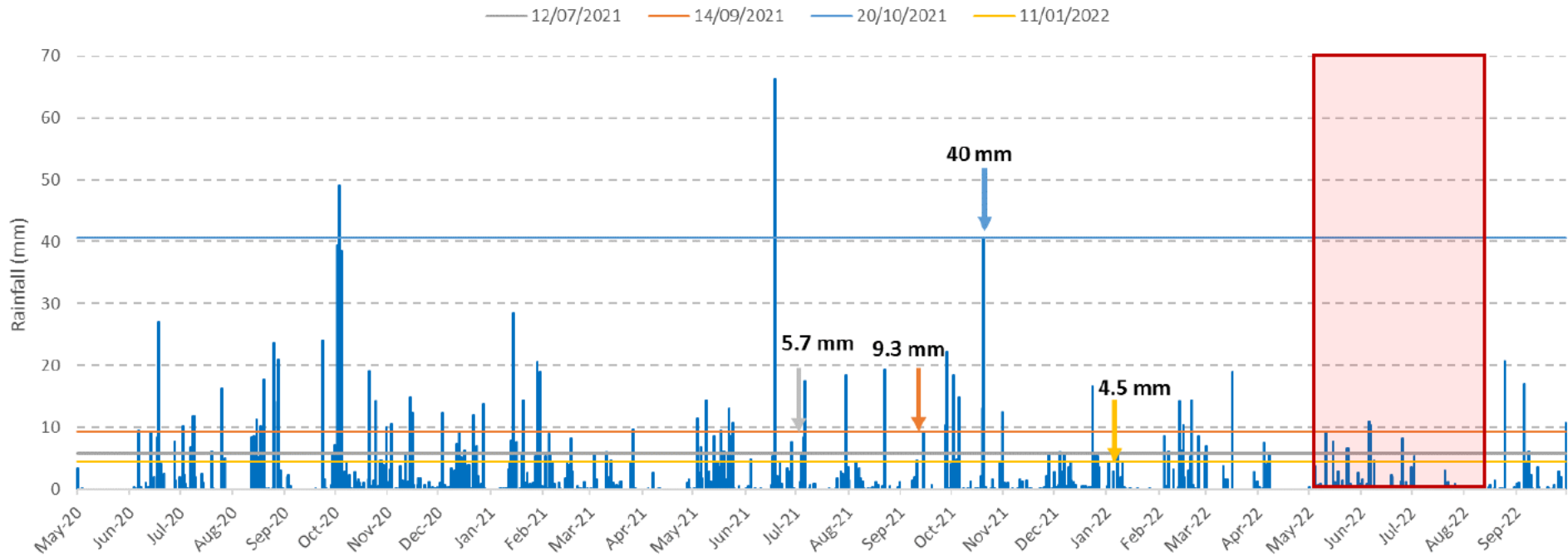
<sup>16</sup> <https://www.legislation.gov.uk/uksi/2016/614/schedule/2>



- May recorded the lowest rainfall totals in 2020 (3.6 mm). In 2021, the UK experienced the 4th highest rainfall totals on record for the month of May, as a result, this month experienced the highest rainfall totals (121 mm).
- April was the driest month of 2021 (lower = 5.7 mm), mirroring a national picture of predominantly dry and sunny weather.
- Rainfall during the period between February and June 2022 was low, corresponding with a national picture of reduced rainfall across all regions of England.
- During the summer of 2022 the UK experienced a prolonged period of dry weather culminating in a severe summer heatwave. This is echoed in the 2022 data at Dancers End Reservoir with flows considerably reduced, marked by the red shaded box in Figure 2-2.

These data will be used to analyse high frequency sonde and water quality spot sampling data, providing context for shifts in determinand concentrations as a result of weather patterns.





**Figure 2-2 – Daily rainfall totals observed at Dancers End Reservoir (EA Station Number: 261602) for selected location to be used in the analysis of GUC sonde and chemical data series.<sup>17</sup> Red shading highlights period of reduced rainfall resulting in drought conditions across the UK.**

<sup>17</sup> Coloured lines represent rainfall totals of days corresponding with sample collection. Corresponding sample collection days are highlighted with corresponding coloured arrows. Rainfall total on sample collection days are also given.



## 3. Results

### 3.1 WFD and EQSD Environmental Quality Standards (EQS)

#### 3.1.1 Overview

In order to determine parameters of risk, values have been compared against the relevant EQS as detailed by the 2015 WFD Directions and the EA Surface Water Pollution Risk Assessment Parameters EQSD, these include:

- Freshwater specific pollutants and operational EQS
- Freshwater priority hazardous substances
- Priority substances and other pollutants

It is important to note that standards or condition limits for certain parameters under the WFD (e.g., dissolved oxygen, BOD, ammoniacal nitrogen, and ANC), are determined by categorising the water body by type, dependent on its altitude and alkalinity. ANC standards are determined by annual mean dissolved organic carbon concentrations. In addition, soluble reactive phosphorus (SRP) standards are determined by the water body's altitude and alkalinity, cadmium standards are determined by categorising the water body, by type, dependent on the hardness of the water, and zinc standards are determined by the ambient background concentration (ABC) of dissolved zinc. EA site specific standards (where available) were used (e.g. SRP), Where these were not available, site-specific standards were calculated. Table 3-1 shows the categorisation of each monitoring site in order to determine water body type, and Table 3-2 details the resultant site-specific EQS which were used as part of our analysis. Whilst we have used site-specific EQS or WFD Good standards for the Minworth WwRC final effluent for indicative purposes, it is important to note that these standards should not be routinely applied to final effluent samples as they are in-river standards (EQS compliance does not apply to Minworth as it is not an environmental sample).

Water quality monitoring data collected by ALS during Phase 1 of this monitoring programme have been included in this report. These extra data cover 11 months between May 2020 and March 2021 for sites 1 (Minworth WwRC final effluent) and 3 (Coventry Canal at Atherstone). These data were not collected by AtkinsRéalis staff or analysed at laboratories recommended by AtkinsRéalis and as such have been included at face value, under the assumption that the data are of good quality and have been previously quality assured following appropriate protocols. This report presents data from the 11-month period of Phase 1 (Sites 1 and 3) alongside the 6-month period of Phase 2 and the 9-month period of Phase 3 (Sites 1, 3, 5, 6). The total number of sampling rounds at Sites 1, 3, 5 and 6 were 31, 30, 19 and 20 respectively. Sites 10 – 16 were added during the Phase 3 and cover a 6-month period, represented by six sampling rounds from each site.

For the purpose of this analysis, it should be noted that we have compared all data to annual EQS values, often expressed as either annual averages, 10<sup>th</sup>, 90<sup>th</sup> or 95<sup>th</sup> percentiles or maximum allowable concentrations (MAC). As such these exceedances are likely to change as the dataset expands. The same is true for the site-specific EQS, which uses water quality data gathered as part of this monitoring programme. Based on the data collected thus far, with metal concentrations (copper, zinc, manganese, and nickel) converted to bioavailable

concentrations using the M-BAT tool box,<sup>18</sup> across all sites there were 96 EQS exceedances. The distribution of these EQS exceedances is shown in Figure 3-1.

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<sup>18</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktag](#)



**Table 3-1 - Categorisation of each monitoring site to determine water body type**

| Site                              | Elevation (m) | Average alkalinity as CaCO <sub>3</sub> (mg/l) | Type (for dissolved oxygen, BOD and ammoniacal nitrogen standards) | Average dissolved organic carbon (mg/l) | Average water hardness as CaCO <sub>3</sub> (mg/l) | Cadmium class | ABC for dissolved zinc (catchment / group of catchments) | ABC for dissolved zinc (µg/l) |
|-----------------------------------|---------------|--|--|---|--|---------------|--|-------------------------------|
| 1. Minworth WwRC final effluent*  | 85            | 91   | 4  | 9.3                                     | 169  | 4             | Humber   | 2.9                           |
| 3. Coventry Canal at Atherstone   | 74            | 118  | 5  | 4.5                                     | 487  | 5             | Humber   | 2.9                           |
| 5. GUC at Welton Lane, Daventry   | 137           | 150  | 6  | 3.7                                     | 242  | 5             | Nene   | 4                             |
| 6. GUC at Grove, Leighton Buzzard | 95            | 175  | 6  | 4.9                                     | 265  | 5             | Great Ouse   | 3.1                           |
| 10. GUC at Bedworth               | 98            | 170  | 6  | 6.0                                     | 266  | 5             | Humber   | 2.9                           |
| 11. GUC at Long Buckby            | 109           | 183  | 6  | 5.6                                     | 290  | 5             | Nene   | 4                             |
| 12. GUC at Gayton                 | 93            | 220  | 7  | 2.5                                     | 349  | 5             | Nene   | 4                             |
| 13. GUC at Stoke Bruerne          | 74            | 233  | 7  | 3.1                                     | 315  | 5             | Great Ouse   | 3.1                           |
| 14. GUC at Cosgrove               | 70            | 187  | 5  | 5.0                                     | 303  | 5             | Great Ouse   | 3.1                           |
| 15. GUC at Stoke Hammond          | 79            | 160  | 5  | 4.9                                     | 271  | 5             | Great Ouse   | 3.1                           |
| 16. GUC at Marsworth              | 108           | 157  | 6  | 3.7                                     | 230  | 5             | Great Ouse   | 3.1                           |

\* Waterbody types should not be applied to final effluent. We have used these for indicative purposes only in order to determine and understand the potential effects on the receiving waterbodies



**Table 3-2 - Site specific EQS or WFD Good Status values used**

| Site                              | Dissolved Oxygen (% saturation) (10th percentile) WFD Good status | BOD (mg/l) (90th percentile) WFD Good status | Ammoniacal Nitrogen (mg/l) (90th percentile) WFD Good status | ANC (annual average) WFD Good status | SRP (mg/l) (annual average) WFD Good status | Cadmium (µg/l) (annual average) EQS | Cadmium (µg/l) (maximum allowable concentration) EQS | Zinc bioavailable plus ABC dissolved (µg/l) EQS |
|-----------------------------------|---|--|--|--------------------------------------|---|-------------------------------------|--|---|
| 1. Minworth WwRC final effluent*  | 75  | 4  | 0.3  | 40                                   | 0.054                                       | 0.15                                | 0.9  | 13.8  |
| 3. Coventry Canal at Atherstone   | 60  | 5  | 0.6  | 40                                   | 0.061                                       | 0.25                                | 1.5  | 13.8  |
| 5. GUC at Welton Lane, Daventry   | 75  | 4  | 0.3  | 40                                   | 0.054                                       | 0.25                                | 1.5  | 14.9  |
| 6. GUC at Grove, Leighton Buzzard | 75  | 4  | 0.3  | 40                                   | 0.065                                       | 0.25                                | 1.5  | 14  |
| 10. GUC at Bedworth               | 75  | 4  | 0.3  | 40                                   | 0.064                                       | 0.25                                | 1.5  | 13.8  |
| 11. GUC at Long Buckby            | 75  | 4  | 0.3  | 40                                   | 0.064                                       | 0.25                                | 1.5  | 14.9  |
| 12. GUC at Gayton                 | 60  | 5  | 0.6  | 40                                   | 0.071                                       | 0.25                                | 1.5  | 14.9  |
| 13. GUC at Stoke Bruerne          | 60  | 5  | 0.6  | 40                                   | 0.077                                       | 0.25                                | 1.5  | 14  |
| 14. GUC at Cosgrove               | 60  | 5  | 0.6  | 40                                   | 0.073                                       | 0.25                                | 1.5  | 14  |
| 15. GUC at Stoke Hammond          | 60  | 5  | 0.6  | 40                                   | 0.067                                       | 0.25                                | 1.5  | 14  |
| 16. GUC at Marsworth              | 75  | 4  | 0.3  | 40                                   | 0.06  | 0.25                                | 1.5  | 14  |

\* River EQS or WFD Good Status standards should not be routinely applied to final effluent. We have used these for indicative purposes only in order to determine and understand the potential effects on the receiving waterbodies.



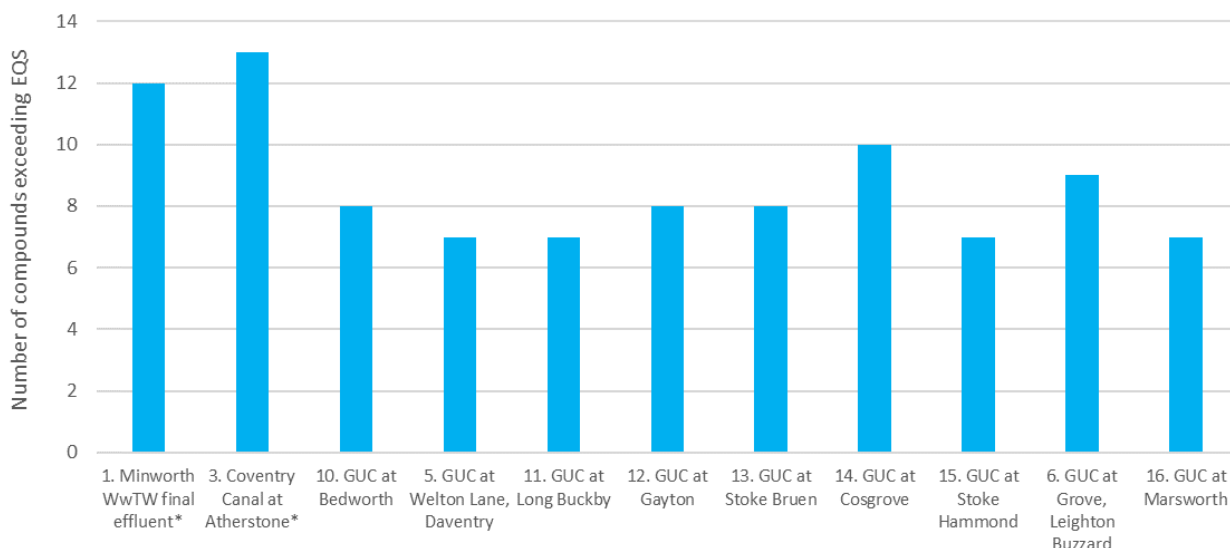


Figure 3-1 - Number of compounds exceeding EQS split by site location.<sup>19</sup>

## 3.1.2 Analysis

### 3.1.2.1 Long term dataset

A list of all compounds that exceeded the quoted EQS split by site is presented in Table 3-3. Of these compounds, those that exceeded the EQS at most sites included two polycyclic aromatic hydrocarbons (PAH) benzo(a)pyrene and fluoranthene. As per the WFD, benzo(a)pyrene is considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water. Benzo(a)pyrene is classed as a priority hazardous substance under both the WFD<sup>20</sup> and EQSD<sup>21</sup> as it has carcinogenic and mutagenic properties, persists in the environment, accumulates in biota and food chains, and has adverse toxic effects on both aquatic and human life. PAHs released to the atmosphere, mainly through emissions from (road) transport and domestic consumption may reach terrestrial and aquatic environments through both wet and dry deposition. Once deposited, for example in terrestrial environments, PAHs can accumulate over long-time scales and can also be transported into adjacent waterbodies, along with other contaminants, following periods of heavy rainfall.<sup>22</sup>

BOD levels resulted in exceedances across all sites except Sites 10 (GUC at Bedworth), 11 (GUC at Long Buckby) and 13 (GUC at Stoke Bruerne). BOD (5-day) is an analytical technique which quantifies the oxygen demand exerted by biochemical processes, typically associated with the presence of organic material that may originate from either point or diffuse sources. As a result of microbial decomposition of organic matter, higher biochemical or chemical oxygen demand values are commonly associated with lower dissolved oxygen levels in the water column.

<sup>19</sup> Asterisks indicate inclusion of Phase 1 monitoring data. Mean values for Sites 1 and 3 cover a 29-month period (May 20 – September 22), Site 6 covers an 18-month period (April 21 – September 22), and Sites 10 – 16 cover a 6-month period (April – September 2022).

<sup>20</sup> [The Water Framework Directive \(Standards and Classification\) Directions \(England and Wales\) 2015 \(legislation.gov.uk\)](https://www.legislation.gov.uk)

<sup>21</sup> [Surface water pollution risk assessment for your environmental permit - GOV.UK \(www.gov.uk\)](https://www.gov.uk)

<sup>22</sup> [Microsoft Word - UKSHS 9 final.doc \(publishing.service.gov.uk\)](https://publishing.service.gov.uk)



Elevated PFOS concentrations also resulted in EQS exceedances at all 11 Sites. PFOS is primarily used as a flame retardant, however, has also been used in pesticides and as a surface coating for fabrics such as carpets and waterproof apparel and is becoming increasingly found in a range of aquatic environments.<sup>23</sup>

SRP also exceeded EQS values at 9 Sites including Minworth WwRC. Standards for SRP are site specific, derived as a function of altitude and alkalinity, and can be seen in Table 3-2.

Bromine (total residual oxidant) resulted in EQS exceedances at all (two) sites, as it is only measured as part of the EQSD analysis suite (see Table 2-2). Bromine has been used in the production of fire retardants, hand sanitiser, and also used in agriculture as an insecticide, and as such may enter aquatic environments through point source discharges or through diffuse agricultural pathways. Bromine can occur in a number of oxidation states from -1 to +7 and is oxidised during drinking water treatment, using either ozone or chlorine dioxide, forming bromate, a suspected carcinogen.<sup>24</sup>

Lastly, low 10<sup>th</sup> percentile dissolved oxygen saturation values resulted in EQS exceedances at eight sites. It should be noted, however, that only six sampling rounds have been conducted for Sites 10-15 and 16. Table 3-4 shows the values corresponding to the test statistics for all compounds in exceedance of the EQS. This table highlights compounds that, while not currently exceeding EQS, may, if final effluent from Minworth WwRC were discharged into the GUC without additional treatment, be at risk of exceeding these WFD EQS values in the receiving waterbodies. This may result in a future WFD compliance risk as the new discharge would prevent the water quality of the receiving body from achieving Good Status in the future. These compounds include chlorothalonil (organic fungicide), cypermethrin (synthetic pyrethroid), permethrin (insecticide), and zinc (bioavailable).

Maximum allowable concentration (MAC) values were examined separately and have been applied to individual results and not mean or percentile data. In total there are 222 instances of MAC exceedances across all sites. Overall, four PAH (benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene) accounted for 25% of these exceedances. As discussed above, benzo(a)pyrene can be considered as a marker for the other PAHs and hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water. The three additional hydrocarbons do, however, have a MAC value under WFD. Bromine (total residual oxidant) accounted for 36 exceedances in the 'upper GUC', Sites 1 and 3. Sulphate (or hydrogen sulphide) exceeded MAC values on 75 occasions. A list of total exceedances split by compound can be seen in Table 3-5.

### 3.1.2.1 Patterns in the last quarter

As discussed in Section 2.6, during the summer of 2022 the UK experienced a prolonged period of dry weather culminating in a severe summer heatwave. While it may be expected that prolonged periods of reduced rainfall act to reduce pollutant transport from surrounding catchment sources, as a result of reduced landscape connectivity, the subsequent reduction in flow may also act to increase, proportionally, the importance of large point sources such as WwRCs within catchments.

Minimal baseline data exist under average flow conditions against which to compare data from the newly added sites (Sites 10 - 16). As a result, it is not yet possible with the data available to examine the impact of reduced flows on instream determinand concentrations. With regards to Sites 1, 3, 5, and 6, against which such longer-term comparisons can be made, one additional EQS exceedance was observed for diazinon (a nonsystemic organophosphate insecticide), which was found to be elevated in the discharge from Minworth WwRC. It should be noted however, that EQS data are used as an environmental benchmark and are not directly applicable to

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<sup>23</sup> [perfluorooctane-sulfonate-and-related-substances-pressure-rbmp-2021.pdf \(environment-agency.gov.uk\)](#)

<sup>24</sup> [Neal\\_bromide.pmd \(copernicus.org\)](#)



point source discharges. Additional MAC exceedances of mercury (both total and dissolved) were observed with concentrations increasing considerably across all sites during the last three months. The cause of this increase is unknown, however, discharges from WwRCs and emissions from thermal power plants are considerable sources of mercury. These increases in mercury concentrations result in a number of EQS-MAC exceedances as seen in Table 3-5.

Canal systems are heavily modified systems and are largely controlled by stored sources of water and ‘topped up’ to ensure they are navigable at all times. As a result, with the exception of the absence of high flow events acting to transport large quantities of potential pollutants during high rainfall, their source water remains largely constant during periods of low flow. While it is common in riverine and lake systems that reduced flow may concentrate pollutants, resulting in increased in-canal concentrations, this is not obvious from the latest data collected in this report.

Additional temporal patterns in determinands which commonly exceed EQS/PCV values are discussed, in the context of the recently experienced reduced rainfall, in Section 3.2.4.1.



Table 3-3 - Number of EQS (WFD and EQSD) exceedances.<sup>25</sup>

| Compound                       | Standard | Unit | Statistic <sup>+</sup> | Upper GUC       |                 | Middle GUC |           |          |          |          |          |          | Lower GUC       |          |   |
|--------------------------------|----------|------|------------------------|-----------------|-----------------|------------|-----------|----------|----------|----------|----------|----------|-----------------|----------|---|
|                                |          |      |                        | Source          | Discharge       |            |           |          |          |          |          |          | Abstraction     |          |   |
|                                |          |      |                        | Site 1          | Site 3          | Site 10    | Site 5    | Site 11  | Site 12  | Site 13  | Site 14  | Site 15  | Site 6          | Site 16  |   |
| Acid neutralisation capacity   | 40       | mg/l | AA                     | 19 <sup>#</sup> | 19 <sup>#</sup> | 6          | 19        | 6        | 6        | 6        | 6        | 6        | 6               | 20       | 6 |
| benzo(a)pyrene                 | 0.00017  | µg/l | AA                     | 31              | 30              | 6          | 19        | 6        | 6        | 6        | 6        | 6        | 6               | 20       | 6 |
| BOD (5 day)                    | *        | mg/l | 90 <sup>th</sup>       | 5               | 5               | 0          | 3         | 0        | 1        | 0        | 1        | 2        | 6               | 1        |   |
| Bromine                        | 0.002    | mg/l | AA                     | 18              | 18 <sup>#</sup> |            |           |          |          |          |          |          |                 |          |   |
| Chlorothalonil                 | 0.035    | µg/l | AA                     | 1 <sup>#</sup>  | 0               |            |           |          |          |          |          |          |                 |          |   |
| Cobalt - dissolved             | 3        | µg/l | AA                     | 0               | 15 <sup>#</sup> |            |           |          |          |          |          |          |                 |          |   |
| Cypermethrin                   | 0.00008  | µg/l | AA                     | 10              | 1               | 2          | 5         | 0        | 0        | 0        | 1        | 0        | 2               | 3        |   |
| Diazinon                       | 0.01     | µg/l | AA                     | 1               | 0               |            |           |          |          |          |          |          | 0               |          |   |
| Dissolved oxygen               | *        | %    | 10 <sup>th</sup>       | 13              | 2               | 4          | 7         | 3        | 2        | 1        | 1        | 0        | 2               | 0        |   |
| Fluoranthene                   | 0.0063   | µg/l | AA                     | 0               | 29              | 6          | 8         | 6        | 6        | 6        | 6        | 6        | 19              | 6        |   |
| Manganese – bioavailable**     | 123      | µg/l | AA                     | 0 <sup>#</sup>  | 17              |            |           |          |          |          |          |          | 0 <sup>##</sup> |          |   |
| Nickel - bioavailable**        | 4        | µg/l | AA                     | 2               | 23              | 0          | 0         | 0        | 0        | 0        | 0        | 0        | 0               | 0        |   |
| Perfluorooctane sulfonic acid  | 0.00065  | µg/l | AA                     | 30              | 30              | 6          | 19        | 6        | 6        | 6        | 6        | 6        | 16              | 6        |   |
| Permethrin                     | 0.001    | µg/l | AA                     | 10 <sup>#</sup> | 1               |            |           |          |          |          |          |          |                 |          |   |
| Soluble reactive phosphorus    | *        | µg/l | AA                     | 23              | 4               | 6          | 8         | 3        | 2        | 4        | 5        | 0        | 17              | 5        |   |
| Sulphide or hydrogen sulphide  | 0.25     | mg/l | AA                     | 7               | 18              | 4          | 9         | 4        | 3        | 6        | 3        | 4        | 14              | 3        |   |
| Total anions                   | 250      | µg/l | AA                     | 5 <sup>#</sup>  | 15 <sup>#</sup> |            |           |          |          |          |          |          | 1               |          |   |
| Tributyltin compounds          | 0.0002   | mg/l | AA                     | 1               | 1               | 1          | 0         | 0        | 5        | 0        | 5        | 0        | 2               | 1        |   |
| Zinc - bioavailable**          | *        | µg/l | AA                     | 12              | 10              | 0          | 0         | 0        | 0        | 0        | 0        | 0        | 0               | 0        |   |
| <b>Total number of samples</b> | -        | -    | -                      | <b>31</b>       | <b>30</b>       | <b>6</b>   | <b>19</b> | <b>6</b> | <b>6</b> | <b>6</b> | <b>6</b> | <b>6</b> | <b>20</b>       | <b>6</b> |   |

<sup>+</sup>AA = Annual Average. Numbers of exceedances are shown for illustrative purposes only and reflect individual samples being compared to an AA or percentile derived EQS.

\* Site specific EQS determined, see Table 3-2 for details.

\*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT)<sup>-26</sup>

<sup>#</sup> Total number of samples collected = 19 (not included in Phase 1 dataset).

<sup>##</sup> Drinking water suite parameters added to this site in October 2021 so total number of samples = 12.

<sup>25</sup> Blue shading indicates EQS (WFD and EQSD) exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. For further detail relating to analysis suites see Table 2-2. The count of individual EQS exceedances are also given\*.

<sup>26</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktag](#)



Table 3-4 – Concentrations of compounds responsible for EQS (WFD and EQSD) exceedance.<sup>27</sup>

| Compound                       | Standard | Unit | Statistic <sup>+</sup> | Upper GUC |           | Middle GUC |           |           |           |           |          |          | Lower GUC   |          |
|--------------------------------|----------|------|------------------------|-----------|-----------|------------|-----------|-----------|-----------|-----------|----------|----------|-------------|----------|
|                                |          |      |                        | Source    | Discharge |            |           |           |           |           |          |          | Abstraction |          |
|                                |          |      |                        | Site 1    | Site 3    | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14  | Site 15  | Site 6      | Site 16  |
| Acid neutralisation capacity   | 40       | mg/l | AA                     | 1858      | 2584      | 3667       | 2921      | 3700      | 4567      | 4467      | 4000     | 3100     | 3425        | 2767     |
| Benzo(a)pyrene                 | 0.00017  | µg/l | AA                     | 0.00145   | 0.0173    | 0.0538     | 0.00536   | 0.0220    | 0.0206    | 0.0301    | 0.0279   | 0.0447   | 0.0248      | 0.0407   |
| BOD (5 day)                    | *        | mg/l | 90 <sup>th</sup>       | 2.84      | 2.82      | 2.67       | 3.43      | 2.48      | 3.37      | 2.48      | 3.17     | 5.47     | 4.93        | 3.28     |
| Bromine                        | 0.002    | mg/l | AA                     | 0.225     | 2.312     |            |           |           |           |           |          |          |             |          |
| Chlorothalonil                 | 0.035    | µg/l | AA                     | 0.0516    | 0.0350    |            |           |           |           |           |          |          |             |          |
| Cobalt - dissolved             | 3        | µg/l | AA                     | 1.79      | 10.7      |            |           |           |           |           |          |          |             |          |
| Cypermethrin                   | 0.00008  | µg/l | AA                     | 0.000211  | 0.000063  | 0.000087   | 0.000074  | 0.000150  | 0.000395  | 0.000160  | 0.000087 | 0.000155 | 0.000091    | 0.000187 |
| Diazinon                       | 0.01     | µg/l | AA                     | 0.0105    | 0.0100    |            |           |           |           |           |          |          | 0.0088      |          |
| Dissolved oxygen               | *        | %    | 10 <sup>th</sup>       | 57.2      | 73.7      | 38.2       | 62.4      | 66.2      | 44        | 56.5      | 59.7     | 80.0     | 74.8        | 79.8     |
| Fluoranthene                   | 0.0063   | µg/l | AA                     | 0.00241   | 0.01922   | 0.02755    | 0.00616   | 0.02453   | 0.01207   | 0.01492   | 0.01822  | 0.03665  | 0.01998     | 0.0347   |
| Manganese - bioavailable**     | 123      | µg/l | AA                     | 14.7      | 1508      |            |           |           |           |           |          |          | 12.7        |          |
| Nickel - bioavailable**        | 4        | µg/l | AA                     | 3.06      | 9.26      | 0.681      | 1.07      | 0.805     | 0.862     | 0.632     | 0.667    | 0.771    | 0.718       | 0.407    |
| Perfluorooctane sulfonic acid  | 0.00065  | µg/l | AA                     | 0.0191    | 0.0075    | 0.0071     | 0.0185    | 0.0018    | 0.0338    | 0.0352    | 0.0097   | 0.0018   | 0.0019      | 0.0034   |
| Permethrin                     | 0.001    | µg/l | AA                     | 0.00247   | 0.00105   |            |           |           |           |           |          |          |             |          |
| Soluble reactive phosphorus    | *        | µg/l | AA                     | 0.326     | 0.132     | 0.107      | 0.119     | 0.060     | 0.052     | 0.112     | 0.128    | 0.028    | 0.171       | 0.132    |
| Sulphide or hydrogen sulphide  | 0.25     | mg/l | AA                     | 7.57      | 15.47     | 12.33      | 12.42     | 12.00     | 9.50      | 15.00     | 13.00    | 14.17    | 25.80       | 10.0     |
| Total anions                   | 250      | µg/l | AA                     | 245       | 427       |            |           |           |           |           |          |          | 182         |          |
| Tributyltin compounds          | 0.0002   | mg/l | AA                     | 0.0000628 | 0.0000901 | 0.000178   | 0.0000389 | 0.0000717 | 0.0002750 | 0.0000492 | 0.000362 | 0.000128 | 0.000144    | 0.000122 |
| Zinc - bioavailable**          | *        | µg/l | AA                     | 14.1      | 9.31      | 2.40       | 2.73      | 1.13      | 1.18      | 0.74      | 2.00     | 1.86     | 2.69        | 2.09     |
| <b>Total number of samples</b> | -        | -    | -                      | <b>31</b> | <b>30</b> | <b>6</b>   | <b>19</b> | <b>6</b>  | <b>6</b>  | <b>6</b>  | <b>6</b> | <b>6</b> | <b>20</b>   | <b>6</b> |

<sup>+</sup>AA = Annual Average.

\* Site specific EQS determined, see Table 3-2 for details

\*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT).<sup>28</sup>

<sup>27</sup> Blue shading indicates EQS exceedance and grey shading indicates where failures relate to EQSD target compounds (not monitored at all sites, and as such not directly comparable across all sites). Concentrations corresponding to test statistic are also shown. For further detail relating to analysis suites see Table 2-2.

<sup>28</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktaq](#)



Table 3-5 – Number of WFD and EQSD MAC exceedances.<sup>29</sup>

| Compound                         | Standard | Unit | Statistic | Upper GUC |           | Middle GUC |           |          |          |          |          |          | Lower GUC |          |
|----------------------------------|----------|------|-----------|-----------|-----------|------------|-----------|----------|----------|----------|----------|----------|-----------|----------|
|                                  |          |      |           | Source    | Discharge | Site 1     | Site 3    | Site 10  | Site 5   | Site 11  | Site 12  | Site 13  | Site 14   | Site 15  |
| Benzo(a)pyrene                   | 0.027    | µg/l | MAC       | 0         | 5         | 5          | 0         | 2        | 1        | 3        | 3        | 4        | 8         | 3        |
| Benzo(b)fluoranthene*            | 0.017    | µg/l | MAC       | 0         |           |            |           |          |          |          |          |          | 8##       |          |
| Benzo(g,h,i)perylene*            | 0.0082   | µg/l | MAC       | 0         |           |            |           |          |          |          |          |          | 11##      |          |
| Benzo(k)fluoranthene*            | 0.017    | µg/l | MAC       | 0         |           |            |           |          |          |          |          |          | 3##       |          |
| Bromine - total residual oxidant | 0.005    | mg/l | MAC       | 18#       | 18        |            |           |          |          |          |          |          |           |          |
| Cypermethrin                     | 0.0006   | µg/l | MAC       | 3         | 0         | 0          | 0         | 0        | 1        | 1        | 0        | 0        | 0         | 0        |
| Mercury - dissolved              | 0.07     | µg/l | MAC       | 2         | 1         | 2          | 1         | 2        | 1        | 1        | 2        | 1        | 2         | 2        |
| Mercury - total                  | 0.07     | µg/l | MAC       | 2         | 2         | 2          | 2         | 2        | 1        | 1        | 2        | 2        | 2         | 2        |
| Nickel - dissolved               | 34       | µg/l | MAC       | 2         | 11        | 0          | 0         | 0        | 0        | 0        | 0        | 0        | 0         | 0        |
| Sulphide or hydrogen sulphide    | 1        | µg/l | MAC       | 7         | 18        | 4          | 9         | 4        | 3        | 6        | 3        | 4        | 14        | 3        |
| <b>Total number of samples</b>   | -        | -    | -         | <b>31</b> | <b>30</b> | <b>6</b>   | <b>19</b> | <b>6</b> | <b>6</b> | <b>6</b> | <b>6</b> | <b>6</b> | <b>20</b> | <b>6</b> |

\* While these determinands have a MAC, as per the WFD there is no corresponding AA statistic as benzo(a)pyrene should be considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water.

# Total number of samples collected = 19 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 12.

<sup>29</sup> Blue shading indicates MAC EQS exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of exceedances also given.



## 3.2 Drinking Water Quality Standards

### 3.2.1 Overview

Drinking water parameters, assessed through their comparison to PCVs are only required to characterise the source water at Minworth WwRC (Site 1) and the downstream abstraction location (Site 6 Leighton Buzzard). It is important to note, that specific drinking water parameters were only added to the analysis suite at Site 6 in October 2021, prior to which, only WFD parameters were analysed. As a result, 12 months of DWSP parameter data are reported, compared to Site 1, for which data from Phases 1-3 are available (29-months). The exception to this is where a determinand has a comparable PCV and is present in the WFD analysis suite (e.g., iron). In these instances, all monitoring data are compared to the relevant drinking water standard.

Across both sites where drinking water PCVs apply, there have been a total of 309 instances of PCV exceedances to date (Site 1 = 189 exceedances, Site 6 = 120 exceedances). The distribution of these exceedances across the sites can be seen in Figure 3-2, with a detailed breakdown in Table 3-6. Several determinands exceeded PCVs in every, or almost every, sampling round. These determinands, along with the number of exceedances observed at Site 6 (the example abstraction location), are given below and discussed in turn in the following section.

- Benzo(a)pyrene (total exceedances = 12)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 12)
- *Escherichia coli* (*E.coli*, total exceedances = 12)
- Iron - total (total exceedances = 17)
- Nitrite (total exceedances = 8)
- Turbidity (total exceedances = 12)

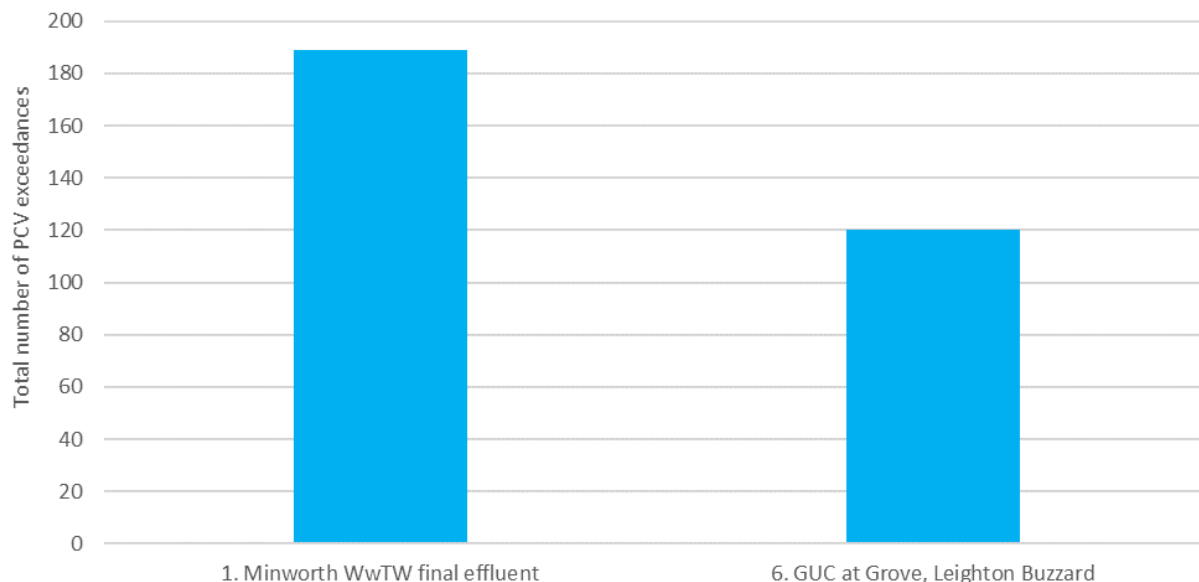


Figure 3-2 - Total number of PCV exceedances split by site location<sup>30</sup>

<sup>30</sup> Site 1 includes data from all phases covering May 20 – September 22, a 29-month period, sampling for the DWSP suite at Site 6 covers the period October 21 – September 22, a 12-month period.

*C. perfringens* (a sulphite-reducing species commonly associated with faecal contamination) is widely distributed in the environment and is regularly evaluated with the aim of understanding the microbiological safety of drinking water supplies. *C. perfringens* is responsible for gastrointestinal disease, the spores of which persist longer than other indicators of contamination, such as Coliforms (which also demonstrated exceedances at all sites and is also an important indicator of faecal contamination). Sources of bacterial contamination can range from the input of animal manures from farmyard runoff and the discharge of untreated, and even treated, sewage effluent.<sup>31</sup> *Cryptosporidium* was not detected at either site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward.

Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores. However, as canal networks often have shallow depths (<6ft), short lived events may be a result of localised disturbance of sediments by boats or dogs and other wildlife swimming in the vicinity of the sensor location.

## 3.2.2 Rainfall events

### 3.2.2.1 Analysis of historic rainfall events

A number of rainfall events were captured during the monitoring period. Rainfall events coincided with sampling on 14/09/21 (daily rainfall total = 9.3 mm), 07/12/21 (daily rainfall total = 5.7 mm), and 11/01/22 (daily rainfall total = 4.5 mm). Exceedances in both nitrite (1.2 = mg/l NO<sub>2</sub>, PCV = 0.5 mg/l NO<sub>2</sub>) and iron (total = 230 µg/l, PCV = 200 µg/l) were observed during the rainfall event that occurred on 14/09/21. DWSP were only added to Site 6 in November 2021 and as such none of these determinands can be assessed. During the second rainfall event that coincided with sampling on 07/12/21, additional PCV exceedances in ammonium (1.88 mg/l NH<sub>4</sub>, PCV = 0.5 mg/l NH<sub>4</sub>), nitrate (53 mg/l NO<sub>3</sub>, PCV = 50 mg/l NO<sub>3</sub>) and colour (24 mg/lPt/Co, PCV = 20 mg/lPt/Co) were observed. Although cell counts for *E.coli* regularly exceed PCVs (as this is set to 0 MPN/100 ml) these were elevated during the rainfall event. Cell counts of 1730 MPM/100ml were observed on 07/12/21, compared to the preceding dry sample value of 687 MPM/100ml (09/11/21).

A number of exceedances were also observed for an additional sample collected on 20/10/2021 which coincided with a period of intense rainfall relative to the other storms captured (see Figure 2-2). October 2021 experienced 120 mm total rainfall compared to 55 mm in the preceding month with a daily total on 20/10/2021 of 40 mm (see Figure 2-2). Of the additional exceedances observed, of note are the presence of tebuconazole, an agricultural triazole fungicide used to treat plant pathogenic fungi, and metribuzin, a synthetic herbicide applied both pre- and post-emergence of vegetable crops. It is likely these are of agricultural origin, leached by the heavy rainfall experienced during the month, with each rainstorm increasing ground saturation and further facilitating additional losses. The Ledburn Book has its confluence with the GUC directly south (upstream) of Site 6. Ledburn Book is a heavily modified water body which lists poor agricultural land management as one of its contributing factors for not achieving good status under WFD. The presence of a ditch upstream of Site 6 was also observed with a visually elevated suspended sediment loading. It is therefore likely that these catchment areas may be responsible for the delivery of these additional compounds during periods of heavy rainfall.

This storm event also resulted in additional exceedances of PAH, aluminium (dissolved), and iron (dissolved), which were not regularly experienced under base flow conditions. A subsequent rainfall event which occurred on 11/01/22 (daily rainfall total = 4.5 mm) demonstrated no additional exceedances of tebuconazole or metribuzin. Antecedent conditions for this month, however, were considerably different from those experienced in October 2021. As discussed in Section 2.6, national rainfall totals for January 2022 were on average 40% lower than the preceding year (January 2022 = 21.2 mm, January 2021 = 127 mm). Reduced rainfall, leading to

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<sup>31</sup> [final\\_jrc\\_tech\\_report\\_dwd\\_06.04.20\\_final\\_pdf\(4\).pdf](#)

drier soil conditions may have resulted in a lower rate of pollutant transport, and as such, there were no additional exceedances of the agricultural biproducts observed during the last period of rainfall that coincided with sample collection.

While these determinands are useful indicators of compounds that may be of concern following abstraction (depending on their relative drinking water treatment removal efficiencies) PCVs apply only to treated drinking water, and not raw source waters, which helps to explain why these numbers are considerably higher than the number of EQS failures. They do however, aid in future planning helping to ensure treatment facilities are tailored towards the chemicals of concern. Table 3-7 shows the maximum concentrations observed across four of the potential abstraction locations. Based on maximum concentrations discharged from Minworth WwRC, the following parameters have the potential to result in additional instream breaches of PCVs: colour, nitrate and PAH (sum).

Rainfall during April 2022 was low (17.9 mm) when compared to both the regional long-term (RLT) mean (1991-2020, UK Met Office Climate Region: England S, 53.4 mm) and data collected from Dancers End Reservoir (DER) in 2021 (5.67 mm). A similar story was observed for both May (RLT = 55.2 mm, DER 2021 = 122 mm, DER 2022 = 47 mm) and June (RLT = 59.1 mm, DER 2021 = 99 mm, DER 2022 = 11.2 mm). As a result of these lower-than-average monthly rainfall totals, no sampling conducted during these sampling rounds coincided with a rainfall event. A similar story was true with data for June, July and August with RLT values of 60.1, 67.9 and 61.9 mm compared to DER rainfall totals of 48.5, 11.2 and 23.8 mm, respectively.

### 3.2.3 Drought conditions

As discussed in Section 2.6, during the summer of 2022 the UK experienced a prolonged period of dry weather culminating in a severe summer heatwave. While additional exceedances in substances that had previously exceeded their respective PCVs were observed, no *additional* PCV substance exceedances were observed during the latest monitoring which coincided with a prolonged period of dry weather.



Table 3-6 – Number of drinking water PCV exceedances<sup>32</sup>.

| Compound   | PCV  | Unit                 | Source          | Abstraction site |
|--|------|----------------------|-----------------|------------------|
|  |      |                      | Site 1**        | Site 6**         |
| Aluminium - total  | 200  | µg/l                 | 0               | 8                |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l                 | 1 <sup>#</sup>  | 1 <sup>#</sup>   |
| Benzo(a)pyrene   | 0.01 | µg/l                 | 0               | 12               |
| Bisphenol A  | 2.5  | µg/l                 | 9 <sup>#</sup>  | 0 <sup>##</sup>  |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml             | 19 <sup>#</sup> | 12 <sup>##</sup> |
| Chlorate   | 0.25 | mg/l                 | 4 <sup>#</sup>  | 0 <sup>##</sup>  |
| Chloride   | 250  | mg/l                 | 1 <sup>#</sup>  | 0 <sup>##</sup>  |
| Chlorite   | 0.25 | µg/l                 | 0 <sup>#</sup>  | 1                |
| Chromium - total   | 50   | µg/l                 | 1               | 0                |
| Clopyralid   | 0.1  | µg/l                 | 1               | 0                |
| Coliform - total   | 0    | MPN/100ml            | 19              | 12 <sup>##</sup> |
| Colour   | 20   | mg/Pt/Co             | 18 <sup>#</sup> | 2 <sup>##</sup>  |
| <i>E. coli</i>   | 0    | MPN/100ml            | 19 <sup>#</sup> | 12 <sup>##</sup> |
| Iron - dissolved   | 200  | µg/l                 | 0               | 1                |
| Iron - total   | 200  | µg/l                 | 6               | 17               |
| Manganese - dissolved  | 50   | µg/l                 | 18 <sup>#</sup> | 1 <sup>##</sup>  |
| Manganese - total  | 50   | µg/l                 | 19 <sup>#</sup> | 3 <sup>##</sup>  |
| Mercury - total  | 1    | µg/l                 | 1               | 0                |
| Metribuzin   | 0.1  | µg/l                 | 0 <sup>#</sup>  | 1 <sup>##</sup>  |
| Nickel - dissolved   | 20   | µg/l                 | 4               | 0                |
| Nickel - total   | 20   | µg/l                 | 4               | 0                |
| Nitrate  | 50   | mg/l NO <sub>3</sub> | 12 <sup>#</sup> | 2                |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub> | 17 <sup>#</sup> | 8                |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                 | 0 <sup>#</sup>  | 4 <sup>##</sup>  |
| PAH sum*   | 0.1  | µg/l                 | 0 <sup>#</sup>  | 8 <sup>##</sup>  |
| Propyzamide  | 0.1  | µg/l                 | 1 <sup>#</sup>  | 0 <sup>##</sup>  |
| Sulphate   | 250  | mg/l SO <sub>4</sub> | 0 <sup>#</sup>  | 1 <sup>##</sup>  |
| Tebuconazole   | 0.1  | µg/l                 | 0 <sup>#</sup>  | 1 <sup>##</sup>  |
| Turbidity  | 1    | NTU                  | 15 <sup>#</sup> | 12 <sup>##</sup> |
| Vinyl chloride   | 0.5  | µg/l                 | 0               | 1                |
| <b>Total number of samples</b>   |      |                      | <b>30</b>       | <b>20</b>        |

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

\*\* Data at Site 1 covers May 20 - September 22 and data at Site 6 covers April 21 - September 22.

# Total number of samples collected = 19 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 12.

<sup>32</sup> Blue shading indicates PCV exceedance, with the number of exceedances provided



**Table 3-7 – Concentrations of compounds responsible for drinking water PCV exceedances.<sup>33</sup>**

| Compound   | PCV  | Unit                    | Source | Abstraction sites |
|--|------|-------------------------|--------|-------------------|
|  |      |                         | Site 1 | Site 6            |
| Aluminium - total  | 200  | µg/l                    | 125    | 530               |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l as NH <sub>4</sub> | 1.4    | 1.88              |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 0.0046 | 0.134             |
| Bisphenol A  | 2.5  | µg/l                    | 137    | 10                |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml                | >100   | >100              |
| Chlorate   | 0.25 | mg/l                    | 2      | 0.7               |
| Chloride   | 250  | mg/l                    | 610    | 75                |
| Chlorite   | 0.25 | µg/l                    | <3     | 15                |
| Chromium - total   | 50   | µg/l                    | 140    | 15                |
| Clopyralid   | 0.1  | µg/l                    | 0.19   | 0.03              |
| Coliform - total   | 0    | MPN/100ml               | >2420  | >2420             |
| Colour   | 20   | mg/Pt/Co                | 41     | 26                |
| <i>E. coli</i>   | 0    | MPN/100ml               | >2420  | >2420             |
| Iron - dissolved   | 200  | µg/l                    | 100    | 1700              |
| Iron total   | 200  | µg/l                    | 310    | 2600              |
| Manganese - dissolved  | 50   | µg/l                    | 130    | 120               |
| Manganese - total  | 50   | µg/l                    | 160    | 150               |
| Mercury - total  | 1    | µg/l                    | 3.7    | 0.71              |
| Metribuzin   | 0.1  | µg/l                    | <0.05  | 0.22              |
| Nickel - dissolved   | 20   | µg/l                    | 61     | 7.1               |
| Nickel - total   | 20   | µg/l                    | 61     | 9.4               |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 120    | 100               |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 3.6    | 2.5               |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | -      | 0.374             |
| PAH sum*   | 0.1  | µg/l                    | <0.05  | 0.62              |
| Propyzamide  | 0.1  | µg/l                    | 0.32   | 0.1               |
| Sulphate   | 250  | mg/l SO <sub>4</sub>    | 180    | 690               |
| Tebuconazole   | 0.1  | µg/l                    | 0.05   | 0.2               |
| Turbidity  | 1    | NTU                     | 14.00  | 210               |
| Vinyl chloride   | 0.5  | µg/l                    | 0.50   | 1.00              |

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

<sup>33</sup> Dark blue shading indicates PCV exceedance, maximum reported values are also given.



## 3.2.4 Analysis

### 3.2.4.1 Long term data records

In this section temporal patterns in key determinand concentrations are explored. For data compilation and the completion of standard data quality assurance procedures, descriptive statistical analyses were conducted on data from all sites, including the generation of mean, maximum, minimum statistics in addition to percentile values including the 95<sup>th</sup>, 90<sup>th</sup>, and 10<sup>th</sup> percentiles. Samples at the limit of detection were included in the analysis and used at face value to adhere to discharge permitting assessment guidance. Any significant outliers were removed from the analysis.

Four sites have data spanning >12 months, these include Site 1 Minworth (30 months), Site 3 Coventry Canal at Atherstone (30 months), Site 5 GUC at Welton Lane, Daventry (19 months) and Site 6 Grove Lock, Leighton Buzzard (19 months) and as such discussion around temporal trends are reserved for these sites. The remaining sites including Site 10 GUC at Bedworth, Site 11 GUC at Little Heath Long Buckby, Site 12 GUC at Gayton, Site 13 GUC at Stoke Bruerne, Site 14 GUC at Cosgrove, Site 15 GUC at Stoke Hammond and Site 16 GUC at Marsworth all have six months of data. The addition and removal of sites has resulted in site numbers no longer being in numerical order correlating with distance downstream. As a result, sites are plotted below in order of distance downstream to aid interpretation, rather than by site number. Temporal plots of the four most common determinands to breach EQS values (benzo(a)pyrene, PFOS, soluble reactive phosphorus, and BOD) across all sites can be seen in Figure 3-3 to Figure 3-13. These determinands are discussed in turn below.

#### Benzo(a)pyrene

Site 3 exhibits the most striking temporal pattern in benzo(a)pyrene concentrations. Increases in benzo(a)pyrene concentration were observed through mid/late summer peaking in August/September at 0.0695 µg/l, 0.042 µg/l, and 0.065 µg/l for 2020, 2021 and 2022 respectively. The occurrence of peak concentrations at a similar time of year for three consecutive years suggests this is a seasonal pattern and may have been the result of an increase in fossil fuel combustion resulting from increasing usage of the canal network for transport and recreation during the summer months. A reduction in dilution capacity caused by a lower frequency of rainfall events may have acted to further exacerbate this trend. A marginal increase in concentration was observed in December 2020 and may have been the result of a sudden increase in the inefficient burning of fuel for heating (during the winter months) such as log burning stoves, common on house boats and barges, prevalent across the canal network. This trend of increasing PAH discharge in riverine systems has been observed across the scientific literature.<sup>34</sup>

Data from Minworth final effluent demonstrated no obvious seasonal trends, with peak concentrations occurring in December 2020 and October 2021. Benzo(a)pyrene concentration at Site 6 peaked in October 2021 in the sample collected to coincide with wet weather conditions. This peak in concentration (0.134 µg/l) is considerably higher than all other concentrations observed during this record. Long term trends in benzo(a)pyrene concentrations appear to have increased at Site 6 since the commencement of Phase 3. Both the increased concentration observed during high flow and the steady increase in benzo(a)pyrene concentrations over time may be, at least in part, explained by a marginal shift in sampling location to downstream of the Ledburn Brook, however, as no samples are routinely collected from this tributary, this hypothesis cannot be tested here.

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<sup>34</sup> [Seasonal and long-term trends in atmospheric PAH concentrations: evidence and implications - ScienceDirect](#)

## Soluble reactive phosphorus

Differences in concentration patterns between sites suggest a complex assortment of phosphorus source areas across landscape scales. No clear seasonal trends were evident; however, concentrations were elevated during the autumn and winter months, encompassing October through February. Phosphorus is commonly leached from a number of sources (predominantly agricultural) under intense rainfall conditions due to a combination of its charge, and its affinity for sediment. As a result, it is likely that peaks in phosphorus concentrations outside any observable seasonal pattern were the result of catchment delivery from diffuse sources. The considerable peak in phosphorus concentration that occurred at Site 3 in December 2020 did not correlate with a large rainfall event, suggesting either a more local, flow independent source may be responsible or a localised rainfall event. Peak phosphorus concentrations at Site 6 were observed coinciding with an intense period of rainfall, suggesting flushing of local sources, which are commonly soil phosphorus stores.

By contrast, concentrations at Site 5 peaked during the summer months of 2021 and 2022. Peaks during periods of reduced flows suggests point source loading dominating SRP flux as instream dilution capacity reduces, and the point source discharge comprises a greater proportion of instream flow, increasing concentrations. During the winter months when a greater proportion of the water is entering the river network being transported overland, this overland flow acts to dilute the receiving waterbody, reducing concentrations.

Patterns in data from Minworth treated effluent were highly variable, peaking during Phase 1 between October 2020 and February 2021. This was a considerable increase and may be related to operational issues taking place at the works as concentrations remain below 0.4 mg/l from March 2022 to the end of the reporting period. July-September saw annual maximum SRP concentrations in Minworth WwRC final effluent. The peak in SRP concentration observed in the 2020-2021 period is repeated, although with concentrations reduced, between October 2021 and February 2022 and again during the most recent reporting period from July 2022 onwards. The cyclical nature of these increases suggests this may be the result of regular site maintenance or the delivery of overland sources rich in phosphorus to the works.

## PFOS

Although most uses of PFOS and related substances are now heavily restricted, landscape sources still exist due to its historical use in products such as carpets and other textiles. As a result, 'legacy emissions' relating to the washing of these products and subsequent release to the environment through WwRC or indirectly through the land application of biosolids are common. A weak seasonal pattern was observed in PFOS data with concentrations experiencing a maximum during the late summer months and a minimum during the winter months. This was likely due to the changing dilution capacity of the canal between seasons. As inputs from point sources (e.g., WwRC or septic tanks) are relatively consistent across the year, a seasonal signal is often superimposed on synthetic chemicals as winter dilution from higher baseflow input decreases instream concentrations. This has been found with a number of chemicals of emerging concern including the brominated flame retardant hexabromocyclododecane (HBCDD).<sup>35</sup>

## BOD

Results from the analysis of BOD were more variable and likely reflect local conditions and nutrient sources. Increases in BOD are commonly associated with increases in organic loading (due to the increased oxygen required to break down the organic material). Although no clear seasonal trend exists, BOD broadly peaks during the summer months (June, July, August). This pattern is consistent with bacterial breakdown of a point source input of organic matter, as instream dilution capacity drops during the summer months, increasing nutrient concentrations and BOD. Significant peaks in BOD occurred at Site 3 on between July – September

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<sup>35</sup> [Seasonal variation of contaminant concentrations in wastewater Recycling Center effluents and river waters: Environmental Technology: Vol 41, No 21 \(tandfonline.com\)](#)



2021. While no rainfall events were observed in either July or August, there was a considerable rainfall event corresponding with September sampling (9.3 mm). This rainfall event may have delivered an organic load from a proximal source sufficient to deteriorate local conditions resulting in an increased BOD value. As observed with the other determinands discussed above, no seasonality was evident in final effluent samples collected from Minworth. As discussed in relation to SPR a sudden and continuous increase in BOD values were observed at Site 6 coinciding with the movement of the routine sampling location to downstream of the confluence with the Ledburn Brook. No increases in BOD were observed outside the normal measurement range during the most recent period of reduced rainfall.

#### **3.2.4.2 Patterns in the last quarter**

In the previous report it was stated that data collected from April-June 2022 for sites where baseline data exist (Sites 1, 3, 5, and 6) showed no variation from patterns established during previous monitoring phases as a result of the reduced rainfall in spring 2022. This pattern of reduced rainfall continued through to August 2022 with no considerable increase or decrease in substance concentrations beyond the ranges observed in preceding years (see Section 3.1).

Overall, the accumulation of data over multiple years, helps to identify seasonal patterns in substance concentrations (e.g., benzo[a]pyrene), which then help to explain potential catchment sources and transport mechanisms.



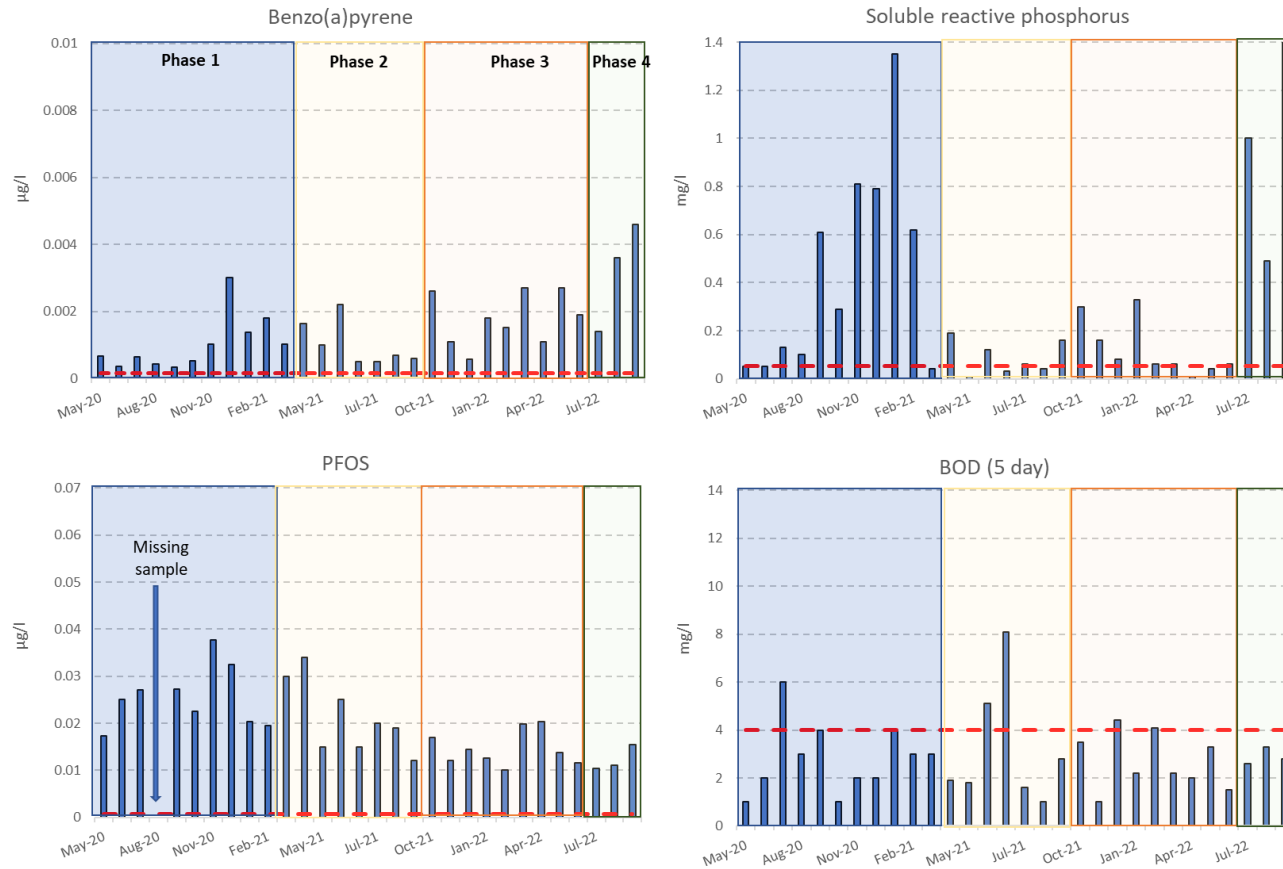


Figure 3-3 - Temporal trends in for key determinands at Site 1 Minworth WwRC final effluent (May 2020 - September 2022).<sup>36</sup>

<sup>36</sup> Red dashed line indicates the EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Note: this EQS is applicable to raw water samples and has been included as a visual guide only. Blue shading indicates Phase 1 data, yellow Phase 2, orange Phase 3 and green Phase 4. Values <LoD have been plotted at the LoD. Note: a different y-axis is used at this site for benzo(a)pyrene and soluble reactive phosphorus as the data reflect treated final effluent and not canal water samples.



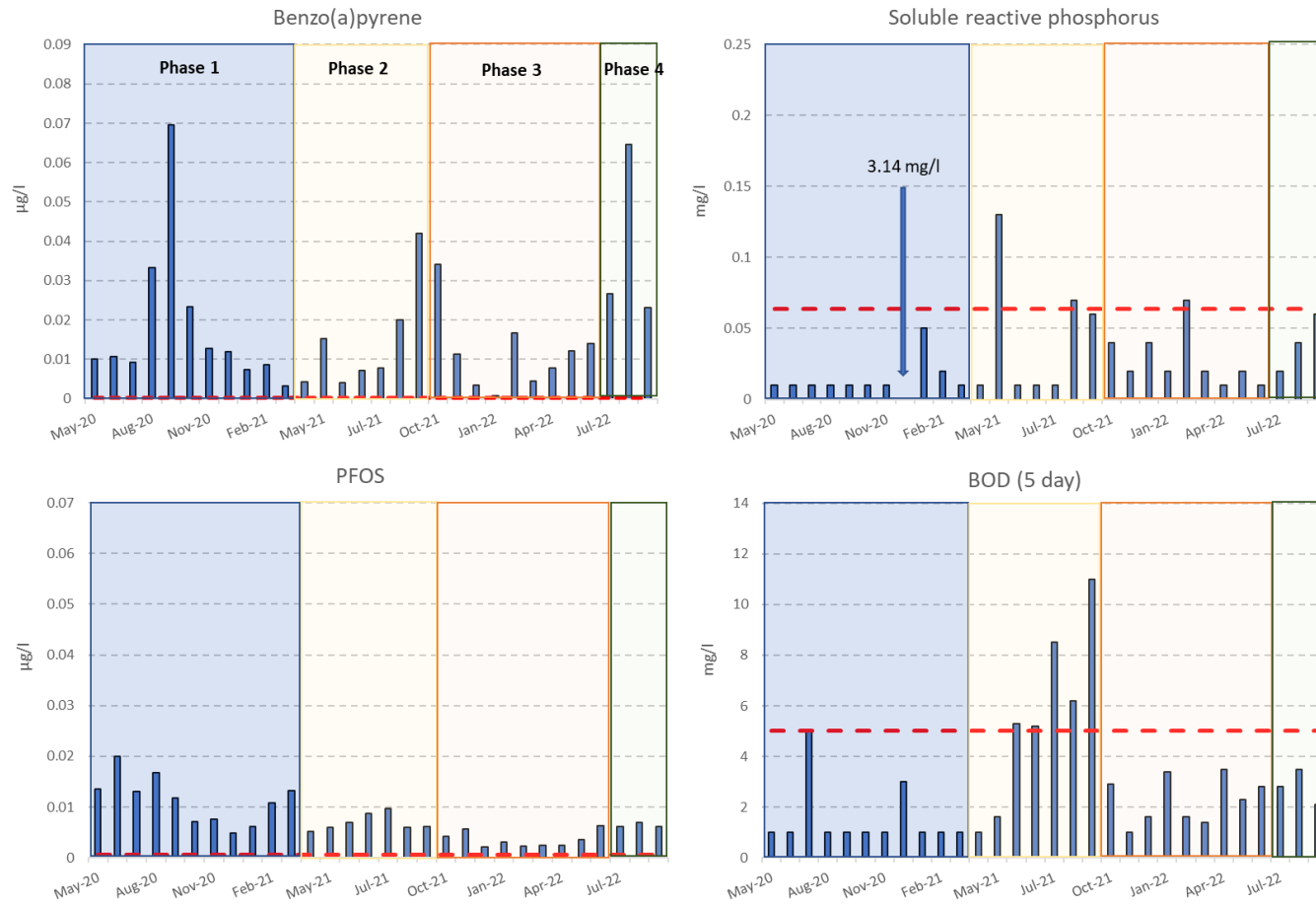
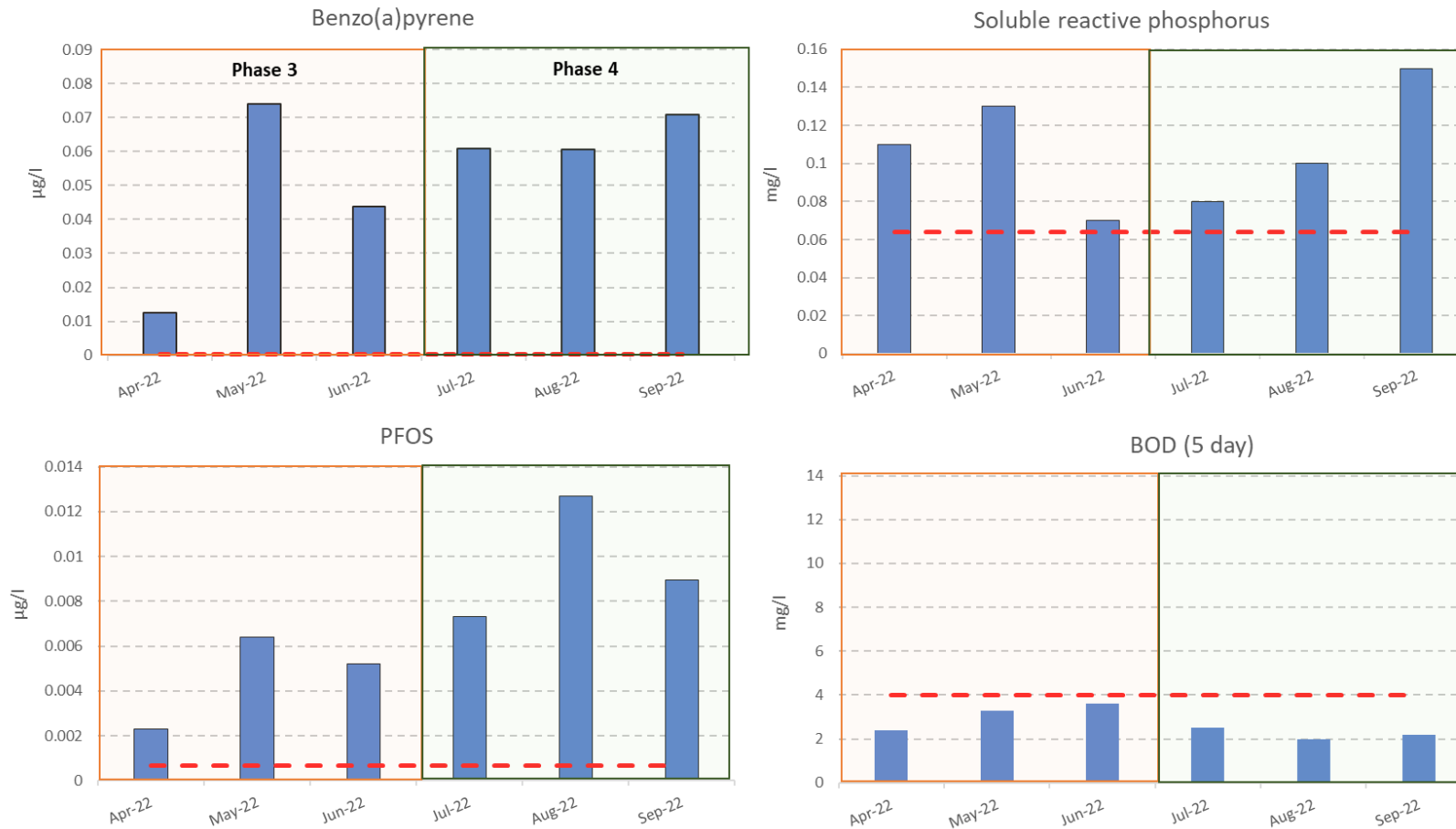


Figure 3-4 - Temporal trends in for key determinands at Site 3 Coventry Canal at Atherstone (May 2020 - September 2022).<sup>37</sup>

<sup>37</sup> Red dashed line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.064 mg/l, BOD = 5 mg/l). Blue shading indicates Phase 1 data, yellow Phase 2, orange Phase 3 and green Phase 4. Phase 1 analyses were conducted at a different analytical laboratory. Values <LoD have been plotted at the LoD.





**Figure 3-5 - Temporal trends in for key determinands at Site 10 GUC at Bedworth, Tring (April 2022 – September 2022).<sup>38</sup>**

<sup>38</sup> Red dashed line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.064 mg/l, BOD = 4 mg/l). Orange shading indicates Phase 3 data and green Phase 4. Values <LoD have been plotted at the LoD. Note: a different y-axis is used for PFOS due to the range of values observed at this site



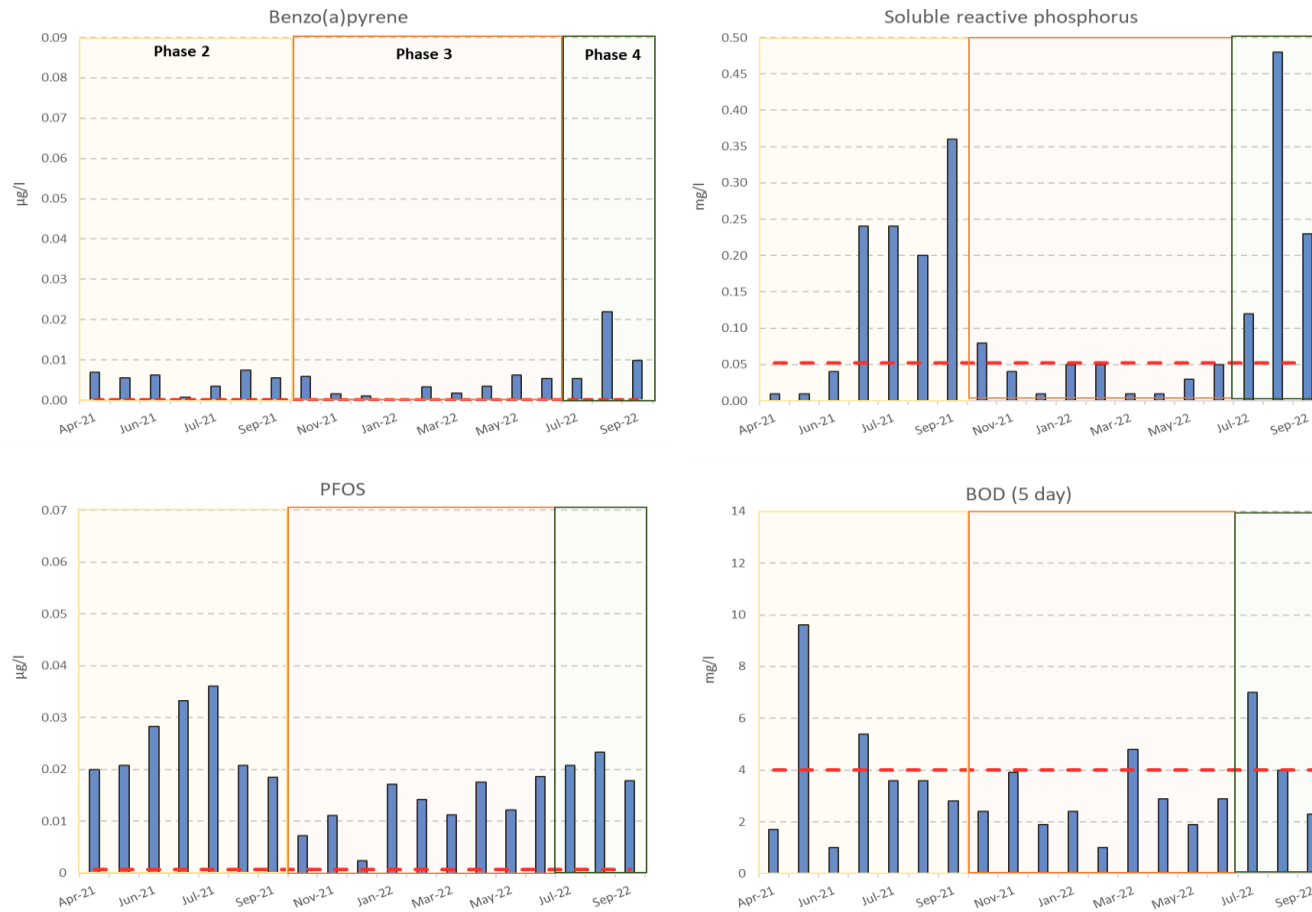


Figure 3-6 – Temporal trends in for key determinands at Site 5 GUC at Welton Lane, Daventry (April 2021 - September 2022).<sup>39</sup>

<sup>39</sup> Red dashed line indicated EQS value (see

Table 3-2 for details). Yellow shading indicated Phase 2 data, orange Phase 3 data and green Phase 4. Values <LoD have been plotted at the LoD (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.052 mg/l, BOD = 4 mg/l). Note: a different y-axis is used for soluble reactive phosphorus due to the range of values observed at this site.



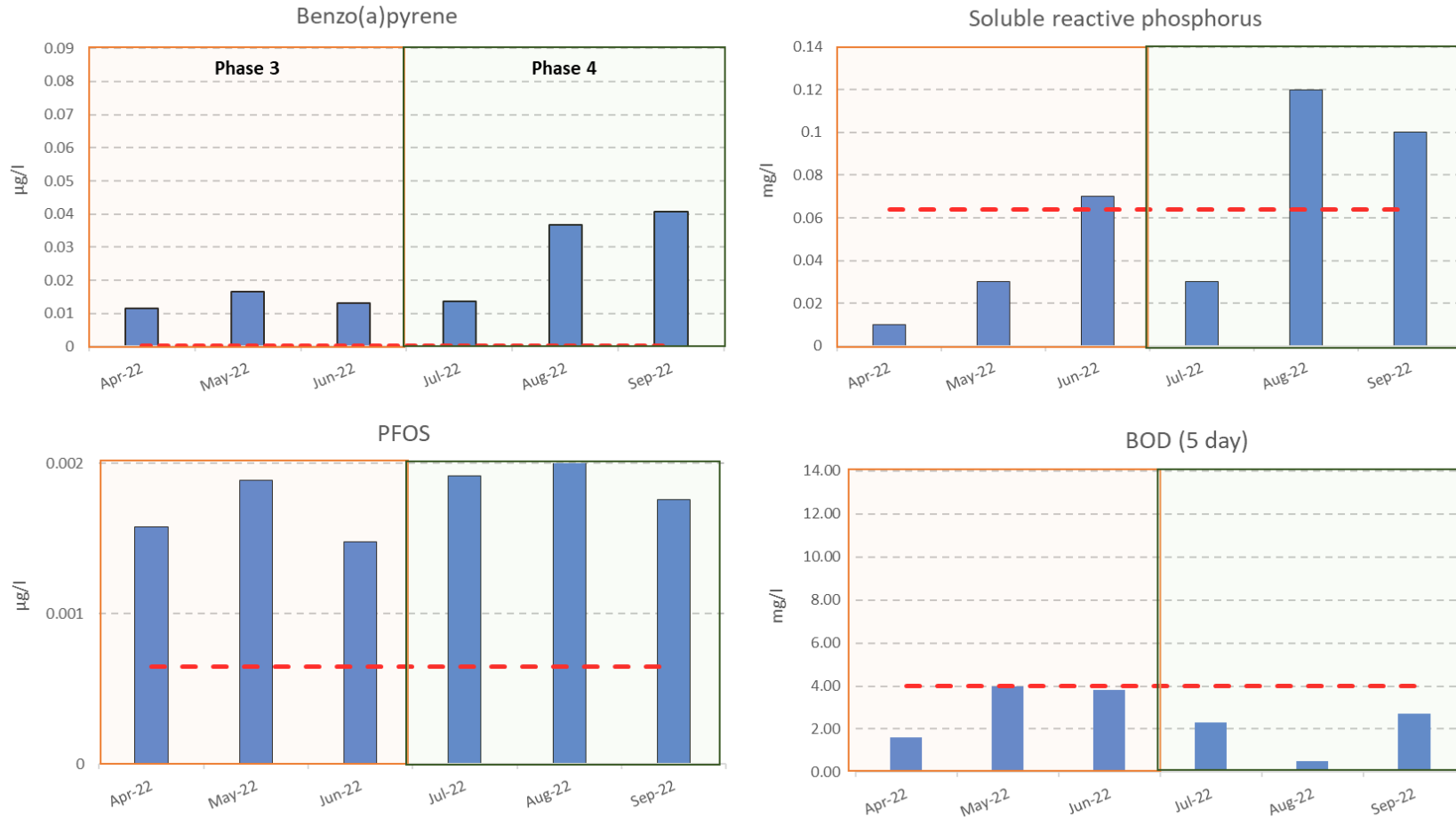


Figure 3-7 – Temporal trends in for key determinands at Site 11 GUC at Little Heath Long Buckby (April 2022 - September 2022).<sup>40</sup>

<sup>40</sup> Red dashed line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.064 mg/l, BOD = 4 mg/l). Orange shading indicates Phase 3 data and green Phase 4. Values <LoD have been plotted at the LoD. Note: a different y-axis is used for PFOS due to the range of values observed at this site.



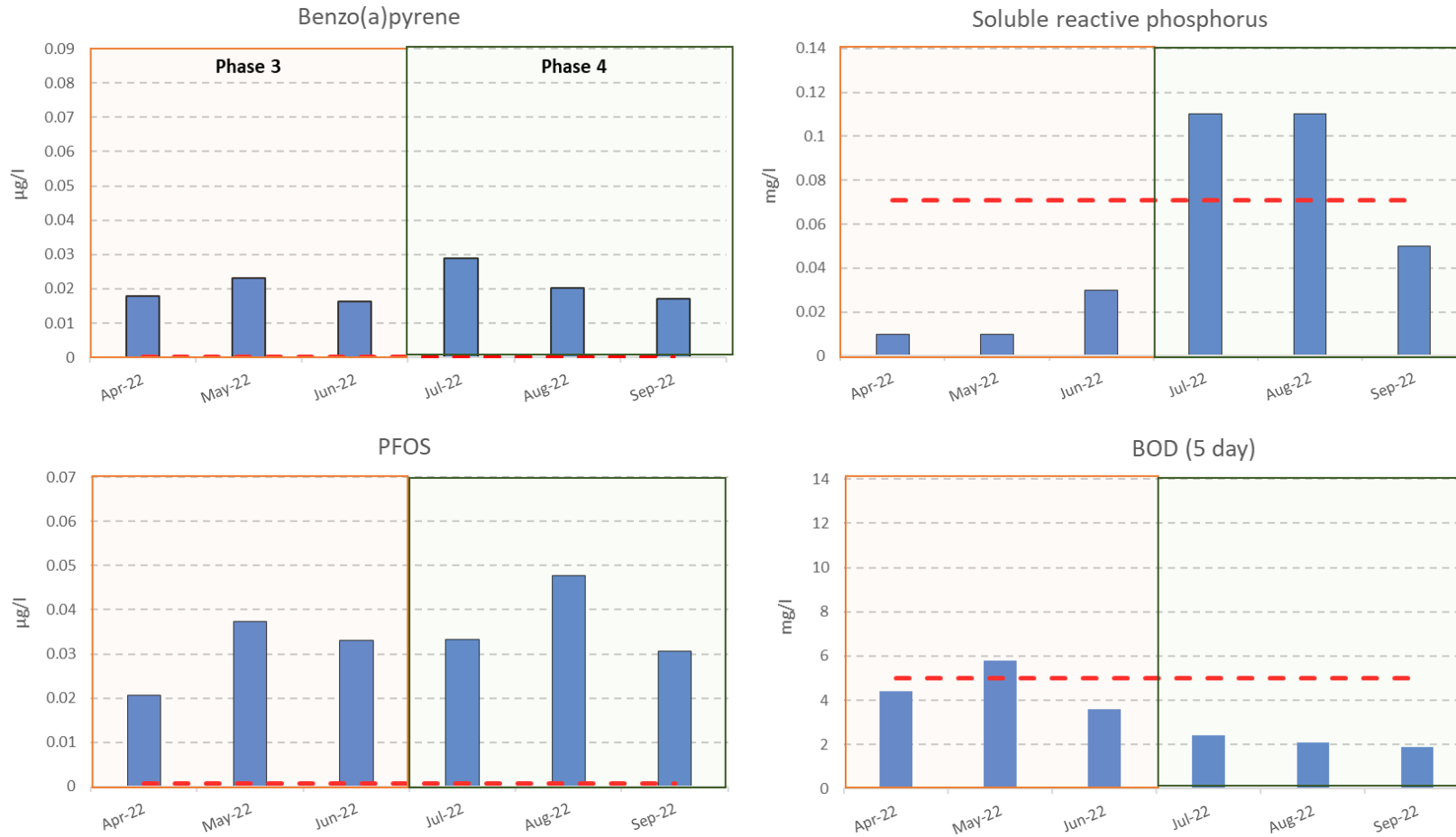
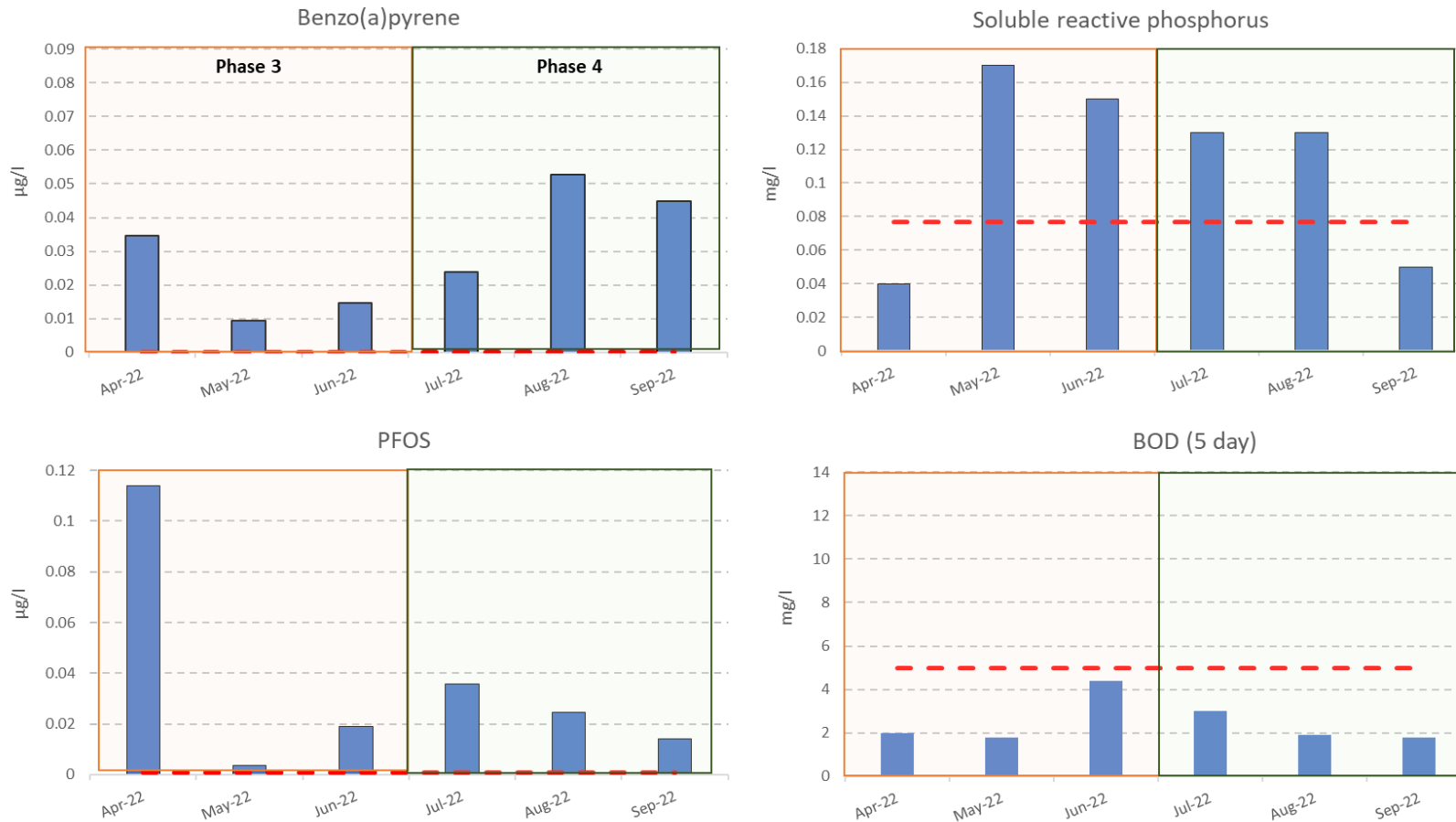


Figure 3-8 - Temporal trends in for key determinands at Site 12 GUC at Gayton (April 2022 – September 2022).<sup>41</sup>

<sup>41</sup> Red line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.071 mg/l, BOD = 5 mg/l). Orange shading indicates Phase 3 data and green Phase 4. Values <LoD have been plotted at the LoD.





**Figure 3-9 – Temporal trends in for key determinands at Site 13 GUC at Stoke Bruerne (April 2022 – September 2022).<sup>42</sup>**

<sup>42</sup> Red line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.077 mg/l, BOD = 5 mg/l). Orange shading indicates Phase 3 data and green Phase 4. Values <LoD have been plotted at the LoD. Concentrations that exceeded the y-axis range are indicated by an arrow with their concentration also given. Note: a different y-axis is used for PFOS due to the range of values observed at this site.



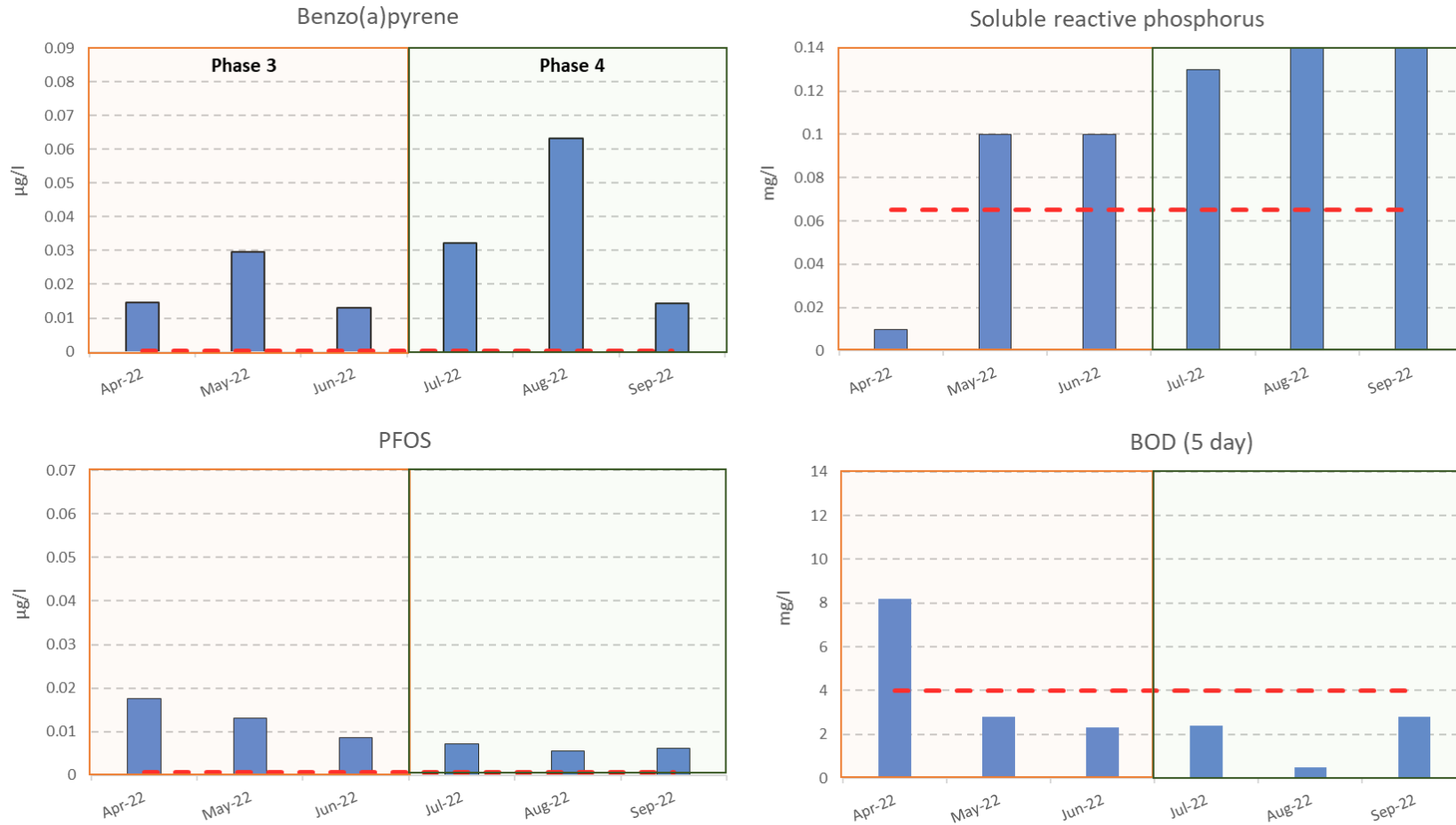
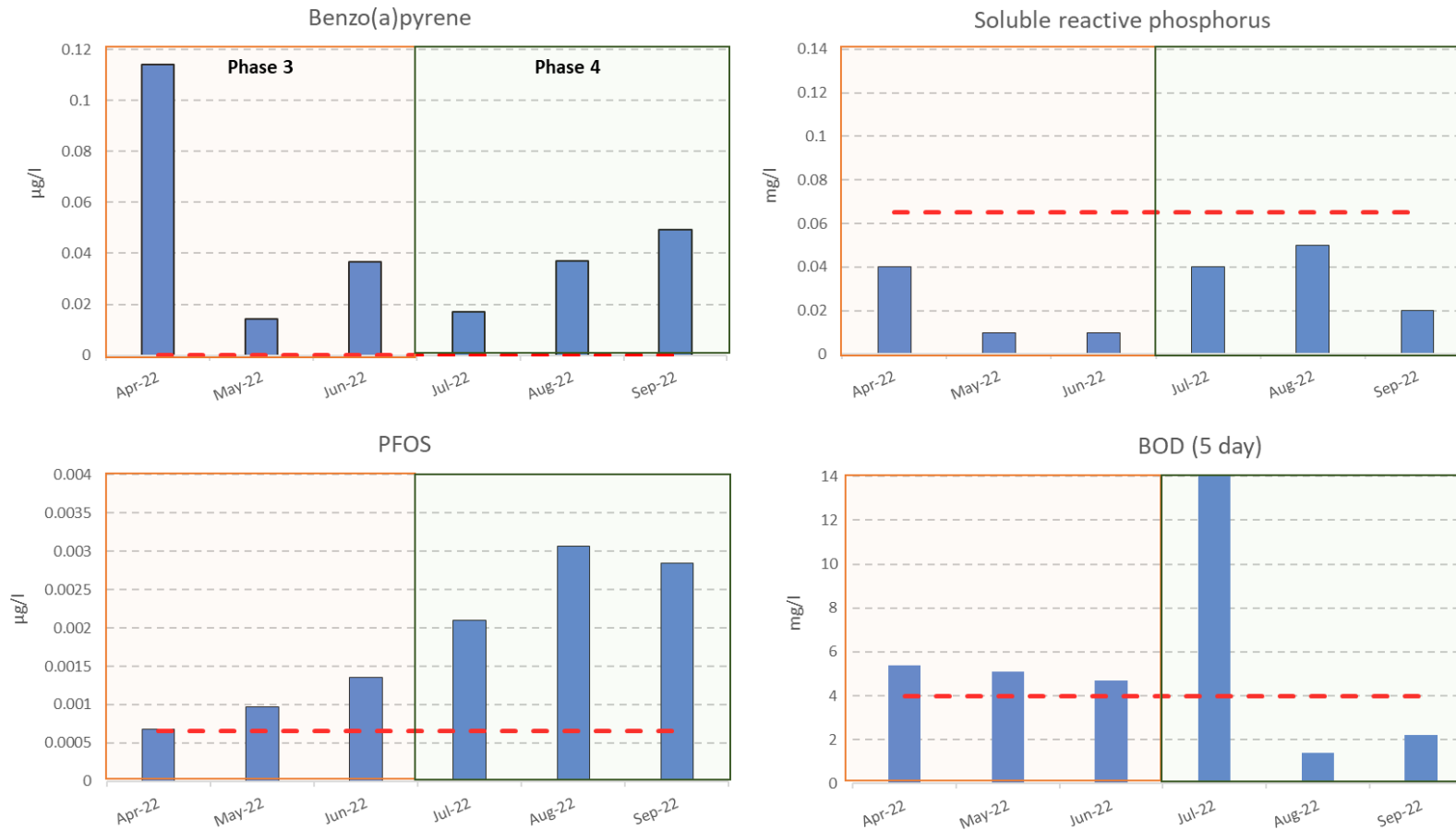


Figure 3-10 – Temporal trends in for key determinands at Site 14 GUC at Cosgrove (April 2022 – September 2022).<sup>43</sup>

<sup>43</sup> Red line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Orange shading indicates Phase 3 data and green Phase 4. Values <LoD have been plotted at the LoD.





**Figure 3-11 - Temporal trends in for key determinands at Site 15 GUC at Stoke Hammond (April 2022 – September 2022).<sup>44</sup>**

<sup>44</sup> Red line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Orange shading indicates Phase 3 data and green Phase 4. Values <LoD have been plotted at the LoD. Concentrations that exceeded the y-axis range are indicated by an arrow with their concentration also given. Note: a different y-axis is used for PFOS due to the range of values observed at this site.



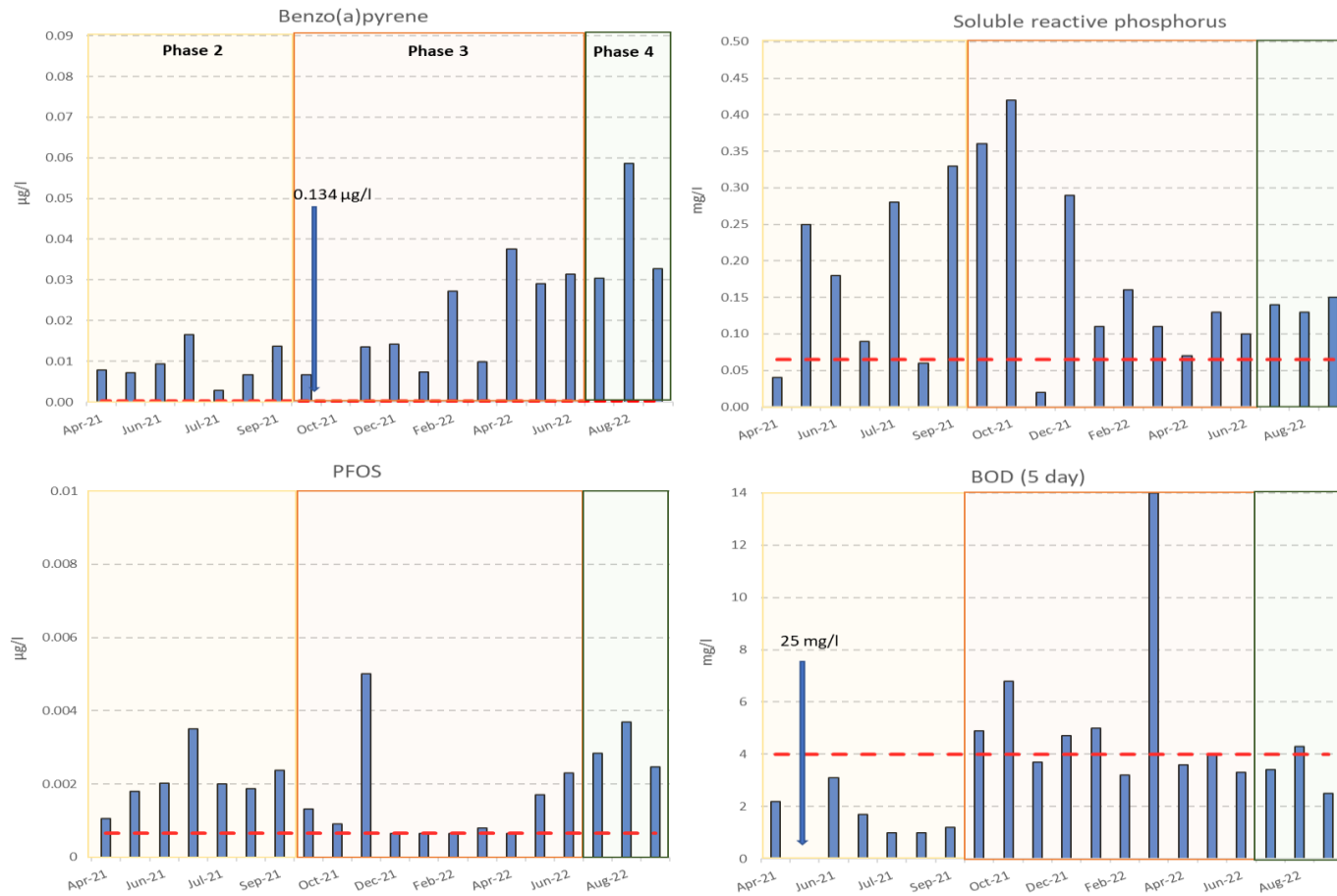
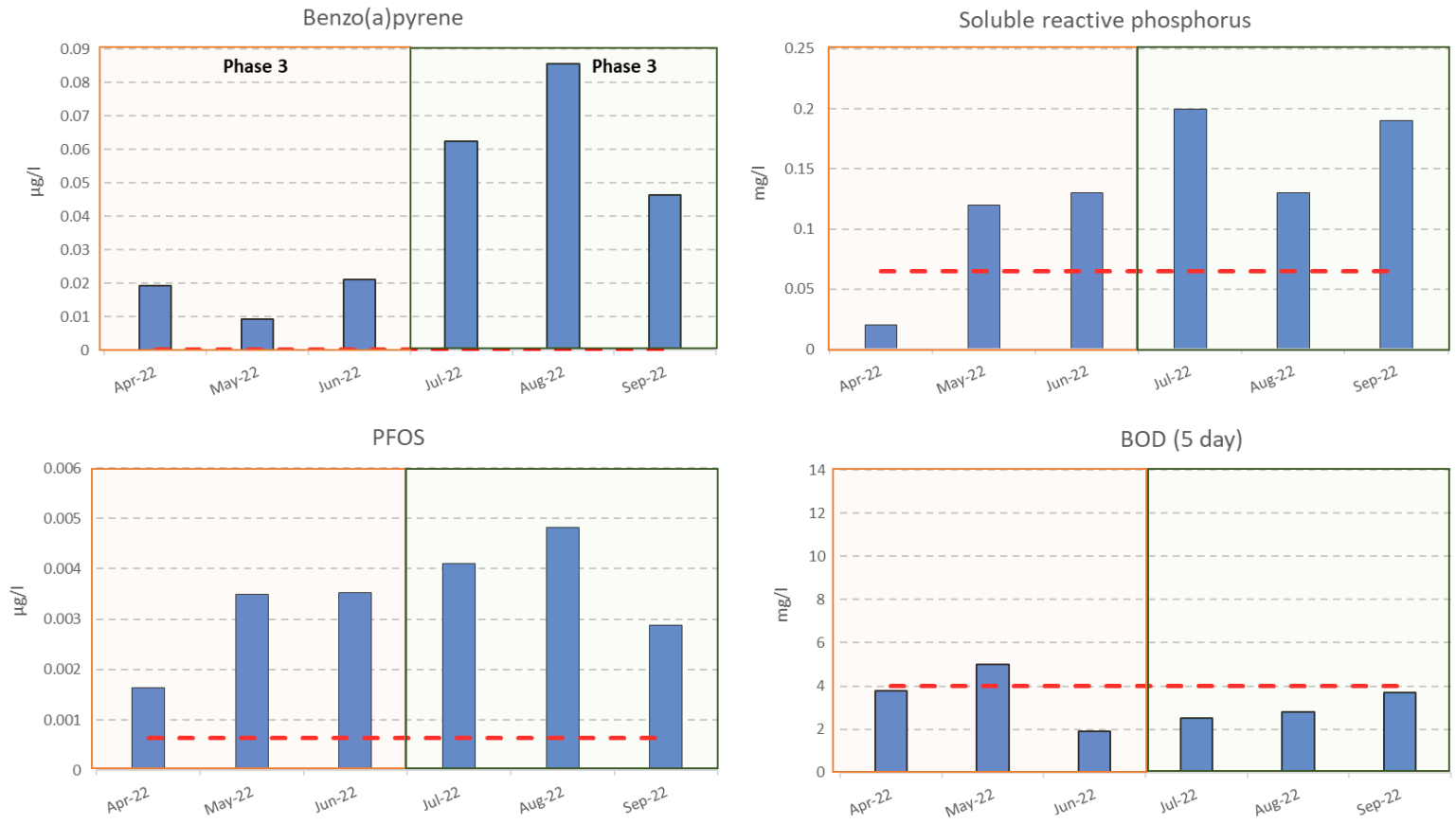


Figure 3-12 - Temporal trends in for key determinands at Site 6 Grove Lock, Leighton Buzzard (April 2021 - September 2022).<sup>45</sup>

<sup>45</sup> Red dashed line indicated EQS value (see Table 3-2 for details). Yellow shading indicated Phase 2 data, orange Phase 3 and green Phase 4. Values <LoD have been plotted at the LoD (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Note: a different y-axis is used for soluble reactive phosphorus and PFOS due to the range of values observed at this site. Concentrations that exceeded the y-axis range are indicated by an arrow with their concentration also given.





**Figure 3-13 - Temporal trends in for key determinands at Site 16 GUC at Marsworth (April 2022 – September 2022).<sup>46</sup>**

<sup>46</sup> Red line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg/l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Orange shading indicates Phase 3 data and green Phase 4. Values <LoD have been plotted at the LoD. Note: a different y-axis is used for PFOS due to the range of values observed at this site.



## 3.3 Continuous Monitoring Data

In the following sections, sonde data are discussed from each continuous monitoring location in turn, comparing relative changes in parameter values with catchment conditions (i.e., rainfall), in order to make inferences regarding nutrient source areas and potential transport pathways. Typical instream responses to storm events, often responsible for the delivery of pollutant material, include a reduction in conductivity, as instream material is diluted by the receiving rainwater, and increases in the flux of suspended solids, inferred using turbidity as a proxy. The inclusion of ammonium sensors within the monitoring suites allows the differentiation of material that is potentially detrimental to aquatic ecosystems. A spike in ammonium concentration for example, may also indicate the mobilisation of not only ammonium, but associated organics that may result in environmental degradation (e.g., reducing BOD following instream mineralisation of any organic material present). It should also be noted that ammonium sensors are good at representing qualitative patterns (i.e., peaks in the data) but not at quantifying absolute values, typically over-estimating concentrations when compared with laboratory derived data. As such ammonium data are considered in conjunction with other parameters such as conductivity or turbidity for interpretation.

### 3.3.1 Site 1, Minworth WwRC

Seasonal variability in the sensor data collected from Minworth WwRC final effluent can be seen in Figure 3-14 with corresponding descriptive statistics in Table 3-8. Dissolved oxygen concentrations during the entire monitoring period were low, ranging between 39.7% and 70.0% (mean = 54.4%) and are indicative of treated final effluent with elevated organic matter concentrations. Diurnal variability in conductivity was also observed. Conductivity represents the ability of water to conduct an electrical charge and is a general indicator of how much ionic material is in the water. This is often elevated in the discharge of treated effluent, and this can be affected by many factors including influent loading and the addition of chemicals during the treatment process.

Ammonium, turbidity, and pH channels were added to the Minworth suite on 05/04/2022. Data collected between this installation date and the end of the current reporting period show a high degree of variability in these data. Ammonium in particular shows a considerable degree of temporal variability with data ranging between 0.6 and 33.4 mg/l. Spikes observed in both turbidity and ammonium do not correlate with shifts in other parameters e.g., conductivity. It is likely that this is driven by variations in influent loading and fluctuations in treatment efficacies. pH data (mean = 6.75) are relatively stable throughout the most recent monitoring period between 6.3 - 7.0, and this range is within expected limits.

### 3.3.2 Site 3, GUC Atherstone

Continuous monitoring was installed at this site on 11/05/2022. Driven by regional differences in underlying geology and soil type, considerable differences in both pH and electrical conductivity were observed at this site when compared to the other sites with continuous monitoring. pH values are lower at this site (mean = 7.39) than those observed at Sites 6 (mean = 7.86) and 16 (mean = 8.00) reflecting the enhanced capacity for instream buffering provided by the calcareous geology in the lower reaches of the canal system. In contrast, electrical conductivity was elevated at Site 3 (mean = 1379  $\mu\text{S cm}^{-1}$ ) when compared to downstream sites (Site 6 mean = 625  $\mu\text{S cm}^{-1}$ , Site 16 mean = 507  $\mu\text{S cm}^{-1}$ ).

Increases in conductivity between the end of May and start of June correspond to local (i.e., Warwickshire County Council) school holiday times encompassing the June bank holiday (30/05/22 – 03/06/22). This short-lived ramp up in conductivity values may be the result of increased holiday traffic during this period putting excess strain on local sewerage infrastructure.

Regular spikes in turbidity (e.g., 02/06/22) that don't correlate with other monitored parameters (specifically conductivity) indicate a flow-independent sediment source. Satellite imagery of this site confirms elevated boat



traffic when compared to other monitored sites. High usage of the canal network and shallow sedimented channel beds are likely to result in regular sediment resuspension and be responsible for the corresponding elevated turbidity values. The water quality sonde at Atherstone was stolen on 14/07/2022, with engineers installing a replacement on 17/08/2022 and as such there is a gap of approximately 1 month in the data record.

### 3.3.3 Site 6 - GUC at Grove, Leighton Buzzard

The sonde at Site 6 (Leighton Buzzard) was installed on 25/11/2021. Clear catchment responses to both small (a) and large (b) precipitation events were seen in Figure 3-16 as sharp increases in turbidity as sediment was mobilised from catchment sources. Sudden reductions in conductivity values were also observed in response to dilution and marginal reductions in pH following the flushing of soil horizons. When precipitation events occur in series (b), moisture falling on already saturated ground has the potential to increase pollutant transport by decreasing the proportion of subsurface flow in favour of the much more efficient overland flow pathways. This increases the distance over which pollutants may be transported. Both temperature and pH values were in line with seasonal expectations. Mean dissolved oxygen was ~90%. A steady increase in oxygen saturation was observed across the monitoring period as colder temperatures during the winter gave way to the warmer summer months. Colder temperatures impact photosynthesis–respiration diurnal dynamics which lead to reductions in both oxygen saturation and its diurnal variability.

A series of algal blooms, that may pose a risk for abstraction owing to their release of potent toxins, were observed between March and May 2022 (spring) with chlorophyll concentrations peaking at 147 µg/l on 03/05/22. Algal blooms occur when light becomes available and thermal stratification starts to occur, which inhibits vertical mixing and results in a high light, high nutrient environment. An additional summer bloom was also observed in late July/early August, although peak chlorophyll concentrations were lower than the observed spring bloom reaching a maximum of 70 µg/l.

Two large pulses were observed in ammonium concentrations toward the end of May (25/05/22, peak concentration = 0.82 mg/l and 01/06/2022, peak concentration = 0.99 mg/l). While these correlated with the occurrence of two relatively small rainfall events, the lack of an observed dilution of instream conductivity (as observed in Figure 3-16) suggests a localised event mobilising a bank-side source of ammonium. A considerably larger third peak was observed correlating with a spike in turbidity and a period of wet weather towards the end of July, culminating in turbidity peaks reaching 1917 NTU and a peak ammonium concentration of 3.99 mg/l. This event also triggered a dramatic drop in oxygen saturation, suggesting the delivery of labile material into the stream, available for rapid mineralisation.

A sonde change on 20/01/22, evident in Figure 3-16, resulted in a sudden increase in a number of recorded determinands including dissolved oxygen, pH, chlorophyll, and ammonium. This is a common issue when reporting long-term sensor data. Sondes commonly experience “drift”, which, as discussed in section 2.3.1, is why dedicated maintenance site visits are scheduled every four to six weeks to proactively clean and calibrate the sensors and check equipment. When additional cleaning or maintenance is required, sondes are replaced.

### 3.3.4 Site 16, GUC at Marsworth

This site was added to the monitoring suite on 24/05/2022. Temperature, pH, and dissolved oxygen are all within the normal range that would be expected. Oxygen super saturation (saturation above 100%) is observed with high signal amplitude. This is to be expected during the summer months in a well oxygenated system with considerable instream vegetation. Mean dissolved oxygen saturation at this site is 97.4%, the highest saturation of all sites monitored, and there is a large data range (minimum value = 20.2%, maximum = 215%). Chlorophyll concentrations remain low at this site, with a mean of 14.8 µg/l observed and no considerable algal bloom events recorded. Peaks in conductivity were observed correlating with increases in both ammonium and chlorophyll data, suggesting short lived algal bloom events. An example sequence of this is demonstrated in Figure 3-17 by the numbers (1-3), where (1) demonstrates the increase in chlorophyll concentration, (2) the



peak in oxygen saturation, and (3) the sudden reduction in oxygen saturation as the causal pulses in labile material are rapidly metabolised, leading to algal death and subsequent decay.

**Table 3-8 - Mean sensor data. All data presented to 3 significant figures.**

| Determinand      | Unit     | 1. Minworth WwRC Final Effluent* | 3. GUC at Atherstone** | 6. GUC at Grove, Leighton Buzzard*** | 16. GUC at Marsworth** |
|------------------|----------|----------------------------------|------------------------|--------------------------------------|------------------------|
| Temperature      | °C       | 16.6                             | 16.2                   | 12.9                                 | 18.2                   |
| Conductivity     | µS/cm    | 805                              | 1380                   | 625                                  | 507                    |
| Dissolved Oxygen | %        | 54.4                             | 75.6                   | 77.9                                 | 97.4                   |
| pH               | pH units | 6.75                             | 7.39                   | 7.86                                 | 8.00                   |
| Ammonium         | mg N/l   | 2.18                             | 0.559                  | 0.491                                | 0.469                  |
| Turbidity        | NTU      | 14.7                             | 20.0                   | 24.6                                 | 5.81                   |
| Chlorophyll      | µg/l     | -                                | 10.9                   | 26.7                                 | 17.4                   |

\* Site 1 (Minworth WwRC) sonde data monitoring for conductivity, temperature, and dissolved oxygen commenced at the start of Phase 2 monitoring on 18/05/2022. Additional parameters including pH, ammonium, and turbidity were added on 05/04/2022.

\*\* Site 3 (GUC at Atherstone) and Site 16 (GUC at Marsworth) sondes were deployed on 11/05/22 and 24/05/22 respectively.

\*\*\* Site 6 (Grove, Leighton Buzzard) sonde was deployed on 25/11/21



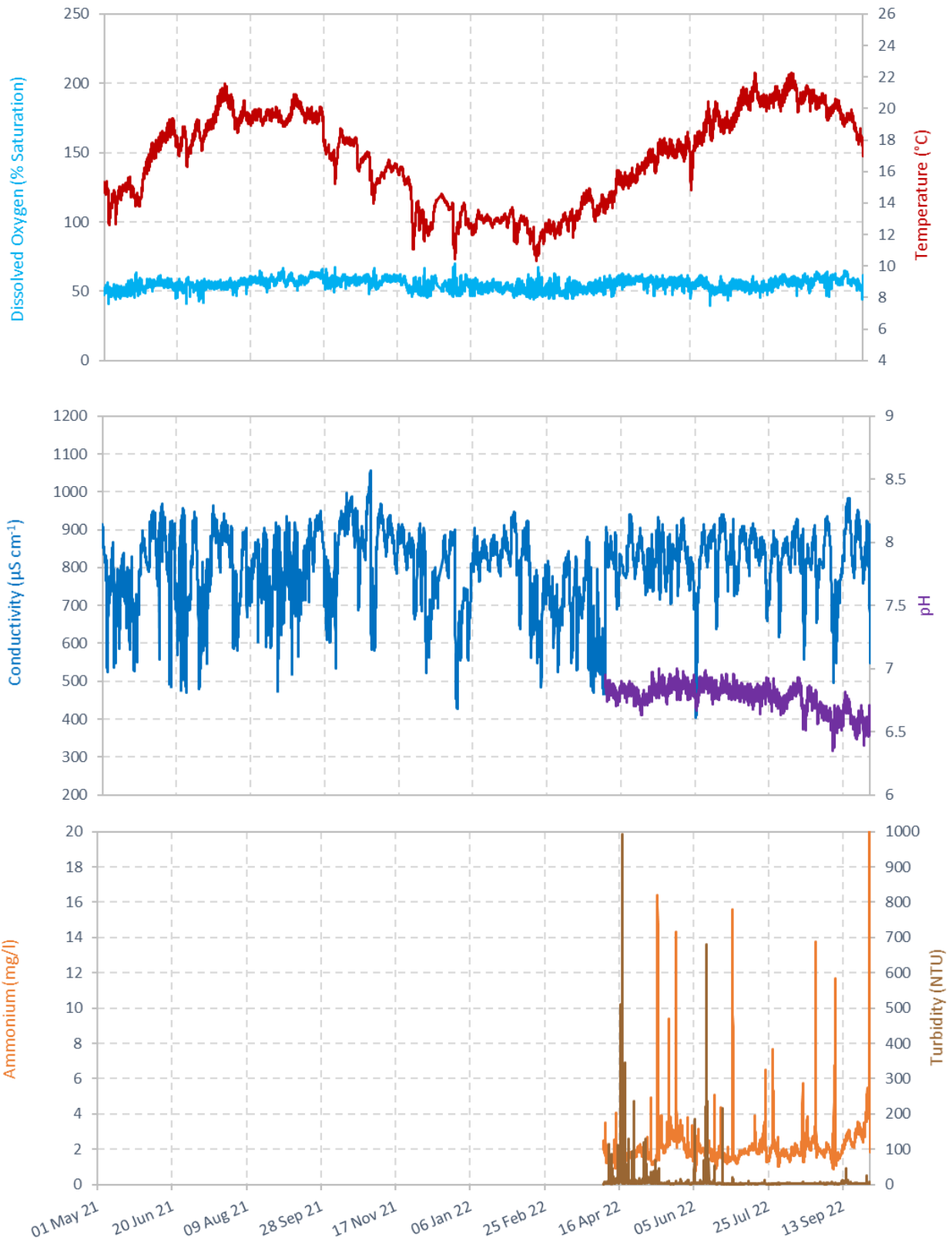


Figure 3-14 - Instream data at Site 1, Minworth WwRC Final Effluent (May 2021 – October 2022)<sup>47</sup>

<sup>47</sup> Additional channels for pH, ammonium, and turbidity were added to monitoring on 05/04/2022.

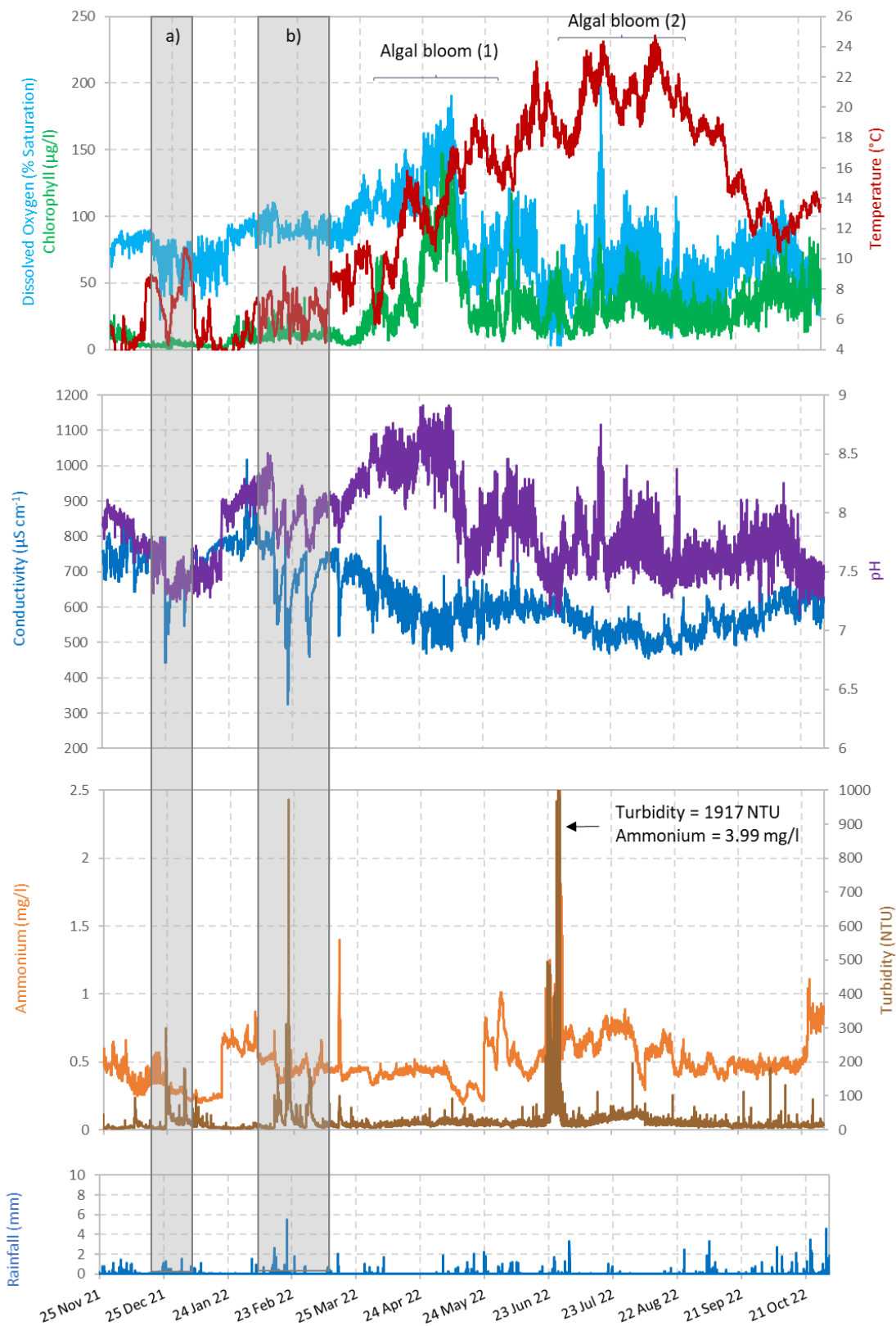




Figure 3-15 – Instream sensor data at Site 3, GUC Atherstone (May 2022 – October 2022).<sup>48</sup>

<sup>48</sup> Rainfall data source: Environment Agency (Station number: 261602TP).





**Figure 3-16 - Instream sensor data at Site 6, GUC at Grove, Leighton Buzzard (November 2021 – October 2022).**<sup>49</sup>

<sup>49</sup> Letters a and b indicate example storm event responses. Rainfall data source: Environment Agency (Station number: 261602TP)..



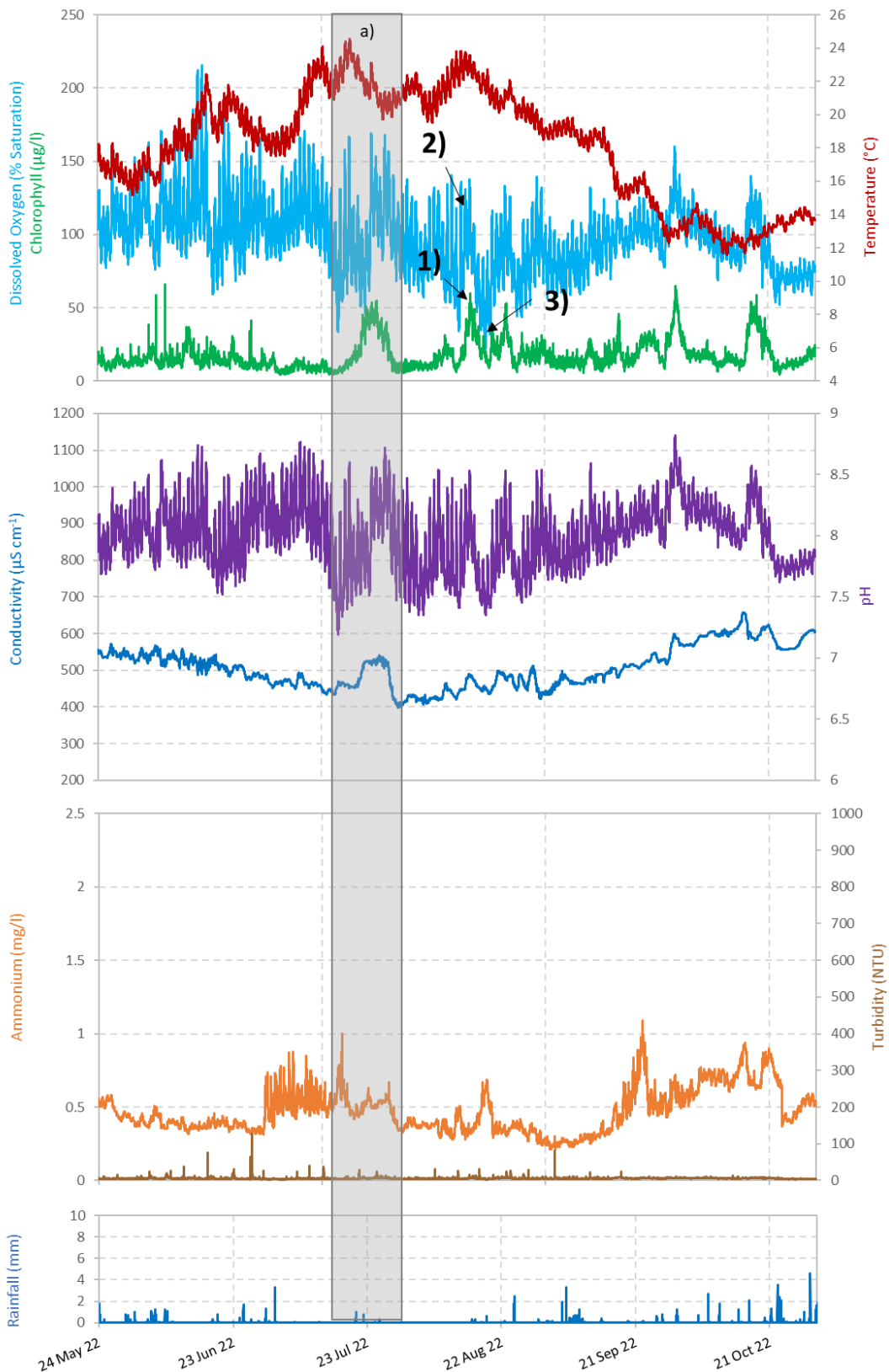


Figure 3-17 - Instream sensor data at Site 16, GUC at Marsworth (May 2022 - October 2022).<sup>50</sup>

<sup>50</sup> Rainfall data source: Environment Agency (Station number: 261602TP).



## 4. Conclusions

At present, the following determinands demonstrated the greatest number of WFD EQS exceedances on an individual sample basis:

- ANC (11 sites, a total of 119 individual occurrences)
- Benzo(a)pyrene (11 sites, a total of 142 individual occurrences)
- BOD - 5-day (8 sites, a total of 24 individual occurrences)
- Dissolved Oxygen (8 sites, a total of 32 individual occurrences)
- Fluoranthene (9 sites, a total of 98 individual occurrences)
- PFOS (11 sites, a total of 137 individual occurrences)
- SRP (8 sites, a total of 77 individual occurrences)
- Sulphide or hydrogen sulphide (9 sites, a total of 75 individual occurrences)

In addition, the following determinands exceeded WFD / EQSD MAC values:

- Sulphide or hydrogen sulphide (total individual exceedances across all sites = 75)
- Bromine - total residual oxidant (total individual exceedances across all sites = 36)
- Benzo(a)pyrene (total residual oxidant, total individual exceedances across all sites = 34)
- Nickel - dissolved (total individual exceedances across all sites = 13)
- Benzo(g,h,i)perylene (total individual exceedances across all sites = 11)
- Benzo(b)fluoranthene (total individual exceedances across all sites = 8)
- Benzo(k)fluoranthene (total individual exceedances across all sites = 3)
- Cypermethrin (total individual exceedances across all sites = 5)
- Mercury - dissolved (total individual exceedances across all sites = 17)
- Mercury - total (total individual exceedances across all sites = 20)

Some concentrations in the Minworth WwRC effluent were greater than the EQS in the receiving water at Site 3, Coventry Canal, Atherstone (noting these standards do not directly apply to effluent and discharge standards are set through the permitting regime). These include chlorothalonil (an organic fungicide), cypermethrin (a synthetic pyrethroid), bioavailable zinc, and dissolved oxygen. As a result, if Minworth WwRC discharge were diverted into any of the proposed sub-discharge routes without additional treatment applied, additional instream exceedances may occur, resulting in a future WFD compliance risk as the new discharge would prevent the water quality of the receiving body from achieving Good Status. Current mean bioavailable zinc concentration at Site 3 is 9.31 µg/l, marginally reduced since the last report period, against a site specific EQS of 13.9 µg/l. The addition of the discharge of final effluent from Minworth may take concentrations at Site 3 closer to its EQS. Further assessment is required to determine the level of confidence if this is indeed the case (e.g., through modelling or pairwise assessment of samples once a full year of data is collected). Treatment or other removal at works will be required in order to provide a resolution to this issue.

Minworth WwRC treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of these 'high risk' compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permitting risk (e.g., due to within class deterioration).

As discussed in Section 3.2, PCVs apply only to treated drinking water, and not raw source waters. However, the monitoring of these determinands and regular comparison with drinking water standards enables a threshold for screening out determinands that may be considerably elevated in raw water, thus helping to inform treatment design at the example abstraction location. With that in mind, the following determinands are currently routinely exceeding PCV targets at Site 6.

- Benzo(a)pyrene (total exceedances = 12)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 12)



- *Escherichia coli* (*E.coli*, total exceedances = 12)
- Iron - total (total exceedances = 17)
- Nitrite (total exceedances = 8)
- Turbidity (total exceedances = 12)

*C. perfringens* exceeded PCV values all both sites as it is widely distributed across the environment and as such, is regularly evaluated to monitor the microbiological safety of drinking water supplies. Sources of bacterial contamination can range from the input of animal manures from farmyard runoff to discharge from untreated or treated sewage effluent. *Cryptosporidium* was not detected at any site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores or localised disturbance events.

A water sample collected at Site 6 on 20/10/2021 captured a period of heavy rainfall resulting in a number of additional exceedances not observed during lower flow conditions. These additional exceedances included PAHs, aluminium (dissolved), and iron (dissolved). However, of particular interest were the presence of tebuconazole, an agricultural triazole fungicide used to treat plant pathogenic fungi, and metribuzin, a synthetic herbicide applied both pre- and post-emergence of vegetable crops, suggesting an agricultural origin. The heavily modified, and agricultural Ledburn brook, located approximately <20 m south (upstream) of the monitoring location may be the source of these additional exceedances. Wet weather sampling captured a number of additional PCV exceedances common across abstraction locations, including nitrate and ammonium. It is recommended that AfW update their DWSP and complete a review of planned mitigation to factor in these additional determinands. Rainfall events also coincided with sampling on 14/09/21 (daily rainfall total = 9.3 mm), 07/12/21 (daily rainfall total = 5.7 mm) and 11/01/22 (daily rainfall total = 4.5 mm). Exceedances in both nitrite and iron were observed during the rainfall event that occurred on 14/09/21, while exceedances in ammonium, nitrate and colour observed following rainfall on 07/12/21. *E.coli* counts were also elevated during rainfall events.

All sensor data appear to be within ranges typical of freshwater environments. A series of large spring algal blooms, that may pose a risk for abstraction, were observed in the data at Site 6 between March and April 2022 with chlorophyll concentrations peaking at 147 µg/l. A series of blooms were observed in the data from Site 16 between July and August with peak chlorophyll concentration >59 µg/l; this is, however, considerably smaller than the bloom observed at Site 6. A series of additional peaks in chlorophyll data are observed coinciding with peaks in conductivity data and elevated dissolved oxygen values. No spring bloom is observed in the data for Site 16; however, it may have occurred prior to the commencement of monitoring on 24/05/2022.

The most recent three months of monitoring (June – September 2022) have captured a period of reduced rainfall (see Section 2.6 for discussion). To date, this reduced rainfall, and resultant reduction of instream dilution capacity, has only resulted in a small number of additional exceedances being observed with both total and dissolved mercury exceeding its MAC on a number of occasions across all sites.

Data on emerging substances are now being gathered and the process is currently underway to find suitable benchmarking standards to compare these values against, as most do not have an EQS or PCV. Consultation is underway with our technical experts along with the EA and DWI to determine appropriate reference standards. Currently data on PNECs along with any relevant EQS/PCV are being gathered. These data will be discussed in detail in the next quarterly report.



# APPENDICES



# Appendix A. WFD analysis suite

| Group                     | Parameter                                       | Unit  | Annual<br>average EQS | 90 <sup>th</sup><br>percentile | 95 <sup>th</sup><br>percentile | MAC  | LoD         |
|---------------------------|---|-------|-----------------------|--------------------------------|--------------------------------|------|-------------|
| <b>General parameters</b> | Dissolved oxygen*                               | mg/l  | ***                   | -                              | -                              | -    | -           |
|                           | Temperature**                                   | °C    | 28                    | -                              | -                              | -    | -           |
|                           | pH  | pH    | ***                   | -                              | -                              | -    | 0.1 pH unit |
|                           | BOD 5   | mg/l  | -                     | ***                            | -                              | -    | 1           |
|                           | Chemical oxygen demand                          | mg/l  | -                     | -                              | -                              | -    | 5           |
|                           | Reactive phosphorus                             | mg/l  | ***                   | -                              | -                              | -    | 0.01        |
|                           | Total phosphorus                                | mg/l  | -                     | -                              | -                              | -    | 0.01        |
|                           | Salinity (at 20°C)                              | µS/cm | -                     | -                              | -                              | -    | 1           |
|                           | Conductivity (at 20°C)                          | µS/cm | -                     | -                              | -                              | -    | -           |
|                           | Ammoniacal Nitrogen (as N)                      | mg/l  | ***                   | -                              | -                              | -    | 0.015       |
|                           | Ammonia (as N)                                  | mg/l  | -                     | -                              | -                              | -    | 0.1         |
|                           | Nitrate (as NO <sub>3</sub> )                   | mg/l  | -                     | -                              | -                              | -    | 0.1         |
|                           | Nitrate (as N)                                  | mg/l  | -                     | -                              | -                              | -    | calc        |
|                           | Nitrite (as NO <sub>2</sub> )                   | mg/l  | -                     | -                              | -                              | -    | 0.1         |
|                           | Nitrite (as N)                                  | mg/l  | -                     | -                              | -                              | -    | calc        |
|                           | Total nitrogen (oxidised as N)                  | mg/l  | -                     | -                              | -                              | -    | 5           |
|                           | Keldhal nitrogen                                | mg/l  | -                     | -                              | -                              | -    | 0.2         |
|                           | Organic nitrogen                                | mg/l  | -                     | -                              | -                              | -    | calc        |
|                           | Sulphide or hydrogen sulphide                   | µg/l  | 0.25                  | -                              | -                              | 1    | 10          |
|                           | Alkalinity (as CaCO <sub>3</sub> )              | mg/l  | -                     | -                              | -                              | -    | 5           |
|                           | Acid Neutralisation Capacity (ANC) (unfiltered) | mg/l  | 40                    | -                              | -                              | -    | 5           |
|                           | Hardness as (CaCO <sub>3</sub> )                | mg/l  | -                     | -                              | -                              | -    | 0.1         |
|                           | Dissolved organic carbon                        | mg/l  | -                     | -                              | -                              | -    | 0.5         |
|                           | Total organic carbon                            | mg/l  | -                     | -                              | -                              | -    | 0.5         |
|                           | Solids, Suspended (at 105°C)                    | mg/l  | -                     | -                              | -                              | -    | 2           |
|                           | Chlorophyll                                     | µg/l  | -                     | -                              | -                              | -    | 20          |
|                           | Phaeophytin                                     | µg/l  | -                     | -                              | -                              | -    | 20          |
| <b>Metals</b>             | Antimony - total                                | µg/l  | -                     | -                              | -                              | -    | 0.17        |
|                           | Antimony - dissolved                            | µg/l  | -                     | -                              | -                              | -    | 0.17        |
|                           | Aluminium - total                               | µg/l  | -                     | -                              | -                              | -    | 10          |
|                           | Aluminium - dissolved                           | µg/l  | -                     | -                              | -                              | -    | 10          |
|                           | Aluminium - reactive                            | µg/l  | -                     | -                              | -                              | -    | 4           |
|                           | Arsenic - total                                 | µg/l  | 50                    | -                              | -                              | -    | 0.16        |
|                           | Arsenic - dissolved                             | µg/l  | -                     | -                              | -                              | -    | 0.16        |
|                           | Cadmium - total                                 | µg/l  | 0.25                  | -                              | -                              | 1.5  | 0.02        |
| Cadmium - dissolved       | µg/l  | 0.25  | -                     | -                              | 1.5                            | 0.02 |             |



|                             |   |      |         |      |   |       |         |
|-----------------------------|---|------|---------|------|---|-------|---------|
|                             | Calcium - total   | mg/l | -       | -    | - | -     | 0.09    |
|                             | Copper - total  | µg/l | -       | -    | - | -     | 0.4     |
|                             | Copper - bioavailable   | µg/l | 1       | -    | - | -     | 0.4     |
|                             | Chromium - total  | µg/l | -       | -    | - | -     | 0.25    |
|                             | Chromium - dissolved  | ug/l | -       | -    | - | -     | 0.25    |
|                             | Iron - total  | µg/l | 1,000   | -    | - | -     | 5.5     |
|                             | Iron - dissolved  | µg/l | 1,000   | -    | - | -     | 5.5     |
|                             | Lead - total  | µg/l | 1.2     | -    | - | -     | 0.09    |
|                             | Lead - dissolved*   | µg/l | 1.2     | -    | - | 14    | 0.09    |
|                             | Mercury - total   | µg/l | 0.07    | -    | - | 0.07  | 0.001   |
|                             | Mercury - dissolved   | µg/l | 0.07    | -    | - | 0.07  | 0.001   |
|                             | Nickel - total  | µg/l | 4       | -    | - | -     | 0.5     |
|                             | Nickel - dissolved*   | µg/l | 4       | -    | - | 34    | 0.5     |
|                             | Zinc - total  | µg/l | -       | -    | - | -     | 0.5     |
|                             | Zinc - dissolved*   | µg/l | ***     | -    | - | -     | 0.5     |
| <b>PAH Suite</b>            | Fluoranthene  | µg/l | 0.0063  | -    | - | 0.12  | 0.0009  |
|                             | Benzo(a)pyrene  | µg/l | 0.00017 | -    | - | 0.027 | 0.00017 |
| <b>Phthalates</b>           | Di(2-ethylhexyl)-phthalate (DEHP)   | µg/l | 1.3     | -    | - | -     | 0.15    |
| <b>Other WFD parameters</b> | Brominated diphenylethers Total (sum of BDE penta congeners 28,47,99,100,153,154) | µg/l | -       | -    | - | 0.14  | 0.0005  |
|                             | BDE-28  | µg/l | -       | -    | - | -     | 0.0001  |
|                             | BDE-47  | µg/l | -       | -    | - | -     | 0.0001  |
|                             | BDE-99  | µg/l | -       | -    | - | -     | 0.0001  |
|                             | BDE-100   | µg/l | -       | -    | - | -     | 0.0001  |
|                             | BDE-153   | µg/l | -       | -    | - | -     | 0.0001  |
|                             | BDE-154   | µg/l | -       | -    | - | -     | 0.0001  |
|                             | Triclosan   | µg/l | 0.1     | 0.28 | - | -     | 0.01    |
|                             | Nonylphenols. (4-Nonylphenol Technical Mix)                                       | µg/l | 0.3     | -    | - | 2     | 0.04    |
|                             | 4-n-Nonylphenol   | µg/l | 0.3     | -    | - | 2     | 0.04    |
|                             | Nonylphenol ethoxylates (sum)   | µg/l | -       | -    | - | -     | 0.12    |
|                             | Nonylphenol monoethoxylate NPEO1  | µg/l | -       | -    | - | -     | 0.04    |
|                             | Nonylphenol diethoxylate NPEO2  | µg/l | -       | -    | - | -     | 0.04    |
|                             | Nonylphenol triethoxylate NPEO3   | µg/l | -       | -    | - | -     | 0.04    |
|                             | Octylphenols ((4-(1,1', 3,3'-tetramethylbutyl)-phenol))                           | µg/l | 0.1     | -    | - | -     | 0.01    |
|                             | Octylphenol ethoxylates (Sum OPEO 1-3)  | µg/l | -       | -    | - | -     | 0.06    |
|                             | Octylphenol monoethoxylate (OPEO1)  | µg/l | -       | -    | - | -     | 0.02    |



|                     |   |      |         |   |   |        |         |
|---------------------|---|------|---------|---|---|--------|---------|
|                     | Octylphenol diethoxylate (OPEO2)              | µg/l | -       | - | - | -      | 0.02    |
|                     | Octylphenol triethoxylate (OPEO3)             | µg/l | -       | - | - | -      | 0.02    |
|                     | Tributyltin compounds (as Tributyltin cation) | µg/l | 0.0002  | - | - | 0.0015 | 0.00002 |
|                     | Perfluorooctane sulfonic acid PFOS            | µg/l | 0.00065 | - | - | 36     | 0.00065 |
|                     | Perfluorooctanoic acid (PFOA)                 | µg/l | -       | - | - | -      | 0.00065 |
|                     | HexabromocycLoDodecane (HBCDD) Total          | µg/l | -       | - | - | -      | 0.00014 |
|                     | alpha - HexabromocycLoDodecane (α-HBCDD)      | µg/l | -       | - | - | -      | 0.00004 |
|                     | beta - HexabromocycLoDodecane (β-HBCDD)       | µg/l | -       | - | - | -      | 0.00004 |
|                     | gamma - HexabromocycLoDodecane (γ-HBCDD)      | µg/l | -       | - | - | -      | 0.00004 |
| <b>VOCs</b>         | Trichloroethylene                             | µg/l | -       | - | - | -      | 1       |
| <b>THMs</b>         | Chloroform                                    | µg/l | 2.5     | - | - | -      | 1       |
|                     | Trichloroethane (1 1 1)                       | µg/l | 100     | - | - | -      | 1       |
|                     | Trichloroethane (1 1 2)                       | µg/l | 400     | - | - | -      | 1       |
| <b>Insecticides</b> | Cypermethrin                                  | µg/l | 0.00008 | - | - | 0.0006 | 0.00008 |

\*Dissolved oxygen EQS refers to a 10<sup>th</sup> percentile.

\*\*Temperature EQS refers to a 98<sup>th</sup> percentile.

\*\*\*It is noted that some WFD EQS are different for different river types (e.g. upland, lowland, salmonid, cyprinid). Each SRO assessment will use different EQS depending on the local context, see Table 3-2 for further detail.

\*EQS refers to bioavailable concentration.



## Appendix B. EQSD analysis suite

| Parameter                              | Unit | Annual average EQS | 90th percentile | 95th percentile | MAC  | RL <sup>51</sup> |
|--|------|--------------------|-----------------|-----------------|------|------------------|
| 1,1,1-trichloroethane                  | µg/l | 100                | -               | -               | -    | 1                |
| 1,1,2-trichloroethane                  | µg/l | 400                | -               | -               | -    | 1                |
| 2,4-dichlorophenol                     | µg/l | 4.2                | -               | -               | 140  | 0.02             |
| 2,4-dichlorophenoxyacetic acid (2,4-D) | µg/l | 0.3                | -               | 1.3             | -    | 0.02             |
| 2-chlorophenol                         | µg/l | 50                 | -               | -               | -    | 0.02             |
| 3,4-dichloroaniline                    | µg/l | 0.2                | -               | 5.4             | -    | 1                |
| 4-chloro-3-methylphenol                | µg/l | 40                 | -               | -               | -    | 0.02             |
| Abamectin                              | µg/l | 0.01               | -               | -               | 0.03 | 5                |
| Ammonia (un-ionised)                   | µg/l | -                  | -               | -               | -    | 0.1              |
| Arsenic - dissolved                    | µg/l | 50                 | -               | -               | -    | 0.16             |
| Azinphos-methyl - dissolved            | µg/l | 0.01               | -               | -               | -    | 0.01             |
| Bentazone                              | µg/l | 500                | -               | -               | -    | 0.02             |
| Benzyl butyl phthalate                 | µg/l | 7.5                | -               | 51              | -    | 0.2              |
| Biphenyl                               | µg/l | 25                 | -               | -               | -    | 0.02             |
| Boron - total                          | µg/l | 2,000              | -               | -               | -    | 12               |
| Bromine - total residual oxidant       | mg/l | 0.002              | -               | -               | 5    | 1                |
| Bromoxynil                             | µg/l | 100                | -               | -               | 1000 | 0.02             |
| Carbendazim                            | µg/l | 0.15               | -               | -               | 0.7  | 0.1              |
| Chloride                               | µg/l | 250,000            | -               | -               | -    | 0.1              |
| Chlorine - total residual oxidant      | µg/l | 2                  | -               | -               | 5    | 0.1              |
| Chloronitro toluenes                   | µg/l | 10                 | -               | -               | -    | 0.02             |
| Chlorothalonil                         | µg/l | 0.035              | -               | -               | 1.2  | 0.035            |
| Chlorotoluron                          | µg/l | 2                  | -               | -               | 20   | 0.05             |
| Chlorpropham                           | µg/l | 10                 | -               | -               | 40   | 0.1              |
| Chromium (III) - dissolved             | µg/l | 4.7                | -               | 32              | -    | 0.25             |
| Chromium (VI) - dissolved              | µg/l | 3.4                | -               | -               | -    | 7                |

<sup>51</sup> Instrumental LoD may be lower but Reporting Limit (RL) is set by validation in real matrix based on 11 batches in duplicate and calculated as per MCERTS water definition.



| Parameter                                       | Unit | Annual average EQS | 90th percentile | 95th percentile | MAC    | RL <sup>51</sup> |
|---|------|--------------------|-----------------|-----------------|--------|------------------|
| Cobalt - dissolved                              | µg/l | 3                  | -               | -               | 100    | 0.16             |
| Copper - dissolved*                             | µg/l | 1                  | -               | -               | -      | 0.4              |
| Coumaphos                                       | µg/l | 0.03               | -               | -               | 0.1    | 0.02             |
| Cyanide - total                                 | µg/l | 1                  | -               | -               | -      | 40               |
| Cyfluthrin                                      | µg/l | 0.001              | -               | 0.001           | -      | 0.1              |
| Cypermethrin                                    | µg/l | 0.00008            | -               | -               | 0.0006 | 0.00008          |
| Demetons  | µg/l | 0.5                | -               | -               | -      | 0.02             |
| Diazinon (sheep dip)                            | µg/l | 0.01               | -               | 0.02            | -      | 0.01             |
| Dibutyl phthalate                               | µg/l | 8                  | -               | -               | 40     | 0.02             |
| Dichlorobenzene - total dichlorobenzene isomers | µg/l | 20                 | -               | -               | 200    | 0.1              |
| Dichlorvos                                      | µg/l | 0.0006             | -               | -               | 0.0007 | 0.01             |
| Diethyl phthalate                               | µg/l | 200                | -               | -               | 1000   | 0.02             |
| Diflubenzuron                                   | µg/l | 0.001              | -               | -               | 0.015  | 0.001            |
| Dimethoate                                      | µg/l | 0.48               | -               | 4               | -      | 0.02             |
| Dimethyl phthalate                              | µg/l | 800                | -               | -               | 4000   | 0.02             |
| Diocetyl phthalate                              | µg/l | 20                 | -               | -               | 40     | 0.02             |
| Doramectin                                      | µg/l | 0.001              | -               | -               | 0.01   | 5                |
| EDTA  | µg/l | 400                | -               | -               | 4000   | 100              |
| Fenchlorphos                                    | µg/l | 0.03               | -               | -               | 0.1    | 0.02             |
| Fenitrothion                                    | µg/l | 0.01               | -               | -               | -      | 0.01             |
| Flucofuron                                      | µg/l | -                  | -               | 1               | -      | 0.05             |
| Fluoride – dissolved <50mg/l CaCO <sub>3</sub>  | µg/l | 1000               | -               | -               | -      | 10               |
| Fluoride - dissolved >50mg/l CaCO <sub>3</sub>  | µg/l | 5000               | -               | -               | 15,000 | 10               |
| Formaldehyde                                    | µg/l | 5                  | -               | -               | 50     | 50               |
| Glyphosate                                      | µg/l | 196                | -               | 398             | -      | 0.1              |
| Hydrogen sulphide                               | µg/l | 0.25               | -               | -               | -      | 10               |
| loxynil   | µg/l | 10                 | -               | -               | 100    | 0.02             |
| Iron - dissolved                                | µg/l | 1,000              | -               | -               | -      | 5.5              |
| Ivermectin                                      | µg/l | 0.0001             | -               | -               | 0.001  | 5                |
| Linuron   | µg/l | 0.5                | -               | 0.9             | -      | 0.01             |
| Malachite green                                 | µg/l | 0.5                | -               | -               | 100    | 1                |



| Parameter  | Unit     | Annual average EQS | 90th percentile | 95th percentile | MAC    | RL <sup>51</sup> |
|--|----------|--------------------|-----------------|-----------------|--------|------------------|
| Malathion  | µg/l     | 0.01               | -               | -               | -      | 0.02             |
| Mancozeb   | µg/l     | 2                  | -               | -               | 20     | 0.1              |
| Maneb  | µg/l     | 3                  | -               | -               | 30     | 0.1              |
| Manganese - dissolved*                                       | µg/l     | 123                | -               | -               | -      | 0.22             |
| MCPA pH <7   | µg/l     | 12                 | -               | -               | 80     | 0.02             |
| MCPA pH >7   | µg/l     | 80                 | -               | -               | 100    | 0.02             |
| Mecoprop   | µg/l     | 18                 | -               | 187             | -      | 0.02             |
| Methiocarb   | µg/l     | 0.01               | -               | 0.77            | -      | 0.1              |
| Mevinphos  | µg/l     | -                  | -               | -               | 0.02   | 0.02             |
| Nitritotriacetic acid (NTA)                                  | µg/l     | 1,000              | -               | -               | 10,000 | 100              |
| Omethoate  | µg/l     | 0.01               | -               | -               | -      | 0.01             |
| PCSDs (polychloro chloromethyl sulphonamido diphenyl ethers) | µg/l     | -                  | -               | -               | -      | 0.2              |
| Pendimethalin  | µg/l     | 0.3                | -               | 0.58            | -      | 0.02             |
| Permethrin   | µg/l     | 0.01               | -               | 0.01            | -      | 0.001            |
| pH   | pH units | 6 to 9             | -               | -               | -      | 0.01             |
| Phenol   | µg/l     | 7.7                | -               | 46              | -      | 1                |
| Pirimicarb   | µg/l     | 1                  | -               | -               | 5      | 0.1              |
| Pirimiphos-methyl  | µg/l     | 0.015              | -               | -               | 0.05   | 0.01             |
| Prochloraz   | µg/l     | 4                  | -               | -               | 40     | 0.1              |
| Propetamphos   | µg/l     | 0.03               | -               | -               | 0.1    | 0.02             |
| Propyzamide  | µg/l     | 100                | -               | -               | 1000   | 0.01             |
| Silver - dissolved   | µg/l     | 0.05               | -               | -               | 0.1    | 1                |
| Styrene  | µg/l     | 50                 | -               | -               | 500    | 0.1              |
| Sulcofuron   | µg/l     | -                  | -               | 25              | -      | 0.05             |
| Sulphate   | µg/l     | 400,000            | -               | -               | -      | 0.1              |
| Tecnazene - total  | µg/l     | 1                  | -               | -               | 10     | 0.02             |
| Tetrachloroethane  | µg/l     | 140                | -               | 1848            | -      | 0.1              |
| Thiabendazole  | µg/l     | 5                  | -               | -               | 50     | 0.1              |
| Tin (inorganic) - total                                      | µg/l     | 25                 | -               | -               | -      | 0.4              |
| Toluene  | µg/l     | 74                 | -               | 380             | -      | 0.1              |
| Total anions   | µg/l     | 250,000            | -               | -               | -      | <1000            |



| Parameter                           | Unit | Annual average EQS | 90th percentile | 95th percentile | MAC  | RL <sup>51</sup> |
|-------------------------------------|------|--------------------|-----------------|-----------------|------|------------------|
| Triallate                           | µg/l | 0.25               | -               | -               | 5    | 0.02             |
| Triazaphos                          | µg/l | 0.005              | -               | -               | -    | 0.02             |
| Tributyl phosphate                  | µg/l | 50                 | -               | -               | 500  | 0.02             |
| Triclosan                           | µg/l | 0.1                | -               | 0.28            | -    | 0.01             |
| Triphenyltin and derivatives        | µg/l | -                  | -               | -               | 0.02 | 0.002            |
| Vanadium <200mg/l CaCO <sub>3</sub> | µg/l | 20                 | -               | -               | -    | 0.6              |
| Vanadium >200mg/l CaCO <sub>3</sub> | µg/l | 60                 | -               | -               | -    | 0.6              |
| Xylene                              | µg/l | 30                 | -               | -               | -    | 1                |
| Zinc - dissolved*                   | µg/l | **                 | -               | -               | -    | 0.5              |

\*EQS refers to bioavailable concentration.

\*\*It is noted that some WFD EQS are different for different river types (e.g. upland, lowland, salmonid, cyprinid). Each SRO assessment will use different EQS depending on the local context, see Table 3-2 for further detail.



## Appendix C. Drinking water analysis suites

| Parameter <sup>52</sup>                                 | Unit  | PCV  | Source <sup>53, 54</sup>                  | LoD    |
|---|-------|------|---|--------|
| 1, 2, 3-Benzotriazole                                   | µg/l  | -    |   | 0.1    |
| 1,4-Dioxane   | µg/l  | -    |   | 1      |
| 1, 2 Dibromoethane                                      | µg/l  | -    |   | 1      |
| 17β Oestradiol  | µg/l  | -    |   | 0.0003 |
| 1H-Benzotriazole, 4 (or 5)-methyl                       | µg/l  | -    |   | 0.1    |
| 2 3 6-TBA   | µg/l  | -    |   | 0.02   |
| 2 4 5-T   | µg/l  | -    |   | 0.02   |
| 2 4-D   | µg/l  | -    |   | 0.02   |
| 2 4-DB  | µg/l  | -    |   | 0.02   |
| 2 EDD   | µg/l  | -    |   | 0.1    |
| 2 EMD   | µg/l  | -    |   | 0.1    |
| 2-(2-Butoxyethoxy) ethanol (DEGBE)                      | mg/l  | -    |   | 10     |
| 22C PC Neat (plate count)                               | µg/l  | -    |   | 300    |
| 2-Methylphenol  | µg/l  | -    |   | 0.02   |
| 2-Methylisoborneol (MIB)                                | ng/l  | -    |   | -      |
| 37C PC Neat (plate count)                               | No/ml | -    |   | 300    |
| 3-Methylphenol  | µg/l  | -    |   | 0.02   |
| 4-Methylphenol  | µg/l  | -    |   | 0.02   |
| Acrylamide  | µg/l  | 0.1  | Water Supply Regulations 2016, schedule 1 | 0.1    |
| Adenovirus  | -     | -    |   | -      |
| Aldrin  | µg/l  | 0.03 | Drinking Water Directive, 2021            | 0.02   |
| Algae cell count  | No/ml | -    |   | -      |
| Algal speciation (diatoms/blue-green cyanobacteria etc) | -     | -    |   | -      |
| Alkalinity AS CaCO <sub>3</sub>                         | mg/l  | -    |   | 5      |
| Alkalinity as HCO <sub>3</sub>                          | mg/l  | -    |   | -      |
| Alpha activity - total                                  | Bq/l  | -    |   | 0.02   |

<sup>53</sup> <https://www.legislation.gov.uk/uksi/2016/614/schedule/1>

<sup>54</sup> <https://www.legislation.gov.uk/uksi/2016/614/schedule/2>



| Parameter <sup>52</sup>                      | Unit      | PCV  | Source <sup>53,54</sup>   | LoD     |
|--|-----------|------|---|---------|
| Aluminium - total and dissolved              | µg/l      | 200  | Water Supply Regulations 2016, Schedule 1                                 | 10      |
| Ametryne                                     | µg/l      | 0.1  | Water Supply Regulations 2016, Schedule 1                                 | 0.02    |
| Amino tris(methylene phosphonic acid) (ATMP) | µg/l      | -    |   | 1       |
| Ammoniacal nitrogen                          | mg/l      | -    |   | 0.015   |
| Ammonium as NH4                              | mg/l      | 0.5  | Water Supply Regulations 2016, Schedule 2                                 | 0.02    |
| Antimony - total and dissolved               | µg Sb/l   | 5    | Water Supply Regulations 2016, Schedule 1                                 | 0.017   |
| Arsenic - total and dissolved                | µg/l      | 10   | Water Supply Regulations 2016, Schedule 1                                 | 0.16    |
| Atrazine                                     | µg/l      | 0.1  | Water Supply Regulations 2016, Schedule 1                                 | 0.02    |
| Azoxystrobin                                 | µg/l      | -    |   | 0.05    |
| Barium - total and dissolved                 | µg/l      | -    |   | -       |
| Benazolin                                    | µg/l      | -    |   | 0.02    |
| Bentazone                                    | µg/l      | -    |   | 0.02    |
| Benzene                                      | µg/l      | 1    | Water Supply Regulations 2016, Schedule 1                                 | 0.1     |
| Benzo(a)pyrene                               | µg/l      | 0.01 | Water Supply Regulations 2016, Schedule 1                                 | 0.00017 |
| Benzo(b)fluoranthene                         | µg/l      | -    |   | -       |
| Benzo(k)fluoranthene                         | µg/l      | -    |   | -       |
| Benzo(g,h,i)perylene                         | µg/l      | -    |   | -       |
| Beryllium - total and dissolved              | µg/l      | -    |   | 0.1     |
| Beta - estradiol                             | µg/l      | -    | Added to the Drinking Water Directive watch list- no regulatory value yet | 0.0003  |
| Beta activity - total                        | Bq/l      | -    |   | -       |
| Bisphenol A                                  | µg/l      | 2.5  | Drinking Water Directive, 2021  | 10      |
| BOD  | mg/l      | -    |   | 1       |
| Boron - total and dissolved                  | µg/l-B    | 1000 | Water Supply Regulations 2016, Schedule 1                                 | 12      |
| Boscalid                                     | µg/l      | 0.1  | Water Supply Regulations 2016, Schedule 1                                 | 0.1     |
| Bromate                                      | µg BrO3/l | 10   | Water Supply Regulations 2016, Schedule 1                                 | 2       |
| Bromide                                      | mg/l      | -    |   | 0.1     |
| Bromodichloromethane                         | µg/l      | 60   |   | 1       |
| Bromoform                                    | µg/l      | 100  |   | 1       |
| Bromoxynil                                   | µg/l      | 0.1  | Water Supply Regulations 2016, Schedule 1                                 | 0.02    |
| Cadmium - total and dissolved                | µg Cd/l   | 5    | Water Supply Regulations 2016, Schedule 1                                 | 0.02    |



| Parameter <sup>52</sup>                | Unit       | PCV   | Source <sup>53,54</sup>                       | LoD  |
|--|------------|-------|---|------|
| Calcium - total and dissolved          | mg/l       | -     |   | 0.09 |
| Carbendazim                            | µg/l       | 0.1   | Water Supply Regulations 2016, Schedule 1     | 0.1  |
| Carbetamide                            | µg/l       | 0.1   | Water Supply Regulations 2016, Schedule 1     | 0.01 |
| Carbon tetrachloride                   | µg/l       | -     |   | 1    |
| Carbon, dissolved organic              | mg/l       | -     |   | 2    |
| Carbon, total organic                  | mg/l       | -     |   | 1    |
| Carbophenothion                        | µg/l       | 0.1   | Water Supply Regulations 2016, Schedule 1     | 0.02 |
| Chemical oxygen demand                 | mg/l       | -     |   | 10   |
| Chlorate                               | mg/l       | 0.25  | Drinking Water Directive, 2021                | 0.7  |
| Chlordane                              | µg/l       | -     |   | 0.02 |
| Chloride (as Cl)                       | mg/l       | 250   | Water Supply Regulations 2016, Schedule 2     | -    |
| Chlorite                               | mg/l       | 0.25  | Drinking Water Directive, 2021                | 3    |
| Chloroform                             | µg/l       | -     |   | 1    |
| Chloromethylphenol (4, 3)              | -          | -     |   | -    |
| Chlorophenol (2)                       | µg/l       | -     |   | 0.02 |
| Chlorophenol (4)                       | µg/l       | -     |   | 0.02 |
| Chlorophyll                            | µg/l       | -     |   | 20   |
| Chlortoluron                           | µg/l       | 0.1   | Water Supply Regulations 2016, Schedule 1     | -    |
| Chromium - total and dissolved         | µg/l       | 50    | Water Supply Regulations 2016, Schedule 1     | 0.25 |
| Cl. Perfringens-veg & spores confirmed | No/100ml   | 0     | Drinking Water Directive, 2021                | -    |
| Clopyralid                             | µg/l       | 0.1   | Water Supply Regulations 2016, Schedule 1     | 0.02 |
| Clostridium perfringens                | No/100ml   | 0     | Water Supply Regulations 2016, Schedule 2     | -    |
| Cobalt - total and dissolved           | µg/l       | -     |   | 0.16 |
| Cocamidopropyl betaine (CAPB)          | -          | -     |   | 1    |
| Coliform - total                       | No/100ml   | 0     | Water Supply Regulations 2016, Schedule 1 & 2 | -    |
| Colour                                 | mg/l Pt/Co | 20    | Water Supply Regulations 2016, Schedule 1     | 1    |
| Conductivity (at 20°C)                 | µS/cm-1    | 2,500 | Water Supply Regulations 2016, Schedule 2     | -    |
| Copper - total and dissolved           | µg/l       | 2,000 | Water Supply Regulations 2016, Schedule 1     | 0.4  |
| Cryptosporidium                        | µg/l       | -     |   | -    |



| Parameter <sup>52</sup>                                      | Unit     | PCV  | Source <sup>53, 54</sup>                  | LoD    |
|--|----------|------|---|--------|
| Cyanazine  | µg/l     | -    |   | 0.02   |
| Cyanide Total  | µg/l     | 50   | Water Supply Regulations 2016, Schedule 1 | 40     |
| Dalapon  | µg/l     | -    |   | 0.02   |
| DDE PP'  | µg/l     | -    |   | 0.02   |
| DDT OP'  | -        | -    |   | -      |
| DDT PP'  | µg/l     | -    |   | 0.025  |
| Desethyl Atrazine  | µg/l     | -    |   | 0.02   |
| DHC Benzene  | µg/l     | -    |   | 0.1    |
| DHC Cumene   | µg/l     | -    |   | 0.0025 |
| DHC Decane   | µg/l     | -    |   | 0.1    |
| DHC Ethyl benzene  | µg/l     | -    |   | 0.1    |
| DHC Heptane  | µg/l     | -    |   | 0.1    |
| DHC Octane   | µg/l     | -    |   | 0.1    |
| DHC Phenanthracene   | µg/l     | -    |   | -      |
| DHC Tetradecane  | µg/l     | -    |   | 0.1    |
| DHC Toluene  | µg/l     | -    |   | 0.1    |
| Diazinon   | µg/l     | -    |   | 0.01   |
| Dibromochloromethane   | µg/l     | -    |   | 1      |
| Dicamba  | µg/l     | -    |   | 0.02   |
| Dichlobenil  | µg/l     | -    |   | 0.02   |
| Dichloprop   | µg/l     | -    |   | 0.02   |
| Dichloroethane (1, 2)  | µg/l     | 3    | Water Supply Regulations 2016, Schedule 1 | 1      |
| Dichlorophenol (2, 4)  | µg/l     | -    |   | 1      |
| Dieldrin   | µg/l     | 0.03 | Drinking Water Directive, 2021            | 0.02   |
| Diethylenetriamine penta (methylene phosphonic acid) (DTPMP) | µg/l     | -    |   | 1      |
| Diflufenican   | µg/l     | -    |   | 0.1    |
| Dimethylphenol (2, 4)  | µg/l     | -    |   | 0.02   |
| Dimethylphenol (2, 5)  | µg/l     | -    |   | 0.02   |
| Dimethylphenol (3, 5)  | µg/l     | -    |   | 0.02   |
| Dissolved oxygen (on Site)                                   | %        | -    |   | -      |
| Diuron   | µg/l     | -    |   | 0.05   |
| E.coli   | No/100ml | 0    | Water Supply Regulations 2016, Schedule 1 | -      |
| Endosulfan A   | µg/l     | -    |   | 0.02   |



| Parameter <sup>52</sup>                  | Unit     | PCV  | Source <sup>53,54</sup>                   | LoD    |
|--|----------|------|---|--------|
| Endrin                                   | µg/l     | -    |   | 0.02   |
| Enterococci confirmed                    | No/100ml | 0    | Water Supply Regulations 2016, Schedule 1 | -      |
| Enterovirus                              | -        | -    |   | -      |
| Epichlorohydrin                          | µg/l     | 0.1  | Water Supply Regulations 2016, Schedule   | 0.1    |
| Ethofumesate                             | µg/l     | -    |   | 0.05   |
| Ethylbenzene                             | µg/l     | -    |   | 1      |
| Fenoprop                                 | µg/l     | -    |   | 0.02   |
| Flufenacet                               | µg/l     | -    |   | 0.02   |
| Fluoranthene                             | µg/l     | -    |   | 0.0009 |
| Fluoride                                 | mg/l     | 1.5  | Water Supply Regulations 2016, Schedule 1 | -      |
| Fluoroanthene                            | µg/l     | -    |   | 0.0009 |
| Fluroxypyr                               | µg/l     | -    |   | 0.02   |
| Geosmin                                  | ng/l     | -    |   | -      |
| Giardia                                  | No/l     | -    |   | -      |
| Glyphosate                               | µg/l     | -    |   | 0.1    |
| Haloacetic Acids (HAAs)                  | µg/l     | 60   | Drinking Water Directive, 2021            | -      |
| Hardness - total (as Ca)                 | mg/l     | -    |   | 0.1    |
| Hardness - total (as CaCO <sub>3</sub> ) | mg/l     | -    |   | -      |
| HCH Alpha                                | µg/l     | -    |   | 0.02   |
| HCH Beta                                 | µg/l     | -    |   | 0.02   |
| HCH Delta                                | µg/l     | -    |   | 0.02   |
| HCH Gamma                                | µg/l     | -    |   | 0.02   |
| Heptachlor                               | µg/l     | 0.03 | Drinking Water Directive, 2021            | 0.001  |
| Heptachlor epoxide                       | µg/l     | 0.03 | Drinking Water Directive, 2021            | 0.001  |
| Hexachlorobenzene                        | µg/l     | -    |   | 0.02   |
| Indeno(1,2,3-cd)pyrene                   | µg/l     | -    |   | -      |
| Ioxynil                                  | µg/l     | -    |   | 0.02   |
| Iron - total and dissolved               | µg/l     | 200  | Water Supply Regulations 2016, Schedule 1 | 5.5    |
| Isodrin                                  | µg/l     | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.02   |
| Isoproturon                              | µg/l     | -    |   | 0.002  |
| Lead - total and dissolved               | µg/l     | 10   | Water Supply Regulations 2016             | 0.09   |
| Linear alkylbenzene sulphonate (LAS)     | µg/l     | -    |   | 0.1    |
| Linuron                                  | µg/l     | -    |   | 0.01   |



| Parameter <sup>52</sup>               | Unit | PCV  | Source <sup>53,54</sup>                   | LoD  |
|---------------------------------------|------|------|---|------|
| Magnesium - total and dissolved       | mg/l | -    |   | -    |
| Malathion                             | µg/l | -    |   | 0.02 |
| Manganese - total and dissolved       | µg/l | 50   | Water Supply Regulations 2016, Schedule 1 | -    |
| MCPA                                  | µg/l | -    |   | 0.02 |
| MCPB                                  | µg/l | -    |   | 0.02 |
| Mecoprop                              | µg/l | -    |   | 0.02 |
| Mercury - total and dissolved         | µg/l | 0.07 | Water Supply Regulations 2016, Schedule 1 | 1    |
| Meta & Para-xylene                    | µg/l | -    |   | 0.1  |
| Metaldehyde                           | µg/l | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.02 |
| Metamitron                            | µg/l | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.02 |
| Metazachlor                           | µg/l | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.1  |
| Methoxychlor                          | µg/l | -    |   | 0.02 |
| Methyl tertiary amyl ether            | µg/l | -    |   | -    |
| Metribuzin                            | µg/l | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.05 |
| Microcystin-LR (algal toxin)          | µg/l | 1    | Drinking Water Directive, 2021            | 5    |
| Molybdenum - total and dissolved      | µg/l | -    |   | 1.1  |
| Monuron                               | µg/l | 0.1  | Water Supply Regulations 2016, Schedule 1 | 0.05 |
| MTBE                                  | µg/l | -    |   | 1    |
| Nickel - total and dissolved          | µg/l | 20   | Water Supply Regulations 2016, Schedule 1 | 0.5  |
| Nitrate as N                          | µg/l | 11.4 | Water Supply Regulations 2016, Schedule 1 | -    |
| Nitrate as NO <sub>3</sub>            | mg/l | 50   | Water Supply Regulations 2016, Schedule 1 | -    |
| Nitrite & nitrate (calculation)       | mg/l | -    |   | -    |
| Nitrite as N                          | mg/l | -    |   | -    |
| Nitrite as NO <sub>2</sub>            | mg/l | 0.5  | Water Supply Regulations 2016, Schedule 1 | -    |
| Nitrosamines                          | -    | -    |   | -    |
| N-Nitrosodimethylamine (NDMA)         | µg/l | -    |   | 0.1  |
| Non coliforms                         | -    | -    |   | -    |
| Nonylphenol                           | µg/l | -    |   | 0.04 |
| Number of crypto like bodies (4-6 µm) | /10l | -    |   | -    |
| Odour                                 | -    | -    |   | -    |



| Parameter <sup>52</sup>             | Unit     | PCV     | Source <sup>53, 54</sup>                   | LoD     |
|-------------------------------------|----------|---------|--|---------|
| Oocyst Count                        | Number   | -       |  | -       |
| Ortho-xylene                        | µg/l     | -       |  | 1       |
| Oxadixyl                            | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.05    |
| Oxamyl                              | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.05    |
| O-xylene                            | µg/l     | -       |  | 0.1     |
| P soluble reactive                  | mg/l     | -       |  | 0.01    |
| PAH (total of 4 in new reg 200)     | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.05    |
| PAH                                 | µg/l     | 0.1     | Drinking Water Directive, 2021             | 0.05    |
| Parathion                           | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.02    |
| Particulate Organic Carbon          | mg/l     | -       |  | 2       |
| PCP (phenols method)                | µg/l     | -       |  | -       |
| Pendimethalin                       | µg/l     | -       |  | 0.02    |
| Pentachlorophenol                   | µg/l     | -       |  | 0.02    |
| Perfluorooctane sulfonate (PFOS)    | µg/l     | -       |  | 0.00065 |
| Perfluorooctanoic acid (PFOA)       | µg/l     | -       |  | 0.005   |
| Pesticides - total                  | µg/l     | 0.5     | Water Supply Regulations 2016, Schedule 1. | 0.1     |
| PFAS - total                        | µg/l     | 0.5     | Drinking Water Directive, 2021             | -       |
| pH value                            | pH units | 6.5-9.5 | Water Supply Regulations 2016, Schedule 2  | 0.1     |
| Phenol                              | µg/l     | -       |  | 1       |
| Phenols - total                     | µg/l     | -       |  | 1       |
| Phosphorus - total inorganic (as P) | mg/l     | -       |  | 0.01    |
| Picloram                            | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.02    |
| Potassium - total and dissolved     | mg/l     | -       |  | 0.08    |
| Prometryn                           | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | -       |
| Propazine                           | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.02    |
| Propetamphos                        | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.02    |
| Propyzamide                         | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | 0.01    |
| Pseudomonas (confirmed)             | No/100ml | -       |  | 100     |
| Quinmerac                           | µg/l     | 0.1     | Water Supply Regulations 2016, Schedule 1  | -       |
| Radon                               | Bq/l     | -       |  | 10      |



| Parameter <sup>52</sup>             | Unit | PCV | Source <sup>53,54</sup>                   | LoD     |
|-------------------------------------|------|-----|---|---------|
| Selenium - total and dissolved      | µg/l | 10  | Water Supply Regulations 2016, Schedule 1 | 0.25    |
| Silica reactive (SiO <sub>2</sub> ) | mg/l | -   |   | -       |
| Silver - total and dissolved        | µg/l | -   |   | 1       |
| Simazine                            | µg/l | 2   |   | 0.02    |
| Sodium - total and dissolved        | mg/l | 200 | Water Supply Regulations 2016, Schedule 1 | -       |
| Solids, suspended (105°C)           | mg/l | -   |   | 5       |
| Somatic coliphages                  | -    | -   |   | -       |
| Specific abs (254 nm)               | abs  | -   |   | -       |
| Strontium - total and dissolved     | mg/l | -   |   | 0.4     |
| Sulphate as SO <sub>4</sub>         | mg/l | 250 | Water Supply Regulations 2016, Schedule 2 | -       |
| Sulphide                            | µg/l | -   |   | 10      |
| TDE OP'                             | -    | -   |   | -       |
| TDE PP'                             | -    | -   |   | -       |
| Tebuconazole                        | µg/l | 0.1 | Water Supply Regulations 2016, Schedule 1 | 0.1     |
| Tebuthiuron                         | µg/l | 0.1 | Water Supply Regulations 2016, Schedule 1 | 0.1     |
| Tecnazine                           | µg/l | 0.1 | Water Supply Regulations 2016, Schedule 1 | -       |
| Temp (on Site)                      | °C   | -   |   | -       |
| Terbutryn                           | µg/l | 0.1 | Water Supply Regulations 2016, Schedule 1 | 0.02    |
| Tetra & trichloroethane (total)     | µg/l | 10  | Water Supply Regulations 2016, Schedule 1 | 1       |
| Tetrachloroethene                   | µg/l | 40  |   | 1       |
| THM (total)                         | µg/l | 100 | Water Supply Regulations 2016, Schedule 1 | 4       |
| Tin - total and dissolved           | µg/l | -   |   | 0.4     |
| Titanium - total and dissolved      | µg/l | -   |   | 0.3     |
| Toluene                             | -    | -   |   | 1       |
| Total dissolved solids (TDS)        | mg/l | -   |   | -       |
| Total dry solids (at 180°C)         | mg/l | -   |   | -       |
| Total oxidised nitrogen             | mg/l | -   |   | -       |
| Transmission (at 254 nm)            | %    | -   |   | -       |
| Tributyltin compounds (TBT)         | µg/l | -   |   | 0.00003 |
| Trichloroethane (1, 1, 1)           | µg/l | -   |   | -       |



| <b>Parameter<sup>52</sup></b>             | <b>Unit</b> | <b>PCV</b> | <b>Source<sup>53, 54</sup></b>            | <b>LoD</b> |
|---|-------------|------------|---|------------|
| Trichloroethene                           | -           | -          |   | 1          |
| Trichlorophenol (2 ,4, 5)                 | µg/l        | -          |   | -          |
| Trichlorophenol (2, 4, 6)                 | µg/l        | 200        | Water Supply Regulations 2016, Schedule 1 | -          |
| Triclopyr                                 | µg/l        | 0.1        | Water Supply Regulations 2016, Schedule 1 | 0.02       |
| Triclosan                                 | µg/l        | -          |   | 0.01       |
| Trifluralin                               | µg/l        | -          |   | 0.02       |
| Trihalomethanes (THM) Formation Potential | µg/l        | 100        | Water Supply Regulations 2016, Schedule 1 | -          |
| Tritium                                   | Bq/l        | 100        | Water Supply Regulations 2016, Schedule 2 | 10         |
| Tungsten - total and dissolved            | µg/l        | -          |   | 10         |
| Turbidity                                 | NTU         | 1          | Water Supply Regulations 2016             | -          |
| Uranium (as U)                            | µg/l        | 30         | Drinking Water Directive, 2021            | 10         |
| Vanadium - total and dissolved            | µg/l        | -          |   | -          |
| Vinyl chloride                            | µg/l        | 0.5        | Water Supply Regulations 2016, Schedule 1 | 0.1        |
| Xylene                                    | µg/l        | 500        | Water Supply Regulations 2016, Schedule 1 | 1          |
| Zinc - total and dissolved                | µg/l        | -          |   | 0.5        |



# Appendix D. Emerging substances analysis suite

| Parameter  | CAS no.     | Parameter                            | CAS no.     |
|--|-------------|--------------------------------------|-------------|
| 1,1,1-trichloro-2-(2-chlorophenyl)-2-(4-chlorophenyl) (or DDT op)                      | 789-02-6    | Linear alkylbenzene sulphonate (LAS) | 68411-30-3  |
| 1,2-dichloroethane   | 107-06-2    | manganese dissolved                  | 7439-96-5   |
| 17 $\alpha$ ethinyloestradiol [also as Ethinylestradiol (EE2) (Estrogenic substances)] | 57-63-6     | MeFOSA; N-MeFOSA                     | 31506-32-8  |
| 17 $\beta$ oestradiol  | 50-28-2     | MeFOSE                               | 24448-09-7  |
| 3:3 FTCA   | 356-02-5    | Mercury (dissolved)                  | 7439-97-6   |
| 4:2 FTSA; 4:2 FTS  | 757124-72-4 | Mercury (total)                      | 7439-97-6   |
| 4-nonylphenol  | 104-40-5    | Microcystin-LR                       | 101043-37-2 |
| 4-nonylphenol diethoxylate   | 9016-45-9   | molybdenum dissolved                 | 7439-98-7   |
| 4-nonylphenol monoethoxylate   | 104-35-8    | molybdenum total                     | 7439-98-7   |
| 4-nonylphenol triethoxylate  | 51437-95-7  | naphthalene                          | 91-20-3     |
| 4-octylphenol  | 1806-26-4   | NEtFOSAA; EtFOSAA                    | 2991-50-6   |
| 5:3 FTCA   | 914637-49-3 | NFDHA                                | 151772-58-6 |
| 6:2 Cl-PFESA; 9Cl- PF3ONS  | 756426-58-1 | Nickel (dissolved)                   | 7440-02-0   |
| 6:2 FTSA; 6:2 FTS  | 27619-97-2  | Nickel (total)                       | 7440-02-0   |
| 7:3 FTCA   | 812-70-4    | NMeFOSAA; MeFOSAA                    | 2355-31-9   |
| 8:2 Cl-PFESA; 11Cl- PF3OUdS  | 763051-92-9 | Nonylphenol                          | 25154-52-3  |
| 8:2 FTSA; 8:2 FTS  | 39108-34-4  | Oestrone                             | 53-16-7     |
| acrylamide   | 79-06-1     | PCBs congener 101                    | 37680-73-2  |
| Aluminium (dissolved)  | 7429-90-5   | PCBs congener 118                    | 31508-00-6  |
| Aluminium (total)  | 7429-90-5   | PCBs congener 136                    | 38411-22-2  |
| Aminomethylphosphonic acid (AMPA, metabolite)  | 1066-51-9   | PCBs congener 153                    | 35065-27-1  |
| Antimony   | 7440-36-0   | PCBs congener 180                    | 35065-29-3  |
| Arsenic  | 7440-38-2   | PCBs congener 28                     | 7012-37-5   |
| barium dissolved   | 7440-39-3   | PCBs congener 52                     | 35693-99-3  |
| BDE 100  | 189084-64-8 | Perfluorobutane sulfonic acid (PFBS) | 375-73-5    |



| Parameter                               | CAS no.       | Parameter   | CAS no.     |
|---|---------------|---|-------------|
| BDE 153                                 | 68631-49-2    | perfluorododecane sulfonic acid (PFDoDS; PFDoS)             | 79780-39-5  |
| BDE 154                                 | 207122-15-4   | perfluorododecanoic acid (PFDoDA; PFDoA)                    | 307-55-1    |
| BDE 47                                  | 5436-43-1     | perfluoroheptane sulfonic acid (PFHpS)                      | 375-92-8    |
| BDE 99                                  | 60348-60-9    | perfluoroheptanoic acid (PFHpA)                             | 375-85-9    |
| BDE total (sum of 28,47,99,100,153,154) | Refer to note | Perfluorohexanesulfonic acid (PFHxS)                        | 355-46-4    |
| BDE-183                                 | 207122-16-5   | Perfluorooctane sulfonic acid (PFOS)                        | 1763-23-1   |
| BDE28                                   | 41318-75-6    | Perfluorooctanoic acid (PFOA)                               | 335-67-1    |
| Benzo(a)pyrene                          | 50-32-8       | perfluoropentane sulfonic acid (PFPS; PFPeS)                | 2706-91-4   |
| Bisphenol A                             | 80-05-7       | Perfluoropentanoic acid (PFPeA, or PFPA in SRO Review data) | 2706-90-3   |
| boron dissolved                         | 7440-42-8     | perfluorotridecane sulfonic acid (PFTrDS)                   |             |
| boron total                             | 7440-42-8     | perfluoroundecanoic acid (PFUnDA; PFUnA; PFUdA)             | 2058-94-8   |
| bromate                                 | 15541-45-4    | PFBA  | 375-22-4    |
| Bromide                                 | 24959-67-9    | PFDA  | 335-76-2    |
| bromodichloromethane                    | 75-27-4       | PFDS  | 335-77-3    |
| Cadmium (dissolved)                     | 7440-43-9     | PFecHS *CAS No needs checking                               | 133201-07-7 |
| Cadmium (total)                         | 7440-43-9     | PFEEESA   | 113507-82-7 |
| Chlorate                                | 14866-68-3    | PFHxA (perfluorohexanoic acid)                              | 307-24-4    |
| chloride                                | 16887-00-6    | PFHxDA  | 67905-19-5  |
| Chlorite                                | 14998-27-7    | PFMOBA  | 863090-89-5 |
| Chloroform as CHCl3 (trichloromethane)  | 67-66-3       | PFMOPrA   | 377-73-1    |
| Chromium (dissolved)                    | 7440-47-3     | PFNA  | 375-95-1    |
| Chromium (total)                        | 7440-47-3     | PFNS  | 68259-12-1  |
| Chromium-6 (Cr(VI))                     | 18540-29-9    | PFODA   | 16517-11-6  |
| Copper (dissolved)                      | 7440-50-8     | PFTeA   | 376-06-7    |
| Copper (total)                          | 7440-50-8     | PFTrDA; PFTriA  | 72629-94-8  |
| Cyanide                                 | 57-12-5       | PFUnDS  | 749786-16-1 |
| Cypermethrin                            | 52315-07-8    | Phenol  | 108-95-2    |



| Parameter   | CAS no.       | Parameter  | CAS no.                   |
|---|---------------|--|---------------------------|
| dibromochloromethane  | 124-48-1      | polycyclic aromatic hydrocarbons (PAH) sum                     | 130498-29-2               |
| dichloromethane   | 75-09-2       | Propiconazole  | 60207-90-1                |
| Diclofenac  | 15307-86-5    | Selenium   | 7782-49-2                 |
| Diethylhexyl-phthalate (DEHP)<br>[also appears as dioctyl phthalate in SRO Review data] | 117-81-7      | Silver   | 7440-22-4                 |
| Disinfection Byproducts (DBPs)  | n/a           | sodium dissolved   | 7440-23-5                 |
| DONA; ADONA   | 919005-14-4   | Soluble methane  | 74-82-8                   |
| epichlorohydrin   | 106-89-8      | Solvents (i.e., benzene)                                       | 71-43-2                   |
| EtFOSA; N-EtFOSA  | 4151-50-2     | Somatic Coliphages   | n/a                       |
| EtFOSE  | 1691-99-2     | sulphate   | 14808-79-8                |
| FBSA  | 30334-69-1    | Sulphide (as S)  | 18496-25-8                |
| FHxSA   | 41997-13-1    | tetra & trichloroethane total                                  | 25322-20-7 and 25323-89-1 |
| Fluoranthene  | 206-44-0      | tetrachloroethylene  | 127-18-4                  |
| Fluoride  | 16984-48-8    | Tin  | 7440-31-5                 |
| FOSA  | 754-91-6      | Tolytriazole   | 29385-43-1                |
| Glyphosate  | 1071-83-6     | Total metals   | n/a                       |
| Haloacetic Acids (HAAs)   | Refer to note | Tri-(2-chloroethyl) phosphate                                  | 115-96-8                  |
| Hexabromo-cyclododecane (HBCDD)   | 25637-99-4    | Tributyltin  | 688-73-3                  |
| HFPO-DA (Gen X)   | 13252-13-6    | Trichloroethylene as C2HCl3                                    | 79-01-6                   |
| HFPO-TA   | 13252-14-7    | Triclocarban (1-(4-chlorophenyl)-3-(3,4- dichlorophenyl)-urea) | 101-20-2                  |
| Iron (dissolved)  | 7439-89-6     | Triclosan  | 3380-34-5                 |
| Iron (total)  | 7439-89-6     | Uranium  | 7440-61-1                 |
| Lead (dissolved)  | 7439-92-1     | vinyl chloride   | 75-01-4                   |
| Lead (total)  | 7439-92-1     | Zinc (dissolved)   | 7440-66-6                 |
| Legionella  | n/a           | Zinc (total)   | 7440-66-6                 |



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# Gate 3 Water Quality Monitoring: Quarter 3 Results

Severn Trent, Affinity Water and Canal & River  
Trust

23 June 2023

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# GRAND UNION CANAL STRATEGIC RESOURCE OPTION

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## Client signoff

|                              |  |
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| <b>Client</b>                | Severn Trent, Affinity Water and Canal & River Trust |
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# INTRODUCTION



# 1. Introduction

## 1.1 Purpose of this document

The purpose of this document is to provide an update for data collected over the monitoring period spanning October - December 2022, in the context of longer-term monitoring data collected to date, where available. Data collection is ongoing, and this report provides interested parties with a look at all data collected thus far in the monitoring programme.



# METHODOLOGY



## 2. Methodology

### 2.1 Site locations

For the purpose of conceptualising the monitoring programme, the GUC system has been split into three main geographical sections, an overview of which can be seen with specific reach maps found in **Figure 2-1**. These are summarised below:

- **Upper section** - Covering the discharge from Minworth to the example discharge location (Coventry Canal at Atherstone).
- **Middle section** - GUC from the Braunston Junction to the Aylesbury Arm (Marsworth, North of Tring).
- **Lower section** - GUC from the Aylesbury Arm to Hanwell, London. This section includes the example abstraction location (GUC at Grove Lock, Leighton Buzzard).



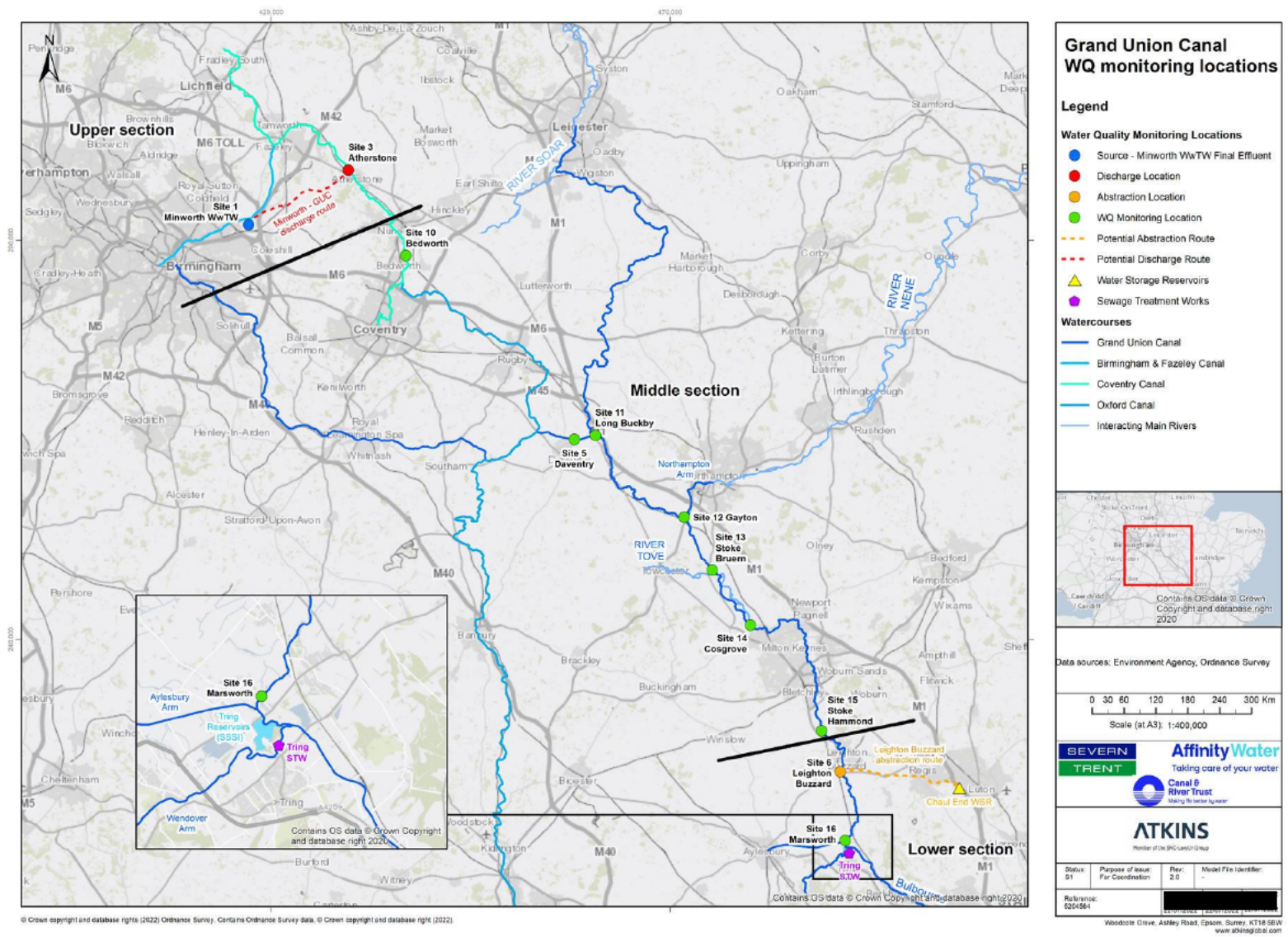


Figure 2-1 – Key elements/ reaches of the GUC scheme (black lines note the upper, middle and lower sections) Author names redacted



## 2.2 Monitoring, sampling, and analysis procedures

### 2.2.1 Continuous water quality monitoring sondes

There were no changes to the monitoring programme this quarter. Data were downloaded for all monitoring sondes for all parameters. The additional data in this report covers October – December 2022.

### 2.2.2 Spot water quality sampling

Spot water quality samples were taken in line with the programme outlined in the GUC Gate 3 Water Quality Monitoring report. No sites or samples were omitted due to access or safety issues this quarter.

The samples for the October 2022 round were taken on 17th October 2022

The samples for the November 2022 round were taken on 28th November 2022

The samples for the December 2022 round were taken on 12th December 2022

The analysis suites selected for analysis are based on 4 key legislative and design drivers. These are:

- **Environmental risks as required by the Water Framework Directive (WFD)** (WFD Suite)
- **Environmental permitting risks as required by the Environmental Quality Standards Directive (EQSD)** (EQSD suite)
- **Drinking Water risks as required by DWI (Drinking Water Inspectorate)** (Drinking water suite)
- **Emerging substances** (Emerging substances suite)

### 2.2.3 Rainfall data

Rainfall data were available from the EA for multiple locations along the GUC covering the entire monitoring period. For the Upper GUC, data have been compared to Lea Marsh gauge (Station ID: 096781). For the Middle reach of the GUC, data have been compared to Quinton rain gauge (EA Station ID: 170945) and for the lower GUC, Dancers End Reservoir has been used (EA Station ID: 261602). Additional data to cover the monitoring period covered in this quarter (October – December 2022) has been included.

These data are presented in Figure 2-2. There was one period of heavy rainfall during the October – December 2022 monitoring period which occurred between the 19<sup>th</sup> and 20<sup>th</sup> October 2022.



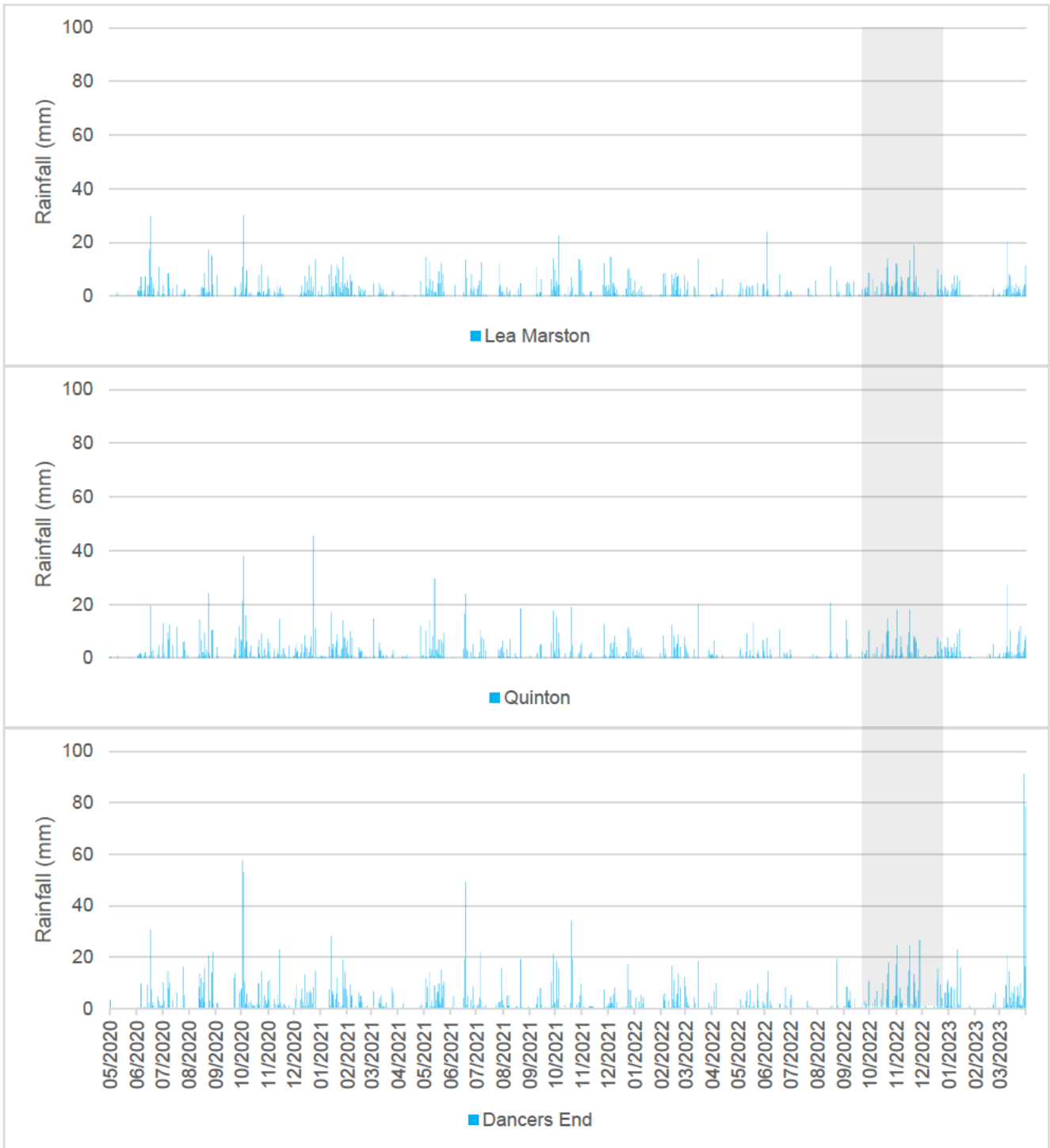


Figure 2-2 – Daily rainfall totals observed at Lea Marsh (EA Station ID: 096781), Quinton (EA Station ID: 170945) and Dancers End Reservoir (EA Station Number: 261602) for use in the analysis of GUC sonde and chemical data series. Grey shading highlights the monitoring period (October-December 2022).



# RESULTS



## 3. Results

### 3.1 Spot sample environmental quality standards comparison

#### 3.1.1 Overview

In order to determine parameters of risk, values have been compared against the relevant EQS as detailed by the 2015 WFD Directions and the EA Surface Water Pollution Risk Assessment Parameters EQSD. It is important to note that standards or condition limits for certain parameters under the WFD (e.g., dissolved oxygen, BOD, ammoniacal nitrogen, and ANC), are determined by categorising the water body by type, dependent on its altitude and alkalinity. ANC standards are determined by annual mean dissolved organic carbon concentrations. In addition, soluble reactive phosphorus (SRP) standards are determined by the water body's altitude and alkalinity, cadmium standards are determined by categorising the water body, by type, dependent on the hardness of the water, and zinc standards are determined by the ambient background concentration (ABC) of dissolved zinc. EA site specific standards (where available) were used (e.g. SRP), Where these were not available, site-specific standards have been calculated using the available data.

Whilst we have used site-specific EQS or WFD Good standards for the Minworth WwRC final effluent for indicative purposes, it is important to note that these standards should not be routinely applied to final effluent samples as they are in-river standards (these standards do not directly apply to effluent and discharge standards are set through the permitting regime). It is also important to note that we are considering all data on record when comparing against the standards which are applied as annual averages. Samples at the limit of detection were included in the analysis and used at face value to adhere to discharge permitting assessment guidance. Any significant outliers were removed from the analysis.

Based on the data collected to date across all sites, there have been a total of 100 individual EQS exceedances. It must be noted that EQS are typically applied as an annual average, maximum allowable concentration or specified percentile, therefore comparison against EQS is designed to be indicative of quality only.

#### 3.1.2 Temporal patterns

##### 3.1.2.1 Long term dataset

A list of all compounds that exceeded the quoted EQS split by site are presented in Table 3-1. Of these compounds, those that exceeded the EQS at most sites included two polycyclic aromatic hydrocarbons (PAH) benzo(a)pyrene and fluoranthene. BOD levels have historically resulted in exceedances across all sites except 11 (GUC at Long Buckby) and 13 (GUC at Stoke Bruerne). Elevated PFOS concentrations also resulted in EQS exceedances at all 11 Sites. Soluble Reactive Phosphorus (SRP) also exceeded EQS values at 10 Sites including Minworth WwRC.

Bromine (total residual oxidant) resulted in EQS exceedances at all (two) sites, as it is only measured as part of the EQSD analysis suite.

Lastly, low 10<sup>th</sup> percentile dissolved oxygen saturation values resulted in EQS exceedances at eight sites. It should be noted, however, that only six sampling rounds have been conducted for Sites 10-15 and 16. Failures to obtain the WFD standard typically occur in summer where temperatures are warmer and dilution capacity is reduced.



Table 3-2 shows the values corresponding to the test statistics for all compounds in exceedance of the EQS. This table highlights compounds that, while not currently exceeding EQS, may, if final effluent from Minworth WwRC were discharged into the GUC without additional treatment, be at risk of exceeding these WFD EQS values in the receiving waterbodies. This may result in a future WFD compliance risk as the new discharge would prevent the water quality of the receiving body from achieving Good Status in the future. These compounds include chlorothalonil (organic fungicide), cypermethrin (synthetic pyrethroid), permethrin (insecticide), and zinc (bioavailable).

Maximum allowable concentration (MAC) values were examined separately and have been applied to individual results and not mean or percentile data. In total there are 222 instances of MAC exceedances across all sites. Overall, four PAH (benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene) accounted for 25% of these exceedances. Bromine (total residual oxidant) accounted for 42 exceedances in the 'upper GUC', Sites 1 and 3. Sulphate (or hydrogen sulphide) exceeded MAC values on 107 occasions. A list of total exceedances split by compound can be seen in Table 3-3.



Table 3-1 - Number of EQS (WFD and EQSD) exceedances <sup>1</sup>.

| Compound                       | Standard | Unit | Statistic*       | Upper GUC       |                 | Middle GUC |        |         |         |         |         |         | Lower GUC Abstraction |         |
|--------------------------------|----------|------|------------------|-----------------|-----------------|------------|--------|---------|---------|---------|---------|---------|-----------------------|---------|
|                                |          |      |                  | Source          | Discharge       | Site 10    | Site 5 | Site 11 | Site 12 | Site 13 | Site 14 | Site 15 | Site 6                | Site 16 |
| Acid neutralisation capacity   | 40       | mg/l | AA               | 22 <sup>#</sup> | 22 <sup>#</sup> | 9          | 22     | 9       | 9       | 9       | 9       | 9       | 23                    | 9       |
| Benzo(a)pyrene                 | 0.00017  | µg/l | AA               | 34              | 33              | 9          | 22     | 9       | 9       | 9       | 9       | 9       | 23                    | 9       |
| BOD (5 day)                    | *        | mg/l | 90 <sup>th</sup> | 5               | 5               | 1          | 5      | 0       | 1       | 0       | 1       | 3       | 8                     | 3       |
| Bromine                        | 0.002    | mg/l | AA               | 21              | 21 <sup>#</sup> |            |        |         |         |         |         |         |                       |         |
| Cadmium - total                | 0.25     | µg/l | AA               | 0               | 12              | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                     | 0       |
| Chlorothalonil                 | 0.035    | µg/l | AA               | 1               | 0               |            |        |         |         |         |         |         |                       |         |
| Cobalt – dissolved             | 3        | µg/l | AA               | 0               | 17 <sup>#</sup> |            |        |         |         |         |         |         |                       |         |
| Cypermethrin                   | 0.00008  | µg/l | AA               | 24              | 4               | 4          | 2      | 2       | 2       | 2       | 3       | 5       | 6                     | 4       |
| Diazinon                       | 0.01     | µg/l | AA               | 1               | 0               |            |        |         |         |         |         |         | 0                     |         |
| Dissolved oxygen               | *        | %    | 10 <sup>th</sup> | 4               | 6               | 5          | 8      | 5       | 1       | 0       | 4       | 2       | 6                     | 2       |
| Fluoranthene                   | 0.0063   | µg/l | AA               | 1               | 31              | 8          | 9      | 8       | 7       | 8       | 8       | 9       | 21                    | 9       |
| Formaldehyde                   | 0.25     | µg/l | AA               | 1               | 0               |            |        |         |         |         |         |         |                       |         |
| Manganese – bioavailable**     | 123      | µg/l | AA               | 0 <sup>#</sup>  | 31              | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0 <sup>##</sup>       | 0       |
| Nickel - bioavailable**        | 4        | µg/l | AA               | 3               | 25              | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                     | 0       |
| Perfluorooctane sulfonic acid  | 0.00065  | µg/l | AA               | 33              | 32              | 7          | 20     | 7       | 7       | 7       | 7       | 7       | 18                    | 7       |
| Permethrin                     | 0.001    | µg/l | AA               | 12 <sup>#</sup> | 1               |            |        |         |         |         |         |         |                       |         |
| Soluble reactive phosphorus    | *        | µg/l | AA               | 26              | 4               | 9          | 9      | 4       | 2       | 7       | 7       | 0       | 20                    | 8       |
| Sulphide or hydrogen sulphide  | 0.25     | mg/l | AA               | 10              | 21              | 7          | 11     | 7       | 6       | 9       | 6       | 7       | 17                    | 6       |
| Total anions                   | 250      | µg/l | AA               | 6 <sup>#</sup>  | 18 <sup>#</sup> |            |        |         |         |         |         |         | 1                     |         |
| Tributyltin compounds          | 0.0002   | mg/l | AA               | 1               | 2               | 1          | 0      | 0       | 5       | 0       | 8       | 0       | 2                     | 1       |
| Zinc - bioavailable**          | *        | µg/l | AA               | 14              | 11              | 2          | 0      | 0       | 0       | 0       | 0       | 0       | 0                     | 0       |
| <b>Total number of samples</b> | -        | -    | -                | 34              | 33              | 9          | 22     | 9       | 9       | 9       | 9       | 9       | 23                    | 9       |

\*AA = Annual Average. Numbers of exceedances are shown for illustrative purposes only and reflect individual samples being compared to an AA or percentile derived EQS.

\* Site specific EQS determined.

\*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT)<sup>2</sup>.

# Total number of samples collected = 22 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 15.

<sup>1</sup> Blue shading indicates EQS (WFD and EQSD) exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of individual EQS exceedances is also given.

<sup>2</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktag](#)

Table 3-2 – Concentrations of compounds responsible for EQS (WFD and EQSD) failure<sup>3</sup>.

| Compound                       | Standard | Unit | Stat*            | Upper GUC |           | Middle GUC   |              |         |         |         |         |         | Lower GUC |         |  |  |
|--------------------------------|----------|------|------------------|-----------|-----------|--------------|--------------|---------|---------|---------|---------|---------|-----------|---------|--|--|
|                                |          |      |                  | Source    | Discharge | Abstraction  |              |         |         |         |         |         |           |         |  |  |
|                                |          |      |                  | Site 1    | Site 3    | Site 10      | Site 5       | Site 11 | Site 12 | Site 13 | Site 14 | Site 15 | Site 6    | Site 16 |  |  |
| Acid neutralisation capacity   | 40       | mg/l | AA               | 1827      | 2518      | 3389         | 2845         | 3733    | 4356    | 4378    | 3767    | 3144    | 3400      | 3044    |  |  |
| Benzo(a)pyrene                 | 0.00017  | µg/l | AA               | 0.0016    | 0.016     | 0.043        | 0.005        | 0.018   | 0.017   | 0.024   | 0.027   | 0.039   | 0.023     | 0.034   |  |  |
| BOD (5 day)                    | *        | mg/l | 90 <sup>th</sup> | 2.77      | 2.69      | 2.88         | 3.32         | 2.41    | 3.02    | 2.43    | 3.18    | 4.69    | 4.72      | 3.59    |  |  |
| Bromine                        | 0.002    | mg/l | AA               | 0.215     | 2.048     |              |              |         |         |         |         |         |           |         |  |  |
| Cadmium - total                | 0.25     | µg/l | AA               | 0.0246    | 0.2848    | 0.0444       | 0.0250       | 0.020   | 0.020   | 0.020   | 0.0211  | 0.0444  | 0.0330    | 0.020   |  |  |
| Chlorothalonil                 | 0.035    | µg/l | AA               | 0.0493    | 0.035     |              |              |         |         |         |         |         |           |         |  |  |
| Cobalt - dissolved             | 3        | µg/l | AA               | 1.79      | 11.2      |              |              |         |         |         |         |         | 0.4       |         |  |  |
| Cypermethrin                   | 0.00008  | µg/l | AA               | 0.00025   | 0.000083  | 0.00017<br>3 | 0.00011<br>9 | 0.00022 | 0.00039 | 0.00022 | 0.00017 | 0.00021 | 0.00118   | 0.00023 |  |  |
| Diazinon                       | 0.01     | µg/l | AA               | 0.0105    | 0.01      |              |              |         |         |         |         |         |           |         |  |  |
| Dissolved oxygen               | *        | %    | 10 <sup>th</sup> | 43.18     | 72.4      | 35.69        | 60.87        | 53.82   | 47.34   | 62.95   | 51.12   | 75.88   | 74.94     | 78.24   |  |  |
| Fluoranthene                   | 0.0063   | µg/l | AA               | 0.003     | 0.018     | 0.023        | 0.006        | 0.019   | 0.010   | 0.013   | 0.017   | 0.031   | 0.019     | 0.031   |  |  |
| Formaldehyde                   | 5        | µg/l | AA               | 51.4      | 50        |              |              |         |         |         |         |         |           |         |  |  |
| Manganese - bioavailable**     | 123      | µg/l | AA               | 14.7      | 1378      |              |              |         |         |         |         |         | 11        |         |  |  |
| Nickel - bioavailable**        | 4        | µg/l | AA               | 3         | 9.4       | 0.78         | 1.01         | 0.86    | 0.86    | 0.63    | 0.67    | 0.8     | 0.73      | 0.48    |  |  |
| Perfluorooctane sulfonic acid  | 0.00065  | µg/l | AA               | 0.0183    | 0.0073    | 0.0071       | 0.0184       | 0.0018  | 0.0318  | 0.034   | 0.009   | 0.0018  | 0.0019    | 0.0034  |  |  |
| Permethrin                     | 0.001    | µg/l | AA               | 0.0024    | 0.0011    |              |              |         |         |         |         |         |           |         |  |  |
| Soluble reactive phosphorus    | *        | µg/l | AA               | 0.36      | 0.12      | 0.114        | 0.11         | 0.06    | 0.046   | 0.12    | 0.11    | 0.026   | 0.18      | 0.23    |  |  |
| Sulphide or hydrogen sulphide  | 0.25     | mg/l | AA               | 9.72      | 16.12     | 19.67        | 14.95        | 17      | 19.67   | 27.56   | 21.67   | 19      | 27.87     | 17.67   |  |  |
| Total anions                   | 250      | µg/l | AA               | 245       | 430       |              |              |         |         |         |         |         | 177       |         |  |  |
| Tributyltin compounds          | 0.0002   | µg/l | AA               | 0.07      | 0.10      | 0.17         | 0.05         | 0.09    | 0.24    | 0.07    | 0.34    | 0.13    | 0.15      | 0.11    |  |  |
| Zinc - bioavailable**          | *        | µg/l | AA               | 14.4      | 11.7      | 12.6         | 2.87         | 1.54    | 1.31    | 1.31    | 3.17    | 1.86    | 2.49      | 1.89    |  |  |
| <b>Total number of samples</b> | -        | -    | -                | 34        | 33        | 9            | 22           | 9       | 9       | 9       | 9       | 9       | 23        | 9       |  |  |

\*AA = Annual Average.

\* Site specific EQS determined.

\*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT)<sup>4</sup>.

<sup>3</sup> Blue shading indicates EQS exceedance and grey shading indicates where failures relate to EQSD target compounds (not monitored at all sites, and as such not directly comparable across all sites). Concentrations corresponding to test statistic are also shown.

<sup>4</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktaq](#)

Table 3-3 – Number of WFD and EQSD MAC exceedances<sup>5</sup>.

| Compound                         | Standard | Unit | Statistic | Upper GUC       |           | Middle GUC |        |         |         |         |         |         | Lower GUC        |         |
|----------------------------------|----------|------|-----------|-----------------|-----------|------------|--------|---------|---------|---------|---------|---------|------------------|---------|
|                                  |          |      |           | Source          | Discharge | Site 10    | Site 5 | Site 11 | Site 12 | Site 13 | Site 14 | Site 15 | Abstraction      | Site 16 |
| Benzo(a)pyrene                   | 0.027    | µg/l | MAC       | 0               | 5         | 6          | 0      | 2       | 1       | 3       | 5       | 5       | 8                | 5       |
| Benzo(b)fluoranthene*            | 0.017    | µg/l | MAC       | 0               |           |            |        |         |         |         |         |         | 8 <sup>#</sup>   |         |
| Benzo(g,h,i)perylene*            | 0.0082   | µg/l | MAC       | 0               |           |            |        |         |         |         |         |         | 12 <sup>##</sup> |         |
| Benzo(k)fluoranthene*            | 0.017    | µg/l | MAC       | 0               |           |            |        |         |         |         |         |         | 3 <sup>##</sup>  |         |
| Bromine - total residual oxidant | 0.005    | mg/l | MAC       | 21 <sup>#</sup> | 21        |            | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| Cadmium - dissolved              | 1.5      | µg/l | MAC       | 0               | 1         | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| Cadmium - total                  | 1.5      | µg/l | MAC       | 0               | 1         | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| Cypermethrin                     | 0.0006   | µg/l | MAC       | 5               | 0         | 0          | 0      | 1       | 2       | 2       | 1       | 1       | 0                | 1       |
| Formaldehyde                     | 50       | µg/l | MAC       | 1               | 0         | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| Mercury - dissolved              | 0.07     | µg/l | MAC       | 2               | 1         | 2          | 1      | 2       | 1       | 1       | 2       | 1       | 2                | 2       |
| Mercury - total                  | 0.07     | µg/l | MAC       | 2               | 2         | 2          | 2      | 2       | 1       | 1       | 2       | 2       | 2                | 2       |
| Nickel - dissolved               | 34       | µg/l | MAC       | 2               | 12        | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| Sulphide or hydrogen sulphide    | 1        | µg/l | MAC       | 10              | 21        | 7          | 11     | 7       | 6       | 9       | 6       | 7       | 17               | 6       |
| Tributyltin compounds            | 0.02     | µg/l | MAC       | 2               | 2         |            |        |         |         |         |         |         |                  | 0       |
| <b>Total number of samples</b>   | -        | -    | -         | 34              | 33        | 9          | 22     | 9       | 9       | 9       | 9       | 9       | 23               | 9       |

\* While these determinands have a MAC, as per the WFD there is no corresponding AA statistic as benzo(a)pyrene should be considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water.

# Total number of samples collected = 22 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 15.

<sup>5</sup> Blue shading indicates MAC EQS exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of exceedances also given.

### 3.1.2.2 Notable concentration changes in the last quarter (October 2022 – December 2022)

For the first time BOD exceeded EQS at Site 10 this quarter. Cadmium (total) also exceeded the annual average EQS at Site 3. Formaldehyde, while previously undetected in all samples was detected at Site 1 for the first time this quarter. It should be noted the LoD for formaldehyde is 50 ug/l which is higher than the EQS of 0.25 ug/l. As such this is the first 'true' detection however formaldehyde may still have been present in previous samples. Tributyltin compounds also exceeded the annual average EQS for the first time at both Site 1 and 3. Cadmium (total), formaldehyde and tributyltin compounds also exceeded the MAC EQS this quarter.

In the last quarter, Diazinon (a nonsystemic organophosphate insecticide) was found to be elevated in the discharge from Minworth WwRC. No new substance exceedances were noted this quarter at any site. It should be noted however, that EQS data are used as an environmental benchmark and are not directly applicable to point source discharges.

The MAC exceedances of mercury (both total and dissolved) which were observed in the previous set of results (July to September) with concentrations increasing considerably across all sites, was not observed this quarter. The cause of the previous increase remains unknown, however, discharges from WwRCs are considerable sources of mercury. These increases in mercury concentrations result in a number of EQS-MAC exceedances as seen in Table 3-3. In this quarter the observed values for mercury returned to typical historical concentrations suggesting the peaks last quarter may have been an isolated event.

Canal systems are heavily modified systems and are largely controlled by stored sources of water and 'topped up' to ensure they are navigable at all times. As a result, with the exception of the absence of high flow events acting to transport large quantities of potential pollutants during high rainfall, their source water remains largely constant during periods of low or high flow.

## 3.1.3 Spatial patterns

In this section we directly compare the quality of treated effluent discharged from Minworth STW with the main sections of the GUC. The key changes identified this quarter are discussed below.

### 3.1.3.1 Minworth vs. GUC Upper Section (Site 3)

At Site 3, the example discharge location (Atherstone), most substances which exceed EQS at Minworth also exceed here. Exceptions include chlorothalonil, diazinon and formaldehyde which do not exceed at Site 3. This suggests these substances may be at increased risk of EQS exceedance in this section of the canal without additional treatment. While permethrin and soluble reactive phosphorus have exceeded EQS on occasion, these occur more frequently in the discharge from Minworth WwRC suggesting EQS failures would become more likely without additional treatment.

### 3.1.3.2 Minworth vs. GUC Middle Section (Sites 5,10,11,12,13,14 and 15)

The following substances exceed EQS in Minworth WwRC discharge but do not currently exceed EQS at any site in the middle section of the GUC:

- Bromine - total residual oxidant
- Chlorothalonil
- Cobalt - dissolved
- Diazinon
- Manganese - dissolved
- Nickel - dissolved
- Permethrin
- Total anions (sum of Br, Cl, F, NO<sub>2</sub>, NO<sub>3</sub>, PO<sub>4</sub>, SO<sub>4</sub>)

These substances are the most at risk of exceeding their respective EQS should an Minworth discharge be introduced. Site 15 is the only site where SRP has not exceeded EQS. Given this has regularly exceeded at all



sites this is at risk from the Minworth discharge. Dissolved zinc has previously exceeded EQS at Site 10 but not at any other site in this section. As with the substances above, this is likely at risk of exceedance.

### 3.1.3.3 Minworth vs. GUC Lower Section (Sites 6 and 16)

The following substances in the Minworth discharge do not currently exceed EQS at any site in the lower section:

- Bromine - total residual oxidant
- Chlorothalonil
- Cobalt - dissolved
- Manganese - dissolved
- Nickel - dissolved
- Permethrin
- Zinc - dissolved

These substances are most at risk from deterioration following a Minworth discharge. Total anions (sum of Br, Cl, F, NO<sub>2</sub>, NO<sub>3</sub>, PO<sub>4</sub>, SO<sub>4</sub>) only exceeded EQS at Site 6. Unlike the middle section, SRP regularly exceeds EQS at Sites 6 and 16.

## 3.2 Continuous Monitoring Data

This section describes the broad seasonal patterns observed in parameters monitored by the continuous sondes. Summary statistics (mean and standard deviation) of continuous monitoring data to date for each location are provided in Table 3-4. Summary statistics cover from the start of the record per site through to the end of the reporting period (31/12/2022). The continuous sonde data collected can be seen for all sites in Figures 3-1 to 3-4.

**Table 3-4 - Mean ± Standard Deviation (StDev) values observed at continuous monitoring locations.**

| Determinand      | Unit     | 1. Minworth WwRC Final Effluent* |       | 3. GUC at Atherstone** |       | 6. GUC at Grove, Leighton Buzzard*** |       | 16. GUC at Marsworth** |       |
|------------------|----------|----------------------------------|-------|------------------------|-------|--------------------------------------|-------|------------------------|-------|
|                  |          | Mean                             | StDev | Mean                   | StDev | Mean                                 | StDev | Mean                   | StDev |
| Temperature      | °C       | 16.6                             | 2.8   | 13.8                   | 4.6   | 12.3                                 | 5.9   | 15.9                   | 5.2   |
| Conductivity     | µS/cm    | 796                              | 102   | 1308                   | 471   | 636                                  | 93.9  | 537                    | 74.8  |
| Dissolved Oxygen | %        | 54.3                             | 4.3   | 75.0                   | 8.3   | 76.0                                 | 3.2   | 93                     | 2.2   |
| pH               | pH units | 6.73                             | 0.1   | 7.3                    | 0.2   | 7.83                                 | 0.3   | 7.93                   | 0.3   |
| Ammonium         | mg N/l   | 2.04                             | 1.42  | 0.476                  | 0.269 | 0.520                                | 0.208 | 0.50                   | 0.2   |
| Turbidity        | NTU      | 12.0                             | 51.2  | 18.8                   | 23.9  | 22.7                                 | 60.7  | 5.26                   | 2.7   |
| Chlorophyll      | µg/l     | -                                | -     | 8.88                   | 5.08  | 29.3                                 | 24.9  | 15.5                   | 9.4   |

\* Site 1 sonde data monitoring for conductivity, temperature, and dissolved oxygen commenced at the start of Phase 2 monitoring on 18/05/2022. Additional parameters including pH, ammonium, and turbidity were added on 05/04/2022.

\*\* Site 3 and Site 16 sondes were deployed on 11/05/22 and 24/05/22 respectively.

\*\*\* Site 6 sonde was deployed on 25/11/21.

## 3.2.1 Temperature

The temperature of a watercourse is regulated by several factors, including local climate, channel depth, riparian shading, and the presence of flow impediments. In general, watercourses are warmer in the summer and cooler in the winter and follow a predictable temporal pattern. The same is true of the Minworth discharge however the variability is considerably less than in a canal. Temperatures above 25°C can begin to stress cyprinid species while salmonid species can be affected above 20°C. Temperatures at most monitored locations are well below the thresholds for fish stress, however, temperatures at Site 16 occasionally exceeded the thresholds for stress in salmonid species with a maximum temperature recorded of 24.6°C between July and August 2022 during a period of exceptionally warm weather experienced across much of the UK. It should also be noted that this standard applies to rivers and not canals. Despite this, the effects on fish stress would occur at similar temperatures in a canal system, which, due to their shallower depth and reduced flow, are generally warmer than rivers. As this quarter falls within the winter period temperatures at all sites were well below the thresholds for fish stress.

Temperatures typically range from 10-23°C in the Minworth discharge. By contrast the canal at Atherstone ranges from 5-23°C. Temperatures between Minworth and Atherstone are generally comparable in summer months however the Minworth discharge is up to 8°C warmer than the canal in winter. Temperatures are, on average, 12.3°C at the example abstraction location at Site 6 making this the coolest site monitored.

## 3.2.2 Conductivity

Conductivity is a measure of the ability of a water body to conduct an electrical charge and reflects the concentration of ions in solution (e.g., sodium, calcium etc). Instream conductivity is primarily controlled by underlying geology. Temporary increases and reductions in conductivity can be observed in response to pulses of mineral rich material from catchment sources (e.g., agricultural runoff). Conversely, instream reductions in conductivity can occur when rainfall runoff from the surrounding area results in an instream dilution. Long term increases in conductivity, above what would be considered typical for a particular catchment can be indicative of nutrient enrichment from the surrounding landscape from point (e.g., STW) or diffuse (e.g., agricultural) sources.

Instream dilutions in conductivity are observed in response to wet weather events at Site 6 (Leighton Buzzard). This is indicative of a catchment underlain by calcareous geology, where catchment runoff is depleted in ions relative to the groundwater, which is enriched in base cations, primarily calcium due to the long water retention time experienced in the underground aquifer. There are a few instances observed in Site 16 when rainfall events result in short lived increases in baseline conductivity values. This suggested the delivery of nutrient rich material from surrounding catchment sources. Overall, mean conductivity is highest at Site 3. Values downstream at Sites 6 and 16 are approximately half that of Site 3 suggesting a difference in underlying geology and/ or nutrient enrichment.

## 3.2.3 Dissolved oxygen

Dissolved oxygen, typically measured in % saturation (or mg/l) describes the amount of oxygen that is dissolved in water. It is essential for aquatic life, with low DO saturation resulting in anoxia and subsequent fish kills and is associated with the development of eutrophic conditions. The pattern of DO saturation in watercourses varies seasonally. A typically well aerated river or stream will have a DO % saturation of ~100%. Canals typically experience lower DO saturation than rivers. This is partly due to the slow flowing nature of canals and lack of natural aeration from turbulent water as it travels downstream. Diurnal variability is highest during the summer months driven largely by photosynthesis-respiration dynamics. DO can however, exceed 100% instream due to the presence of photosynthetic aquatic organisms. This is observed at Site 6, just prior to an algal bloom event. Low DO saturation is typically observed in discharges from STWs, and Minworth is no exception with mean DO levels of 54.3%, this is largely due to the mineralisation of organic matter that occurs during the STW process. The discharge of treated wastewater into a riverine system typically results in an immediate downstream reduction in instream DO% saturation, as wastewater contains a higher organic load than its receiving waterbody. Relative to the canal sites, the Minworth discharge experiences a reduced

dissolved oxygen saturation of 54%. By contrast saturation at the exemplified discharge location at Atherstone (Site 3) measured 76%.

### 3.2.4 pH

The pH of a watercourse is a measure of how acidic or basic the water is. The pH is mainly driven by geology (and resultant soil type) however, can be influenced by catchment factors such as pollutant discharges and the leaching of soil horizons under differing flow conditions. As pH is recorded on a logarithmic scale, slight changes in pH can have significant impacts on the organisms that live in a watercourse. The optimum pH for water to sustain fish and invertebrate life, is around 6 to 9. Across all sites, pH was within acceptable limits for fish and invertebrates. It should be noted that pH at Minworth (6.7) is more acidic (lower) than the example discharge location at Site 3 (7.3). The example abstraction location at Site 6 as well as Site 16 are both slightly more basic measuring 7.8 and 7.9 respectively. This suggests pH may increase along the proposed transfer route.

### 3.2.5 Ammonium

Ammonium is a type of nitrogenous compound that is naturally present in water but can also be released into rivers from a variety of sources, including agricultural runoff, sewage treatment and industrial wastewater discharges. High concentrations of ammonium in rivers can be harmful to aquatic life, particularly fish, as it can disrupt their metabolism and respiration. In some cases, it can even be fatal. Ammonium can also contribute to the formation of algal blooms, which can further degrade water quality and make it unsafe for drinking, swimming, and fishing. Average ammonium concentrations were highest at Site 1 (Minworth WwRC) and lowest at the example discharge location (Site 3 Atherstone).

When compared to laboratory derived concentrations, *in-situ* measurements of ammonium commonly over record ammonium concentrations. As such, it is important to use these data to infer catchment trends rather than absolute concentrations.

### 3.2.6 Turbidity

Turbidity is a measure of how cloudy water is and can be used as a proxy for suspended sediment concentrations. It is caused by the presence of suspended particles in the water, such as sediment, algae, or other organic matter. Turbidity can make it difficult for sunlight to penetrate the water, which can reduce the amount of photosynthesis that takes place. A high loading of suspended sediment, when combined with reduced flow velocities can result in sediment deposition causing damage to macrophytes and reducing hydrological exchanges with the hyporheic zone. Increased sediment loading can result in the unintended substance transport. For example, the dominant form of phosphorus exported from agricultural systems is particulate phosphorus, which when exported from the terrestrial to aquatic systems has the potential to desorb and becoming available to facilitate instream heterotrophy.

Increases in turbidity can be caused by a number of factors, including erosion, runoff from agricultural fields following poor land and soil management practises, stormwater runoff and point source pollution, such as from sewage treatment plants. Turbidity values are typically highest at Site 6 measuring 22.7 NTU on average. This site also experiences the greatest variability due to its high responsiveness to rainfall events. At the example discharge location (Site 3), the average is 18.8 NTU however this site experiences much lower peaks following rainfall. By contrast, the Minworth discharge measures 12.0 NTU on average. The lowest average turbidity is at Site 16 with is significantly lower measuring 5.62 NTU with low peaks following rainfall.

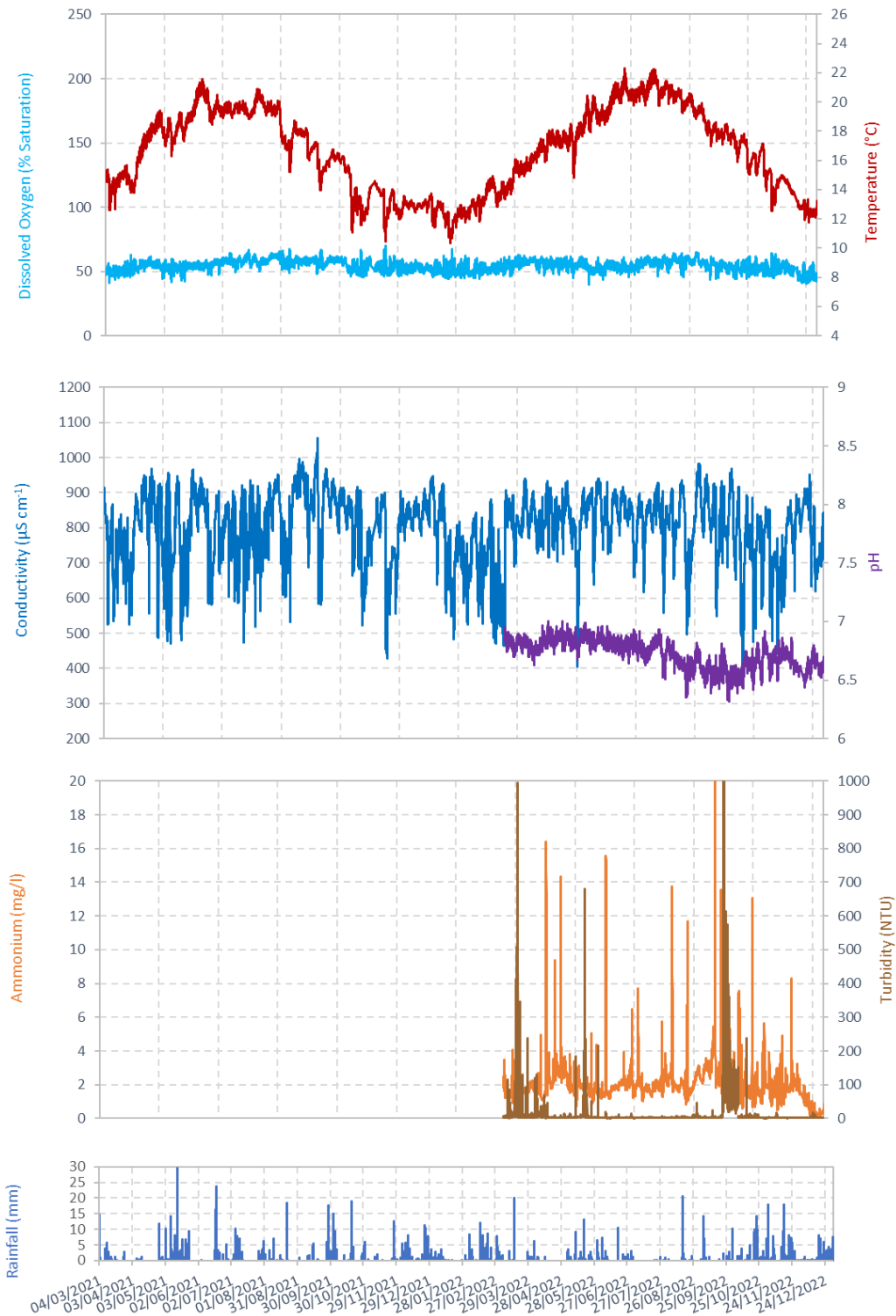
During the last quarter turbidity was low across all sites with no significant events. Historically, turbidity spikes across all sites following rainfall events.

### 3.2.7 Chlorophyll

Chlorophyll is a green pigment found in algae and plants. It is essential for photosynthesis, the process by which plants convert sunlight into energy. Chlorophyll can be used as a measure of the quantity of algae in a

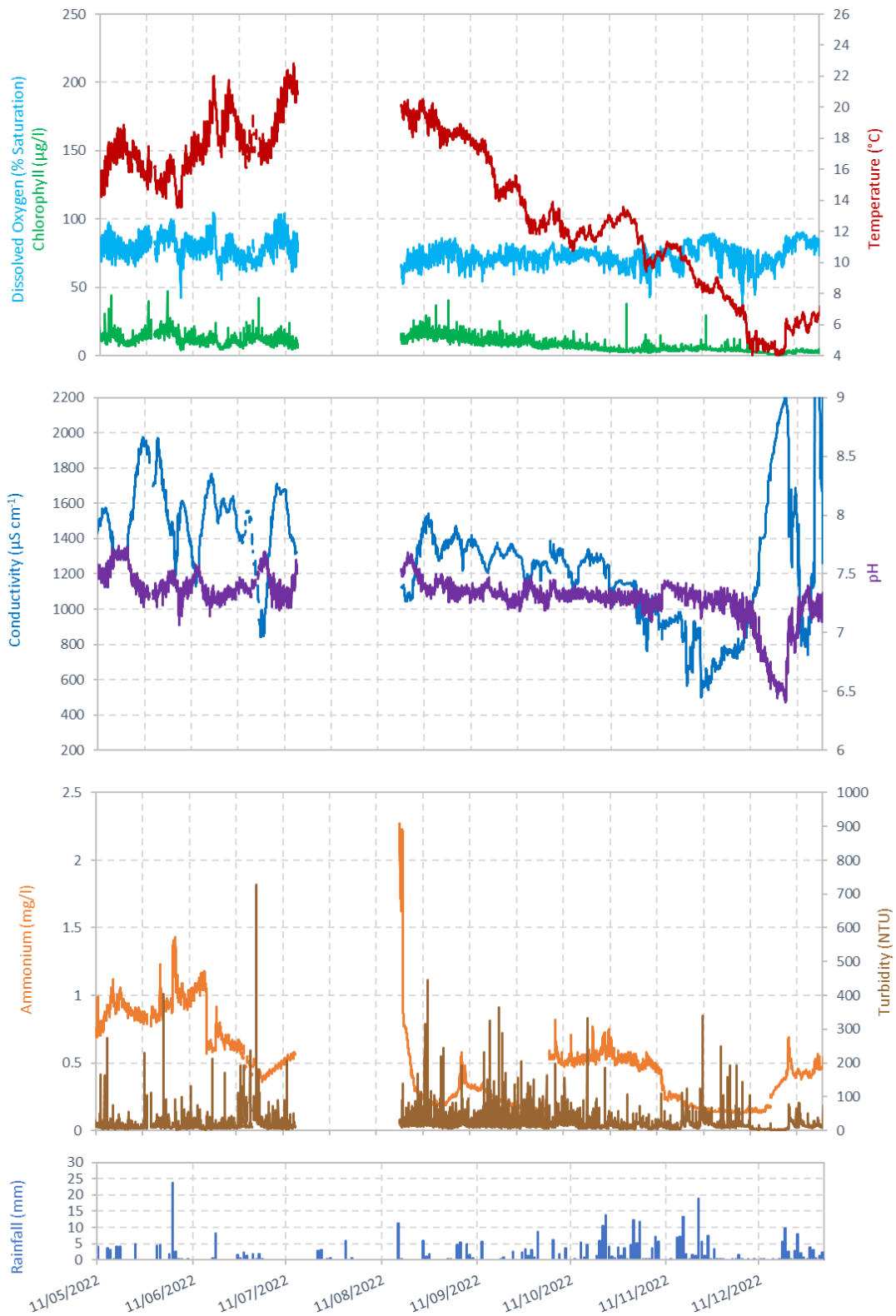


river. Higher levels of chlorophyll indicate more algae, which can lead to problems such as algal blooms, decreased oxygen levels, and the production of toxins. There are a number of factors that can affect the level of chlorophyll in a river, including nutrient levels, sunlight levels, temperature and flow. Chlorophyll concentrations are generally highest at Site 6 and have been observed to peak with a number of algal blooms events observed during the Spring and Summer months. Recent data collected covering October to December 2022 falls within the winter period and as such no algal blooms were observed this quarter.



**Figure 3-1 - Continuous sonde data collected to date at Site 1 (Minworth). Turbidity, ammonium and pH sensors were added to the sonde in April 2022.**





**Figure 3-2 - Continuous sonde data collected to date at Site 3 (GUC at Atherstone). Data gap between July and August 2022 was due to the sonde being stolen.**



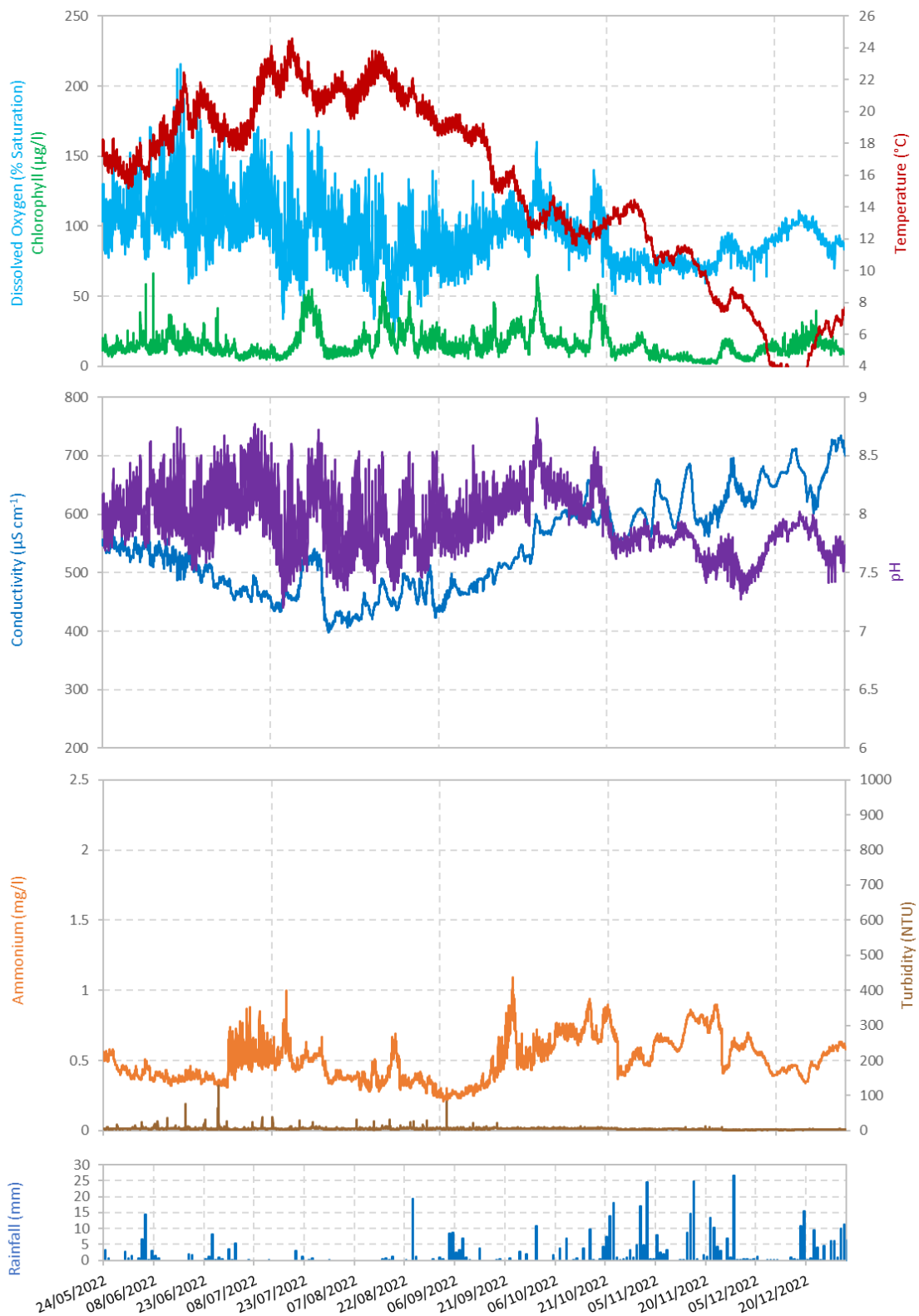
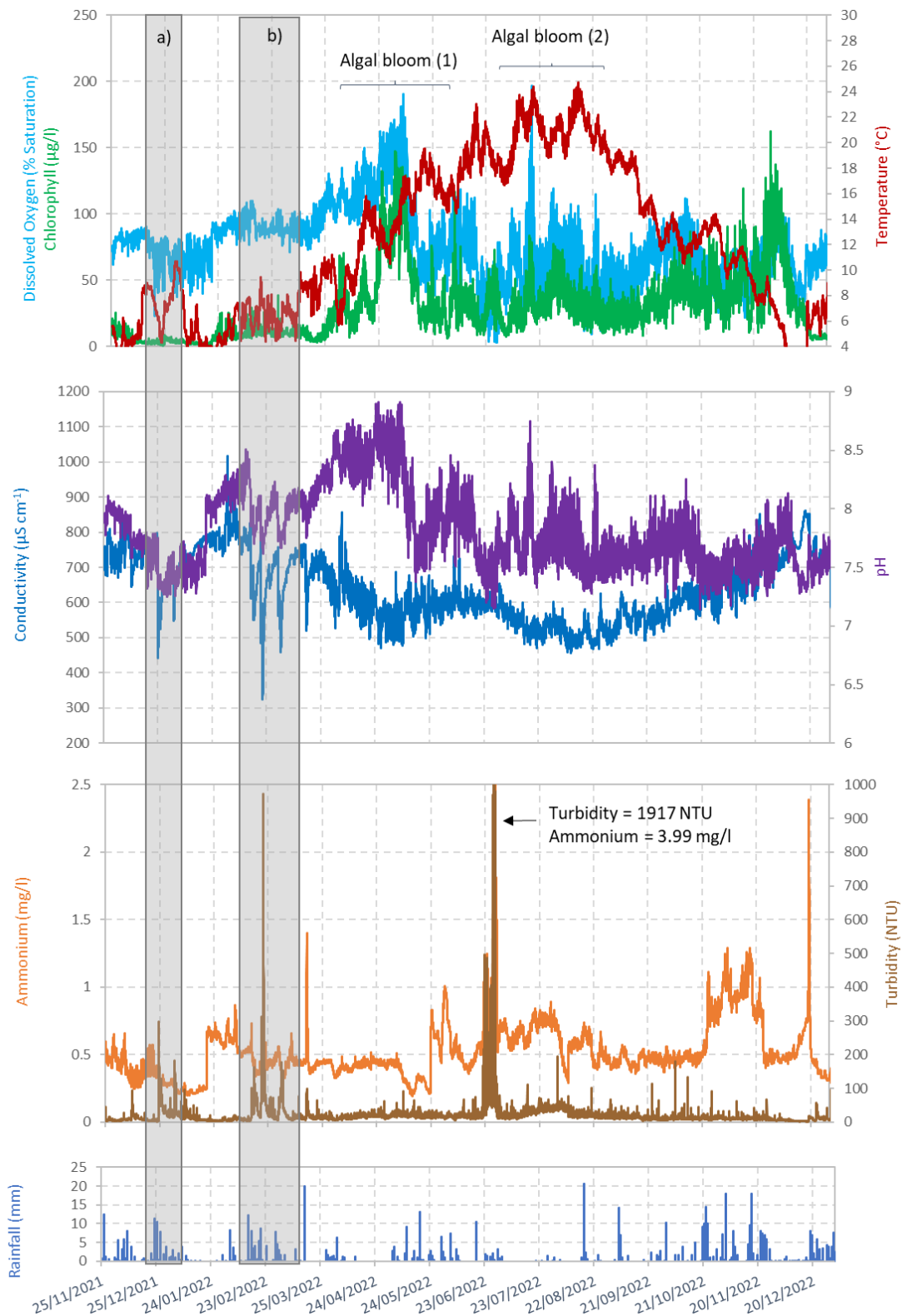


Figure 3-3 - Continuous sonde data collected to date at Site 16 (GUC at Marsworth).



**Figure 3-4 - Continuous sonde data collected to date at Site 6 (GUC at Grove, Leighton Buzzard). Grey shading indicates typical storm event responses across all parameters.**

## 3.3 Drinking Water Quality Standards

### 3.3.1 Overview

Drinking water parameters, assessed through their comparison to PCVs are only required to characterise the source water at Minworth WwRC (Site 1) and the downstream abstraction location (Site 6 Leighton Buzzard). It is important to note, that specific drinking water parameters were only added to the analysis suite at Site 6 in October 2021, prior to which, only WFD parameters were analysed. As a result, 15 months of DWSP parameter data are reported, compared to Site 1, for which data from Phases 1-3 are available (32-months). The exception to this is where a determinand has a comparable PCV and is present in the WFD analysis suite (e.g., iron). In these instances, all monitoring data are compared to the relevant drinking water standard. It should be noted that these standards are being applied to raw 'untreated' water where typically they would apply at the point of use i.e., a customer's tap. This had been undertaken to provide guidance on which substances may require targeted treatment when operational. PCV exceedances in wastewater discharge and an operational canal are therefore expected.

At Site 1 (Minworth) 218 exceedances have been recorded to date. At Site 6, 140 PCV exceedances have been recorded. The distribution of these is detailed in Table 3-1. Several determinands exceeded PCVs in every, or almost every, sampling round. These determinands, along with the number of exceedances observed at Site 6 (the example abstraction location), are given below. It must be noted that these standards are applicable to drinking water at the point of consumption, and these are effluent (Minworth) and surface water (Atherstone) sites.

- Benzo(a)pyrene (total exceedances = 14)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 15)
- *Escherichia coli* (*E. coli*, total exceedances = 15)
- Iron - total (total exceedances = 18)
- Nitrite (total exceedances = 10)
- Turbidity (total exceedances = 15)

*C. perfringens* (a sulphite-reducing species commonly associated with faecal contamination) is widely distributed in the environment and is regularly evaluated with the aim of understanding the microbiological safety of drinking water supplies. *C. perfringens* is responsible for gastrointestinal disease, the spores of which persist longer than other indicators of contamination, such as Coliforms (which also demonstrated exceedances at all sites and is also an important indicator of faecal contamination). Sources of bacterial contamination can range from the input of animal manures from farmyard runoff and the discharge of untreated, and even treated, sewage effluent<sup>6</sup>. *Cryptosporidium* was not detected at either site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores. However, as canal networks often have shallow depths (<6ft), short lived events may be a result of localised disturbance of sediments by boats or dogs and other wildlife swimming in the vicinity of the sensor location.

<sup>6</sup> [final\\_jrc\\_tech\\_report\\_dwd\\_06.04.20\\_final\\_pdf\(4\).pdf](#)

Table 3-5 – Number of drinking water PCV exceedances.

| Compound   | PCV  | Unit                 | Source    | Abstraction site |
|--|------|----------------------|-----------|------------------|
|  |      |                      | Site 1**  | Site 6**         |
| Aluminium - dissolved  | 200  | µg/l                 | 0         | 1                |
| Aluminium - total  | 200  | µg/l                 | 0         | 9                |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l                 | 3#        | 1##              |
| Benzo(a)pyrene   | 0.01 | µg/l                 | 0         | 14               |
| Bisphenol A  | 2.5  | µg/l                 | 9#        | 0##              |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml             | 22#       | 15##             |
| Chlorate   | 0.25 | mg/l                 | 4#        | 0##              |
| Chloride   | 250  | mg/l                 | 1#        | 0##              |
| Chlorite   | 0.25 | µg/l                 | 0#        | 1                |
| Chromium - total   | 50   | µg/l                 | 1         | 0                |
| Clopyralid   | 0.1  | µg/l                 | 1         | 0                |
| Coliform - total   | 0    | MPN/100ml            | 22        | 15##             |
| Colour   | 20   | mg/Pt/Co             | 19#       | 2##              |
| <i>E. coli</i>   | 0    | MPN/100ml            | 22#       | 15##             |
| Iron - dissolved   | 200  | µg/l                 | 0         | 1                |
| Iron - total   | 200  | µg/l                 | 7         | 18               |
| Manganese - dissolved  | 50   | µg/l                 | 21#       | 1##              |
| Manganese – total  | 50   | µg/l                 | 22#       | 3##              |
| Mercury - total  | 1    | µg/l                 | 1         | 0                |
| Metribuzin   | 0.1  | µg/l                 | 0#        | 1##              |
| Nickel - dissolved   | 20   | µg/l                 | 5         | 0                |
| Nickel - total   | 20   | µg/l                 | 5         | 0                |
| Nitrate  | 50   | mg/l NO <sub>3</sub> | 15#       | 2                |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub> | 19#       | 10               |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                 | 0#        | 4##              |
| PAH sum*   | 0.1  | µg/l                 | 0#        | 8##              |
| Propyzamide  | 0.1  | µg/l                 | 1#        | 0##              |
| Sodium - dissolved   | 200  | mg/l                 | 0         | 1                |
| Sulphate   | 250  | mg/l SO <sub>4</sub> | 0#        | 1##              |
| Tebuconazole   | 0.1  | µg/l                 | 0#        | 1##              |
| Turbidity  | 1    | NTU                  | 18#       | 15##             |
| Vinyl chloride   | 0.5  | µg/l                 | 0         | 1                |
| <b>Total number of samples</b>   |      |                      | <b>30</b> | <b>20</b>        |

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

\*\* Data at Site 1 covers May 20 - December 22 and data at Site 6 covers April 21 – December 22.

# Total number of samples collected = 22 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 15.



**Table 3-6 – Maximum concentrations of compounds responsible for drinking water PCV exceedances<sup>7</sup>.**

| Compound   | PCV  | Unit                    | Source | Abstraction sites |
|--|------|-------------------------|--------|-------------------|
|  |      |                         | Site 1 | Site 6            |
| Aluminium - dissolved  | 200  | µg/l                    | 50     | 1000              |
| Aluminium - total  | 200  | µg/l                    | 125    | 530               |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l as NH <sub>4</sub> | 1.4    | 1.88              |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 0.0046 | 0.134             |
| Bisphenol A  | 2.5  | µg/l                    | 137    | 10                |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml                | >100   | >100              |
| Chlorate   | 0.25 | mg/l                    | 2      | 0.7               |
| Chloride   | 250  | mg/l                    | 610    | 75                |
| Chlorite   | 0.25 | µg/l                    | <3     | 15                |
| Chromium - total   | 50   | µg/l                    | 140    | 15                |
| Clopyralid   | 0.1  | µg/l                    | 0.19   | 0.03              |
| Coliform - total   | 0    | MPN/100ml               | >2420  | >2420             |
| Colour   | 20   | mg/Pt/Co                | 41     | 26                |
| <i>E. coli</i>   | 0    | MPN/100ml               | >2420  | >2420             |
| Iron - dissolved   | 200  | µg/l                    | 100    | 1700              |
| Iron total   | 200  | µg/l                    | 310    | 2600              |
| Manganese - dissolved  | 50   | µg/l                    | 130    | 120               |
| Manganese - total  | 50   | µg/l                    | 160    | 150               |
| Mercury - total  | 1    | µg/l                    | 3.7    | 0.71              |
| Metribuzin   | 0.1  | µg/l                    | <0.05  | 0.22              |
| Nickel - dissolved   | 20   | µg/l                    | 61     | 7.1               |
| Nickel - total   | 20   | µg/l                    | 61     | 9.4               |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 120    | 100               |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 3.6    | 2.5               |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | -      | 0.374             |
| PAH sum*   | 0.1  | µg/l                    | <0.05  | 0.62              |
| Propyzamide  | 0.1  | µg/l                    | 0.32   | 0.1               |
| Sodium - dissolved   | 200  | mg/l                    | 78     | 510               |
| Sulphate   | 250  | mg/l SO <sub>4</sub>    | 180    | 690               |
| Tebuconazole   | 0.1  | µg/l                    | 0.05   | 0.2               |
| Turbidity  | 1    | NTU                     | 14.00  | 210               |
| Vinyl chloride   | 0.5  | µg/l                    | 0.50   | 1.00              |

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

<sup>7</sup> Dark blue shading indicates PCV exceedance, maximum reported concentrations are shown.



### 3.3.1.1 Notable concentration changes in the last quarter (October 2022 – December 2022)

In this quarter there was one additional PCV exceedance recorded at Site 6 (Table 3.5 and 3.6). On 22/12/2022 a concentration of sodium (dissolved) of 510 mg/l was observed. December 2022 was one of the only months in 2022 which saw below average temperatures. As a result, road gritting and salt spreading would have been prevalent in a large number of areas. Sodium enriched runoff reaching the water course at Site 6 may provide an explanation of the sudden, short lived, increase in sodium concentrations from a site baseline mean concentration of 56 mg/l (October 2021 – November 2022, n = 15). There were no additional substances identified as exceeding a PCV.

## 3.3.2 Spatial patterns

### 3.3.2.1 Minworth vs. example abstraction location (Site 6)

The following substances were found to have concentrations above their respective PCVs at the discharge from Minworth WwRC, however, were below PCVs instream at Site 6 (GUC at Grove, Leighton Buzzard). While it is beyond the scope of this report to infer if an instream PCV exceedance would occur at Site 6 if effluent discharge were re-directed into the GUC, these compounds of note should be subject to future analysis.

- Bisphenol A
- Chlorate
- Chloride
- Chromium - total
- Clopyralid
- Mercury - total
- Nickel - dissolved
- Nickel - total
- Propyzamide

Bisphenol A and chlorate measure above PCV at Minworth but below PCV at Site 6. The LoD for Bisphenol A is higher than the PCV. As such concentrations in the canal cannot currently be accurately assessed against the discharge, however, values are assumed low at present. Chloride exceeds PCV concentration at Minworth with 113 mg/l on average while measuring 44.1 ug/l on average (max 75 µg/l) at Site 6. This suggests concentrations are well below the PCV of 250 µg/l but could be at risk of exceedance if a Minworth discharge were introduced. Chromium (total) exceeds PCV at Minworth while measuring a maximum of 15 µg/l. This is below the PCV of 50 µg/l. Concentrations in the canal could be at risk of exceedance following introduction of a Minworth discharge given the PCV is exceeded by a significant margin. Clopyralid exceeds PCV by a small margin at Minworth while being well below PCV at Site 6. There may be some risk to in canal concentrations from a Minworth discharge. Mercury (total) at Site 6 is only slightly below the PCV of 1 µg/l (mean = 0.7 µg/l). This substance may be at risk of PCV exceedance following the introduction of a Minworth discharge given the high discharge concentrations. Mean concentration of both nickel (total and dissolved) are both close to exceeding the PCV of 20 µg/l at Site 6. Consequently, these substances are highly likely to exceed PCV following a Minworth discharge. Mean concentrations of propyzamide are similar at Minworth and Site 6 but do exceed PCV at Minworth. There is moderate risk to the propyzamide PCV being breached at Site 6 following a Minworth discharge. These substances may be influenced at Site 6 with the addition of the Minworth discharge and as such, in the absence of additional treatment at Minworth, these substances may require additional treatment following abstraction.



# CONCLUSIONS



## 4. Conclusions

At present, the following determinands demonstrated the greatest number of AA EQS exceedances on an individual sample basis:

- **Minworth** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - ANC (a total of 22 individual occurrences)
  - Benzo(a)pyrene (a total of 34 individual occurrences)
  - BOD - 5-day (a total of 5 individual occurrences)
  - Dissolved Oxygen (a total of 19 individual occurrences)
  - Fluoranthene (a total of 1 individual occurrences)
  - PFOS (a total of 33 individual occurrences)
  - SRP (a total of 26 individual occurrences)
  - Sulphide or hydrogen sulphide (a total of 10 individual occurrences)
  
- **GUC**
  - ANC (10 sites, a total of 130 individual occurrences)
  - Benzo(a)pyrene (10 sites, a total of 141 individual occurrences)
  - BOD - 5-day (7 sites, a total of 27 individual occurrences)
  - Dissolved Oxygen (7 sites, a total of 32 individual occurrences)
  - Fluoranthene (8 sites, a total of 118 individual occurrences)
  - PFOS (10 sites, a total of 119 individual occurrences)
  - SRP (7 sites, a total of 70 individual occurrences)
  - Sulphide or hydrogen sulphide (9 sites, a total of 97 individual occurrences)

In addition, the following determinands exceeded WFD / EQSD MAC values:

- **Minworth** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - Sulphide or hydrogen sulphide (total individual exceedances = 10)
  - Bromine - total residual oxidant (total individual exceedances = 21)
  - Nickel - dissolved (total individual exceedances = 2)
  - Cypermethrin (total individual exceedances = 5)
  - Formaldehyde (total individual exceedances = 1)
  - Mercury - dissolved (total individual exceedances = 2)
  - Mercury - total (total individual exceedances = 2)
  - Triphenyltin compounds (as triphenyltin cation) (total individual exceedances = 2)
  
- **GUC**
  - Benzo(a)pyrene (total individual exceedances = 40)
  - Benzo(b)fluoranthene (total individual exceedances = 8)
  - Benzo(g,h,i)perylene (total individual exceedances = 12)
  - Benzo(k)fluoranthene (total individual exceedances = 3)
  - Cadmium total (total individual exceedances = 1)



- Cadmium dissolved (total individual exceedances = 1)
- Sulphide or hydrogen sulphide (total individual exceedances = 40)
- Bromine - total residual oxidant (total individual exceedances = 21)
- Nickel - dissolved (total individual exceedances = 12)
- Cypermethrin (total individual exceedances = 8)
- Mercury - dissolved (total individual exceedances = 15)
- Mercury - total (total individual exceedances = 18)
- Triphenyltin compounds (as triphenyltin cation) (total individual exceedances = 2)

Some concentrations in the Minworth WwRC effluent were greater than the EQS in the receiving water at Site 3, Coventry Canal, Atherstone (noting these standards do not directly apply to effluent and discharge standards are set through the permitting regime). These include chlorothalonil (an organic fungicide), cypermethrin (a synthetic pyrethroid), bioavailable zinc, and dissolved oxygen. As a result, if Minworth WwRC discharge were diverted into any of the example sub-discharge routes without additional treatment applied, additional instream exceedances may occur, resulting in a future WFD compliance risk as the new discharge would prevent the water quality of the receiving body from achieving Good Status. Current mean bioavailable zinc concentration at Site 3 is 11.7 µg/l, marginally reduced since the last report period, against a site specific EQS of 13.9 µg/l. The addition of the discharge of final effluent from Minworth may take concentrations at Site 3 closer to its EQS. Further assessment is required to determine the level of confidence if this is indeed the case (e.g., through modelling or pairwise assessment of samples once a full year of data is collected). Treatment or other removal at works will be required in order to provide a resolution to this issue.

Minworth WwRC treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of these 'high risk' compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permitting risk (e.g., due to within class deterioration).

As discussed in Section 3.1.2.2, PCVs apply only to treated drinking water, and not raw source waters. However, the monitoring of these determinands and regular comparison with drinking water standards enables a threshold for screening out determinands that may be considerably elevated in raw water, thus helping to inform treatment design at the example abstraction location. With that in mind, the following determinands are currently routinely exceeding PCV targets at Site 6.

- Benzo(a)pyrene (total exceedances = 14)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 37)
- *Escherichia coli* (*E. coli*, total exceedances = 37)
- Iron - total (total exceedances = 25)
- Nitrite (total exceedances = 29)
- Turbidity (total exceedances = 33)

*C. perfringens* exceeded PCV values at both sites as it is widely distributed across the environment and as such, is regularly evaluated to monitor the microbiological safety of drinking water supplies. Sources of bacterial contamination can range from the input of animal manures from farmyard runoff to discharge from untreated or treated sewage effluent. *Cryptosporidium* was not detected at any site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores or localised disturbance events.

All sensor data appear to be within ranges typical of freshwater environments during a winter period.



A series of spring algal blooms, which may pose a risk for abstraction, were observed in the data at Site 6 between March and April 2022. A series of blooms were also observed in the data from Site 16 between July and August. This was, however, considerably smaller than the bloom observed at Site 6. No algal blooms were noted during this quarter.

With respect to WFD EQS, in the upper GUC chloronathonil, diazinon and formaldehyde are the substances most at risk with permethrin and SRP also at risk. For the middle and lower sections, the following substances are at risk:

- Bromine - total residual oxidant
- Chlorothalonil
- Cobalt - dissolved
- Diazinon
- Manganese - dissolved
- Nickel - dissolved
- Permethrin
- Zinc - dissolved

Total anions (sum of Br, Cl, F, NO<sub>2</sub>, NO<sub>3</sub>, PO<sub>4</sub>, SO<sub>4</sub>) is only at risk in the middle section. SRP is only at risk in the middle section as this regularly exceeds EQS in the lower section.

With respect to PCVs, the following substances are potentially at risk from the Minworth discharge to the GUC:

- Bisphenol A
- Chlorate
- Chloride
- Chromium total
- Clopyralid
- Mercury - total
- Nickel - dissolved
- Nickel - total
- Propyzamide

## 4.1 Next Steps

We will continue to analyse water quality data collected as part of the GUC water quality monitoring programme which will continue through to November 2024. As part of this process, we will continue providing quarterly updates which will be communicated to the GUC project team and the Minworth WwRC and abstraction treatment engineers to understand the feasibility of designing treatment for any 'high risk' compounds. We will also work with the team to identify any changes that may be required to the monitoring programme i.e., the addition or removal of sites and/or parameters.

Our water quality analysis will continue to investigate environmental and drinking water risks, comparing results to individual EQS and PCVs, and where these do not exist (and where possible) Predicted No-Effect Concentrations (PNECs). Our analysis will also continue to investigate whether there is a potential risk of water quality deterioration by comparing Minworth WwRC final effluent with canal sites.

We will also update the drinking water quality risk assessment for Gate 3 following the All Company Working Group (ACWG) methodology. This was previously undertaken for Gate 1 and subsequently updated for Gate 2, with the caveat that this assessment is based on raw water before treatment, so PCV breaches are expected.



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# Gate 3 Water Quality Monitoring: Quarter 4 Results

Severn Trent, Affinity Water and Canal & River  
Trust

29 September 2023

5204564 / 7 / DG / 030

# GRAND UNION CANAL STRATEGIC RESOURCE OPTION

# Notice

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This document has 35 pages including the cover.

## Document history

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## Client signoff

|                              |  |
|------------------------------|--|
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| <b>Project</b>               | Grand Union Canal Strategic Resource Option          |
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# INTRODUCTION



# 1. Introduction

## 1.1 Purpose of this document

The purpose of this document is to provide an update of data collected over the monitoring period spanning January-March 2023, and where available, set these data in the context of longer-term monitoring data collected to date. This report has been restructured compared to previous versions with this iteration focussing more on in-quarter changes. Data collection for the Grand Union Canal (GUC) Strategic Resource Option (SRO) is ongoing. This report provides stakeholders an update on the data, as it is collected and draws comparisons, when possible, to environmental, and drinking water standards.

**Key changes in spot and continuous data observed in-quarter are highlighted in callouts for clarity.**



# METHODOLOGY



## 2. Methodology

### 2.1 Site locations

For the purpose of conceptualising the monitoring programme, the GUC network has been split into three main geographical sections including an overview map of the upper, middle, and lower section (Figure 2-1) and are summarised below:

- **Upper section** – Covering the discharge from Minworth to the example discharge location (Coventry Canal at Atherstone).
- **Middle section** – GUC from the Braunston Junction to the Aylesbury Arm (Marsworth, North of Tring).
- **Lower section** – GUC from the Aylesbury Arm to Hanwell, London. This section includes the example abstraction location (GUC at Grove Lock, Leighton Buzzard).





## 2.2 Monitoring, sampling, and analysis procedures

### Key changes to monitoring programme.

There were no changes to the monitoring programme this quarter. Data were downloaded for all monitoring sondes for all parameters. Data added in this most recent summary report covers the period January – March 2023.

### 2.2.1 Spot water quality sampling

Spot water quality samples were taken in line with the programme and operating procedures outlined in the Gate 3 Water Quality Monitoring report. No sites or samples were omitted due to access or safety issues this quarter.

The samples for the January 2023 round were taken on 30th January 2023

The samples for the February 2023 round were taken on 20th February 2023

The samples for the March 2023 round were taken on 13th March 2023

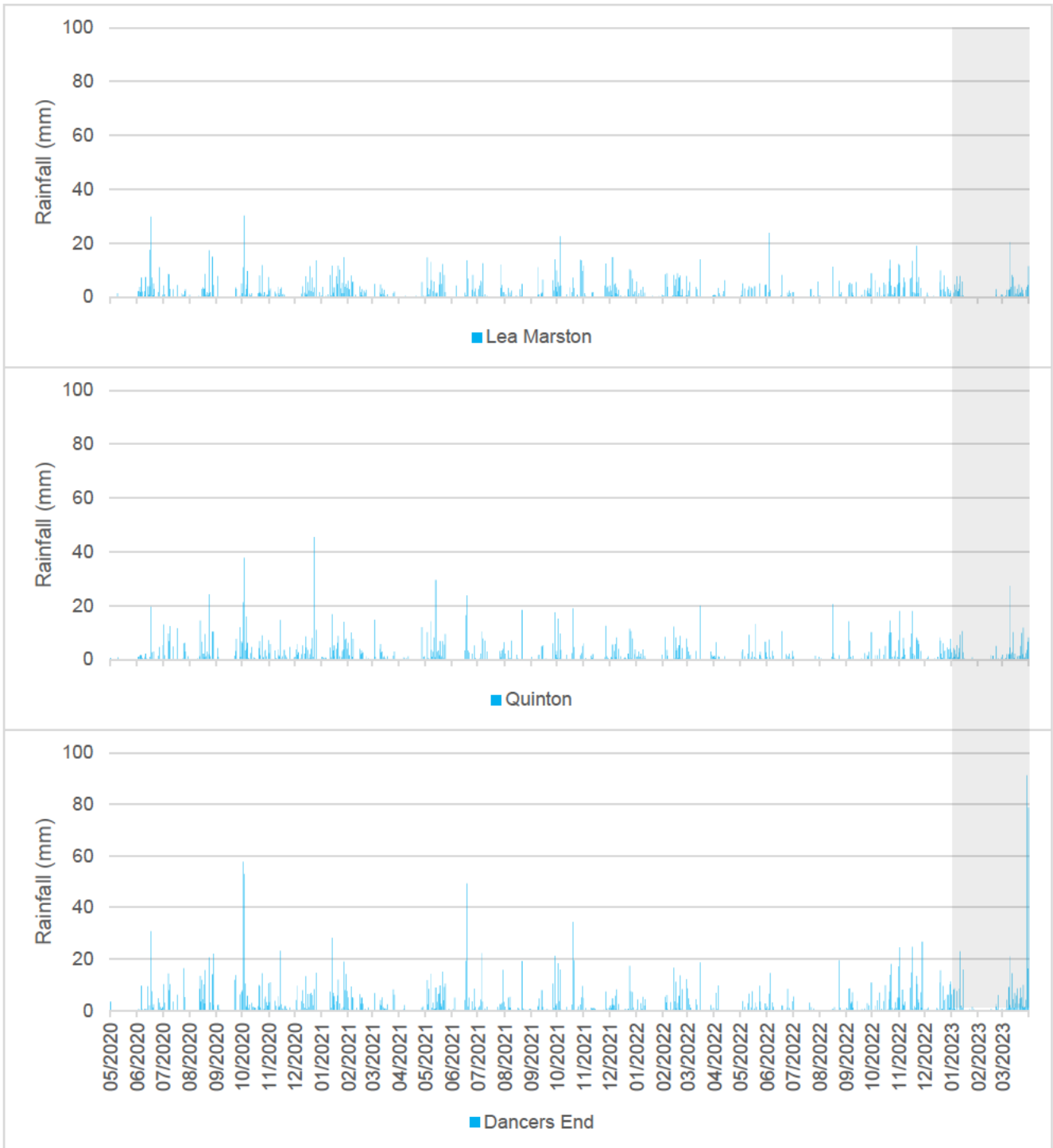
The analysis suites selected for analysis are based on 4 key legislative and design drivers. These include:

- **Environmental risks as required by the Water Framework Directive (WFD)** (WFD Suite)
- **Environmental permitting risks as required by the Environmental Quality Standards Directive (EQSD)** (EQSD suite)
- **Drinking Water risks as required by DWI (Drinking Water Inspectorate)** (Drinking water suite)
- **Emerging substances** (Emerging substances suite)

### 2.2.2 Rainfall data

Rainfall data were available from the Environment Agency (EA) for multiple locations along the GUC covering the entire monitoring period. For the Upper GUC, data have been compared to Lea Marsh gauge (Station ID: 096781), for the Middle reach of the GUC, data have been compared to Quinton rain gauge (EA Station ID: 170945), and for the lower GUC data from Dancers End Reservoir have been used (EA Station ID: 261602). These data are presented in **Figure 2-2**. There were three periods of heavy rainfall during the January – March 2023 monitoring period, defined as rainfall greater than 20.0 mm, which occurred on the 11<sup>th</sup> January (22.9 mm), 9<sup>th</sup> March 2023 (21.1 mm) and 29<sup>th</sup> March 2023 (91.2 mm) as measured at Dancers End Reservoir.





**Figure 2-2 – Daily rainfall totals observed at Lea Marsh (EA Station ID: 096781), Quinton (EA Station ID: 170945) and Dancers End Reservoir (EA Station Number: 261602) for use in the analysis of GUC sonde and chemical data series. Grey shading highlights the current reporting period (January – March 2023).**

# RESULTS



## 3. Results

### 3.1 Spot sample environmental quality standards comparison

#### Notable concentration changes in the last quarter (January 2023 – March 2023)

For the first time a single exceedance of di(2-ethylhexyl)phthalate (DEHP), an organic compound commonly used as a plasticiser, was detected above EQS at both Sites 3 and 6 (EQS = 1.3 µg/l, concentration observed at Site 3 = 4.35 µg/l, concentration observed at Site 6 = 1.41 µg/l) with both exceedances observed on 20/02/2023. These exceedances did not coincide with any peaks in rainfall, or any parameters monitored as part of the continuous sonde deployment. This suggests a proximal, flow independent source rather than flushing from the surrounding catchment during a period of rainfall. In quarter continuous monitoring data are discussed in Section 3.2.

A new annual average exceedance of cadmium (dissolved) was also observed at Site 3 (EQS = 0.25 µg/l, site mean 0.257 µg/l); this was driven by two in quarter exceedances observed on 30/01/2023 (3.73 µg/l) and 13/03/2023 (0.52 µg/l), respectively. No peaks in rainfall were observed on or prior to the January sampling date, however, March experienced considerable rainfall with 6.8 mm observed on the day of exceedance.

A single exceedance of BOD above the EQS was also observed at Site 11 (EQS = 4 mg/l, concentration observed at Site 3 = 5 mg/l) for the first time.

Substances previously exceeding their respective MACs occurring this quarter include benzo(a)pyrene (Site 6, 14 and 15 with Site 5 and 12 being the first time an exceedance occurs); Bromine (Sites 1 and 3), cadmium total and dissolved (Site 3 only), Nickel dissolved (Site 3) and lastly sulphide or hydrogen sulphide (All sites).

#### 3.1.1 Overview

In order to determine parameters of risk, values have been compared against the relevant EQS as detailed by the 2015 WFD Directions and the EA Surface Water Pollution Risk Assessment Parameters EQSD. It is important to note that standards or condition limits for certain parameters under the WFD (e.g., dissolved oxygen, BOD, ammoniacal nitrogen, and ANC), are determined by categorising the water body by type, dependent on its altitude and alkalinity. ANC standards are determined by annual mean dissolved organic carbon concentrations. In addition, soluble reactive phosphorus (SRP) standards are determined by the water body's altitude and alkalinity, cadmium standards are determined by categorising the water body, by type, dependent on the hardness of the water, and zinc standards are determined by the ambient background concentration (ABC) of dissolved zinc. EA site specific standards (where available) were used (e.g. SRP), Where these were not available, site-specific standards have been calculated using the available data.

Whilst we have used site-specific EQS or WFD Good standards for the Minworth WwRC final effluent for indicative purposes, it is important to note that these standards should not be routinely applied to final effluent samples as they are in-river standards (these standards do not directly apply to effluent and discharge standards are set through the permitting regime).. It is also important to note that all data on record are



considered when comparing against the environmental standards which are applied, under a formal assessment, as Annual Averages (AA), Maximum Allowable Concentrations (MAC), or specified percentiles. Samples at the limit of detection were included in the analysis and used at face value to adhere to discharge permitting assessment guidance. Any significant outliers were removed from the analysis. Based on the available across all sites, there have been a total of 103 EQS exceedances. A discussion of exceedances along with source water/ canal section comparison can be found in sections 3.1.2 and 3.1.3.

### 3.1.1 Exceedances to date

A list of all compounds that exceeded the quoted EQS split by site are presented in Table 3-1. Maximum allowable concentration (MAC) values were examined separately and have been applied to individual results and not mean or percentile data.

Two polycyclic aromatic hydrocarbons (PAH), benzo(a)pyrene and fluoranthene, exceeded at all sites with the exception of fluoranthene at Minworth WwRC, the mean concentration of which is considerably below the stated EQS (Mean concentration = 0.00247 µg/l, EQS = 0.0063 µg/l). Biochemical Oxygen Demand (BOD) concentrations have EQS exceedances across a number of the canal's middle sections (Sites 5, 14 and 15) along with the example abstraction location (Site 6) and lower canal section (Site 16). As canal systems are shallow and experience typically very low flow, they contain high levels of accumulated silts along the channel bed. Due to their continued usage for navigation activities which disturb this silt (such as propeller wash) can cause localised, temporary BOD increases which could last several days.

Elevated PFOS concentrations also resulted in EQS exceedances at all 11 sites with Soluble Reactive Phosphorus (SRP) also exceeding EQS values at 8 sites including Minworth WwRC.

Bromine (total residual oxidant) resulted in EQS exceedances at all sites monitored by several orders of magnitude, however, it is only measured at 2 sites as part of the EQSD analysis suite.

Lastly, low 10<sup>th</sup> percentile dissolved oxygen saturation values resulted in EQS exceedances at two sites this quarter (Site 1 and Site 10). Site 1 exceeded in all samples, noting this is sewage effluent and the EQS does not directly apply, whereas Site 10 only exceeded in January. There was no apparent reason for the low DO seen at Site 10 as there was no preceding rainfall or other elevated parameter, noting DO is generally lower at this site.

Table 3-2 shows the data as it corresponds to the test statistics for all compounds in exceedance of the EQS. This table allowed identification of compounds that may exceed EQS if the final effluent from Minworth WwRC were discharged into the GUC without additional treatment. This may result in a future WFD compliance risk as the new discharge may result in a deterioration of instream quality and may prevent the water quality of the receiving body from achieving Good Status in the future. Compounds that exceed at Minworth with no comparable exceedance instream include chlorothalonil (organic fungicide), cypermethrin (synthetic pyrethroid), permethrin (insecticide), and zinc (bioavailable). The exceedance of permethrin is largely due to the observed concentration being less than the limit of detection (<LoD; 0.001 µg/l) on all occasions with the exception of one exceedance (exceedance concentration = 0.002 µg/l observed on 19/07/2021).

In total there are 333 instances of MAC exceedances across all sites. Overall, four PAH (benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene) accounted for 21% of these exceedances. Bromine (total residual oxidant) accounted for 48 exceedances in the 'upper GUC', Sites 1 and 3. Sulphate (or hydrogen sulphide) exceeded MAC values on 140 occasions. A list of total exceedances split by compound can be seen in Table 3-3.



Table 3-1 - Number of EQS (WFD and EQSD) exceedances <sup>1</sup>.

| Compound                         | Standard | Unit | Statistic*       | Upper GUC       |                 | Middle GUC |           |           |           |           |           | Lower GUC Abstraction |                 |           |
|----------------------------------|----------|------|------------------|-----------------|-----------------|------------|-----------|-----------|-----------|-----------|-----------|-----------------------|-----------------|-----------|
|                                  |          |      |                  | Source          | Discharge       | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15               | Site 6          | Site 16   |
| Acid neutralisation capacity     | 40       | mg/l | AA               | 24 <sup>#</sup> | 25 <sup>#</sup> | 12         | 25        | 12        | 12        | 12        | 12        | 12                    | 26              | 12        |
| Benzo(a)pyrene                   | 0.00017  | µg/l | AA               | 37              | 36              | 12         | 25        | 12        | 12        | 12        | 12        | 12                    | 26              | 12        |
| BOD (5 day)                      | *        | mg/l | 90 <sup>th</sup> | 5               | 5               | 1          | 6         | 1         | 1         | 0         | 2         | 4                     | 9               | 4         |
| Bromine                          | 0.002    | mg/l | AA               | 24              | 24 <sup>#</sup> |            |           |           |           |           |           |                       |                 |           |
| Cadmium - total                  | 0.25     | µg/l | AA               | 0               | 15              | 0          | 0         | 0         | 0         | 0         | 0         | 0                     | 0               | 0         |
| Chlorothalonil                   | 0.035    | µg/l | AA               | 1               | 0               |            |           |           |           |           |           |                       |                 |           |
| Cobalt – dissolved               | 3        | µg/l | AA               | 0               | 20 <sup>#</sup> |            |           |           |           |           |           |                       |                 |           |
| Cypermethrin                     | 0.00008  | µg/l | AA               | 27              | 4               | 4          | 2         | 2         | 2         | 2         | 4         | 6                     | 7               | 6         |
| Diazinon                         | 0.01     | µg/l | AA               | 1               | 0               |            |           |           |           |           |           |                       | 0               |           |
| Dissolved oxygen                 | *        | %    | 10 <sup>th</sup> | 4               | 7               | 5          | 8         | 5         | 1         | 0         | 5         | 2                     | 6               | 2         |
| Fluoranthene                     | 0.0063   | µg/l | AA               | 1               | 31              | 8          | 9         | 8         | 7         | 8         | 8         | 9                     | 21              | 9         |
| Formaldehyde                     | 0.25     | µg/l | AA               | 1               | 0               |            |           |           |           |           |           |                       |                 |           |
| Manganese – bioavailable**       | 123      | µg/l | AA               | 0 <sup>#</sup>  | 31              | 0          | 0         | 0         | 0         | 0         | 0         | 0                     | 0 <sup>##</sup> | 0         |
| Nickel - bioavailable**          | 4        | µg/l | AA               | 3               | 25              | 0          | 0         | 0         | 0         | 0         | 0         | 0                     | 0               | 0         |
| Perfluorooctane sulfonic acid    | 0.00065  | µg/l | AA               | 41              | 36              | 11         | 24        | 11        | 10        | 11        | 11        | 8                     | 20              | 11        |
| Permethrin                       | 0.001    | µg/l | AA               | 15 <sup>#</sup> | 1               |            |           |           |           |           |           |                       |                 |           |
| Soluble reactive phosphorus      | *        | µg/l | AA               | 28              | 5               | 12         | 10        | 5         | 3         | 10        | 8         | 1                     | 23              | 11        |
| Sulphide or hydrogen sulphide    | 0.25     | mg/l | AA               | 13              | 24              | 10         | 14        | 10        | 9         | 12        | 9         | 10                    | 20              | 9         |
| Total anions                     | 250      | µg/l | AA               | 8 <sup>#</sup>  | 19 <sup>#</sup> |            |           |           |           |           |           |                       | 1               |           |
| Tributyltin compounds            | 0.0002   | mg/l | AA               | 1               | 3               | 2          | 1         | 1         | 7         | 0         | 11        | 1                     | 2               | 1         |
| Zinc - bioavailable**            | *        | µg/l | AA               | 14              | 11              | 2          | 0         | 0         | 0         | 0         | 0         | 0                     | 0               | 0         |
| Cadmium dissolved                | 0.25     | µg/l | AA               | 0               | 4               | 0          | 0         | 0         | 0         | 0         | 0         | 0                     | 0               | 0         |
| di(2-ethylhexyl)phthalate (DEHP) | 1.3      | µg/l | AA               | 1               | 1               | 0          | 0         | 0         | 0         | 0         | 0         | 0                     | 1               | 1         |
| <b>Total number of samples</b>   | -        | -    | -                | <b>37</b>       | <b>25</b>       | <b>12</b>  | <b>25</b> | <b>12</b> | <b>12</b> | <b>12</b> | <b>12</b> | <b>12</b>             | <b>25</b>       | <b>12</b> |

\*AA = Annual Average. Numbers of exceedances are shown for illustrative purposes only and reflect individual samples being compared to an AA or percentile derived EQS.

\* Site specific EQS determined.

\*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT)<sup>2</sup>.

# Total number of samples collected = 25 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 18.

<sup>1</sup> Blue shading indicates EQS (WFD and EQSD) exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of individual EQS exceedances is also given.

<sup>2</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktaq](#)

Table 3-2 – Concentrations of compounds responsible for EQS (WFD and EQSD) exceedance<sup>3</sup>.

| Compound                         | Standard | Unit | Stat*            | Upper GUC |           | Middle GUC |           |           |           |           |           |           | Abstraction | Lower GUC |
|----------------------------------|----------|------|------------------|-----------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-----------|
|                                  |          |      |                  | Source    | Discharge | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Site 6      | Site 16   |
|                                  |          |      |                  | Site 1    | Site 3    |            |           |           |           |           |           |           |             |           |
| Acid neutralisation capacity     | 40       | mg/l | AA               | 1748      | 2520      | 3425       | 2924      | 3558      | 4142      | 4433      | 3691      | 3100      | 3481        | 3200      |
| Benzo(a)pyrene                   | 0.00017  | µg/l | AA               | 0.00162   | 0.01519   | 0.03919    | 0.00584   | 0.01603   | 0.01505   | 0.02078   | 0.02546   | 0.03730   | 0.02216     | 0.02839   |
| BOD (5 day)                      | *        | mg/l | 90 <sup>th</sup> | 2.68      | 2.66      | 2.99       | 3.32      | 2.73      | 3.10      | 2.58      | 3.51      | 4.93      | 4.60        | 3.61      |
| Bromine                          | 0.002    | mg/l | AA               | 0.208     | 1.821     |            |           |           |           |           |           |           |             |           |
| Cadmium - total                  | 0.25     | µg/l | AA               | 0.0242    | 0.4422    | 0.0433     | 0.0268    | 0.0200    | 0.0200    | 0.0200    | 0.0218    | 0.0383    | 0.0319      | 0.0200    |
| Chlorothalonil                   | 0.035    | µg/l | AA               | 0.0476    | 0.0350    |            |           |           |           |           |           |           |             |           |
| Cobalt - dissolved               | 3        | µg/l | AA               | 1.83      | 15.2      |            |           |           |           |           |           |           | 0.3         |           |
| Cypermethrin                     | 0.00008  | µg/l | AA               | 0.000250  | 0.000067  | 0.000093   | 0.000081  | 0.000182  | 0.000314  | 0.000187  | 0.000156  | 0.000190  | 0.000112    | 0.000237  |
| Diazinon                         | 0.01     | µg/l | AA               | 0.0104    | 0.0100    |            |           |           |           |           |           |           | 0.0100      |           |
| Dissolved oxygen                 | *        | %    | 10 <sup>th</sup> | 45.37     | 73.54     | 36.20      | 61.46     | 57.30     | 50.70     | 69.40     | 53.28     | 79.27     | 75.48       | 78.51     |
| Fluoranthene                     | 0.0063   | µg/l | AA               | 0.00247   | 0.01700   | 0.02185    | 0.00681   | 0.01681   | 0.00946   | 0.01191   | 0.01569   | 0.02951   | 0.01791     | 0.02643   |
| Formaldehyde                     | 5        | µg/l | AA               | 51.2400   | 50.0000   |            |           |           |           |           |           |           |             |           |
| Manganese - bioavailable**       | 123      | µg/l | AA               | 10.2      | 1617      |            |           |           |           |           |           |           | 10          |           |
| Nickel - bioavailable**          | 4        | µg/l | AA               | 2.9       | 11.1      | 0.84       | 0.97      | 0.51      | 0.79      | 0.56      | 0.63      | 0.75      | 0.73        | 0.56      |
| Perfluorooctane sulfonic acid    | 0.00065  | µg/l | AA               | 1.1775    | 0.0930    | 0.0053     | 0.0162    | 0.0110    | 0.0244    | 0.0358    | 0.0082    | 0.0013    | 0.0608      | 0.0025    |
| Permethrin                       | 0.001    | µg/l | AA               | 0.00240   | 0.00104   |            |           |           |           |           |           |           |             |           |
| Soluble reactive phosphorus      | *        | µg/l | AA               | 0.365     | 0.119     | 0.122      | 0.105     | 0.060     | 0.058     | 0.126     | 0.099     | 0.037     | 0.182       | 0.227     |
| Sulphide or hydrogen sulphide    | 0.25     | mg/l | AA               | 10.85     | 16.89     | 21.83      | 16.56     | 19.92     | 23.00     | 27.33     | 23.91     | 21.92     | 28.38       | 21.58     |
| Total anions                     | 250      | µg/l | AA               | 244       | 396       |            |           |           |           |           |           |           | 177         |           |
| Tributyltin compounds            | 0.0002   | µg/l | AA               | 0.0000778 | 0.0001045 | 0.0002000  | 0.0000624 | 0.0001317 | 0.0003033 | 0.0000658 | 0.0003473 | 0.0001383 | 0.0001490   | 0.0001017 |
| Zinc - bioavailable**            | *        | µg/l | AA               | 14.9      | 17.2      | 10.08      | 2.72      | 1.77      | 1.20      | 1.15      | 3.95      | 2.24      | 2.30        | 1.68      |
| Cadmium dissolved                | 0.25     | µg/l | AA               | 0.0230    | 0.2573    | 0.0200     | 0.0212    | 0.0200    | 0.0200    | 0.0200    | 0.0200    | 0.0200    | 0.0254      | 0.0200    |
| di(2-ethylhexyl)phthalate (DEHP) | 1.3      | µg/l | AA               | 0.2673    | 0.2831    | 0.1875     | 0.1652    | 0.1500    | 0.1542    | 0.1500    | 0.1500    | 0.1567    | 0.1985      | 2.1375    |
| <b>Total number of samples</b>   | -        | -    | -                | <b>37</b> | <b>25</b> | <b>12</b>  | <b>25</b> | <b>12</b> | <b>12</b> | <b>12</b> | <b>12</b> | <b>12</b> | <b>25</b>   | <b>12</b> |

\*AA = Annual Average.

\* Site specific EQS determined

\*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT)<sup>4</sup>.

Table 3-3 - Compounds responsible for WFD and EQSD MAC exceedances<sup>5</sup>.

Upper GUC

Middle GUC

Lower GUC

<sup>3</sup> Blue shading indicates EQS exceedance and grey shading indicates where failures relate to EQSD target compounds (not monitored at all sites, and as such not directly comparable across all sites). Concentrations corresponding to test statistic are also shown.

<sup>4</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktaq](#)

<sup>5</sup> Blue shading indicates MAC EQS exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of exceedances also given.

| Compound                         | Standard | Unit | Statistic | Source    | Discharge |           |           |           |           |           |           |           |           | Abstraction |  |
|----------------------------------|----------|------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|--|
|                                  |          |      |           | Site 1    | Site 3    | Site 10   | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Site 6    | Site 16     |  |
| Benzo(a)pyrene                   | 0.027    | µg/l | MAC       | 0         | 5         | 8         | 1         | 2         | 1         | 3         | 6         | 6         | 8         | 5           |  |
| Benzo(b)fluoranthene*            | 0.017    | µg/l | MAC       | 0         |           |           |           |           |           |           |           |           | 8##       |             |  |
| Benzo(g,h,i)perylene*            | 0.0082   | µg/l | MAC       | 0         |           |           |           |           |           |           |           |           | 13##      |             |  |
| Benzo(k)fluoranthene*            | 0.017    | µg/l | MAC       | 0         |           |           |           |           |           |           |           |           | 3##       |             |  |
| Bromine - total residual oxidant | 0.005    | mg/l | MAC       | 24#       | 24        |           | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           |  |
| Cadmium - dissolved              | 1.5      | µg/l | MAC       | 0         | 2         | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           |  |
| Cadmium - total                  | 1.5      | µg/l | MAC       | 0         | 2         | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           |  |
| Cypermethrin                     | 0.0006   | µg/l | MAC       | 5         | 0         | 0         | 0         | 1         | 2         | 2         | 1         | 1         | 0         | 1           |  |
| Formaldehyde                     | 50       | µg/l | MAC       | 1         | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           |  |
| Mercury - dissolved              | 0.07     | µg/l | MAC       | 2         | 1         | 2         | 1         | 2         | 1         | 1         | 2         | 1         | 2         | 2           |  |
| Mercury - total                  | 0.07     | µg/l | MAC       | 2         | 2         | 2         | 2         | 2         | 1         | 1         | 2         | 2         | 2         | 2           |  |
| Nickel - dissolved               | 34       | µg/l | MAC       | 2         | 15        | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           |  |
| Sulphide or hydrogen sulphide    | 1        | µg/l | MAC       | 13        | 24        | 10        | 14        | 10        | 9         | 12        | 9         | 10        | 20        | 9           |  |
| Tributyltin compounds            | 0.02     | µg/l | MAC       | 2         | 2         | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           |  |
| <b>Total number of samples</b>   | -        | -    | -         | <b>37</b> | <b>25</b> | <b>12</b> | <b>25</b> | <b>12</b> | <b>12</b> | <b>12</b> | <b>12</b> | <b>12</b> | <b>25</b> | <b>12</b>   |  |

\* While these determinands have a MAC, as per the WFD there is no corresponding AA statistic as benzo(a)pyrene should be considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water.

# Total number of samples collected = 25 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 18.

## 3.1.2 Source water and canal section comparisons

In this section the quality of treated effluent discharged from Minworth WwRC is directly compared with all respective sections of the GUC. The key changes identified this quarter are discussed below.

### 3.1.2.1 Minworth vs. GUC Upper Section (Site 3)

The majority of substances which exceed EQS at Minworth also exceed at Site 3, the example discharge location (Atherstone). Exceptions include chlorothalonil, cypermethrin, dissolved oxygen, diazinon and formaldehyde which do not exceed at Site 3. This suggests these substances may be at increased risk of EQS exceedance instream if discharge from Minworth is received without additional treatment. While permethrin and soluble reactive phosphorus have exceeded EQS on occasion, these occur more frequently in the discharge from Minworth WwRC suggesting EQS failures would become more likely without additional treatment. By contrast, dissolved cobalt, fluoranthene, dissolved manganese and nickel, sulphide or hydrogen sulphide, total anions and total cadmium exceed EQS at Site 3 with no exceedances observed in the discharge from Minworth WwRC, suggesting a wider catchment source.

### 3.1.2.2 Minworth vs. GUC Middle Section (Sites 5,10,11,12,13,14 and 15)

The following substances exceed EQS in Minworth WwRC discharge but do not currently exceed EQS at any site in the middle section of the GUC:

- Zinc - bioavailable

The following substances exceed EQS in the Minworth WwRC discharge but are not currently monitored under the currently agreed monitoring suites in the Middle Section of the GUC:

- Bromine - total residual oxidant
- Chlorothalonil
- Formaldehyde
- Permethrin

These substances may be the most at risk of exceeding their respective EQS should an Minworth discharge be introduced depending on instream concentrations. Sites 5, 14 and 15 are the only sites where BOD has exceeded the annual average EQS. SRP exceeds EQS at Sites 10, 5, 13 and 14. Given SRP has regularly exceeded at these sites they are at risk from the introduction of Minworth discharge. Dissolved zinc previously exceeded EQS at Site 10, however no longer exceeds at any site in the Middle section. As with the other substances above, this is likely at risk of exceedance. TBT compounds now exceed at Middle GUC sites 12 and 14, noting this is a single occurrence and does not occur at Minworth WwRC suggesting a wider catchment source. TBT was historically used as an antifouling agent in paints and binds strongly to sediments, as such this may be present and easily released in a canal when sediment is disturbed.

### 3.1.2.3 Minworth vs. GUC Lower Section (Sites 6 and 16)

The following substances that exceed EQS in the Minworth discharge do not currently exceed EQS at any site in the lower section:

- Diazinon
- Dissolved oxygen
- Zinc - bioavailable

The following substances exceed EQS in the Minworth WwRC discharge but are not monitored in the Lower GUC:

- Bromine - total residual oxidant
- Chlorothalonil
- Formaldehyde
- Permethrin



These substances are most at risk from deterioration following a Minworth discharge. DEHP was identified above EQS at Site 16 but not in the Minworth WwRC discharge suggesting a catchment source.

## 3.2 Continuous monitoring data

### Notable sonde changes in the last quarter (January 2023 – March 2023)

Below are key changes in the last quarter of data, these events are described in detail in subsequent sections (3.2.1 to 3.2.7).

**Temperature** - No notable changes in quarter.

**Conductivity** - Conductivity peaked at all Sites 1 and 6 on 9<sup>th</sup> March 2023 following heavy rainfall.

**Dissolved Oxygen** - No notable changes in quarter.

**pH** - No notable changes in quarter.

**Ammonium** - Peaks in ammonium at Sites 1 and 3 observed in response to high rainfall events.

**Turbidity** - Peaks in turbidity at Site 1 are linked to vegetation growth in channel, a resolution to this is being investigated.

**Chlorophyll** - No notable changes in quarter.

This section describes the broad seasonal patterns observed in parameters monitored by the continuous sondes. Summary statistics (mean and standard deviation) of continuous monitoring data to date for each location are provided in Table 3-4. Summary statistics cover from the start of the record per site through to the end of the reporting period (31/03/2023). The continuous sonde data collected can be seen for all sites in Figures 3-1 to 3-4.

### 3.2.1 Temperature

Over the period of record temperatures typically range from 9-23°C in the Minworth discharge. By contrast, the canal at Atherstone ranges from 4-23°C. Temperatures between Minworth and Atherstone are similar in summer months however the Minworth discharge is up to 8°C warmer than the canal in winter. As there is potentially a risk of a >3°C temperature increase in the receiving waterbody due to the temperature differences seen at this time of year, appropriate considerations must be made at the design stage to reduce potential impacts to fish.

This quarter, temperatures were highest at Site 1 measuring 12.6°C. In the canal itself the highest temperature was Site 16 with 7.2°C and lowest at Site 6 with 6.2°C. There was a notable dip in temperature at all sites, most prominently at Minworth WwRC which followed a period of heavy rain on 9<sup>th</sup> March 2023. As this quarter falls within the winter period temperatures at all sites were well below the thresholds for fish stress.

### 3.2.2 Conductivity

Conductivity is a measure of the ability of a water body to conduct an electrical charge and reflects the concentration of ions in solution (e.g., sodium, calcium etc). Instream conductivity is primarily controlled by underlying geology. Temporary increases and reductions in conductivity can be observed in response to pulses of mineral rich material from catchment sources (e.g., agricultural runoff). Conversely, instream reductions in conductivity can occur when rainfall runoff from the surrounding area results in an instream dilution. Long term



increases in conductivity, above what would be considered typical for a particular catchment can be indicative of nutrient enrichment from the surrounding landscape from point (e.g., STW) or diffuse (e.g., agricultural) sources.

Conductivity on average was highest at Site 3 with 2008  $\mu\text{S}/\text{cm}$  and lowest at Site 16 with 683  $\mu\text{S}/\text{cm}$ . The Minworth WwRC discharge measured 801  $\mu\text{S}/\text{cm}$ . Conductivity peaked at all Sites 1 and 6 on 9<sup>th</sup> March 2023 following heavy rainfall. This is likely an inflow of contaminated 'first flush' surface water into Minworth WwRC network which gives rise to a short conductivity peak. For Site 6 this similar result suggests a localised inflow of surface water.

### 3.2.3 Dissolved oxygen

Dissolved oxygen, typically measured in percent saturation (or mg/l) describes the amount of oxygen that is dissolved in water. It is essential for aquatic life, with low dissolved oxygen saturation resulting in anoxia and subsequent fish kills and is associated with the development of eutrophic conditions. The pattern of dissolved oxygen saturation in watercourses varies seasonally. A typically well aerated river or stream will have a dissolved oxygen % saturation of ~100%. Canals typically experience lower dissolved oxygen saturation than rivers. This is partly due to the slow flowing nature of canals and lack of natural aeration from turbulent water as it travels downstream. Diurnal variability is highest during the summer months driven largely by photosynthesis-respiration dynamics. Dissolved oxygen can, however, exceed 100% instream due to the presence of photosynthetic aquatic organisms.

This quarter, dissolved oxygen saturation measured highest at Site 6 (85.4%) while measuring lowest at Site 1 (Minworth WwRC) with 43%. Sites 3 and 16 were comparable to long term averages however Site 6 was considerably higher (long term 45.8%) nothing this site experiences algal blooms and dissolved oxygen drawdown during these times. Rainfall does not appear to affect dissolved oxygen saturation at any site and is predominantly driven by the diurnal variability described above.

### 3.2.4 pH

The pH of a watercourse is a measure of how acidic or basic/alkaline the water is. The pH is mainly driven by geology (and resultant soil type) however, can be influenced by catchment factors such as pollutant discharges and the leaching of soil horizons under differing flow conditions. As pH is recorded on a logarithmic scale, slight changes in pH can have significant impacts on the organisms that live in a watercourse. The optimum pH for water to sustain fish and invertebrate life, is around 6 to 9. Across all sites, pH was within acceptable limits for fish and invertebrates. It should be noted that pH at Minworth (6.7) is more acidic (lower) than the example discharge location at Site 3 (7.3). The example abstraction location at Site 6 as well as Site 16 are both slightly more basic measuring 7.8 and 7.9 respectively. This suggests pH may increase along the proposed transfer route.

This quarter, all sites measured comparably to their long-term means. pH was lowest in the Minworth WwRC discharge (Site 1) at 6.6. In the canal, Site 6 measured the highest at 8.0 while lowest at Site 3 with a pH of 7.2.

### 3.2.5 Ammonium

Ammonium is a type of nitrogenous compound that is naturally present in water but can also be released into rivers from a variety of sources, including agricultural runoff, sewage treatment and industrial wastewater discharges. High concentrations of ammonium in rivers can be harmful to aquatic life, particularly fish, as it can disrupt their metabolism and respiration. In some cases, it can even be fatal. Ammonium can also contribute to the formation of algal blooms, which can further degrade water quality and make it unsafe for drinking, swimming, and fishing. Average ammonium concentrations were highest at Site 1 (Minworth WwRC) and lowest at the example discharge location (Site 3 Atherstone).

Ammonium shows some responsiveness to rainfall events (9<sup>th</sup> March 2023), with peaks in ammonium at Sites 1 and 3, but this is not observed at Site 6 or 16.

When compared to laboratory derived concentrations, *in-situ* measurements of ammonium commonly over record ammonium concentrations. As such, it is important to use these data to infer catchment trends rather than absolute concentrations.

### 3.2.6 Turbidity

Turbidity is a measure of how cloudy water is and can be used as a proxy for suspended sediment concentrations. It is caused by the presence of suspended particles in the water, such as sediment, algae, or other organic matter. Turbidity can make it difficult for sunlight to penetrate the water, which can reduce the amount of photosynthesis that takes place. A high loading of suspended sediment, when combined with reduced flow velocities can result in sediment deposition causing damage to macrophytes and reducing hydrological exchanges with the hyporheic zone. Increased sediment loading can result in the unintended substance transport. For example, the dominant form of phosphorus exported from agricultural systems is particulate phosphorus, which when exported from the terrestrial to aquatic systems has the potential to desorb and become available to facilitate instream heterotrophy.

Increases in turbidity can be caused by a number of factors, including erosion, runoff from agricultural fields following poor land and soil management practises, stormwater runoff and point source pollution, such as from sewage treatment plants. Turbidity values are typically highest at Site 6 measuring 35.4 NTU on average. This site also experiences the greatest variability due to its high responsiveness to rainfall events. At the example discharge location (Site 3), the average is 17.9 NTU however this site experiences much lower peaks following rainfall. By contrast, the Minworth discharge measures 12.0 NTU on average. The lowest mean turbidity value is recorded at Site 16 measuring 5.62 NTU.

During the last quarter turbidity was low across most sites with regular turbidity spikes at the Minworth WwRC (Site 1) discharge. Some turbidity data this quarter at Site 1 has been affected by tree growth around the sensor. Historically, turbidity spikes across all sites following rainfall events.

### 3.2.7 Chlorophyll

Chlorophyll is a green pigment found in algae and plants. It is essential for photosynthesis, the process by which plants convert sunlight into energy. Chlorophyll can be used as a measure of the quantity of algae in a river. Higher levels of chlorophyll indicate more algae, which can lead to problems such as algal blooms, decreased oxygen levels, and the production of toxins. There are a number of factors that can affect the level of chlorophyll in a river, including nutrient levels, sunlight levels, temperature and flow. Chlorophyll concentrations are generally highest at Site 6 and have been observed to peak with a number of algal blooms events observed during the Spring and Summer months.

Recent data collected covering January to March 2023 falls within the late winter/early spring period. No algal blooms were observed this quarter, however, increases in chlorophyll concentration occurred at Site 16 in mid-February. Algal blooms do not typically occur at this time of year but the increase in concentration does coincide with an increase in temperature which could drive increased algal activity. Peaks seen at Site 6 appear to be erroneous as they coincide with very high turbidity due to the sensor being silted up. It is expected that algal blooms may start to occur in the later spring months (May onwards), as previously observed in spring and summer at Site 6.



**Table 3-4 – Overall mean and quarterly mean values observed at continuous monitoring locations.**

| Determinand      | Unit     | 1. Minworth WwRC Final Effluent <sup>1</sup> |                | 3. GUC at Atherstone <sup>2</sup> |                | 6. GUC at Grove, Leighton Buzzard <sup>3</sup> |                | 16. GUC at Marsworth <sup>2</sup> |                |
|------------------|----------|--|----------------|-----------------------------------|----------------|--|----------------|-----------------------------------|----------------|
|                  |          | Overall Mean                                 | Quarterly Mean | Overall Mean                      | Quarterly Mean | Overall Mean                                   | Quarterly Mean | Overall Mean                      | Quarterly Mean |
| Temperature      | °C       | 16.0   | 12.6           | 12.8                              | 6.7            | 11.8   | 6.2            | 14.6                              | 7.2            |
| Conductivity     | µS/cm    | 785  | 801            | 1355                              | 2008           | 642  | 702            | 569                               | 683            |
| Dissolved Oxygen | %        | 59.2   | 43.0           | 65.5                              | 71.5           | 45.8   | 85.4           | 71.6                              | 77.7           |
| pH               | pH units | 6.7  | 6.6            | 7.3                               | 7.2            | 7.8  | 8.0            | 7.9                               | 7.8            |
| Ammonium         | mg N/l   | 1.94   | 0.68           | 0.52                              | 0.53           | 0.51   | 0.45           | 0.46                              | 0.47           |
| Turbidity        | NTU      | 38.4   | 196.7          | 29.3                              | 13.9           | 32.3   | 92.4           | 4.6                               | 3.17           |
| Chlorophyll      | µg/l     | -  | -              | 9.4                               | 6.55           | 31.7   | 55.3           | 13.5                              | 18.3           |

Blue shading indicates values reported as 10<sup>th</sup> percentiles to facilitate comparisons to EQS.

<sup>1</sup> Site 1 sonde data monitoring for conductivity, temperature, and dissolved oxygen commenced at the start of Phase 2 monitoring on 18/05/2022. Additional parameters including pH, ammonium, and turbidity were added on 05/04/2022.

<sup>2</sup> Site 3 and Site 16 sondes were deployed on 11/05/22 and 24/05/22 respectively.

<sup>3</sup> Site 6 sonde was deployed on 25/11/21.

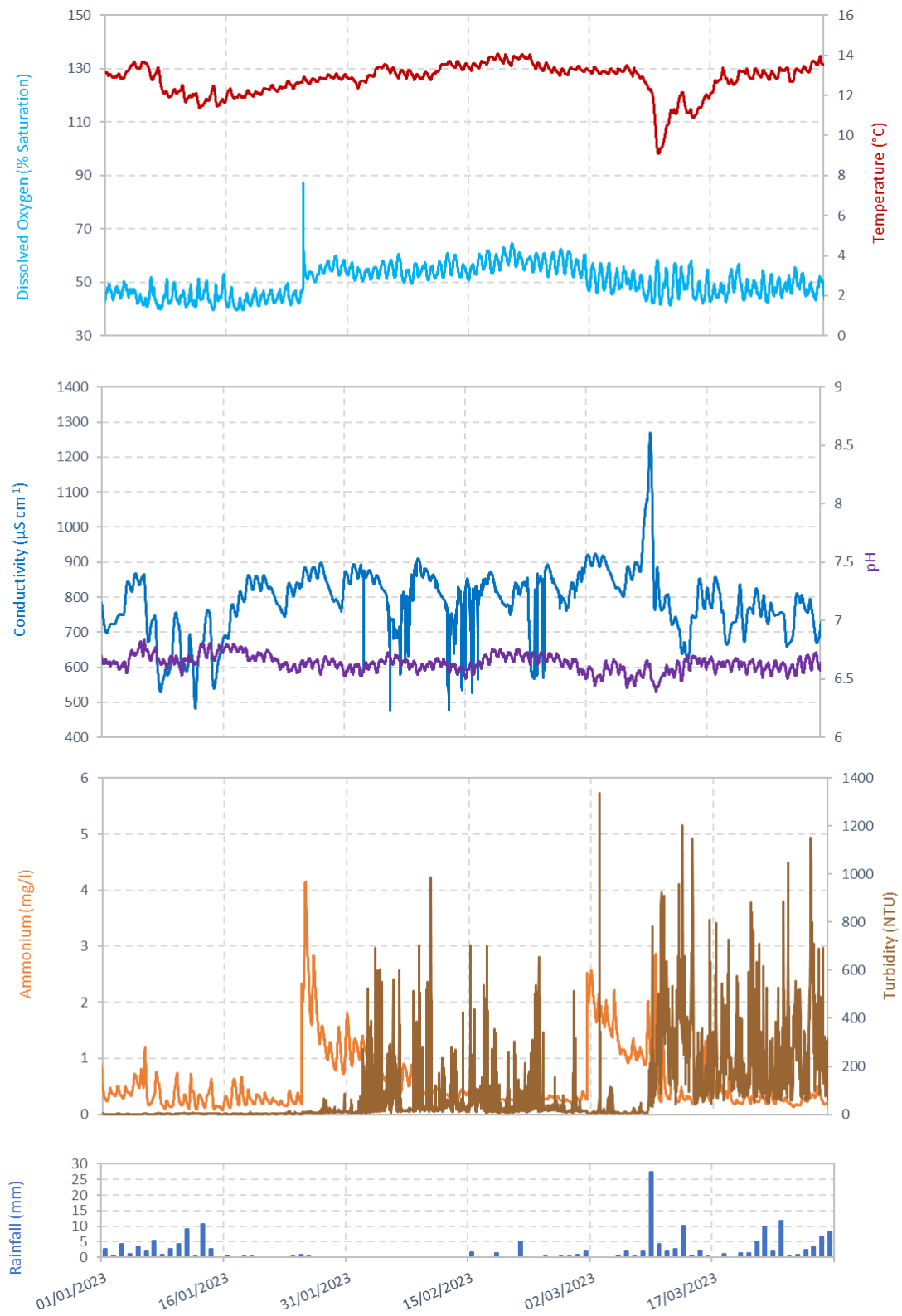
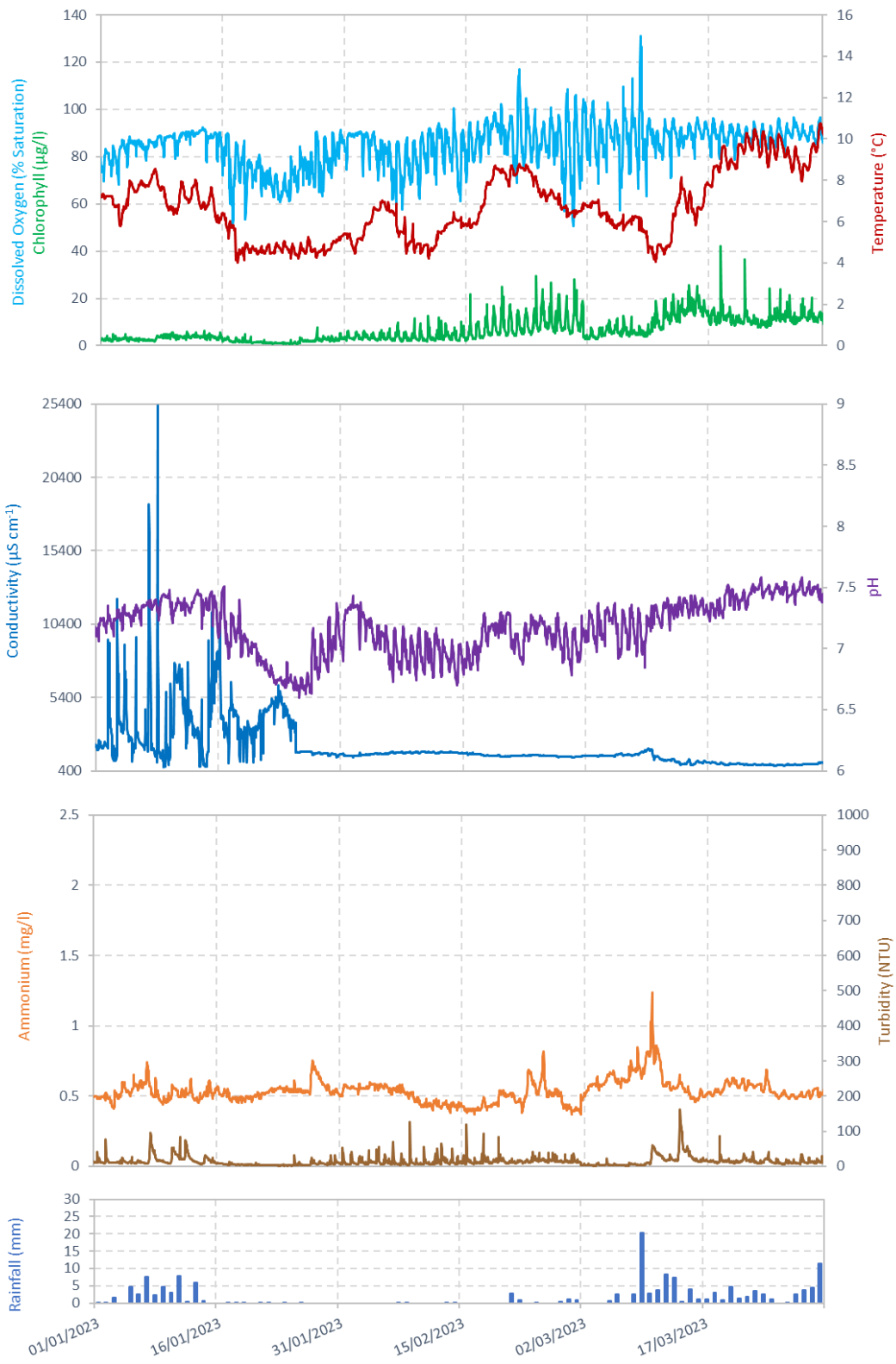


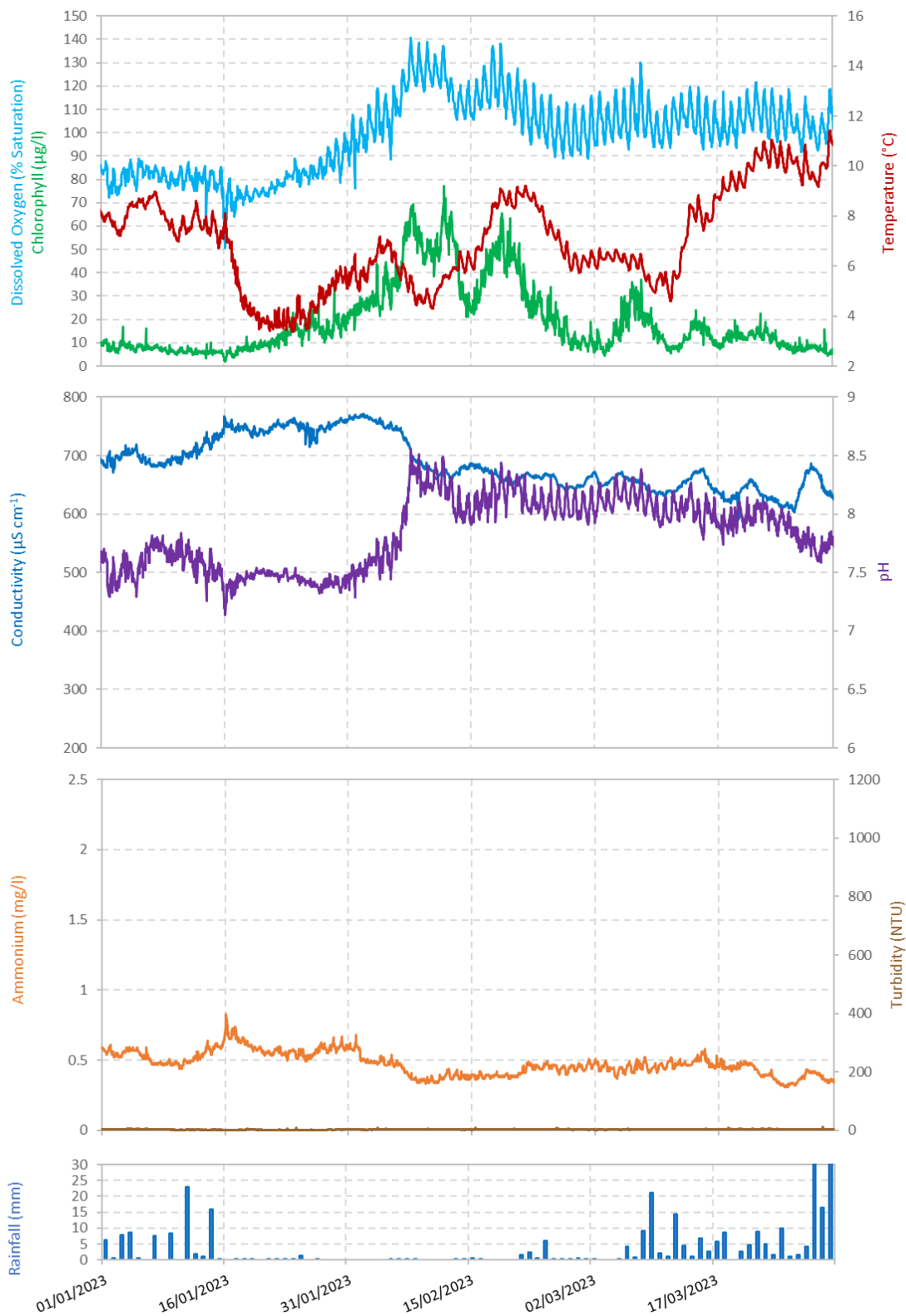
Figure 3-1 - Continuous sonde data collected between 01/01/2023 to 31/03/2023 at Site 1 (Minworth).





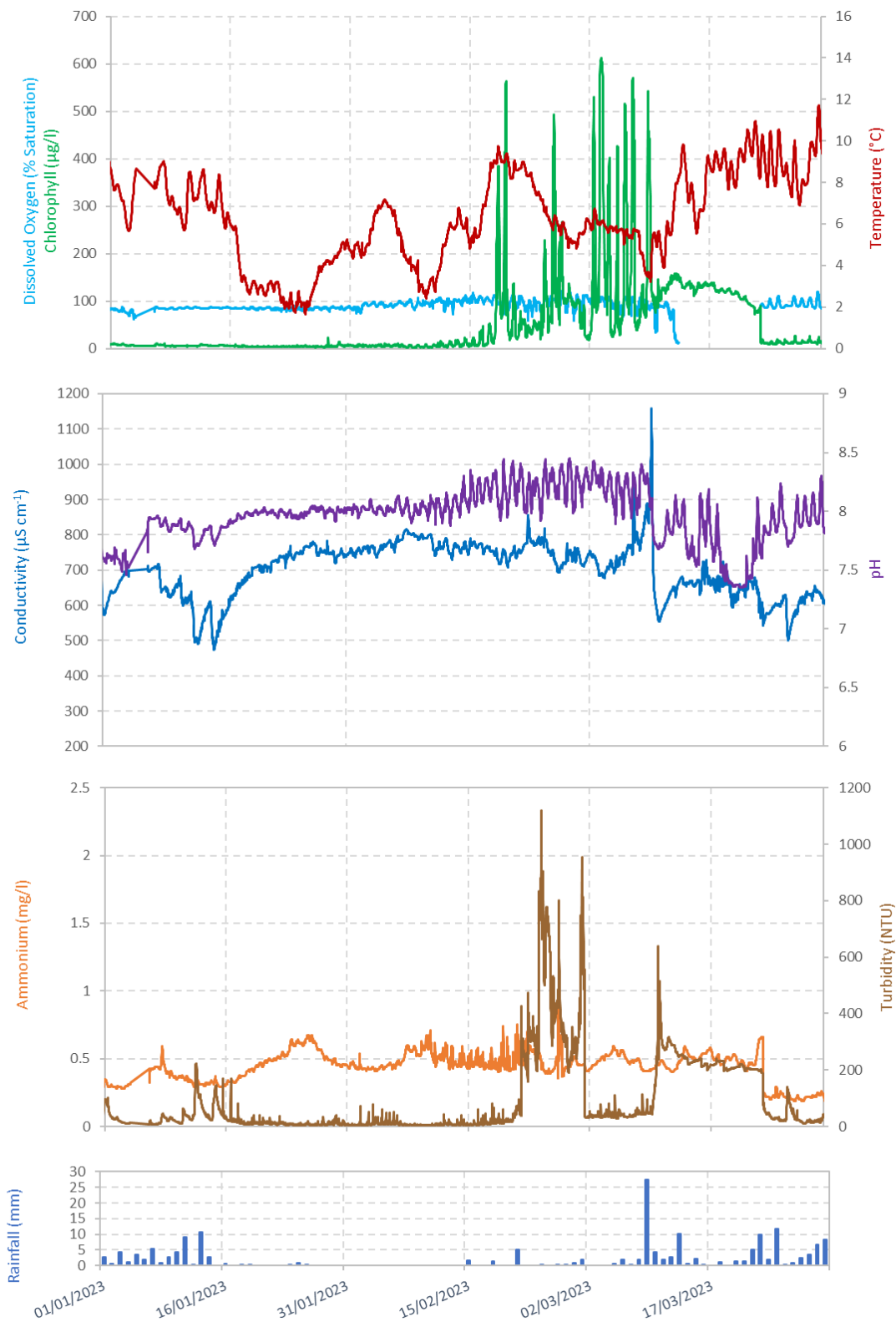
**Figure 3-2 - Continuous sonde data collected between 01/01/2023 to 31/03/2023 at Site 3 (GUC at Atherstone).**





**Figure 3-3 - Continuous sonde data collected between 01/01/2023 to 31/03/2023 at Site 16 (GUC at Marsworth).**





**Figure 3-4 - Continuous sonde data collected between 01/01/2023 to 31/03/2023 at Site 6 (GUC at Grove, Leighton Buzzard).**



## 3.3 Spot sample drinking water quality standards comparison

### Notable concentration changes in the last quarter (April 2023 – June 2023)

This quarter there were no additional substances exceeding PCV at any site.

### 3.3.1 Overview

Drinking water parameters, assessed through their comparison to Predicted Concentration Values (PCVs) are only required to characterise the source water at Minworth WwRC (Site 1) and the downstream abstraction location (Site 6 Leighton Buzzard). It is important to note, that specific drinking water parameters were only added to the analysis suite at Site 6 in October 2021, prior to which, only WFD parameters were analysed. As a result, 18 months of DWSP parameter data are reported, compared to Site 1, for which data from Phases 1-3 are available (34-months). The exception to this is where a determinand has a comparable PCV and is present in the WFD analysis suite (e.g., iron). In these instances, all monitoring data are compared to the relevant drinking water standard. It should be noted that these standards are being applied to raw 'untreated' water where typically they would apply at the point of use i.e., a customer's tap. This had been undertaken to provide guidance on which substances may require targeted treatment when abstraction is operational. PCV exceedances in wastewater discharge and an operational canal are therefore expected.

### 3.3.2 Exceedances to date

At Site 1 (Minworth) 243 exceedances have been recorded to date. At Site 6, 157 PCV exceedances have been recorded. The distribution of these is detailed in Table 3-1. Several determinands exceeded PCVs in every, or almost every, sampling round. These determinands, along with the number of exceedances observed at Site 6 (the example abstraction location), are given below. It must be noted that these standards are applicable to drinking water at the point of consumption, and these are effluent (Minworth) and surface water (Atherstone) sites.

- Benzo(a)pyrene (total exceedances = 15)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 43)
- *Escherichia coli* (*E. coli*, total exceedances = 43)
- Iron - total (total exceedances = 26)
- Nitrite (total exceedances = 21)
- Turbidity (total exceedances = 39)

*C. perfringens* (a sulphite-reducing species commonly associated with faecal contamination) is widely distributed in the environment and is regularly evaluated with the aim of understanding the microbiological safety of drinking water supplies. *C. perfringens* is responsible for gastrointestinal disease, the spores of which persist longer than other indicators of contamination, such as Coliforms (which also demonstrated exceedances at all sites and is also an important indicator of faecal contamination). Sources of bacterial contamination can range from the input of animal manures from farmyard runoff and the discharge of untreated, and even treated, sewage effluent<sup>6</sup>. *Cryptosporidium* was not detected at either site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores. However, as canal networks often have shallow depths (<6ft), short lived events may be a result of localised disturbance of sediments by boats or wildlife causing disturbance in the vicinity of the sensor location.

<sup>6</sup> [final\\_jrc\\_tech\\_report\\_dwd\\_06.04.20\\_final\\_pdf\(4\).pdf](#)

**Table 3-5 - Number of drinking water PCV exceedances.**

| Compound   | PCV  | Unit                    | Source    | Abstraction site |
|--|------|-------------------------|-----------|------------------|
|  |      |                         | Site 1**  | Site 6**         |
| Aluminium - dissolved  | 200  | µg/l                    | 0         | 1                |
| Aluminium - total  | 200  | µg/l                    | 0         | 10               |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l as NH <sub>4</sub> | 3         | 2                |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 0         | 15               |
| Bisphenol A  | 2.5  | µg/l                    | 9         | 0                |
| C. perfringens veg & spores, confirmed   | 0    | No/100ml                | 25        | 18               |
| Chlorate   | 0.25 | mg/l                    | 4         | 0                |
| Chloride   | 250  | mg/l                    | 1         | 0                |
| Chlorite   | 0.25 | µg/l                    | 0         | 4                |
| Chromium - total   | 50   | µg/l                    | 1         | 0                |
| Clopyralid   | 0.1  | µg/l                    | 1         | 0                |
| Coliform - total   | 0    | MPN/100ml               | 25        | 18               |
| Colour   | 20   | mg/Pt/Co                | 20        | 2                |
| E. coli  | 0    | MPN/100ml               | 25        | 18               |
| Iron - dissolved   | 200  | µg/l                    | 0         | 1                |
| Iron total   | 200  | µg/l                    | 7         | 19               |
| Manganese - dissolved  | 50   | µg/l                    | 24        | 1                |
| Manganese - total  | 50   | µg/l                    | 25        | 3                |
| Mercury - total  | 1    | µg/l                    | 1         | 0                |
| Metribuzin   | 0.1  | µg/l                    | 0         | 1                |
| Nickel - dissolved   | 20   | µg/l                    | 6         | 0                |
| Nickel - total   | 20   | µg/l                    | 7         | 0                |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 19        | 2                |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 21        | 10               |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | 0         | 4                |
| PAH sum*   | 0.1  | µg/l                    | 0         | 8                |
| Propyzamide  | 0.1  | µg/l                    | 1         | 0                |
| Sodium - dissolved   | 200  | mg/l                    | 0         | 1                |
| Sulphate   | 250  | mg/l SO <sub>4</sub>    | 0         | 1                |
| Tebuconazole   | 0.1  | µg/l                    | 0         | 1                |
| Turbidity  | 1    | NTU                     | 21        | 18               |
| Vinyl chloride   | 0.5  | µg/l                    | 0         | 1                |
| <b>Total number of samples</b>   |      |                         | <b>37</b> | <b>25</b>        |

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

\*\* Data at Site 1 covers May 20 – March 23 and data at Site 6 covers April 21 – March 23.

# Total number of samples collected = 25 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 21.



**Table 3-6 – Maximum concentrations of compounds responsible for drinking water PCV exceedances<sup>7</sup>.**

| Compound   | PCV  | Unit                    | Source    | Abstraction sites |
|--|------|-------------------------|-----------|-------------------|
|  |      |                         | Site 1    | Site 6            |
| Aluminium - dissolved  | 200  | µg/l                    | 50.0      | 67                |
| Aluminium - total  | 200  | µg/l                    | 125.0     | 530               |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l as NH <sub>4</sub> | 1.2       | 1.9               |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 0.0046    | 0.134             |
| Bisphenol A  | 2.5  | µg/l                    | 137.0     | <0.01**           |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml                | 100.0     | 1000.0            |
| Chlorate   | 0.25 | mg/l                    | 2.0       | 0.7               |
| Chloride   | 250  | mg/l                    | 610.0     | 75.0              |
| Chlorite   | 0.25 | µg/l                    | <3.0      | 15.0              |
| Chromium - total   | 50   | µg/l                    | 140.0     | 15.0              |
| Clopyralid   | 0.1  | µg/l                    | 0.2       | 0.03              |
| Coliform - total   | 0    | MPN/100ml               | 2420.0    | 2420.0            |
| Colour   | 20   | mg/Pt/Co                | 43.0      | 26.0              |
| <i>E. coli</i>   | 0    | MPN/100ml               | 2420.0    | 2420.0            |
| Iron - dissolved   | 200  | µg/l                    | 100.0     | 1700.0            |
| Iron total   | 200  | µg/l                    | 310.0     | 2600.0            |
| Manganese - dissolved  | 50   | µg/l                    | 130.0     | 120.0             |
| Manganese - total  | 50   | µg/l                    | 160.0     | 150.0             |
| Mercury - total  | 1    | µg/l                    | 3.7       | 0.7               |
| Metribuzin   | 0.1  | µg/l                    | 0.1       | 0.2               |
| Nickel - dissolved   | 20   | µg/l                    | 61.0      | 7.1               |
| Nickel - total   | 20   | µg/l                    | 61.0      | 9.4               |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 120.0     | 100.0             |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 3.6       | 2.5               |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | -         | 0.4               |
| PAH sum*   | 0.1  | µg/l                    | 0.1       | 0.6               |
| Propyzamide  | 0.1  | µg/l                    | 0.3       | 0.1               |
| Sodium - dissolved   | 200  | mg/l                    | 78.0      | 510.0             |
| Sulphate   | 250  | mg/l SO <sub>4</sub>    | 180.0     | 690.0             |
| Tebuconazole   | 0.1  | µg/l                    | 0.1       | 0.2               |
| Turbidity  | 1    | NTU                     | 14.0      | 210.0             |
| Vinyl chloride   | 0.5  | µg/l                    | 0.5       | 1.0               |
| <b>Total number of samples</b>   |      |                         | <b>37</b> | <b>25</b>         |

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

\*\* LoD reduced to 0.01 µg/l from April 2022 onwards.

<sup>7</sup> Dark blue shading indicates PCV exceedance, maximum reported concentrations are shown.



### 3.3.3 Source water/canal section comparison

#### 3.3.3.1 Minworth vs. example abstraction location (Site 6)

The following substances were found to have concentrations above their respective PCVs at Minworth WwRC final effluent, however, were below PCVs instream at Site 6 (GUC at Grove, Leighton Buzzard). While it is beyond the scope of this report to infer if an instream PCV exceedance would occur at Site 6 if effluent discharge were re-directed into the GUC, these compounds of note should be subject to future analysis.

- Bisphenol A
- Chlorate
- Chloride
- Chromium - total
- Clopyralid
- Mercury - total
- Nickel - bioavailable
- Nickel - total
- Propyzamide

Bisphenol A and chlorate measure above PCV at Minworth but below PCV at Site 6, noting the LoD for Bisphenol A is higher than the PCV. As such, concentrations in the canal cannot currently be accurately assessed against the discharge, however, values are assumed low at present. Chloride exceeds PCV concentration at Minworth with 101 mg/l on average while measuring 43.7 µg/l on average (max 75 µg/l) at Site 6. This suggests concentrations are well below the PCV of 250 µg/l but could be at risk of exceedance if a Minworth discharge were introduced. Chlorite by contrast exceeds PCV at Site 6 measuring 15 µg/l. Chromium (total) exceeds PCV at Minworth while measuring a maximum of 15 µg/l at Site 6. This is below the PCV of 50 µg/l. Concentrations in the canal could be at risk of exceedance following introduction of a Minworth discharge given the PCV is exceeded by a significant margin. Clopyralid exceeds PCV (0.1 µg/l) by a small margin at Minworth while being well below PCV at Site 6 (0.03 µg/l). There may be some risk to in canal concentrations from a Minworth discharge. Mercury (total) at Site 6 is only slightly below the PCV of 1 µg/l (mean = 0.7 µg/l). This substance may be at risk of PCV exceedance following the introduction of a Minworth discharge given the high discharge concentrations. Mean concentration of both nickel (total and dissolved) are both close to exceeding the PCV of 20 µg/l at Site 6. Consequently, these substances are highly likely to exceed PCV following a Minworth discharge. Mean concentrations of propyzamide are similar at Minworth and Site 6 but do exceed PCV at Minworth. There is moderate risk to the propyzamide PCV being breached at Site 6 following a Minworth discharge. These substances may be influenced at Site 6 with the addition of the Minworth discharge and as such, in the absence of additional treatment at Minworth, these substances may require additional treatment following abstraction.



# CONCLUSIONS



## 4. Conclusions

At present, the following determinands demonstrated the greatest number of AA EQS exceedances on an individual sample basis across all sampling rounds to date and post a potential risk at the discharge location:

- **Minworth** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - ANC (a total of 24 individual occurrences)
  - Benzo(a)pyrene (a total of 37 individual occurrences)
  - BOD - 5-day (a total of 5 individual occurrences)
  - Dissolved Oxygen (a total of 24 individual occurrences)
  - Cypermethrin (a total of 27 individual occurrences)
  - PFOS (a total of 41 individual occurrences)
  - SRP (a total of 28 individual occurrences)
  - Sulphide or hydrogen sulphide (a total of 13 individual occurrences)
  
- **GUC**
  - ANC (10 sites, a total of 184 individual occurrences)
  - Benzo(a)pyrene (10 sites, a total of 208 individual occurrences)
  - BOD - 5-day (9 sites, a total of 38 individual occurrences)
  - Dissolved Oxygen (9 sites, a total of 45 individual occurrences)
  - Fluoranthene (10 sites, a total of 142 individual occurrences)
  - PFOS (10 sites, a total of 194 individual occurrences)
  - SRP (10 sites, a total of 166 individual occurrences)
  - Sulphide or hydrogen sulphide (10 sites, a total of 140 individual occurrences)

In addition, the following determinands exceeded WFD / EQSD MAC values:

- **Minworth** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - Sulphide or hydrogen sulphide (total individual exceedances = 13)
  - Bromine - total residual oxidant (total individual exceedances = 24)
  - Nickel - dissolved (total individual exceedances = 2)
  - Cypermethrin (total individual exceedances = 5)
  - Formaldehyde (total individual exceedances = 1)
  - Mercury - dissolved (total individual exceedances = 2)
  - Mercury - total (total individual exceedances = 2)
  - Triphenyltin compounds (as triphenyltin cation) (total individual exceedances = 2)
  
- **GUC**
  - Benzo(a)pyrene (total individual exceedances = 45)
  - Benzo(b)fluoranthene (total individual exceedances = 8)
  - Benzo(g,h,i)perylene (total individual exceedances = 13)
  - Benzo(k)fluoranthene (total individual exceedances = 3)
  - Cadmium total (total individual exceedances = 2)



- Cadmium dissolved (total individual exceedances = 2)
- Sulphide or hydrogen sulphide (total individual exceedances = 127)
- Bromine - total residual oxidant (total individual exceedances = 24)
- Nickel - dissolved (total individual exceedances = 15)
- Cypermethrin (total individual exceedances = 8)
- Mercury - dissolved (total individual exceedances = 15)
- Mercury - total (total individual exceedances = 18)
- Triphenyltin compounds (as triphenyltin cation) (total individual exceedances = 2)

Some concentrations in the Minworth WwRC effluent were greater than the EQS in the receiving water at Site 3, Coventry Canal, Atherstone (noting these standards do not directly apply to effluent and discharge standards are set through the permitting regime). These include chlorothalonil (an organic fungicide), cypermethrin (a synthetic pyrethroid), diazinon, formaldehyde, and dissolved oxygen. As a result, if Minworth WwRC final effluent was diverted to the example discharge location without additional treatment applied, additional in canal exceedances may occur, resulting in a future WFD compliance risk as the new discharge would prevent the water quality of the receiving body from achieving Good Status. Current mean bioavailable zinc concentration at Site 3 now exceeds EQS at 17.2 µg/l, increasing from 11.7 µg/l since the last report period, against a site specific EQS of 13.9 µg/l. The addition of the discharge of final effluent from Minworth WwRC looks increasingly likely to take concentrations at Site 3 above the EQS. Further assessment is required to determine the level of confidence if this is indeed the case (e.g., through modelling or pairwise assessment of samples once a full year of data were collected). Treatment or other removal at works will be required in order to provide a resolution to this issue.

Minworth WwRC treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of these 'high risk' compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permitting risk (e.g., due to within class deterioration).

As discussed in Section 3.1.3, PCVs apply only to treated drinking water, and not raw source waters. However, the monitoring of these determinands and regular comparison with drinking water standards enables a threshold for screening out determinands that may be considerably elevated in raw water, thus helping to inform treatment design at the example abstraction location. With that in mind, the following determinands are currently routinely exceeding PCV targets at Site 6.

- Benzo(a)pyrene (total exceedances = 15)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 43)
- *Escherichia coli* (*E. coli*, total exceedances = 43)
- Iron - total (total exceedances = 26)
- Nitrite (total exceedances = 31)
- Turbidity (total exceedances = 39)

*C. perfringens* exceeded PCV values at both sites as it is widely distributed across the environment and as such, is regularly evaluated to monitor the microbiological safety of drinking water supplies. Sources of bacterial contamination can range from the input of animal manures from farmyard runoff to discharge from untreated or treated sewage effluent. *Cryptosporidium* was not detected at any site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores or localised disturbance events.

All sensor data is within ranges typical of freshwater environments during a winter period. Some responsiveness to rainfall events was noted with temperatures decreasing at Site 1, 3 and 6 on 9th March. For this same event conductivity peaked at Sites 1 and 6 while reducing at Site 3. With respect to ammonium, peaks were seen at Site 1

and 3 suggesting this is rainfall driven, however, an earlier peak at Site 1 on 21<sup>st</sup> January does not coincide with rainfall and the cause is unknown. Turbidity also appears driven by rainfall at Site 3 and 6 with clear peaks following rainfall events. Site 16 shows little response to rainfall suggesting limited hydrological connectivity to the surrounding catchment at this location in the canal.

No algal blooms were noted during this quarter due to the time of year, however, these may start to be seen as we move toward spring and summer, particularly Sites 6 and 16 where these have occurred previously.

With respect to WFD EQS, in the upper GUC chlorothalonil, cypermethrin, diazinon, dissolved oxygen, formaldehyde, permethrin and SRP are the substances most at risk. For the middle and lower sections zinc bioavailable is at risk. SRP is only at risk in the middle section as this regularly exceeds EQS in the lower section however exceedances in the middle section are becoming more common.

With respect to PCVs, the following substances are potentially at risk from the Minworth discharge to the GUC:

- Bisphenol A
- Chlorate
- Chloride
- Chromium total
- Clopyralid
- Mercury - total
- Nickel - bioavailable
- Nickel - total
- Propyzamide

## 4.1 Next steps

We will continue to analyse water quality data collected as part of the GUC water quality monitoring programme which will continue through to November 2024. As part of this process, we will continue providing quarterly updates which will be communicated to the GUC project team and the Minworth WwRC and abstraction treatment engineers to understand the feasibility of designing treatment for any 'high risk' compounds. We will also work with the team to identify any changes that may be required to the monitoring programme i.e., the addition or removal of sites and/or parameters.

Our water quality analysis will continue to investigate environmental and drinking water risks, comparing results to individual EQS and PCVs, and where these do not exist (and where possible) Predicted No-Effect Concentrations (PNECs). Our analysis will also continue to investigate whether there is a potential risk of water quality deterioration by comparing Minworth WwRC final effluent with canal sites.

We will also update the drinking water quality risk assessment for Gate 3 following the All Company Working Group (ACWG) methodology. This was previously undertaken for Gate 1 and subsequently updated for Gate 2, with the caveat that this assessment is based on raw water before treatment, so PCV breaches are expected.

Lastly, we will undertake a new assessment of all determinands by hydrological year (October to September) to assess annual average exceedances against appropriate time scales to facilitate a comparison between years.



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# Gate 3 Water Quality Monitoring: Quarter 5 Results

Severn Trent, Affinity Water and Canal & River  
Trust

29 September 2023

5204564 / 7 / DG / 031

# GRAND UNION CANAL STRATEGIC RESOURCE OPTION

# Notice

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This document has 37 pages including the cover.

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## Client signoff

|                              |  |
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# INTRODUCTION



# 1. Introduction

## 1.1 Purpose of this document

The purpose of this document is to provide an update of data collected over the monitoring period covering April to June 2023, and where available, set these data in the context of longer-term monitoring data collected to date. This report has been restructured, as agreed by the client, compared to previous versions with this iteration focussing more on in-quarter changes. Data collection for the Grand Union Canal (GUC) Strategic Resource Option (SRO) is ongoing. This report provides stakeholders an update on the data, as it is collected and draws comparisons, when possible, to environmental, and drinking water standards.

**Key changes in spot and continuous data observed in-quarter are highlighted in callouts for clarity.**



# METHODOLOGY



## 2. Methodology

### 2.1 Site locations

For the purpose of conceptualising the monitoring programme, the GUC network has been split into three main geographical sections including an overview map of the upper, middle, and lower section (Figure 2-1) and are summarised below.

- **Upper section** – Covering the discharge from Minworth to the example discharge location (Coventry Canal at Atherstone).
- **Middle section** – GUC from the Braunston Junction to the Aylesbury Arm (Marsworth, North of Tring).
- **Lower section** – GUC from the Aylesbury Arm to Hanwell, London. This section includes the example abstraction location (GUC at Grove Lock, Leighton Buzzard).



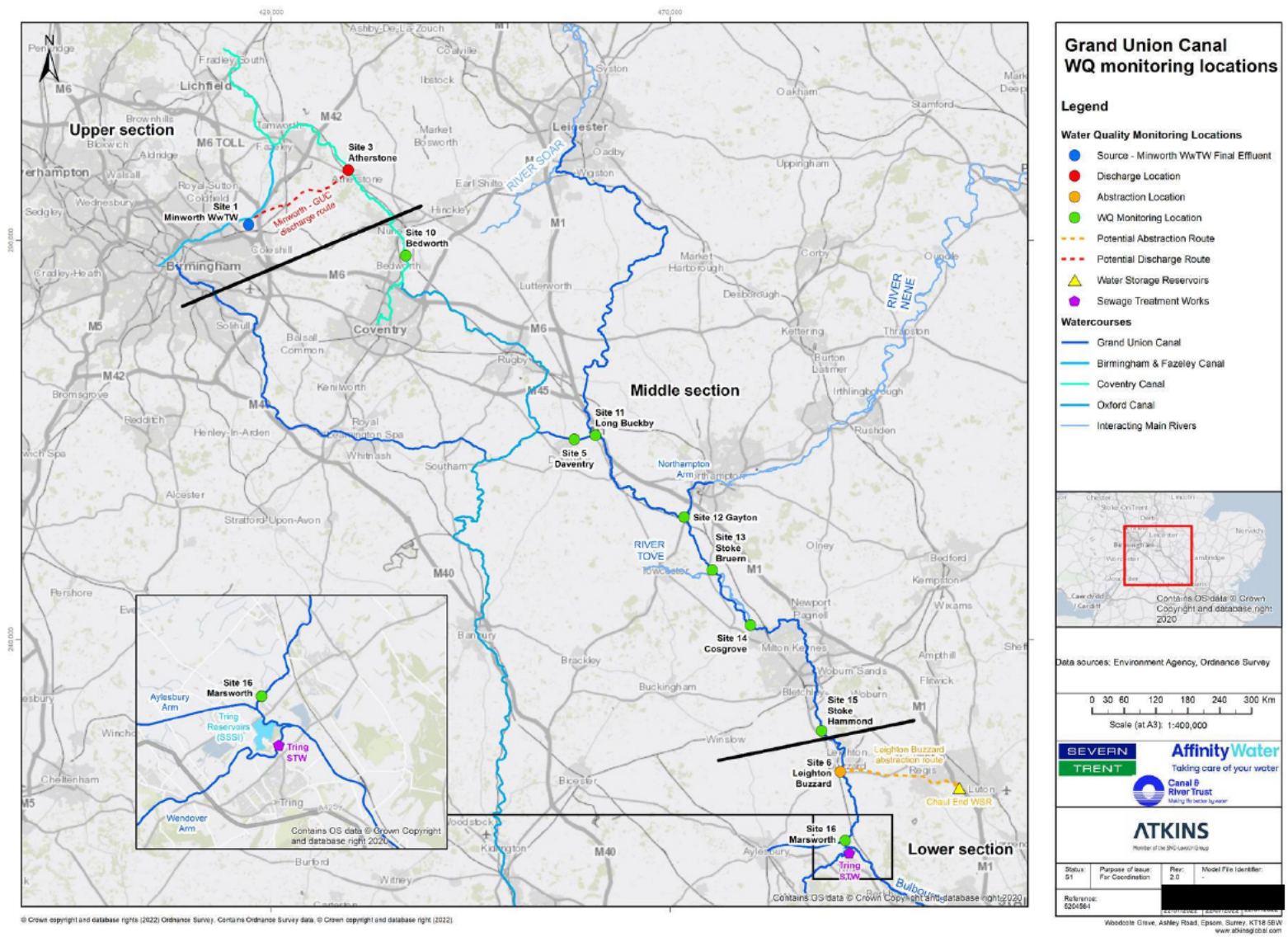


Figure 2-1 – Key elements/ reaches of the GUC scheme (black lines note the upper, middle and lower sections)

Author names redacted



## 2.2 Monitoring, sampling, and analysis procedures

### Key changes to monitoring programme.

There were no changes to the monitoring programme this quarter. Data were downloaded for all monitoring sondes for all parameters. Data added in this most recent summary report covers the period April – June 2023.

### 2.2.1 Spot water quality sampling

Spot water quality samples were taken in line with the programme and operating procedures outlined in the GUC Gate 3 Water Quality Monitoring report. No sites or samples were omitted due to access or safety issues this quarter.

The samples for the April 2023 round were taken on 11<sup>th</sup> April 2023

The samples for the May 2023 round were taken on 15<sup>th</sup> May 2023

The samples for the June 2023 round were taken on 12<sup>th</sup> June 2023

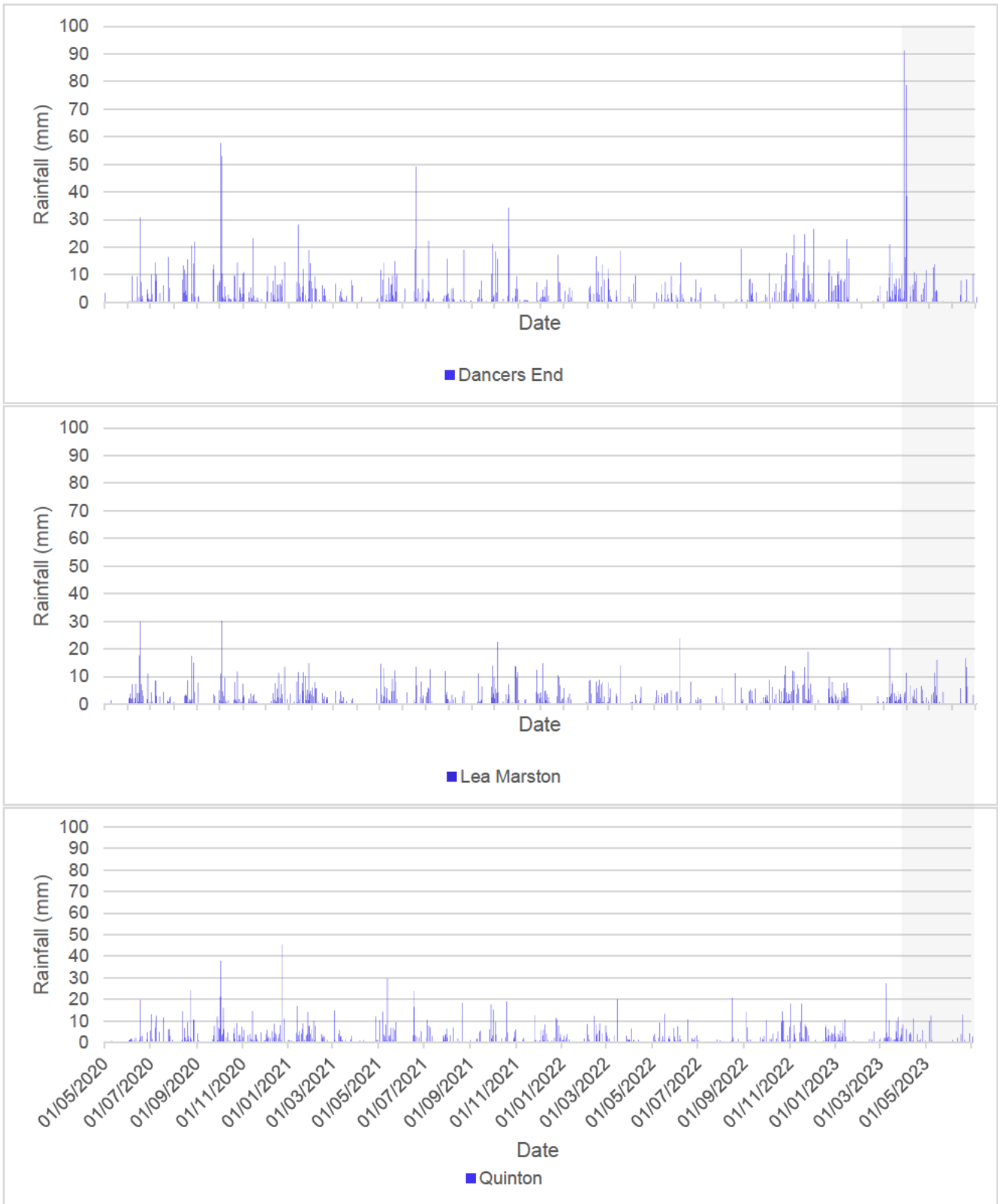
The analysis suites selected for analysis are based on 4 key legislative and design drivers. These include:

- **Environmental risks as required by the Water Framework Directive (WFD)** (WFD Suite)
- **Environmental permitting risks as required by the Environmental Quality Standards Directive (EQSD)** (EQSD suite)
- **Drinking Water risks as required by DWI (Drinking Water Inspectorate)** (Drinking water suite)
- **Emerging substances** (Emerging substances suite)

### 2.2.2 Rainfall data

the entire monitoring period. For the Upper GUC, data have been compared to Lea Marsh gauge (Station ID: 096781), for the Middle reach of the GUC, data have been compared to Quinton rain gauge (EA Station ID: 170945), and for the lower GUC data from Dancers End Reservoir have been used (EA Station ID: 261602). These data are presented in Figure 2-2. There was a single period of heavy rainfall in the April – June 2023 monitoring period, defined as rainfall greater than 20.0 mm, which occurred on 1<sup>st</sup> April (38.6 mm) and followed a period of heavy rain starting on 29<sup>th</sup> March 2023.





**Figure 2-2 – Daily rainfall totals observed at Lea Marsh (EA Station ID: 096781), Quinton (EA Station ID: 170945) and Dancers End Reservoir (EA Station Number: 261602) for use in the analysis of GUC sonde and chemical data series. Grey shading highlights the current reporting period (April – June 2023).**



# RESULTS



## 3. Results

### 3.1 Spot sample environmental quality standards comparison

#### Notable concentration changes in the last quarter (April 2023 – June 2023)

For the first time, maneb, a banned substance historically found in fungicides, was identified above the Maximum Allowable Concentration (MAC) or 30 µg/l at Site 1 measuring 33.6 µg/l. These exceedances did not coincide with any peaks in rainfall, or any parameters monitored as part of the continuous sonde deployment. In quarter continuous monitoring data are discussed in Section 3.2.

Cadmium (dissolved), while exceeding the annual average at Site 3 last quarter, no longer exceeds (Environmental Quality Standard (EQS) = 0.25 µg/l, site mean 0.24 µg/l), this was driven by low concentrations this quarter.

Dissolved oxygen fell below the 10th percentile at Site 6.

Cypermethrin exceeded the MAC EQS at Sites 6, 11, 12, 13, 14 and 15 for the first time.

Mercury dissolved exceeded the MAC EQS at Sites 3, 5, 12, 13 and 15 for the first time.

Mercury total exceeded the MAC EQS at Sites 12 and 13 for the first time.

Substances previously exceeding their respective MACs occurring this quarter include benzo(a)pyrene (Site 3, 12, 13, 14, 15 and 16; Bromine (Sites 1 and 3), Nickel dissolved (Site 3) and sulphide or hydrogen sulphide (All sites).

#### 3.1.1 Overview

In order to determine parameters of risk, values have been compared against the relevant Environmental Quality Standard (EQS) as detailed by the 2015 WFD Directions and the EA Surface Water Pollution Risk Assessment Parameters EQSD. It is important to note that standards or condition limits for certain parameters under the WFD (e.g., dissolved oxygen, BOD, ammoniacal nitrogen, and ANC), are determined by categorising the water body by type, dependent on its altitude and alkalinity. ANC standards are determined by annual mean dissolved organic carbon concentrations. In addition, soluble reactive phosphorus (SRP) standards are determined by the water body's altitude and alkalinity, cadmium standards are determined by categorising the water body, by type, dependent on the hardness of the water, and zinc standards are determined by the ambient background concentration (ABC) of dissolved zinc. EA site specific standards (where available) were used (e.g. SRP), Where these were not available, site-specific standards have been calculated using the available data.

Whilst we have used site-specific EQS or WFD Good standards for the Minworth WwRC final effluent for indicative purposes, it is important to note that these standards should not be routinely applied to final effluent samples as they are in-river standards (these standards do not directly apply to effluent and discharge



standards are set through the permitting regime). It is also important to note that all data on record are considered when comparing against the environmental standards which are applied, under a formal assessment, as Annual Averages (AA), Maximum Allowable Concentrations (MAC), or specified percentiles. Samples at the limit of detection were included in the analysis and used at face value to adhere to discharge permitting assessment guidance. Any significant outliers were removed from the analysis. Based on the available data across all sites, there have been a total of 119 EQS exceedances. A discussion of exceedances along with source water and canal section comparisons can be found in sections 3.1.2 and 3.1.3.

### 3.1.2 Exceedances to date

A list of all compounds that exceeded the quoted EQS split by site are presented in Table 3-1. Maximum allowable concentration (MAC) values were examined separately and have been applied to individual results and not mean or percentile data.

Two polycyclic aromatic hydrocarbons (PAH), benzo(a)pyrene and fluoranthene, exceeded at all sites with the exception of fluoranthene at Minworth WwRC, the mean concentration of which is considerably below the stated EQS (Mean concentration = 0.00247 µg/l, EQS = 0.0063 µg/l). These substances are commonly found in fuels and oils. Biochemical Oxygen Demand (BOD) concentrations have EQS exceedances across a number of the canal's middle sections (Sites 5, 14 and 15) along with the example abstraction location and lower canal section (Site 16). As canal systems are shallow and experience typically very low flow, they contain high levels of accumulated silts along the channel bed. Due to their continued usage for navigation activities which disturb this silt (such as propeller wash) can cause localised, temporary BOD increases which could last several days.

Elevated PFOS concentrations also resulted in EQS exceedances at all 11 sites, with Soluble Reactive Phosphorus (SRP) also exceeding EQS values at 8 sites including Minworth WwRC.

Bromine (total residual oxidant) resulted in EQS exceedances at all sites monitored by several orders of magnitude, however, it is only measured at 2 sites as part of the EQSD analysis suite.

Lastly, low 10<sup>th</sup> percentile dissolved oxygen saturation values resulted in EQS exceedances at five sites this quarter (Sites 1, 5, 10, 14 and 6). Site 1 was below the dissolved oxygen standard in all samples, noting this is sewage effluent and the EQS does not directly apply, whereas Sites 5, 6, 10 and 14 are canal sites with lower dissolved oxygen observed more frequently in June at these sites. This is likely driven by water temperatures, which reduces water ability to hold oxygen combined with increases in algal activity which may be resulting in temporary oxygen drawdowns during the daytime.

Table 3-2 shows the data as it corresponds to the test statistics for all compounds in exceedance of the EQS. The table indicates overall EQS exceedances as well as new exceedances occurring this quarter. This table allows identification of compounds that may exceed EQS if the final effluent from Minworth WwRC were discharged into the GUC without additional treatment. This may result in a future WFD compliance risk as the new discharge may result in a deterioration of instream quality and may prevent the water quality of the receiving body from achieving Good Status in the future. Compounds that exceed at Minworth with no comparable exceedance instream include chlorothalonil (organic fungicide), cypermethrin (synthetic pyrethroid), permethrin (insecticide), and zinc (bioavailable). The exceedance of permethrin is largely due to the observed concentration being less than the limit of detection (<LoD; 0.001 µg/l) on all occasions with the exception of one exceedance (exceedance concentration = 0.002 µg/l observed on 19/07/2021).

In total there are 366 instances of MAC exceedances across all sites. Overall, four PAH (benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene) accounted for 21% of these exceedances. Bromine (total residual oxidant) accounted for 54 exceedances in the 'upper GUC', Sites 1 and 3. Sulphate (or hydrogen sulphide) exceeded MAC values on 150 occasions. A list of total exceedances split by compound can be seen in Table 3-3.



Table 3-1 - Number of EQS (WFD and EQSD) exceedances <sup>1 2</sup>

| Compound                         | Standard | Unit | Statistic <sup>+</sup> | Upper GUC       |                 | Middle GUC |           |           |           |           |           |           | Lower GUC       |           |
|----------------------------------|----------|------|------------------------|-----------------|-----------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------------|-----------|
|                                  |          |      |                        | Source          | Discharge       |            |           |           |           |           |           |           | Abstraction     |           |
|                                  |          |      |                        | Site 1          | Site 3          | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Site 6          | Site 16   |
| Acid neutralisation capacity     | 40       | mg/l | AA                     | 27 <sup>#</sup> | 28 <sup>#</sup> | 12         | 28        | 15        | 15        | 15        | 15        | 15        | 29              | 15        |
| Benzo(a)pyrene                   | 0.00017  | µg/l | AA                     | 40              | 39              | 12         | 28        | 15        | 15        | 15        | 15        | 15        | 29              | 15        |
| BOD (5 day)                      | *        | mg/l | 90 <sup>th</sup>       | 5               | 5               | 1          | 6         | 1         | 1         | 0         | 2         | 4         | 9               | 4         |
| Bromine                          | 0.002    | mg/l | AA                     | 27              | 27 <sup>#</sup> |            |           |           |           |           |           |           |                 |           |
| Cadmium - total                  | 0.25     | µg/l | AA                     | 0               | 16              | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| Chlorothalonil                   | 0.035    | µg/l | AA                     | 1               | 0               |            |           |           |           |           |           |           |                 |           |
| Cobalt – dissolved               | 3        | µg/l | AA                     | 0               | 21 <sup>#</sup> |            |           |           |           |           |           |           |                 |           |
| Cypermethrin                     | 0.00008  | µg/l | AA                     | 30              | 5               | 4          | 2         | 2         | 3         | 2         | 7         | 8         | 10              | 9         |
| Diazinon                         | 0.01     | µg/l | AA                     | 2               | 0               |            |           |           |           |           |           |           | 0               |           |
| Dissolved oxygen                 | *        | %    | 10 <sup>th</sup>       | 5               | 8               | 8          | 10        | 5         | 1         | 0         | 6         | 2         | 6               | 3         |
| Fluoranthene                     | 0.0063   | µg/l | AA                     | 1               | 33              | 11         | 12        | 13        | 11        | 14        | 14        | 15        | 26              | 15        |
| Formaldehyde                     | 0.25     | µg/l | AA                     | 1               | 0               |            |           |           |           |           |           |           |                 |           |
| Manganese – bioavailable**       | 123      | µg/l | AA                     | 0 <sup>#</sup>  | 37              | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0 <sup>##</sup> | 0         |
| Nickel - bioavailable**          | 4        | µg/l | AA                     | 4               | 29              | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| Perfluorooctane sulfonic acid    | 0.00065  | µg/l | AA                     | 44              | 39              | 11         | 27        | 14        | 13        | 14        | 14        | 11        | 22              | 14        |
| Permethrin                       | 0.001    | µg/l | AA                     | 17 <sup>#</sup> | 1               |            |           |           |           |           |           |           |                 |           |
| Soluble reactive phosphorus      | *        | µg/l | AA                     | 30              | 5               | 12         | 10        | 5         | 4         | 12        | 8         | 1         | 24              | 13        |
| Sulphide or hydrogen sulphide    | 0.25     | mg/l | AA                     | 15              | 25              | 10         | 15        | 11        | 9         | 13        | 11        | 11        | 20              | 10        |
| Total anions                     | 250      | µg/l | AA                     | 9 <sup>#</sup>  | 20 <sup>#</sup> |            |           |           |           |           |           |           | 1               |           |
| Tributyltin compounds            | 0.0002   | mg/l | AA                     | 1               | 3               | 2          | 1         | 1         | 9         | 0         | 14        | 1         | 2               | 1         |
| Zinc - bioavailable**            | *        | µg/l | AA                     | 15              | 14              | 2          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| Cadmium dissolved                | 0.25     | µg/l | AA                     | 0               | 4               | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| di(2-ethylhexyl)phthalate (DEHP) | 1.3      | µg/l | AA                     | 1               | 1               | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 1               | 1         |
| <b>Total number of samples</b>   | -        | -    | -                      | <b>40</b>       | <b>28</b>       | <b>15</b>  | <b>28</b> | <b>15</b> | <b>15</b> | <b>15</b> | <b>15</b> | <b>15</b> | <b>28</b>       | <b>15</b> |

<sup>+</sup>AA = Annual Average. Numbers of exceedances are shown for illustrative purposes only and reflect individual samples being compared to an AA or percentile derived EQS.

\* Site specific EQS determined.

\*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT) <sup>3</sup>.

<sup>#</sup> Total number of samples collected = 28 (not included in Phase 1 dataset).

<sup>##</sup> Drinking water suite parameters added to this site in October 2021 so total number of samples = 21.

<sup>1</sup> Blue shading indicates EQS (WFD and EQSD) exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of individual EQS exceedances is also given.

<sup>2</sup> Values in orange indicate the addition of new individual exceedances this quarter.

<sup>3</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktaq](#)

Table 3-2 – Concentrations of compounds responsible for EQS (WFD and EQSD) exceedance<sup>4</sup>

| Compound                         | Standard | Unit | Stat*            | Upper GUC |           | Middle GUC |           |           |           |           |           |           | Lower GUC   |           |
|----------------------------------|----------|------|------------------|-----------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-----------|
|                                  |          |      |                  | Source    | Discharge | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Abstraction | Site 16   |
| Acid neutralisation capacity     | 40       | mg/l | AA               | 1804      | 2493      | 3467       | 2975      | 3587      | 4060      | 4513      | 3707      | 3200      | 3500        | 3207      |
| Benzo(a)pyrene                   | 0.00017  | µg/l | AA               | 0.00158   | 0.01514   | 0.04777    | 0.00613   | 0.01731   | 0.01969   | 0.02187   | 0.02979   | 0.03893   | 0.02119     | 0.02685   |
| BOD (5 day)                      | *        | mg/l | 90 <sup>th</sup> | 2.68      | 2.79      | 2.86       | 3.21      | 2.45      | 2.81      | 2.39      | 4.97      | 4.68      | 4.36        | 3.35      |
| Bromine                          | 0.002    | mg/l | AA               | 0.205     | 1.638     |            |           |           |           |           |           |           |             |           |
| Cadmium - total                  | 0.25     | µg/l | AA               | 0.0239    | 0.4221    | 0.0527     | 0.0261    | 0.0200    | 0.0207    | 0.0200    | 0.0220    | 0.0347    | 0.0379      | 0.0200    |
| Chlorothalonil                   | 0.035    | µg/l | AA               | 0.0463    | 0.0350    |            |           |           |           |           |           |           |             |           |
| Cobalt - dissolved               | 3        | µg/l | AA               | 1.76      | 14.3      |            |           |           |           |           |           |           | 0.3         |           |
| Cypermethrin                     | 0.00008  | µg/l | AA               | 0.000256  | 0.000070  | 0.00009    | 0.00008   | 0.00016   | 0.00027   | 0.000165  | 0.000173  | 0.00031   | 0.000161    | 0.00033   |
| Diazinon                         | 0.01     | µg/l | AA               | 0.0107    | 0.0100    |            |           |           |           |           |           |           | 0.0100      |           |
| Dissolved oxygen                 | *        | %    | 10 <sup>th</sup> | 47.20     | 70.64     | 37.67      | 60.35     | 58.38     | 52.23     | 72.28     | 57.82     | 80.66     | 74.70       | 79.84     |
| Fluoranthene                     | 0.0063   | µg/l | AA               | 0.00238   | 0.01663   | 0.02392    | 0.00681   | 0.01799   | 0.01087   | 0.01243   | 0.01658   | 0.02867   | 0.01710     | 0.02542   |
| Formaldehyde                     | 5        | µg/l | AA               | 51.1071   | 50.0000   |            |           |           |           |           |           |           |             |           |
| Manganese - bioavailable**       | 123      | µg/l | AA               | 10.3      | 1599      |            |           |           |           |           |           |           | 10          |           |
| Nickel - bioavailable**          | 4        | µg/l | AA               | 2.9       | 9.9       | 0.63       | 0.80      | 0.41      | 0.76      | 0.53      | 0.58      | 0.72      | 0.60        | 0.55      |
| Perfluorooctane sulfonic acid    | 0.00065  | µg/l | AA               | 1.0995    | 0.0863    | 0.0049     | 0.0156    | 0.0092    | 0.0227    | 0.0361    | 0.0096    | 0.0012    | 0.0549      | 0.0024    |
| Permethrin                       | 0.001    | µg/l | AA               | 0.00243   | 0.00104   |            |           |           |           |           |           |           |             |           |
| Soluble reactive phosphorus      | *        | µg/l | AA               | 0.356     | 0.111     | 0.115      | 0.095     | 0.053     | 0.057     | 0.120     | 0.089     | 0.031     | 0.170       | 0.197     |
| Sulphide or hydrogen sulphide    | 0.25     | mg/l | AA               | 11.05     | 16.51     | 19.73      | 15.89     | 18.07     | 20.40     | 23.93     | 21.27     | 20.27     | 26.48       | 19.33     |
| Total anions                     | 250      | µg/l | AA               | 242       | 389       |            |           |           |           |           |           |           | 177         |           |
| Tributyltin compounds            | 0.0002   | µg/l | AA               | 0.0000870 | 0.0000988 | 0.00019    | 0.00005   | 0.00011   | 0.00029   | 0.0000613 | 0.0003847 | 0.00013   | 0.0001490   | 0.00009   |
| Zinc - bioavailable**            | *        | µg/l | AA               | 14.0      | 16.4      | 7.15       | 2.02      | 1.51      | 1.62      | 1.08      | 3.01      | 1.94      | 1.78        | 1.53      |
| Cadmium dissolved                | 0.25     | µg/l | AA               | 0.0228    | 0.2470    | 0.0267     | 0.0211    | 0.0200    | 0.0200    | 0.0200    | 0.0200    | 0.0200    | 0.0255      | 0.0200    |
| di(2-ethylhexyl)phthalate (DEHP) | 1.3      | µg/l | AA               | 0.2585    | 0.2728    | 0.1800     | 0.1636    | 0.1500    | 0.1533    | 0.1500    | 0.1500    | 0.1553    | 0.1934      | 1.7400    |
| <b>Total number of samples</b>   | -        | -    | -                | <b>40</b> | <b>28</b> | <b>15</b>  | <b>28</b> | <b>15</b> | <b>15</b> | <b>15</b> | <b>15</b> | <b>15</b> | <b>28</b>   | <b>15</b> |

\*AA = Annual Average.

\* Site specific EQS determined

\*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT)<sup>5</sup>.

<sup>4</sup> Blue shading indicates EQS exceedance and grey shading indicates where failures relate to EQSD target compounds (not monitored at all sites, and as such not directly comparable across all sites). Concentrations corresponding to test statistic are also shown.

<sup>5</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktaq](#)

Table 3-3 - Compounds responsible for WFD and EQSD MAC exceedances<sup>6 7</sup>

| Compound                         | Standard | Unit                    | Statistic | Upper GUC       |           | Middle GUC |        |         |         |         |         |         | Lower GUC        |         |
|----------------------------------|----------|-------------------------|-----------|-----------------|-----------|------------|--------|---------|---------|---------|---------|---------|------------------|---------|
|                                  |          |                         |           | Source          | Discharge | Site 10    | Site 5 | Site 11 | Site 12 | Site 13 | Site 14 | Site 15 | Abstraction      | Site 16 |
| Benzo(a)pyrene                   | 0.027    | µg/l                    | MAC       | 0               | 6         | 8          | 1      | 2       | 2       | 5       | 8       | 9       | 8                | 6       |
| Benzo(b)fluoranthene*            | 0.017    | µg/l                    | MAC       | 0               |           |            |        |         |         |         |         |         | 8 <sup>##</sup>  |         |
| Benzo(g,h,i)perylene*            | 0.0082   | µg/l                    | MAC       | 0               |           |            |        |         |         |         |         |         | 15 <sup>##</sup> |         |
| Benzo(k)fluoranthene*            | 0.017    | µg/l                    | MAC       | 0               |           |            |        |         |         |         |         |         | 3 <sup>##</sup>  |         |
| Bromine - total residual oxidant | 0.005    | mg/l                    | MAC       | 27 <sup>#</sup> | 27        |            | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| Cadmium - dissolved              | 1.5      | µg/l                    | MAC       | 0               | 2         | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| Cadmium - total                  | 1.5      | µg/l                    | MAC       | 0               | 2         | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| Cypermethrin                     | 0.0006   | µg/l                    | MAC       | 5               | 0         | 0          | 0      | 1       | 2       | 2       | 1       | 2       | 1                | 2       |
| Formaldehyde                     | 50       | µg/l                    | MAC       | 1               | 0         | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| Mercury - dissolved              | 0.07     | µg/l                    | MAC       | 2               | 1         | 2          | 1      | 2       | 1       | 1       | 2       | 1       | 2                | 2       |
| Mercury - total                  | 0.07     | µg/l                    | MAC       | 2               | 2         | 2          | 2      | 2       | 1       | 1       | 2       | 2       | 2                | 2       |
| Nickel - dissolved               | 34       | µg/l                    | MAC       | 2               | 16        | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| Sulphide or hydrogen sulphide    | 1        | µg/l                    | MAC       | 15              | 25        | 10         | 15     | 11      | 9       | 13      | 11      | 11      | 20               | 10      |
| Tributyltin compounds            | 0.02     | µg/l                    | MAC       | 2               | 2         | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| Maneb                            | 30       | µg/l<br>CS <sub>2</sub> | MAC       | 1               | 0         | 0          | 0      | 0       | 0       | 0       | 0       | 0       | 0                | 0       |
| <b>Total number of samples</b>   | -        | -                       | -         | 40              | 28        | 15         | 28     | 15      | 15      | 15      | 15      | 15      | 28               | 15      |

\* While these determinands have a MAC, as per the WFD there is no corresponding AA statistic as benzo(a)pyrene should be considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water.

# Total number of samples collected = 28 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 21.

<sup>6</sup> Blue shading indicates MAC EQS exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of exceedances also given.

<sup>7</sup> Values in orange indicate the addition of new individual exceedances this quarter.

### 3.1.3 Source water and canal section comparisons

In this section the quality of treated effluent discharged from Minworth WwRC is directly compared with all respective sections of the GUC. The key changes identified this quarter are discussed below.

#### 3.1.3.1 Minworth vs. GUC Upper Section (Site 3)

The majority of substances which exceed EQS at Minworth also exceed at Site 3, the example discharge location (Atherstone). Exceptions include chlorothalonil, cypermethrin, dissolved oxygen, diazinon and formaldehyde which do not exceed at Site 3. This suggests these parameters may be at increased risk of EQS exceedance in-canal if discharge from Minworth is received without additional treatment. While permethrin and soluble reactive phosphorus (SRP) have exceeded EQS on occasion, these occur more frequently in the Minworth WwRC final effluent suggesting EQS failures would become more likely without additional treatment. By contrast, cobalt - dissolved, fluoranthene, manganese and nickel (bioavailable), sulphide or hydrogen sulphide, total anions and cadmium - total exceed EQS at Site 3 with no exceedances observed in the Minworth WwRC final effluent, suggesting a wider catchment source.

#### 3.1.3.2 Minworth vs. GUC Middle Section (Sites 5,10,11,12,13,14 and 15)

The following substances exceed EQS in Minworth WwRC discharge but do not currently exceed EQS at any site in the middle section of the GUC:

- Zinc - bioavailable

The following substances exceed EQS in the Minworth WwRC discharge but are not currently monitored under the currently agreed monitoring suites in the Middle Section of the GUC:

- Bromine - total residual oxidant
- Chlorothalonil
- Cobalt - dissolved
- Formaldehyde
- Permethrin

These substances may be at risk of exceeding their respective EQS should an Minworth discharge be introduced depending on in-canal concentrations, however this is currently unknown due to lack of data. Site 5, 14 and 15 are the only sites where BOD has exceeded the annual average EQS. SRP exceeds EQS at Sites 10, 5, 13 and 14. Given SRP has regularly exceeded at these sites they are at risk from the introduction of Minworth discharge. Bioavailable zinc calculated using the Metals Bioavailability Assessment Tool (M.BAT), previously exceeded EQS at Site 10, however no longer exceeds at any site in the Middle section. As with the other substances above, this is likely at risk of exceedance. Tributyltin compounds continue to exceed at the Middle GUC sites 12 and 14, noting this is a single occurrence and does not occur at Minworth WwRC suggesting a wider catchment source. TBT was historically used as an antifouling agent in paints and binds strongly to sediments, as such this may be present and easily released in a canal when sediment is disturbed.

#### 3.1.3.3 Minworth vs. GUC Lower Section (Sites 6 and 16)

Dissolved oxygen was lower than the AA EQS this quarter at Site 6. The following substances in the Minworth discharge do not currently exceed EQS at any site in the lower section:

- Diazinon
- Dissolved oxygen
- Zinc - bioavailable

The following substances exceed EQS in the Minworth WwRC discharge but are not monitored in the Lower GUC:



- Bromine - total residual oxidant
- Chlorothalonil
- Formaldehyde
- Permethrin

These substances are most at risk from deterioration following the introduction of a Minworth discharge to the GUC, noting that for the second list, their current status against EQS is unknown. DEHP was identified as above EQS last quarter at Site 16 but did not exceed again this quarter suggesting this may have been an isolated event such as a chemical spill nearby.

## 3.2 Continuous monitoring data

### Notable sonde changes in the last quarter (April 2023 – June 2023)

Below are key changes in the last quarter of data, these events are described in detail in subsequent sections (3.2.1 to 3.2.7).

**Temperature** - Temperatures increased during this period at all sites as we moved from spring to summer.

**Conductivity** - Reductions in conductivity were observed at Site 1 following rainfall events.

**Dissolved Oxygen** - No notable changes in quarter.

**pH** - No notable changes in quarter.

**Ammonium** - Significant peaks in ammonium at Site 1 following rainfall on the 13th and 18th June with 31.6 mg/l and 36.1 mg/l respectively, with smaller peaks at Site 3 suggesting the input of material from the surrounding catchment transported during the rainfall event.

**Turbidity** - Peaks in turbidity at Site 1 are linked to vegetation growth in channel, a resolution to this is being investigated. Silt accumulation affected data leading to unreliable results from Site 3 however this has been resolved.

**Chlorophyll** - Increases in concentrations at Sites 6 and 16 in June peaking at 70.8 µg/l and 18.7 µg/l

This section describes patterns observed in parameters monitored by the continuous sondes and highlights any noteworthy changes observed in the reporting period. Running means of all historical continuous monitoring data along with this quarter's mean for each sampling location provided in Table 3-4. Symbols (increase '↑', decrease '↓' and no change '-') indicate the in-period mean relative to the long-term mean. The in-period continuous sonde data collected can be seen for all sites in Figure 3-1 to 3-4.

### 3.2.1 Temperature

Over the period of record temperatures typically range from 9-22°C in the Minworth discharge. By contrast the canal at Atherstone ranges from 4-23°C. Temperatures between Minworth and Atherstone are similar in summer months however the Minworth discharge is up to 8°C warmer than the canal in winter. As there is potentially a risk of a >3°C temperature increase in the receiving waterbody due to the temperature differences seen at this time of year, appropriate considerations must be made at the design stage to reduce potential impacts to fish<sup>8</sup>.

This quarter, temperatures were highest at Site 1 measuring 16.5°C. In the canal itself the highest temperature was Site 6 with 15.2°C and lowest at Site 16 with 11.5°C. There was a steady increase in temperature across

<sup>8</sup> The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 Part 1, Section 1 (6)

all sites as the seasons progressed from spring to summer. This quarter, temperatures at all sites were below the thresholds for fish stress.

### 3.2.2 Conductivity

Conductivity is a measure of the ability of a water body to conduct an electrical charge and reflects the concentration of ions in solution (e.g., sodium, calcium etc). Instream conductivity is primarily controlled by underlying geology. Temporary increases and reductions in conductivity can be observed in response to pulses of mineral rich material from catchment sources (e.g., agricultural runoff). Conversely, instream reductions in conductivity can occur when rainfall runoff from the surrounding area results in an instream dilution. Long term increases in conductivity, above what would be considered typical for a particular catchment can be indicative of nutrient enrichment from the surrounding landscape from point (e.g., STW) or diffuse (e.g., agricultural) sources.

Conductivity on average was highest at Site 3 with 827  $\mu\text{S}/\text{cm}$  and lowest at Site 16 with 607  $\mu\text{S}/\text{cm}$ . The Minworth WwRC discharge measured 683  $\mu\text{S}/\text{cm}$ . Rainfall was low throughout the monitoring period therefore there were no significant peaks in conductivity observed at any site. Dilution following rainfall was observed at Site 1.

### 3.2.3 Dissolved oxygen

Dissolved oxygen, typically measured in percent saturation (or mg/l) describes the amount of oxygen that is dissolved in water. It is essential for aquatic life, with low DO saturation resulting in anoxia and subsequent fish kills and is associated with the development of eutrophic conditions. The pattern of DO saturation in watercourses varies seasonally. A typically well aerated river or stream will have a DO % saturation of ~100%. Canals typically experience lower DO saturation than rivers. This is partly due to the slow flowing nature of canals and lack of natural aeration from turbulent water as it travels downstream. Diurnal variability is highest during the summer months driven largely by photosynthesis-respiration dynamics. DO can however, exceed 100% instream due to the presence of photosynthetic aquatic organisms.

This quarter, dissolved oxygen saturation measured highest at Site 16 (98.0%) while measuring lowest at Site 3 (Atherstone) with saturation as low as 2%. This is unusually low due to the sensor becoming submerged with sediment leading to a low 10<sup>th</sup> percentile saturation this quarter. Sites 1 and 6 were comparable to long term averages however Site 16 was considerably higher (long term mean = 71.6%) which is likely the occurrence of initial algal blooms given the concurrent chlorophyll peaks (peak concentration = 18.7  $\mu\text{g}/\text{l}$ ). Despite Site 6 being comparable to previous years for this time of year, it should be noted that saturation reduces sharply in early June and remains reduced relative to April and May. A strong diurnal fluctuation indicates photosynthesis and respiration occurring which is more pronounced during summer months. Rainfall does not appear to affect dissolved oxygen saturation at any site and is predominantly driven by the diurnal variability described above.

### 3.2.4 pH

The pH of a watercourse is a measure of how acidic or basic the water is. The pH is mainly driven by geology (and resultant soil type) however, can be influenced by catchment factors such as pollutant discharges and the leaching of soil horizons under differing flow conditions. As pH is recorded on a logarithmic scale, slight changes in pH can have significant impacts on the organisms that live in a watercourse. The optimum pH for water to sustain fish and invertebrate life, is between 6 to 9. Across all sites, pH was within acceptable limits for fish and invertebrates. It should be noted that pH at Minworth (6.7) is more acidic (lower) than the example discharge location at Site 3 (7.3). The example abstraction location at Site 6 as well as Site 16 are slightly more basic measuring 7.9 each. This suggests pH may increase along the proposed transfer route.

This quarter, all sites measured comparably to their long-term means. pH was lowest in the Minworth WwRC discharge (Site 1) at 6.7. In the canal, Site 6 and 16 measured the highest at 7.9 while lowest at Site 3 with a pH of 7.4.



### 3.2.5 Ammonium

Ammonium is a type of nitrogenous compound that is naturally present in water but can also be released into rivers from a variety of sources, including agricultural runoff, sewage treatment and industrial wastewater discharges. High concentrations of ammonium in rivers can be harmful to aquatic life, particularly fish, as it can disrupt their metabolism and respiration. In some cases, it can even be fatal. Ammonium can also contribute to the formation of algal blooms, which can further degrade water quality and make it unsafe for drinking, swimming, and fishing. Average ammonium concentrations were highest at Site 1 (Minworth WwRC) and lowest at the example discharge location (Site 3 Atherstone).

Ammonium shows high responsiveness to rainfall events at Site 1 on 11<sup>th</sup> May, 13<sup>th</sup> June, and 18<sup>th</sup> June 2023 with peak concentration of 17.7 mg/l, 32.4 mg/l and 36.1 mg/l respectively. Similar smaller peaks were also seen at Site 6 but not at Site 3 or 16.

When compared to laboratory derived concentrations, *in-situ* measurements of ammonium commonly over record ammonium concentrations. As such, it is important to use these data to infer catchment trends rather than absolute concentrations.

### 3.2.6 Turbidity

Turbidity is a measure of how cloudy water is and can be used as a proxy for suspended sediment concentrations. It is caused by the presence of suspended particles in the water, such as sediment, algae, or other organic matter. Turbidity can make it difficult for sunlight to penetrate the water, which can reduce the amount of photosynthesis that takes place. A high loading of suspended sediment, when combined with reduced flow velocities can result in sediment deposition causing damage to macrophytes and reducing hydrological exchanges with river bed and surrounding groundwater. Increased sediment loading can result in the unintended substance transport. For example, the dominant form of phosphorus exported from agricultural systems is particulate phosphorus, which when exported from the terrestrial to aquatic systems has the potential to desorb and become available to in stream heterotrophic organisms.

Increases in turbidity can be caused by a number of factors, including erosion, runoff from agricultural fields following poor land and soil management practises, stormwater runoff and point source pollution, such as from sewage treatment plants. Turbidity values are typically highest at Site 1 measuring 38.4 NTU on average. This site also experiences the high variability due to its high responsiveness to rainfall events. At the example discharge location (Site 3), the average is 33.5 NTU however this site experiences much lower peaks following rainfall. This quarter, Site 3 was unusually high however this can be attributed to silt accumulation around the sensor. The lowest mean turbidity value is recorded at Site 16 measuring 4.6 NTU.

During the last quarter turbidity was low across most sites with regular turbidity spikes at the Minworth WwRC (Site 1) discharge and Site 3. Some turbidity data this quarter at Site 1 has been affected by tree growth around the sensor. Historically, turbidity spikes across all sites following rainfall events. Similarly, data from Site 3 is unreliable for this quarter as the sensor became submerged in silt.

### 3.2.7 Chlorophyll

Chlorophyll is a green pigment found in algae and plants. It is essential for photosynthesis, the process by which plants convert sunlight into energy. Chlorophyll can be used as a measure of the quantity of algae in a river. Higher levels of chlorophyll indicate more algae, which can lead to problems such as algal blooms, decreased oxygen levels, and the production of toxins. There are a number of factors that can affect the level of chlorophyll in a river, including nutrient levels, sunlight levels, temperature and flow. Chlorophyll concentrations are generally highest at Site 6 and have been observed to peak with a number of algal blooms events observed during the Spring and Summer months.

Recent data collected covering April to June 2023 falls within the late spring/early summer period. There is some evidence of algal blooms occurring at Site 16 where algae prevalence is increasing since early June. At



Site 6, peaks in chlorophyll coincide with reductions in dissolved oxygen saturation suggesting algal blooms are occurring from early June.



Table 3-4 – Overall mean and quarterly mean values observed at continuous monitoring locations

| Determinand      | Unit     | 1. Minworth WwRC Final Effluent <sup>1</sup> |                |                  | 3. GUC at Atherstone <sup>2</sup> |                |                  | 6. GUC at Grove, Leighton Buzzard <sup>3</sup> |                |                  | 16. GUC at Marsworth <sup>2</sup> |                |                  |
|------------------|----------|--|----------------|------------------|-----------------------------------|----------------|------------------|--|----------------|------------------|-----------------------------------|----------------|------------------|
|                  |          | Overall Mean                                 | Quarterly Mean | Change in period | Overall Mean                      | Quarterly Mean | Change in period | Overall Mean                                   | Quarterly Mean | Change in period | Overall Mean                      | Quarterly Mean | Change in period |
| Temperature      | °C       | 16.0   | 16.5           | ↑                | 12.8                              | 14.8           | ↑                | 11.8   | 15.2           | ↑                | 14.7                              | 11.5           | ↓                |
| Conductivity     | µS/cm    | 785  | 683            | ↓                | 1340                              | 827            | ↓                | 642.3  | 614            | ↓                | 568.6                             | 607            | ↑                |
| Dissolved Oxygen | %        | 47.3   | 46.6           | ↓                | 63.0                              | 2.0            | ↓                | 45.8   | 51.6           | ↑                | 71.6                              | 98.0           | ↑                |
| pH               | pH units | 6.7  | 6.7            | —                | 7.3                               | 7.4            | ↑                | 7.9  | 7.9            | —                | 7.9                               | 7.8            | ↓                |
| Ammonium         | mg N/l   | 1.9  | 3.01           | ↑                | 0.54                              | 0.81           | ↑                | 0.5  | 0.55           | ↑                | 0.46                              | 0.35           | ↓                |
| Turbidity        | NTU      | 38.4   | 64.1           | ↑                | 33.5                              | 115.5          | ↑                | 32.3   | 15.7           | ↓                | 4.6                               | 2.8            | ↓                |
| Chlorophyll      | µg/l     | -  | -              |                  | 10.0                              | 18.4           | ↑                | 31.7   | 19.7           | ↓                | 13.5                              | 3.9            | ↓                |

Blue shading indicates values reported as 10<sup>th</sup> percentiles to facilitate comparisons to EQS.

<sup>1</sup> Site 1 sonde data monitoring for conductivity, temperature, and dissolved oxygen commenced at the start of Phase 2 monitoring on 18/05/2022. Additional parameters including pH, ammonium, and turbidity were added on 05/04/2022.

<sup>2</sup> Site 3 and Site 16 sondes were deployed on 11/05/22 and 24/05/22 respectively.

<sup>3</sup> Site 6 sonde was deployed on 25/11/21.



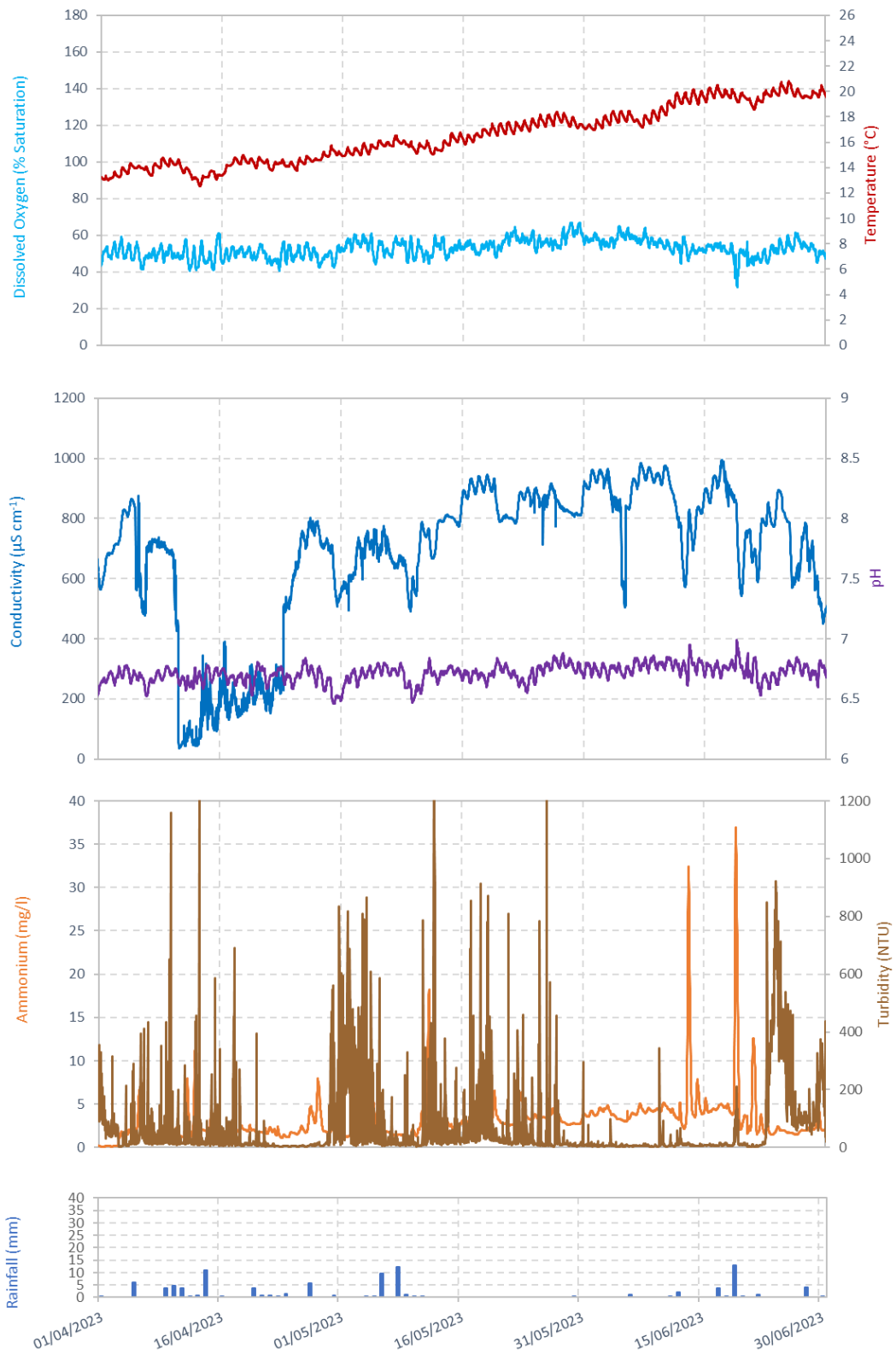
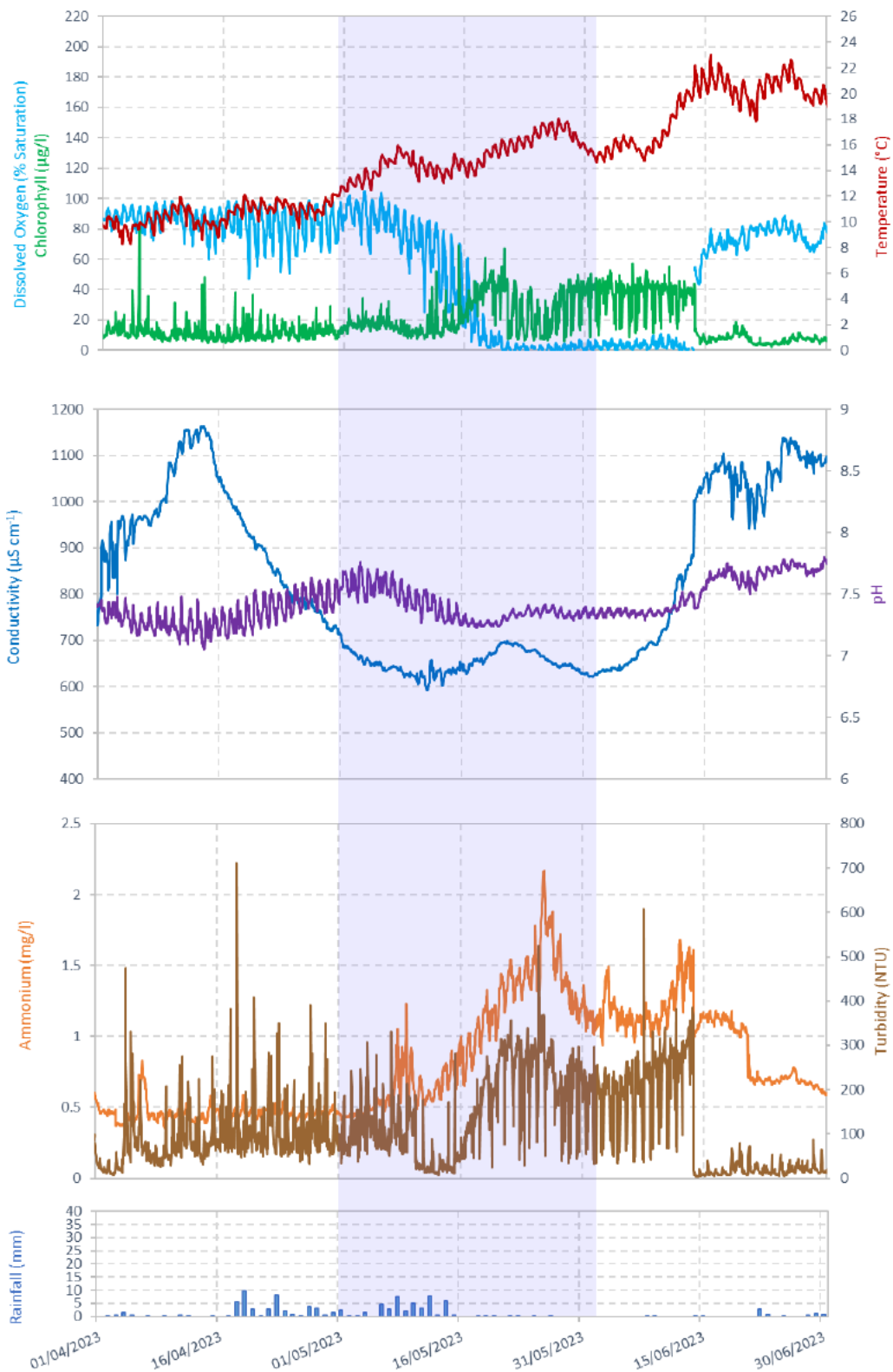
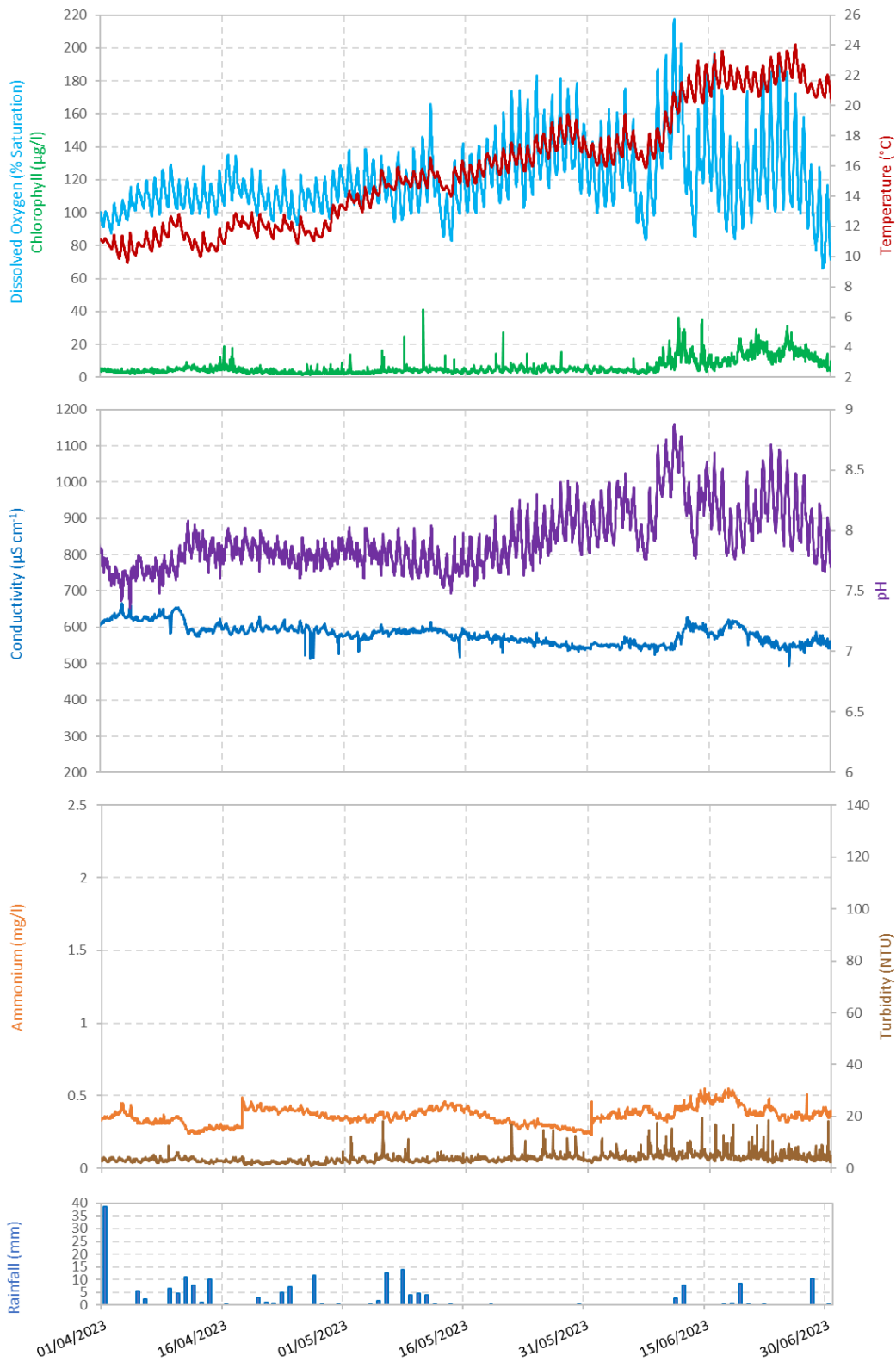


Figure 3-1 - Continuous sonde data collected between 01/04/2023 to 30/06/2023 at Site 1 (Minworth).

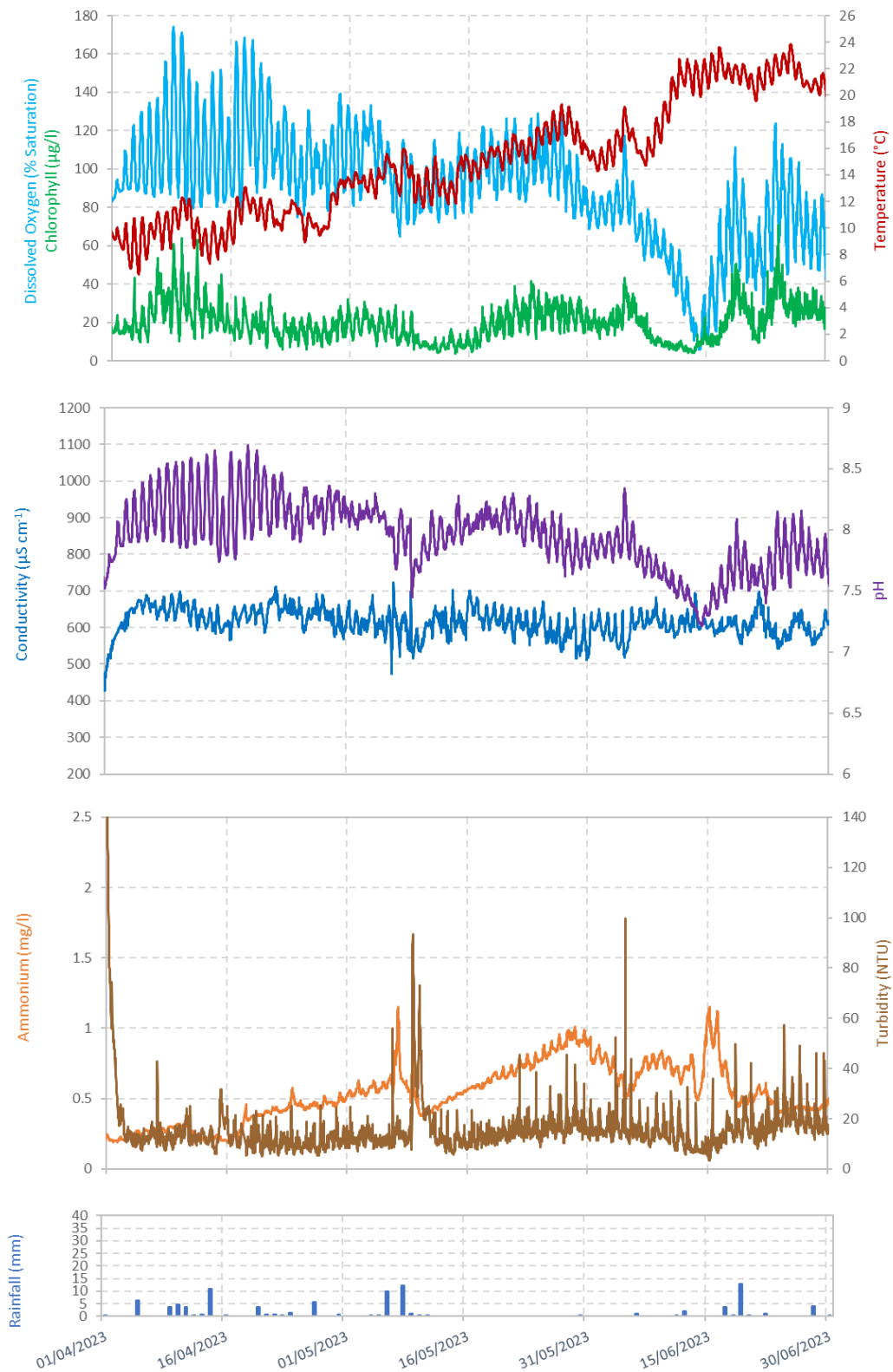




**Figure 3-2 - Continuous sonde data collected between 01/04/2023 to 30/06/2023 at Site 3 (GUC at Atherstone). Grey shading indicates a period (13<sup>th</sup> May 2023 – 15<sup>th</sup> June 2023) where the probe was covered by sediment; as such, readings are considered unreliable but are included for completeness.**



**Figure 3-3 - Continuous sonde data collected between 01/04/2023 to 30/06/2023 at Site 16 (GUC at Marsworth).**



**Figure 3-4 - Continuous sonde data collected between 01/04/2023 to 30/06/2023 at Site 6 (GUC at Grove, Leighton Buzzard).**

## 3.3 Spot sample drinking water quality standards comparison

### Notable concentration changes in the last quarter (April 2023 – June 2023)

This quarter there were no additional substances exceeding PCV at any site. Manganese – total increased above its long-term maximum of 150 µg/l to 360 µg/l at Site 6.

### 3.3.1 Overview

Drinking water parameters, assessed through their comparison to Predicted Concentration Values (PCVs) are only required to characterise the source water at Minworth WwRC (Site 1) and the downstream abstraction location (Site 6 Leighton Buzzard). It is important to note, that specific drinking water parameters were only added to the analysis suite at Site 6 in October 2021, prior to which, only WFD parameters were analysed. As a result, 18 months of DWSP parameter data are reported, compared to Site 1, for which data from Phases 1-3 are available (34-months). The exception to this is where a determinand has a comparable PCV and is present in the WFD analysis suite (e.g., iron). In these instances, all monitoring data are compared to the relevant drinking water standard. It should be noted that these standards are being applied to raw 'untreated' water where typically they would apply at the point of use i.e., a customer's tap. This had been undertaken to provide guidance on which substances may require targeted treatment when abstraction is operational. PCV exceedances in wastewater discharge and an operational canal are therefore expected.

### 3.3.2 Exceedances to date

At Site 1 (Minworth) 274 exceedances have been recorded to date. At Site 6, 178 PCV exceedances have been recorded. The distribution of these is detailed in Table 3-1. Several determinands exceeded PCVs in every, or almost every, sampling round. These determinands, along with the number of exceedances observed at Site 6 (the example abstraction location), are given below. It must be noted that these standards are applicable to drinking water at the point of consumption, and these are effluent (Minworth) and surface water (Atherstone) sites.

- Benzo(a)pyrene (total exceedances = 17)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 49)
- *Escherichia coli* (*E. coli*, total exceedances = 48)
- Iron - total (total exceedances = 26)
- Nitrite (total exceedances = 21)
- Turbidity (total exceedances = 39)

*C. perfringens* (a sulphite-reducing species commonly associated with faecal contamination) is widely distributed in the environment and is regularly evaluated with the aim of understanding the microbiological safety of drinking water supplies. *C. perfringens* is responsible for gastrointestinal disease, the spores of which persist longer than other indicators of contamination, such as Coliforms (which also demonstrated exceedances at all sites and is also an important indicator of faecal contamination). Sources of bacterial contamination can range from the input of animal manures from farmyard runoff and the discharge of untreated, and even treated, sewage effluent<sup>9</sup>. *Cryptosporidium* was not detected at either site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores. However, as canal networks

<sup>9</sup> [final\\_jrc\\_tech\\_report\\_dwd\\_06.04.20\\_final\\_pdf\(4\).pdf](#)

often have shallow depths (<6ft), short lived events may be a result of localised disturbance of sediments by boats or wildlife causing disturbance in the vicinity of the sensor location.



**Table 3-5 - Number of drinking water PCV exceedances**

| Compound   | PCV  | Unit                    | Source    |           |
|--|------|-------------------------|-----------|-----------|
|  |      |                         | Site 1    | Site 6    |
| Aluminium - dissolved  | 200  | µg/l                    | 0         | 1         |
| Aluminium - total  | 200  | µg/l                    | 0         | 12        |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l as NH <sub>4</sub> | 3         | 3         |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 0         | 17        |
| Bisphenol A  | 2.5  | µg/l                    | 9         | 0         |
| C. perfringens veg & spores, confirmed   | 0    | No/100ml                | 28        | 21        |
| Chlorate   | 0.25 | mg/l                    | 4         | 0         |
| Chloride   | 250  | mg/l                    | 1         | 0         |
| Chlorite   | 0.25 | µg/l                    | 0         | 7         |
| Chromium - total   | 50   | µg/l                    | 1         | 0         |
| Clopyralid   | 0.1  | µg/l                    | 1         | 0         |
| Coliform - total   | 0    | MPN/100ml               | 28        | 20        |
| Colour   | 20   | mg/Pt/Co                | 23        | 2         |
| E. coli  | 0    | MPN/100ml               | 28        | 20        |
| Iron - dissolved   | 200  | µg/l                    | 0         | 1         |
| Iron total   | 200  | µg/l                    | 7         | 22        |
| Manganese - dissolved  | 50   | µg/l                    | 27        | 1         |
| Manganese - total  | 50   | µg/l                    | 28        | 4         |
| Mercury - total  | 1    | µg/l                    | 1         | 0         |
| Metribuzin   | 0.1  | µg/l                    | 0         | 1         |
| Nickel - dissolved   | 20   | µg/l                    | 9         | 0         |
| Nickel - total   | 20   | µg/l                    | 10        | 0         |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 21        | 2         |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 23        | 10        |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | 0         | 4         |
| PAH sum*   | 0.1  | µg/l                    | 0         | 8         |
| Propyzamide  | 0.1  | µg/l                    | 1         | 0         |
| Sodium - dissolved   | 200  | mg/l                    | 0         | 1         |
| Sulphate   | 250  | mg/l SO <sub>4</sub>    | 0         | 1         |
| Tebuconazole   | 0.1  | µg/l                    | 0         | 1         |
| Turbidity  | 1    | NTU                     | 24        | 21        |
| Vinyl chloride   | 0.5  | µg/l                    | 0         | 1         |
| <b>Total samples</b>   |      |                         | <b>40</b> | <b>28</b> |

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

\*\* Data at Site 1 covers May 20 – June 23 and data at Site 6 covers April 21 – June 23.

# Total number of samples collected = 28 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 24.

**Table 3-6 – Maximum concentrations of compounds responsible for drinking water PCV exceedances<sup>10</sup>**

| Compound   | PCV  | Unit                    | Source    |                            |
|--|------|-------------------------|-----------|----------------------------|
|  |      |                         | Site 1    | Abstraction site<br>Site 6 |
| Aluminium - dissolved  | 200  | µg/l                    | 50.0      | 1000.0                     |
| Aluminium - total  | 200  | µg/l                    | 125.0     | 1800.0                     |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l as NH <sub>4</sub> | 1.2       | 1.9                        |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 0.0       | 0.1                        |
| Bisphenol A  | 2.5  | µg/l                    | 137.0     | <0.01**                    |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml                | 100.0     | 1000.0                     |
| Chlorate   | 0.25 | mg/l                    | 2.0       | 0.7                        |
| Chloride   | 250  | mg/l                    | 610.0     | 75.0                       |
| Chlorite   | 0.25 | µg/l                    | 3.0       | 15.0                       |
| Chromium - total   | 50   | µg/l                    | 140.0     | 15.0                       |
| Clopyralid   | 0.1  | µg/l                    | 0.2       | 0.0                        |
| Coliform - total   | 0    | MPN/100ml               | 2420.0    | 2420.0                     |
| Colour   | 20   | mg/Pt/Co                | 43.0      | 26.0                       |
| <i>E. coli</i>   | 0    | MPN/100ml               | 2420.0    | 2420.0                     |
| Iron - dissolved   | 200  | µg/l                    | 100.0     | 1700.0                     |
| Iron total   | 200  | µg/l                    | 310.0     | 2600.0                     |
| Manganese - dissolved  | 50   | µg/l                    | 130.0     | 120.0                      |
| Manganese - total  | 50   | µg/l                    | 160.0     | 360.0                      |
| Mercury - total  | 1    | µg/l                    | 3.7       | 0.7                        |
| Metribuzin   | 0.1  | µg/l                    | 0.1       | 0.2                        |
| Nickel - dissolved   | 20   | µg/l                    | 61.0      | 7.1                        |
| Nickel - total   | 20   | µg/l                    | 61.0      | 9.4                        |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 120.0     | 100.0                      |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 3.6       | 2.5                        |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | N/A       | 0.4                        |
| PAH sum*   | 0.1  | µg/l                    | 0.1       | 0.6                        |
| Propyzamide  | 0.1  | µg/l                    | 0.3       | 0.1                        |
| Sodium - dissolved   | 200  | mg/l                    | 78.0      | 510.0                      |
| Sulphate   | 250  | mg/l SO <sub>4</sub>    | 180.0     | 690.0                      |
| Tebuconazole   | 0.1  | µg/l                    | 0.1       | 0.2                        |
| Turbidity  | 1    | NTU                     | 14.0      | 210.0                      |
| Vinyl chloride   | 0.5  | µg/l                    | 0.5       | 1.0                        |
| <b>Total number of samples</b>   |      |                         | <b>40</b> | <b>28</b>                  |

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

### 3.3.3 Source water/canal section comparison

#### 3.3.3.1 Minworth vs. example abstraction location (Site 6)

The following substances were found to have concentrations above their respective PCVs in the Minworth WwRC final effluent, however, were below PCVs in-canal at Site 6 (GUC at Grove, Leighton Buzzard). While it is beyond the scope of this report to infer if an instream PCV exceedance would occur at Site 6 if effluent discharge were re-directed into the GUC, these compounds of note should be subject to future analysis.

<sup>10</sup> Dark blue shading indicates PCV exceedance, maximum reported concentrations are shown.



- Bisphenol A
- Chlorate
- Chloride
- Chromium – total
- Clopyralid
- Mercury – total
- Nickel – bioavailable
- Nickel – total
- Propyzamide

Bisphenol A and chlorate measure above PCV at Minworth but below PCV at Site 6 noting the LoD for Bisphenol A is higher than the PCV. As such, concentrations in the canal cannot currently be accurately assessed against the discharge, however, values are assumed low at present. Chloride exceeds PCV concentration at Minworth with 100 mg/l on average while measuring 43.2 µg/l on average (max 75 µg/l) at Site 6. This suggests concentrations are well below the PCV of 250 µg/l but could be at risk of exceedance if a Minworth discharge were introduced. Chlorite by contrast exceeds PCV at Site 6 measuring 15 µg/l. Chromium (total) exceeds PCV at Minworth WwRC while measuring a maximum of 15 µg/l at Site 6. This is below the PCV of 50 µg/l. Concentrations in the canal could be at risk of exceedance following introduction of a Minworth discharge given the PCV is exceeded by a significant margin. Clopyralid exceeds PCV (0.1 µg/l) by a small margin measuring 0.19 µg/l at Minworth WwRC while being well below PCV at Site 6 (0.03 µg/l). There may be some risk to in-canal concentrations from a Minworth discharge. Mercury (total) at Site 6 is only slightly below the PCV of 1 µg/l (mean = 0.7 µg/l). This substance may be at risk of PCV exceedance following the introduction of a Minworth discharge given the high discharge concentrations. Mean concentrations of nickel (total and dissolved) are both close to exceeding the PCV of 20 µg/l at Site 6. Consequently, these substances are highly likely to exceed PCV following a Minworth discharge. Mean concentrations of propyzamide are similar at Minworth WwRC and Site 6 but do exceed PCV at Minworth WwRC. There is moderate risk to the propyzamide PCV being breached at Site 6 following a Minworth discharge. These substances may be influenced at Site 6 with the addition of the Minworth discharge and as such, in the absence of additional treatment at Minworth WwRC, these substances may require additional treatment following abstraction.



# CONCLUSIONS



## 4. Conclusions

At present, the following determinands demonstrated the greatest number of AA EQS exceedances on an individual sample basis across all sampling rounds to date and post a potential risk at the discharge location:

- **Minworth WwRC** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - ANC (a total of 27 individual occurrences)
  - Benzo(a)pyrene (a total of 40 individual occurrences)
  - BOD - 5-day (a total of 5 individual occurrences)
  - Dissolved Oxygen (a total of 24 individual occurrences)
  - Cypermethrin (a total of 27 individual occurrences)
  - PFOS (a total of 44 individual occurrences)
  - SRP (a total of 30 individual occurrences)
  - Sulphide or hydrogen sulphide (a total of 15 individual occurrences)
  - Zinc – bioavailable
  
- **GUC**
  - ANC (10 sites, a total of 187 individual occurrences)
  - Benzo(a)pyrene (10 sites, a total of 198 individual occurrences)
  - BOD - 5-day (6 sites, a total of 33 individual occurrences)
  - Dissolved Oxygen (6 sites, a total of 49 individual occurrences)
  - Fluoranthene (10 sites, a total of 164 individual occurrences)
  - PFOS (10 sites, a total of 179 individual occurrences)
  - SRP (7 sites, a total of 94 individual occurrences)
  - Sulphide or hydrogen sulphide (10 sites, a total of 140 individual occurrences)

In addition, the following determinands exceeded WFD / EQSD MAC values:

- **Minworth WwRC** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - Sulphide or hydrogen sulphide (total individual exceedances = 15)
  - Bromine - total residual oxidant (total individual exceedances = 27)
  - Nickel - dissolved (total individual exceedances = 2)
  - Cypermethrin (total individual exceedances = 5)
  - Formaldehyde (total individual exceedances = 1)
  - Mercury - dissolved (total individual exceedances = 2)
  - Mercury - total (total individual exceedances = 2)
  - Triphenyltin compounds (as triphenyltin cation) (total individual exceedances = 2)
  - Maneb (total individual exceedances = 1)
  
- **GUC**
  - Benzo(a)pyrene (total individual exceedances = 55)
  - Benzo(b)fluoranthene (total individual exceedances = 8)



- Benzo(g,h,i)perylene (total individual exceedances = 15)
- Benzo(k)fluoranthene (total individual exceedances = 3)
- Cadmium total (total individual exceedances = 2)
- Cadmium dissolved (total individual exceedances = 2)
- Sulphide or hydrogen sulphide (total individual exceedances = 135)
- Bromine - total residual oxidant (total individual exceedances = 27)
- Nickel - dissolved (total individual exceedances = 16)
- Cypermethrin (total individual exceedances = 11)
- Mercury - dissolved (total individual exceedances = 15)
- Mercury - total (total individual exceedances = 18)
- Triphenyltin compounds (as triphenyltin cation) (total individual exceedances = 2)

Some concentrations in the Minworth WwRC effluent were greater than the EQS in the receiving water at Site 3, Coventry Canal, Atherstone (noting these standards do not directly apply to effluent and discharge standards are set through the permitting regime). These include chlorothalonil (an organic fungicide), cypermethrin (a synthetic pyrethroid), diazinon, formaldehyde, and dissolved oxygen. It should be noted that cypermethrin exceeds the annual average EQS at all other canal sites as of this quarter. As a result, if Minworth WwRC final effluent was diverted to the example discharge location without additional treatment applied, additional in-canal exceedances may occur, resulting in a future WFD compliance risk as the new discharge would prevent the water quality of the receiving body from achieving Good Status. Cadmium – dissolved, while exceeding the annual average EQS last quarter, no longer exceeds due to low concentrations this quarter. Maneb (a fungicide), was identified above the MAC EQS at Site 1 (Minworth WwRC) but did not exceed the annual average. Further assessment is required to determine the level of confidence if this is indeed the case (e.g., through modelling or pairwise assessment of samples). Treatment or other removal at works will be required in order to provide a resolution to this issue.

Minworth WwRC treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of these 'high risk' compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permitting risk (e.g., due to within class deterioration).

As discussed in Section 3.1.2.2, PCVs apply only to treated drinking water, and not raw source waters. However, the monitoring of these determinands and regular comparison with drinking water standards enables a threshold for screening out determinands that may be considerably elevated in raw water, thus helping to inform treatment design at the example abstraction location. With that in mind, the following determinands are currently routinely exceeding PCV targets at Site 6.

- Benzo(a)pyrene (total exceedances = 17)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 21)
- *Escherichia coli* (*E. coli*, total exceedances = 20)
- Iron - total (total exceedances = 22)
- Nitrite (total exceedances = 10)
- Turbidity (total exceedances = 21)

*C. perfringens* exceeded PCV values at both sites as it is widely distributed across the environment and as such, is regularly evaluated to monitor the microbiological safety of drinking water supplies. Sources of bacterial contamination can range from the input of animal manures from farmyard runoff to discharge from untreated or treated sewage effluent. *Cryptosporidium* was not detected at any site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores or localised disturbance events.

All sensor data is within ranges typical of freshwater environments a spring summer period. Temperatures steadily increased across all sites. Rainfall events appear to have driven several peaks in ammonium concentration at Site 1 (Minworth WwRC). Concentrations during these events were very high. Turbidity also appears driven by rainfall at Site 1 and Site 3 with clear peaks following rainfall events. Site 16 shows little response to rainfall suggesting limited hydrological connectivity to the surrounding catchment at this location in the canal. Algal blooms appear to be occurring at Site 6 from early June indicated by a reduction in average dissolved oxygen saturation and a strong diurnal pattern. A similar result is observed at Site 16 however dissolved oxygen currently remains higher on average.

With respect to WFD EQS, in the upper GUC chloronathonil, cypermethrin, diazinon, dissolved oxygen, formaldehyde, permethrin and SRP are the substances most at risk. For the middle and lower sections zinc bioavailable is at risk. SRP is only at risk in the middle section as this regularly exceeds EQS in the lower section however exceedances in the middle section are becoming more common.

With respect to PCVs, the following substances are potentially at risk from the Minworth discharge to the GUC:

- Bisphenol A
- Chlorate
- Chloride
- Chromium total
- Clopyralid
- Mercury - total
- Nickel - bioavailable
- Nickel - total
- Propyzamide

## 4.1 Next steps

We will continue to analyse water quality data collected as part of the GUC water quality monitoring programme which will continue through to November 2024. As part of this process, we will continue providing quarterly updates which will be communicated to the GUC project team and the Minworth WwRC and abstraction treatment engineers to understand the feasibility of designing treatment for any 'high risk' compounds. We will also work with the team to identify any changes that may be required to the monitoring programme i.e., the addition or removal of sites and/or parameters.

Our water quality analysis will continue to investigate environmental and drinking water risks, comparing results to individual EQS and PCVs, and where these do not exist (and where possible) Predicted No-Effect Concentrations (PNECs). Our analysis will also continue to investigate whether there is a potential risk of water quality deterioration by comparing Minworth WwRC final effluent with canal sites.

We will also update the drinking water quality risk assessment for Gate 3 following the All Company Working Group (ACWG) methodology. This was previously undertaken for Gate 1 and subsequently updated for Gate 2, with the caveat that this assessment is based on raw water before treatment, so PCV breaches are expected.

Lastly, we will undertake a new assessment of all determinands by hydrological year (October to September) to assess annual average exceedances against appropriate time scales to facilitate a comparison between years.



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# Gate 3 Water Quality Monitoring: Quarter 6 Results

Severn Trent, Affinity Water and Canal & River  
Trust

18 December 2023

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# GRAND UNION CANAL STRATEGIC RESOURCE OPTION

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| Document reference:<br>Revision | Purpose description                              | Originated | Checked | Reviewed | Authorised | Date       |
|---------------------------------|--|------------|---------|----------|------------|------------|
| 1.0                             | Draft for client review                          |            |         |          |            | 18/12/2023 |
| 2.0                             | Revision following 1st line comments             |            |         |          |            | 22/02/2024 |
| 3.0                             | Revision following 2 <sup>nd</sup> line comments |            |         |          |            | 24/04/2024 |
| 4.0                             | Final following SPAG check                       |            |         |          |            | 28/10/2024 |
| 5.0                             | Final following 3 <sup>rd</sup> line assurance   |            |         |          |            | 08/01/2024 |

## Client signoff

|                              |  |
|------------------------------|--|
| <b>Client</b>                | Severn Trent, Affinity Water and Canal & River Trust |
| <b>Project</b>               | Grand Union Canal Strategic Resource Option          |
| <b>Job number</b>            | 5222090  |
| <b>Client signature/date</b> |  |



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# INTRODUCTION



# 1. Introduction

## 1.1 Purpose of this document

The purpose of this document is to provide an update of data collected over the monitoring period spanning July to September 2023, and where available, set these data in the context of longer-term monitoring data collected to date. Data collection for the Grand Union Canal (GUC) Strategic Resource Option (SRO) is ongoing. This report provides stakeholders an update on the data, as it is collected and draws comparisons, when possible, to environmental, and drinking water standards.

**Key changes in spot and continuous data observed in-quarter are highlighted in callouts for clarity.**



# METHODOLOGY



## 2. Methodology

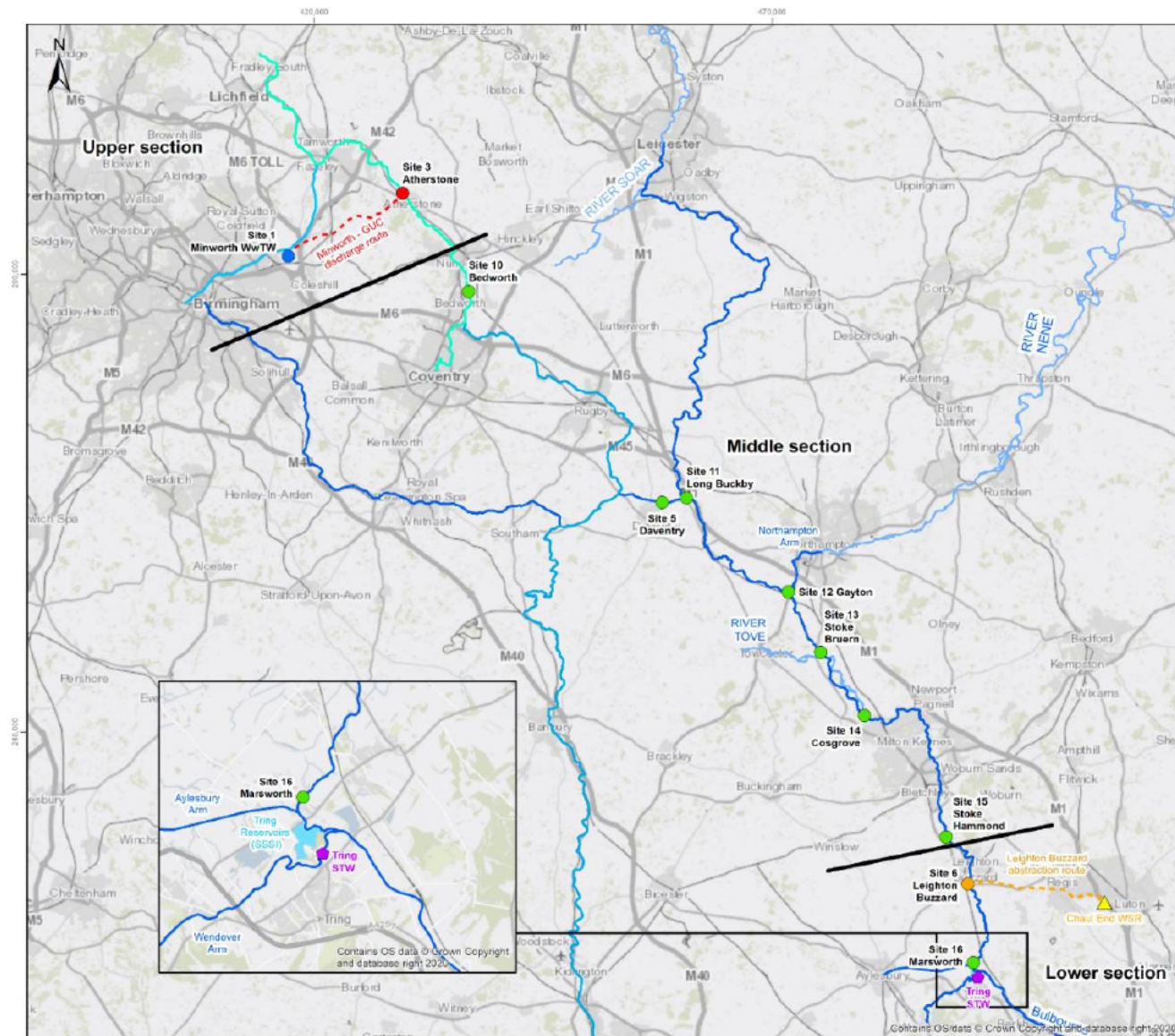
### 2.1 Site locations

#### Key changes to site locations.

There were no changes to the monitoring site locations this quarter.

For the purpose of conceptualising the monitoring programme, the GUC network has been split into three main geographical sections. An overview map of the upper, middle, and lower section (Figure 2-1) is supplied below. The three main geographical areas are summarised below:

- **Upper section** – Covering the discharge from Minworth to the example discharge location (Coventry Canal at Atherstone).
- **Middle section** – GUC from the Braunston Junction to the Aylesbury Arm (Marsworth, North of Tring).
- **Lower section** – GUC from the Aylesbury Arm to Hanwell, London. This section includes the example abstraction location (GUC at Grove Lock, Leighton Buzzard).



### Grand Union Canal WQ monitoring locations

**Legend**

**Water Quality Monitoring Locations**

- Source - Minworth WwTW Final Effluent
- Discharge Location
- Abstraction Location
- WQ Monitoring Location
- - - Potential Abstraction Route
- - - Potential Discharge Route
- ▲ Water Storage Reservoirs
- Sewage Treatment Works

**Watercourses**

- Grand Union Canal
- Birmingham & Fazeley Canal
- Coventry Canal
- Oxford Canal
- Interacting Main Rivers

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Data sources: Environment Agency, Ordnance Survey

0 30 60 120 180 240 300 Km  
Scale (at A3): 1:400,000

**BEVERAN** **AffinityWater**  
TRENT taking care of your water

**Canal & River Trust**  
making rivers and canals work

**ATKINS**  
member of the BOC Group

|                    |                                    |          |                        |
|--------------------|------------------------------------|----------|------------------------|
| Status: S1         | Purpose of issue: For Coordination | Rev: 2.0 | Model File Identifier: |
| Reference: 5204564 | [Redacted]                         |          |                        |

Westgate Grove, Ashley Road, Epsom, Surrey, KT16 5BW  
www.atkinsglobal.com

Figure 2-1 Key elements/ reaches of the GUC scheme (black lines notate the upper, middle and lower sections)

Author names redacted



## 2.2 Monitoring, sampling and analysis procedures

### Key changes to monitoring programme.

There were no changes to the monitoring programme this quarter. Data were downloaded for all monitoring sondes for all parameters. Data added in the most recent summary report covers the period July – September 2023.

### 2.2.1 Spot water quality sampling

Spot water quality samples were taken in line with the programme and operating procedures outlined in the GUC Gate 3 Water Quality Monitoring report. No sites or samples were omitted due to access or safety issues this quarter.

The samples for the July 2023 round were taken on 10<sup>th</sup> July 2023.

The samples for the August 2023 round were taken on 14<sup>th</sup> August 2023.

The samples for the September 2023 round were taken on 11<sup>th</sup> September 2023.

The analysis suites selected for analysis are based on 4 key legislative and design drivers. These include:

- **Environmental risks as required by the Water Framework Directive (WFD)** (WFD Suite).
- **Environmental permitting risks as required by the Environmental Quality Standards Directive (EQSD)** (EQSD suite).
- **Drinking Water risks as required by DWI (Drinking Water Inspectorate)** (Drinking water suite).
- **Emerging substances** (Emerging substances suite).

### 2.2.2 Rainfall data

Rainfall data were available from the Environment Agency (EA) for multiple locations along the GUC covering most of the monitoring period. For the Upper GUC, data have been compared to Lea Marston gauge (Station ID: 096781), for the Middle reach of the GUC, data have been compared to Quinton rain gauge (EA Station ID: 170945), and for the Lower GUC data from Dancers End Reservoir have been used (EA Station ID: 261602). Data for all gauges for this quarter were only available from 1<sup>st</sup> July 2023 to 30<sup>th</sup> September 2023.

# RESULTS



## 3. Results

### 3.1 Spot sample environmental quality standards comparison

#### Notable concentration changes in the last quarter (July 2023 - September 2023).

- Benzo(g,h,i)perylene identified as exceeding MAC EQS this quarter at Site 1 (Minworth WwRC) for the first time.

Other substances which frequently exceed EQS have seen the following changes this quarter:

- Dissolved oxygen fell below the 10<sup>th</sup> percentile at Site 6 (Grove Lock, Leighton Buzzard).
- Benzo(a)pyrene exceeded MAC EQS at Sites 10 (Bedworth), 12 (Gayton), 14 (Cosgrove), 15 (Stoke Hammond), 6 (Grove Lock, Leighton Buzzard) and 16 (Marsworth).
- Benzo(g,h,i)perylene exceeded MAC EQS at Site 1 (Minworth WwRC) and 6 (Grove Lock, Leighton Buzzard).
- Benzo(b)fluoranthene and Benzo(k)fluoranthene exceeded MAC EQS at Site 6 (Grove Lock, Leighton Buzzard) only.
- Bromine - total residual oxidant exceeded MAC EQS at Site 1 (Minworth WwRC) and 3 (Coventry Canal at Atherstone).
- Cypermethrin exceeded the MAC EQS at Sites 15 (Stoke Hammond), 6 (Grove Lock, Leighton Buzzard) and 16 (Marsworth).
- Sulphide or hydrogen sulphide Exceeded MAC EQS as Sites 10 (Bedworth), 5 (Daventry), 11 (Long Buckby), 14 (Cosgrove), 15 (Stoke Hammond) and 16 (Marsworth).

#### 3.1.1 Overview

In order to determine parameters of risk, values have been compared against the relevant Environmental Quality Standard (EQS) as detailed by the 2015 WFD Directions and the EA Surface Water Pollution Risk Assessment Parameters EQSD<sup>1</sup>. It is important to note that standards or condition limits for certain parameters under the WFD (e.g., dissolved oxygen, BOD, ammoniacal nitrogen, and ANC), are determined by categorising the water body by type, dependent on its altitude and alkalinity. ANC standards are determined by annual mean dissolved organic carbon concentrations. In addition, soluble reactive phosphorus (SRP) standards are determined by the water body's altitude and alkalinity, cadmium standards are determined by categorising the water body, by type, dependent on the hardness of the water, and zinc standards are determined by the ambient background concentration (ABC) of dissolved zinc. EA site specific standards (where available) were used (e.g. SRP), Where these were not available, site-specific standards have been calculated using the available data.

Whilst we have used site-specific EQS or WFD Good standards for the Minworth WwRC final effluent for indicative purposes, it is important to note that these standards should not be routinely applied to final effluent samples as they are in-river standards (these standards do not directly apply to effluent

---

<sup>1</sup> EA Guidance. Environmental Quality Standards Directive (EQSD) list for WFD assessments. Published 15 December 2016

and discharge standards are set through the permitting regime). It is also important to note that all data on record are considered when comparing against the environmental standards which are applied, under a formal assessment, as Annual Averages (AA), Maximum Allowable Concentrations (MAC), or specified percentiles. Compliance statistics can only be undertaken by the Environment Agency using data from a single calendar year. Samples at the limit of detection were included in the analysis and used at face value to adhere to discharge permitting assessment guidance. Any significant outliers were removed from the analysis.

Based on the available data across all sites, there have been a total of 109 EQS exceedances. A discussion of exceedances along with source water and canal section comparisons can be found in sections 3.1.2 and 3.1.3.

## 3.1.2 Exceedances to date

A list of all compounds that exceeded the quoted EQS split by site are presented in Table 3-1. Maximum allowable concentration (MAC) values were examined separately and have been applied to individual results and not mean or percentile data.

Two polycyclic aromatic hydrocarbons (PAH), benzo(a)pyrene and fluoranthene, exceeded at all of the eleven sites with the exception of fluoranthene at Minworth WwRC, the mean concentration of which is below the stated EQS (mean concentration = 0.00283 µg/l, EQS = 0.0063 µg/l). These substances are commonly found in fuels and oils and commonly associated with combustion. For Biochemical Oxygen Demand (BOD) there were no exceedances this quarter.

Elevated PFOS concentrations also resulted in AA EQS exceedances at ten of the eleven sites (excluding Site 10) this quarter, with Soluble Reactive Phosphorus (SRP) also exceeding EQS values at Minworth WwRC, Site 12, 13, 6 and 16. It should be noted that sediment laden waterbodies can have internal loading of phosphorus which is able to flux into solution under low oxygen conditions.

Bromine (total residual oxidant) resulted in EQS exceedances at Sites 1 and 3 by several orders of magnitude, note bromine is only measured at these two sites as part of the EQSD analysis suite.

Lastly, low 10<sup>th</sup> percentile dissolved oxygen saturation values resulted in EQS exceedances at seven sites this quarter (Sites 1, 3, 5, 6, 10, 14 and 16). Site 1 (Minworth WwRC) was below the dissolved oxygen standard in all samples, noting this is sewage effluent and the EQS does not directly apply, whereas Sites 5, 6, 10 and 14 are canal sites with lower dissolved oxygen observed more frequently in summer at these sites. This is likely driven by the waters temperature, which reduces water's ability to hold oxygen, combined with increases in algal activity which may be resulting in temporary oxygen drawdowns during the daytime.

Table 3-2 shows the data as it corresponds to the test statistics for all compounds in exceedance of the EQS. Like Table 3-1, this table indicates overall EQS exceedances as well as new exceedances occurring this quarter. This table allows identification of compounds that may exceed EQS if the final effluent from Minworth WwRC were discharged into the GUC without additional treatment. This may result in a future WFD compliance risk as the new discharge may result in a deterioration of instream quality and may prevent the water quality of the receiving body from achieving Good Status in the future. Compounds that exceed AA EQS at Minworth WwRC with no comparable exceedance instream include chlorothalonil (organic fungicide), cypermethrin (synthetic pyrethroid), permethrin (insecticide), and zinc (bioavailable). The exceedance of permethrin is largely due to the observed concentration being less than the limit of detection (<LoD; 0.001 µg/l) on all occasions with the exception of one exceedance (exceedance concentration = 0.002 µg/l observed on 19/07/2021).

In total there were 395 instances of MAC exceedances across all sites. Overall, four PAHs (i.e. benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene) accounted for 100 (25%) of these exceedances. Bromine (total residual oxidant) accounted for 67 exceedances

in the 'upper GUC', Sites 1 and 3. Sulphate (or hydrogen sulphide) exceeded MAC values on 153 occasions. A list of total exceedances split by compound can be seen in Table 3-3.



Table 3-1 Number of EQS (WFD and EQSD) exceedances <sup>2, 3</sup>.

| Compound                         | Standard | Unit | Statistic <sup>+</sup> | Upper GUC      |           | Middle GUC |           |           |           |           |           |           | Lower GUC       |           |
|----------------------------------|----------|------|------------------------|----------------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------------|-----------|
|                                  |          |      |                        | Source         | Discharge | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Abstraction     | Site 16   |
| Acid neutralisation capacity     | 40       | mg/l | AA                     | 30*            | 31*       | 18         | 31        | 18        | 15        | 18        | 18        | 18        | 30              | 17        |
| Benzo(a)pyrene                   | 0.00017  | µg/l | AA                     | 43             | 42        | 18         | 32        | 18        | 15        | 18        | 18        | 18        | 32              | 18        |
| BOD (5 day)                      | *        | mg/l | 90 <sup>th</sup>       | 5              | 5         | 1          | 6         | 1         | 0         | 0         | 2         | 4         | 9               | 4         |
| Bromine                          | 0.002    | mg/l | AA                     | 30             | 30*       |            |           |           |           |           |           |           |                 |           |
| Cadmium - total                  | 0.25     | µg/l | AA                     | 0              | 16        | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| Chlorothalonil                   | 0.035    | µg/l | AA                     | 1              | 0         |            |           |           |           |           |           |           |                 |           |
| Cobalt – dissolved               | 3        | µg/l | AA                     | 0              | 21*       |            |           |           |           |           |           |           |                 |           |
| Cypermethrin                     | 0.00008  | µg/l | AA                     | 33             | 5         | 4          | 2         | 2         | 3         | 3         | 9         | 10        | 12              | 10        |
| Diazinon                         | 0.01     | µg/l | AA                     | 2              | 0         |            |           |           |           |           |           |           | 0               |           |
| Dissolved oxygen                 | *        | %    | 10 <sup>th</sup>       | 5              | 8         | 8          | 10        | 5         | 1         | 0         | 6         | 2         | 6               | 3         |
| Fluoranthene                     | 0.0063   | µg/l | AA                     | 2              | 36        | 17         | 12        | 16        | 11        | 16        | 17        | 18        | 29              | 18        |
| Formaldehyde                     | 0.25     | µg/l | AA                     | 1              | 0         |            |           |           |           |           |           |           |                 |           |
| Manganese – bioavailable**       | 123      | µg/l | AA                     | 0 <sup>#</sup> | 37        | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0 <sup>##</sup> | 0         |
| Nickel - bioavailable**          | 4        | µg/l | AA                     | 4              | 29        | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| Perfluorooctane sulfonic acid    | 0.00065  | µg/l | AA                     | 50             | 42        | 17         | 31        | 17        | 13        | 17        | 17        | 14        | 25              | 17        |
| Permethrin                       | 0.001    | µg/l | AA                     | 19*            | 1         |            |           |           |           |           |           |           |                 |           |
| Soluble reactive phosphorus      | *        | µg/l | AA                     | 32             | 5         | 16         | 12        | 5         | 4         | 13        | 9         | 1         | 26              | 16        |
| Sulphide or hydrogen sulphide    | 0.25     | mg/l | AA                     | 15             | 25        | 11         | 15        | 13        | 9         | 13        | 11        | 11        | 20              | 10        |
| Total anions                     | 250      | µg/l | AA                     | 10*            | 20*       |            |           |           |           |           |           |           | 1               |           |
| Tributyltin compounds            | 0.0002   | mg/l | AA                     | 1              | 3         | 3          | 1         | 1         | 9         | 0         | 17        | 1         | 2               | 1         |
| Zinc - bioavailable**            | *        | µg/l | AA                     | 15             | 14        | 2          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| Cadmium dissolved                | 0.25     | µg/l | AA                     | 0              | 4         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| di(2-ethylhexyl)phthalate (DEHP) | 1.3      | µg/l | AA                     | 1              | 1         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 1               | 1         |
| <b>Total number of samples</b>   | -        | -    | -                      | <b>43</b>      | <b>31</b> | <b>18</b>  | <b>31</b> | <b>18</b> | <b>18</b> | <b>18</b> | <b>18</b> | <b>18</b> | <b>31</b>       | <b>18</b> |

<sup>+</sup>AA = Annual Average. Numbers of exceedances are shown for illustrative purposes only and reflect individual samples being compared to an AA or percentile derived EQS.

\* Site specific EQS determined. \*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT) <sup>4</sup>.

<sup>#</sup> Total number of samples collected = 31 (not included in Phase 1 dataset). <sup>##</sup> Drinking water suite parameters added to this site in October 2021 so total number of samples = 24.

<sup>2</sup> Blue shading indicates EQS (WFD and EQSD) exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites.

The count of individual EQS exceedances is also given.

<sup>3</sup> Values in orange indicate the addition of new individual exceedances this quarter.

<sup>4</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktag](#)



Table 3-2 Concentrations of compounds responsible for EQS (WFD and EQSD) exceedance<sup>5</sup>.

| Compound                         | Standard | Unit | Stat*            | Upper GUC |           | Middle GUC |           |           |           |           |           |           | Lower GUC   |           |
|----------------------------------|----------|------|------------------|-----------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-----------|
|                                  |          |      |                  | Source    | Discharge | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Abstraction | Site 16   |
|                                  |          |      |                  | Site 1    | Site 3    |            |           |           |           |           |           |           | Site 6      |           |
| Acid neutralisation capacity     | 40       | mg/l | AA               | 1700      | 2284      | 2922       | 2644      | 3617      | 3383      | 3811      | 3189      | 2683      | 3181        | 2700      |
| Benzo(a)pyrene                   | 0.00017  | µg/l | AA               | 0.0020    | 0.015     | 0.05937    | 0.0057    | 0.018     | 0.016     | 0.020     | 0.030     | 0.038     | 0.023       | 0.027     |
| BOD (5 day)                      | *        | mg/l | 90 <sup>th</sup> | 2.68      | 2.78      | 2.83       | 3.09      | 2.65      | 2.34      | 2.44      | 4.48      | 4.34      | 4.23        | 3.13      |
| Bromine                          | 0.002    | mg/l | AA               | 0.204     | 1.51      |            |           |           |           |           |           |           |             |           |
| Cadmium - total                  | 0.25     | µg/l | AA               | 0.0236    | 0.41      | 0.0589     | 0.0253    | 0.0200    | 0.0172    | 0.0200    | 0.022     | 0.032     | 0.036       | 0.0200    |
| Chlorothalonil                   | 0.035    | µg/l | AA               | 0.0452    | 0.035     |            |           |           |           |           |           |           |             |           |
| Cobalt - dissolved               | 3        | µg/l | AA               | 1.64      | 13.0      |            |           |           |           |           |           |           | 0.3         |           |
| Cypermethrin                     | 0.00008  | µg/l | AA               | 0.00026   | 0.000071  | 0.000088   | 0.000081  | 0.000148  | 0.000225  | 0.00015   | 0.00019   | 0.00028   | 0.00016     | 0.00031   |
| Diazinon                         | 0.01     | µg/l | AA               | 0.0106    | 0.0100    |            |           |           |           |           |           |           | 0.0100      |           |
| Dissolved oxygen                 | *        | %    | 10 <sup>th</sup> | 47.20     | 70.64     | 37.67      | 60.35     | 58.38     | 52.23     | 72.28     | 57.82     | 80.66     | 74.70       | 79.84     |
| Fluoranthene                     | 0.0063   | µg/l | AA               | 0.0029    | 0.017     | 0.026      | 0.0064    | 0.017     | 0.0091    | 0.012     | 0.016     | 0.027     | 0.018       | 0.026     |
| Formaldehyde                     | 5        | µg/l | AA               | 51.00     | 50.00     |            |           |           |           |           |           |           |             |           |
| Manganese - bioavailable**       | 123      | µg/l | AA               | 10.3      | 1599      |            |           |           |           |           |           |           | 10          |           |
| Nickel - bioavailable**          | 4        | µg/l | AA               | 2.9       | 9.9       | 0.63       | 0.80      | 0.41      | 0.76      | 0.53      | 0.58      | 0.72      | 0.60        | 0.55      |
| Perfluorooctane sulfonic acid    | 0.00065  | µg/l | AA               | 0.972     | 0.081     | 0.0050     | 0.0150    | 0.0080    | 0.0189    | 0.034     | 0.0091    | 0.0012    | 0.0500      | 0.0023    |
| Permethrin                       | 0.001    | µg/l | AA               | 0.0024    | 0.0010    |            |           |           |           |           |           |           |             |           |
| Soluble reactive phosphorus      | *        | µg/l | AA               | 0.34      | 0.10      | 0.117      | 0.093     | 0.050     | 0.047     | 0.11      | 0.084     | 0.028     | 0.163       | 0.19      |
| Sulphide or hydrogen sulphide    | 0.25     | mg/l | AA               | 10.64     | 15.43     | 16.89      | 14.63     | 17.44     | 17.00     | 20.11     | 19.06     | 17.50     | 24.47       | 17.22     |
| Total anions                     | 250      | µg/l | AA               | 229       | 367       |            |           |           |           |           |           |           | 177         |           |
| Tributyltin compounds            | 0.0002   | µg/l | AA               | 0.000095  | 0.000095  | 0.00018    | 0.000056  | 0.00010   | 0.00024   | 0.000056  | 0.00037   | 0.00013   | 0.00014     | 0.000081  |
| Zinc - bioavailable**            | *        | µg/l | AA               | 14.0      | 16.4      | 7.15       | 2.02      | 1.51      | 1.62      | 1.08      | 3.01      | 1.94      | 1.78        | 1.53      |
| Cadmium dissolved                | 0.25     | µg/l | AA               | 0.023     | 0.23      | 0.026      | 0.021     | 0.020     | 0.017     | 0.02      | 0.020     | 0.020     | 0.025       | 0.020     |
| di(2-ethylhexyl)phthalate (DEHP) | 1.3      | µg/l | AA               | 0.25      | 0.26      | 0.18       | 0.16      | 0.15      | 0.13      | 0.15      | 0.150     | 0.15      | 0.19        | 1.48      |
| <b>Total number of samples</b>   | -        | -    | -                | <b>43</b> | <b>31</b> | <b>18</b>  | <b>31</b> | <b>18</b> | <b>18</b> | <b>18</b> | <b>18</b> | <b>18</b> | <b>31</b>   | <b>18</b> |

\*AA = Annual Average.

\* Site specific EQS determined

\*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT)<sup>6</sup>.

<sup>5</sup> Blue shading indicates EQS exceedance and grey shading indicates where failures relate to EQSD target compounds (not monitored at all sites, and as such not directly comparable across all sites). Concentrations corresponding to test statistic are also shown.

<sup>6</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktag](#)



Table 3-3 Compounds responsible for WFD and EQSD MAC exceedances<sup>7</sup>.

| Compound                         | Standard | Unit                 | Statistic | Upper GUC       |           | Middle GUC |           |           |           |           |           |           | Lower GUC        |           |
|----------------------------------|----------|----------------------|-----------|-----------------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|------------------|-----------|
|                                  |          |                      |           | Source          | Discharge | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Abstraction      |           |
|                                  |          |                      |           | Site 1          | Site 3    |            |           |           |           |           |           |           | Site 6           | Site 16   |
| Benzo(a)pyrene                   | 0.027    | µg/l                 | MAC       | 0               | 6         | 14         | 1         | 2         | 2         | 5         | 10        | 10        | 10               | 7         |
| Benzo(b)fluoranthene*            | 0.017    | µg/l                 | MAC       | 0               |           |            |           |           |           |           |           |           | 10 <sup>##</sup> |           |
| Benzo(g,h,i)perylene*            | 0.0082   | µg/l                 | MAC       | 1               |           |            |           |           |           |           |           |           | 18 <sup>##</sup> |           |
| Benzo(k)fluoranthene*            | 0.017    | µg/l                 | MAC       | 0               |           |            |           |           |           |           |           |           | 4 <sup>##</sup>  |           |
| Bromine - total residual oxidant | 0.005    | mg/l                 | MAC       | 30 <sup>#</sup> | 30        |            | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Cadmium - dissolved              | 1.5      | µg/l                 | MAC       | 0               | 2         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Cadmium - total                  | 1.5      | µg/l                 | MAC       | 0               | 2         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Cypermethrin                     | 0.0006   | µg/l                 | MAC       | 5               | 0         | 0          | 0         | 1         | 2         | 2         | 1         | 2         | 1                | 2         |
| Formaldehyde                     | 50       | µg/l                 | MAC       | 1               | 0         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Mercury - dissolved              | 0.07     | µg/l                 | MAC       | 2               | 1         | 2          | 1         | 2         | 1         | 1         | 2         | 1         | 2                | 2         |
| Mercury - total                  | 0.07     | µg/l                 | MAC       | 2               | 2         | 2          | 2         | 2         | 1         | 1         | 2         | 2         | 2                | 2         |
| Nickel - dissolved               | 34       | µg/l                 | MAC       | 2               | 16        | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Sulphide or hydrogen sulphide    | 1        | µg/l                 | MAC       | 15              | 25        | 11         | 15        | 13        | 9         | 13        | 11        | 11        | 20               | 10        |
| Tributyltin compounds            | 0.02     | µg/l                 | MAC       | 2               | 2         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Maneb                            | 30       | µg/l CS <sub>2</sub> | MAC       | 1               | 0         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| <b>Total number of samples</b>   | -        | -                    | -         | <b>43</b>       | <b>31</b> | <b>18</b>  | <b>31</b> | <b>18</b> | <b>18</b> | <b>18</b> | <b>18</b> | <b>18</b> | <b>31</b>        | <b>18</b> |

\* While these determinands have a MAC, as per the WFD there is no corresponding AA statistic as benzo(a)pyrene should be considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water.

# Total number of samples collected = 31 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 24.

<sup>7</sup> Blue shading indicates MAC EQS exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of exceedances also given.



### 3.1.3 Source water and canal section comparisons

In this section the quality of treated effluent discharged from Minworth WwRC is directly compared with all respective sections of the GUC. The key changes identified this quarter are discussed below.

#### 3.1.3.1 Minworth vs. GUC Upper Section (Site 3)

The majority of substances which exceeded the EQS at Minworth also exceed at Site 3, the example discharge location (Atherstone). Exceptions include chlorothalonil, cypermethrin, dissolved oxygen, diazinon and formaldehyde which do not exceed AA EQS at Site 3. This suggests these parameters may be at increased risk of EQS exceedance in-canal if discharge from Minworth is received without additional treatment. While permethrin and SRP have exceeded EQS on occasion, these occur more frequently in the Minworth WwRC final effluent suggesting EQS failures would become more likely without additional treatment. It is noted that EQS failures for SRP may be linked to phosphorus loading in canal sediments which under different oxygen saturation conditions can flux in and out of solution causing the exceedance.

By contrast, cobalt - dissolved, fluoranthene, manganese and nickel (bioavailable), sulphide or hydrogen sulphide, total anions and cadmium - total exceed EQS at Site 3 with no exceedances observed in the Minworth WwRC final effluent, suggesting a wider catchment source. It is understood a number of surface water outfalls are present on this section of canal. These is potential to isolate these sources however additional monitoring would be required to characterise these discharges.

Cadmium total, cobalt dissolved, manganese and nickel bioavailable and tributyltin compounds do not currently exceed in the Minworth WwRC discharge but do at Site 3. Concentrations of these substances may be reduced in the GUC following the introductions of a Minworth WwRC discharge.

#### 3.1.3.2 Minworth vs. GUC Middle Section (Sites 5, 10, 11, 12, 13, 14 and 15)

The following substances exceeded EQS in Minworth WwRC discharge but do not currently exceed EQS at any site in the middle section of the GUC:

- Zinc - bioavailable

The following substances exceed EQS in the Minworth WwRC discharge but are not currently monitored under the currently agreed monitoring suites in the Middle Section of the GUC:

- Bromine - total residual oxidant
- Chlorothalonil
- Cobalt - dissolved
- Formaldehyde
- Permethrin

These substances may be at risk of exceeding their respective EQS should a Minworth WwRC discharge be introduced in the Upper GUC depending on in-canal concentrations, however this is currently unknown due to lack of data. Sites 5, 14 and 15 are the only sites where BOD has exceeded the annual average EQS. SRP exceeds EQS at Sites 10, 5, 13 and 14. Given SRP has regularly exceeded EQS at these sites they are at risk from the introduction of Minworth discharge. Tributyltin (TBT) compounds continue to exceed EQS at the Middle GUC Sites 12 and 14 with new detections above EQS at Sites 10, 12 and 14. There were no additional detections at Minworth WwRC suggesting a wider catchment source. TBT was historically used as an antifouling agent in paints and binds strongly to sediments and bioaccumulates in biota. As such this may be present and easily



released in a canal when sediment is disturbed. It should be noted that concentrations of TBT in the Minworth WwRC discharge are lower than the GUC middle sites and may improve quality in the canal following its introduction.

### **3.1.3.3 Minworth vs. GUC Lower Section (Sites 6 and 16)**

Dissolved oxygen exceeded annual average EQS this quarter at Site 6. The following substances in the Minworth discharge do not currently exceed EQS at any site in the lower section:

- Diazinon
- Cadmium - total
- Tributyltin compounds
- Nickel – bioavailable
- Zinc – bioavailable

The following substances exceed EQS in the Minworth WwRC discharge but are not monitored in the Lower GUC:

- Bromine - total residual oxidant
- Chlorothalonil
- Formaldehyde
- Permethrin

These substances are most at risk from deterioration following the introduction of a Minworth WwRC discharge to the GUC, noting that for the second list, their current status in the GUC against WFD EQS is unknown due to lack of monitoring data. There were no substances identified as potentially improving following a Minworth WwRC discharge for this section of the canal. All determinands were higher at Minworth WwRC or had no data for comparison to the lower sections.



## 3.2 Continuous monitoring data

### Notable sonde changes in the last quarter (July 2023 – September 2023)

Below are key changes in the last quarter of data, these events are described in detail in subsequent section (3.2.1 to 3.2.7).

**Temperature** - Temperatures decreased during this period at all GUC sites as we moved from summer to autumn. Minworth WwRC temperatures were stable.

**Conductivity** - Reductions in conductivity were observed at Site 1 (Minworth WwRC) and Site 6 following most rainfall events.

**Dissolved Oxygen** – There were no notable changes to Dissolved oxygen saturation this quarter.

**pH** - No notable changes in quarter.

**Ammonium** – Ammonium peaked at Sites 1, 3 and 6 on 13<sup>th</sup> September measuring 11.7 mg/l at Site 1 (Minworth WwRC) and 1.1 mg/l at Sites 3 and 6. This coincides with rainfall events.

**Turbidity** – Peaks in turbidity at Site 1 (Minworth WwRC) are linked to known vegetation growth in channel, a resolution to this is being investigated.

**Chlorophyll** – Decreasing concentrations at Sites 6 from mid-September.

This section describes patterns observed in parameters monitored by the continuous sondes and highlights any noteworthy changes observed in the reporting period. Running means of continuous monitoring data along with a within quarter mean for each location and parameter are provided in Table 3-14. Symbols (increase '↑', decrease '↓' and no change '-') indicate the in-period mean relative to the long-term mean. The in quarter continuous sonde data collected can be seen for all sites in Figure 3-1 to Figure 3-43-4.

### 3.2.1 Temperature

Over the period of record temperatures typically range from 9-22°C in the Minworth discharge. By contrast the canal at Atherstone ranges from 4-23°C. Temperatures between Minworth and Atherstone are similar in summer months however the Minworth discharge is up to 8°C warmer than the canal in winter. As there is potentially a risk of a >3°C temperature increase in the receiving waterbody due to the temperature differences seen at this time of year, appropriate considerations must be made at the design stage to reduce potential impacts to fish<sup>8</sup>.

This quarter, temperatures were highest at Site 1 (Minworth WwRC) measuring 19.5°C. In the canal itself the highest temperature was Site 16 with 18.8°C and lowest at Site 3 with 17.8°C. Temperatures at Site 1 (Minworth WwRC) remained consistent across the monitoring period however in the GUC a decrease was observed at all sites from mid-September onwards as the seasons progressed from

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<sup>8</sup> The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 Part 1, Section 1 (6)

summer to early autumn. This quarter, temperatures at all sites were warmer on average than last quarter. All sites were the thresholds for fish stress.

### 3.2.2 Conductivity

Conductivity is a measure of the ability of a water body to conduct an electrical charge and reflects the concentration of ions in solution (e.g., sodium, calcium etc). Instream conductivity is primarily controlled by underlying geology. Temporary increases and reductions in conductivity can be observed in response to pulses of mineral-rich material from catchment sources (e.g., agricultural runoff). Conversely, instream reductions in conductivity can occur when rainfall runoff from the surrounding area results in an instream dilution. Long term increases in conductivity, above what would be considered typical for a particular catchment can be indicative of nutrient enrichment from the surrounding landscape from point (e.g., STW) or diffuse (e.g., agricultural) sources.

Conductivity on average was highest at Site 3 with  $872 \mu\text{S cm}^{-1}$  and lowest at Site 16 with  $492 \mu\text{S cm}^{-1}$ . The Minworth WwRC discharge measured  $742 \mu\text{S cm}^{-1}$ . There were two notable reductions in conductivity observed at all GUC Sites 3 and 6 on the 13<sup>th</sup> and 20<sup>th</sup> September following rainfall events.

### 3.2.3 Dissolved oxygen

Dissolved Oxygen (DO), typically reported in percent saturation (%) or concentration (mg/l) describes the amount of oxygen that is dissolved in water. It is essential for aquatic life, with low DO saturation resulting in anoxia and subsequent fish kills and is associated with the development of eutrophic conditions. The pattern of DO saturation in watercourses varies seasonally. A typically well aerated river or stream will have a DO % saturation of ~100%. Canals typically experience lower DO saturation than rivers. This is partly due to the slow flowing nature of canals and lack of natural aeration from turbulent water as it travels downstream. Diurnal variability is highest during the summer months driven largely by photosynthesis-respiration dynamics. DO can however, exceed 100% instream due to the presence of photosynthetic aquatic organisms.

This quarter, average dissolved oxygen saturation measured highest at Site 16 (97.0%) while measuring lowest at Site 1 (Minworth WwRC) at 53%. All sites were comparable to their long term means. A strong diurnal fluctuation is noted at all GUC sites indicating photosynthesis and respiration occurring which is more pronounced during summer months. Rainfall does not typically affect dissolved oxygen saturation at any site however in the absence of rainfall data this cannot be proven this quarter.

### 3.2.4 pH

The pH of a watercourse is a measure of how acidic or basic the water is. The pH is mainly driven by geology (and resultant soil type) however, can be influenced by catchment factors such as pollutant discharges and the leaching of soil horizons under differing flow conditions. As pH is recorded on a logarithmic scale, slight changes in pH can have significant impacts on the organisms that live in a watercourse. The optimum pH for water to sustain fish and invertebrate life, is between 6 to 9. Across all sites, pH was within acceptable limits for fish and invertebrates. It should be noted that pH at Minworth WwRC (6.7) is more acidic (lower) than the example discharge location at Site 3 (7.3). The example abstraction location at Site 6 as well as Site 16 are slightly more basic measuring 7.9 each. This suggests pH may increase along the proposed transfer route.



This quarter, all sites measured comparably to their long-term means. Mean pH was lowest in the Minworth WwRC discharge (Site 1) at 6.7. In the canal, Site 3 and 6 measured the lowest at 7.8 while highest at Site 16 with a pH of 7.9.

### 3.2.5 Ammonium

Ammonium is a type of nitrogenous compound that is naturally present in water but can also be released into rivers from a variety of sources, including agricultural runoff, sewage treatment and industrial wastewater discharges. High concentrations of ammonium in rivers can be harmful to aquatic life, particularly fish, as it can disrupt their metabolism and respiration. In some cases, it can even be fatal. Ammonium can also contribute to the formation of algal blooms, which can further degrade water quality and make it unsafe for drinking, swimming, and fishing. Average ammonium concentrations were highest at Site 1 (Minworth WwRC) and lowest at the example discharge location (Site 3 Atherstone).

Ammonium peaked at Sites 1, 3 and 6 on 13<sup>th</sup> September measuring, on average, 11.7 mg/l at Site 1 (Minworth WwRC) and 1.1 mg/l at Sites 3 and 6. This may have been in response to rainfall however this cannot be confirmed in the absence of rainfall data. When compared to laboratory derived concentrations, in-situ measurements of ammonium commonly over record ammonium concentrations. As such, it is important to use these data to infer catchment trends rather than absolute concentrations.

### 3.2.6 Turbidity

Turbidity is a measure of how cloudy water is and can be used as a proxy for suspended sediment concentrations. It is caused by the presence of suspended particles in the water, such as sediment, algae, or other organic matter. Turbidity can make it difficult for sunlight to penetrate the water, which can reduce the amount of photosynthesis that takes place. A high loading of suspended sediment, when combined with reduced flow velocities can result in sediment deposition causing damage to macrophytes and reducing hydrological exchanges with river bed and surrounding groundwater. Increased sediment loading can result in the unintended substance transport. For example, the dominant form of phosphorus exported from agricultural systems is particulate phosphorus, which when exported from the terrestrial to aquatic systems has the potential to desorb and become available to in stream heterotrophic organisms.

Increases in turbidity can be caused by a number of factors, including erosion, runoff from agricultural fields following poor land and soil management practises, stormwater runoff and point source pollution, such as from sewage treatment plants. Turbidity values are typically highest at Site 1 (Minworth WwRC) measuring 102.2 NTU on average. At the example discharge location (Site 3), the average is 16.7 NTU. This sensor was unusually high last quarter due to silt accumulation around the sensor however this has been cleared and was within the typical range for this site. The lowest mean turbidity value is recorded at Site 16 measuring 5.0 NTU.

During this quarter turbidity was low across most sites with regular turbidity spikes at Sites 3 and 6. A notable peak was observed on Site 6 with 225 NTU on 21<sup>st</sup> September 2023.

Some turbidity data this quarter at Site 1 (Minworth WwRC) has been affected by tree growth around the sensor resulting in unreliable data. This has been removed where we are confident the data is erroneous. Historically, turbidity spikes across all sites following rainfall events. Similarly, data from Site 3 is unreliable for this quarter as the sensor became submerged in accumulated silt.



### 3.2.7 Chlorophyll

Chlorophyll is a green pigment found in algae and plants. It is essential for photosynthesis, the process by which plants convert sunlight into energy. Chlorophyll can be used as a measure of the quantity of algae in a river. Higher levels of chlorophyll indicate more algae, which can lead to problems such as algal blooms, decreased oxygen levels, and the production of toxins. There are a number of factors that can affect the level of chlorophyll in a river, including nutrient levels, sunlight levels, temperature and flow. Chlorophyll concentrations are generally highest at Site 6 and have been observed to peak with a number of algal blooms events observed during the Spring and Summer months.

Recent data collected covering July to September 2023 falls within the late summer/early autumn period. The algal blooms observed at Site 16 last quarter are no longer occurring. At Site 6, peaks in chlorophyll coincide with reductions in dissolved oxygen saturation suggesting the algal blooms which started in early June were still occurring until late September after which concentrations appear to have reduced.



Table 3-4 - Overall mean and quarterly mean values observed at continuous monitoring locations

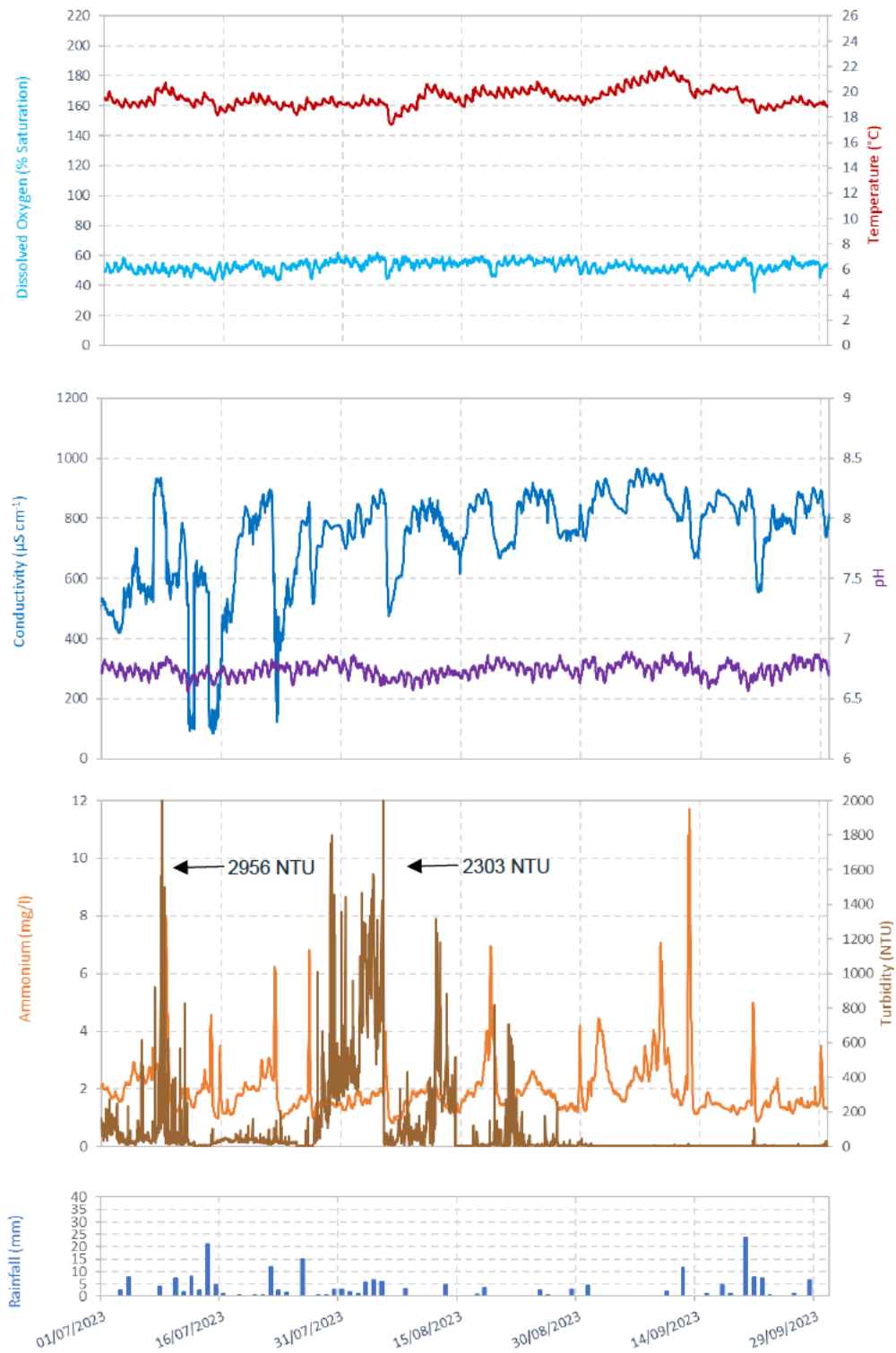
| Determinand      | Unit                | 1. Minworth WwRC Final Effluent <sup>1</sup> |                |                  | 3. GUC at Atherstone <sup>2</sup> |                |                  | 6. GUC at Grove, Leighton Buzzard <sup>3</sup> |                |                  | 16. GUC at Marsworth <sup>2</sup> |                |                  |
|------------------|---------------------|--|----------------|------------------|-----------------------------------|----------------|------------------|--|----------------|------------------|-----------------------------------|----------------|------------------|
|                  |                     | Overall Mean                                 | Quarterly Mean | Change in period | Overall Mean                      | Quarterly Mean | Change in period | Overall Mean                                   | Quarterly Mean | Change in period | Overall Mean                      | Quarterly Mean | Change in period |
| Temperature      | °C                  | 16.4   | 19.5           | ↑                | 14.0                              | 17.8           | ↑                | 12.7   | 18.3           | ↑                | 15.5                              | 18.8           | ↑                |
| Conductivity     | µS cm <sup>-1</sup> | 781  | 742            | ↓                | 1235                              | 872            | ↓                | 637  | 606            | ↓                | 552                               | 492            | ↓                |
| Dissolved Oxygen | %                   | 53.4   | 53.0           | ↓                | 77.4                              | 79             | ↑                | 80.6   | 83.7           | ↑                | 100                               | 97             | ↑                |
| pH               | pH units            | 6.71   | 6.74           | —                | 7.44                              | 7.82           | ↑                | 7.86   | 7.82           | —                | 7.93                              | 7.96           | —                |
| Ammonium         | mg N/l              | 1.94   | 1.94           | —                | 0.49                              | 0.38           | ↓                | 0.53   | 0.63           | ↑                | 0.42                              | 0.26           | ↓                |
| Turbidity        | NTU                 | 49.1   | 102.2          | ↑                | 26.2                              | 16.7           | ↓                | 30.5   | 19.3           | ↓                | 4.67                              | 5.01           | ↑                |
| Chlorophyll      | µg/l                | -  | -              |                  | 9.6                               | 10.17          | ↑                | 31.3   | 29.1           | ↓                | 12.7                              | 9.8            | ↓                |

<sup>1</sup> Site 1 (Minworth WwRC) sonde data monitoring for conductivity, temperature, and dissolved oxygen commenced at the start of Phase 2 monitoring on 18/05/2022. Additional parameters including pH, ammonium, and turbidity were added on 05/04/2022.

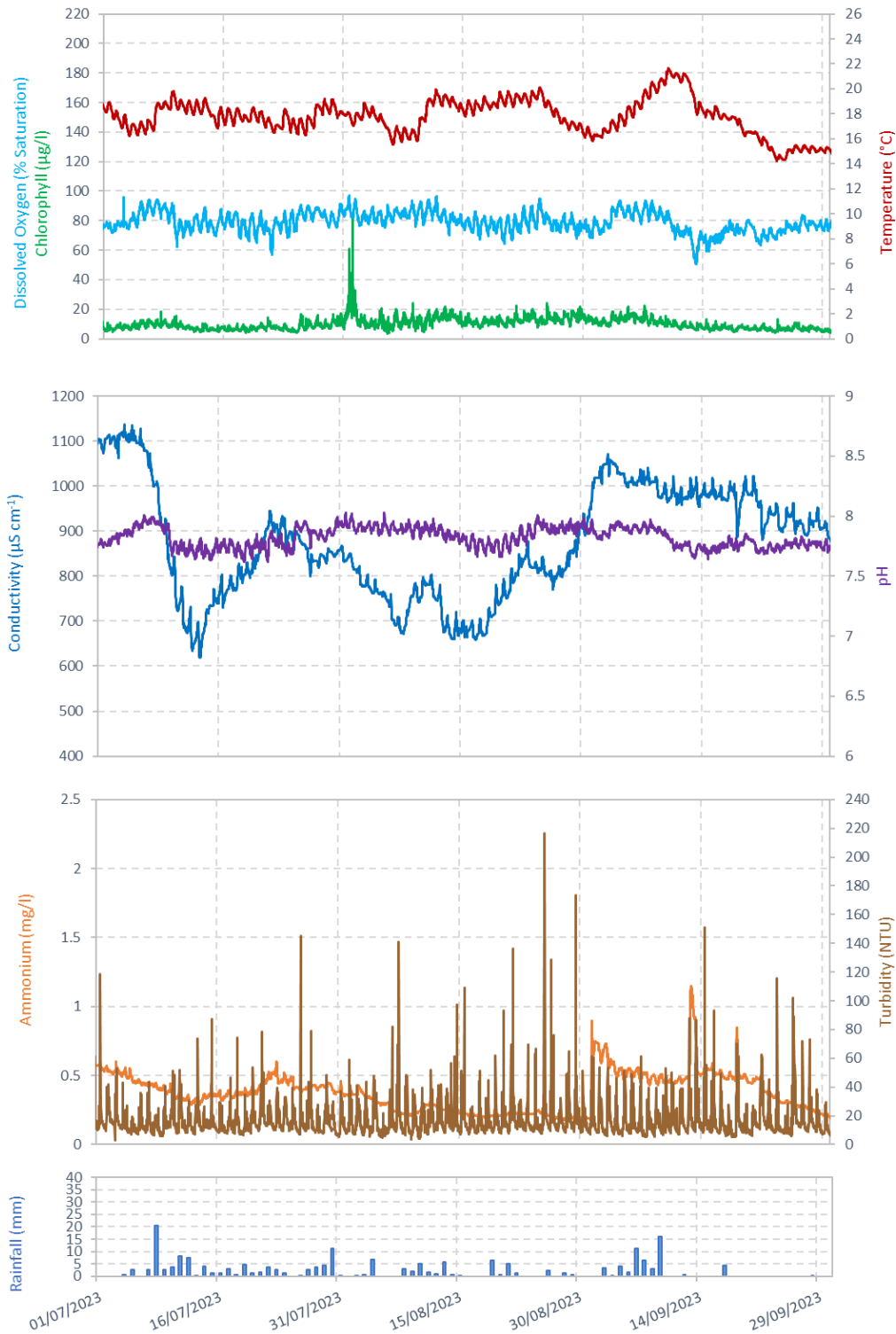
<sup>2</sup> Site 3 and Site 16 sondes were deployed on 11/05/22 and 24/05/22 respectively.

<sup>3</sup> Site 6 sonde was deployed on 25/11/21.

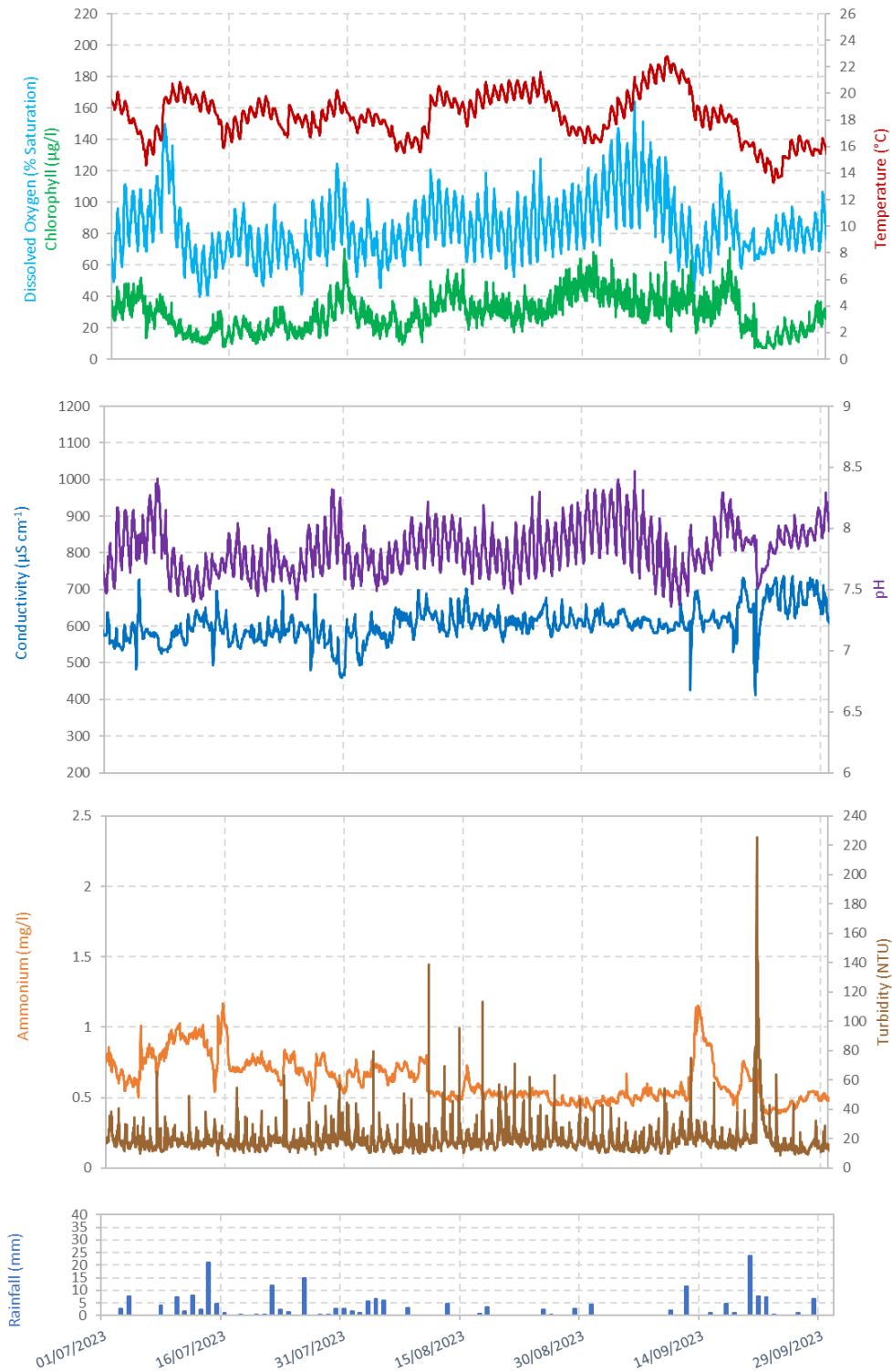




**Figure 3-1 – Continuous sonde data collected between 01/07/2023 to 30/09/2023 at Site 1 (Minworth WwRC).**

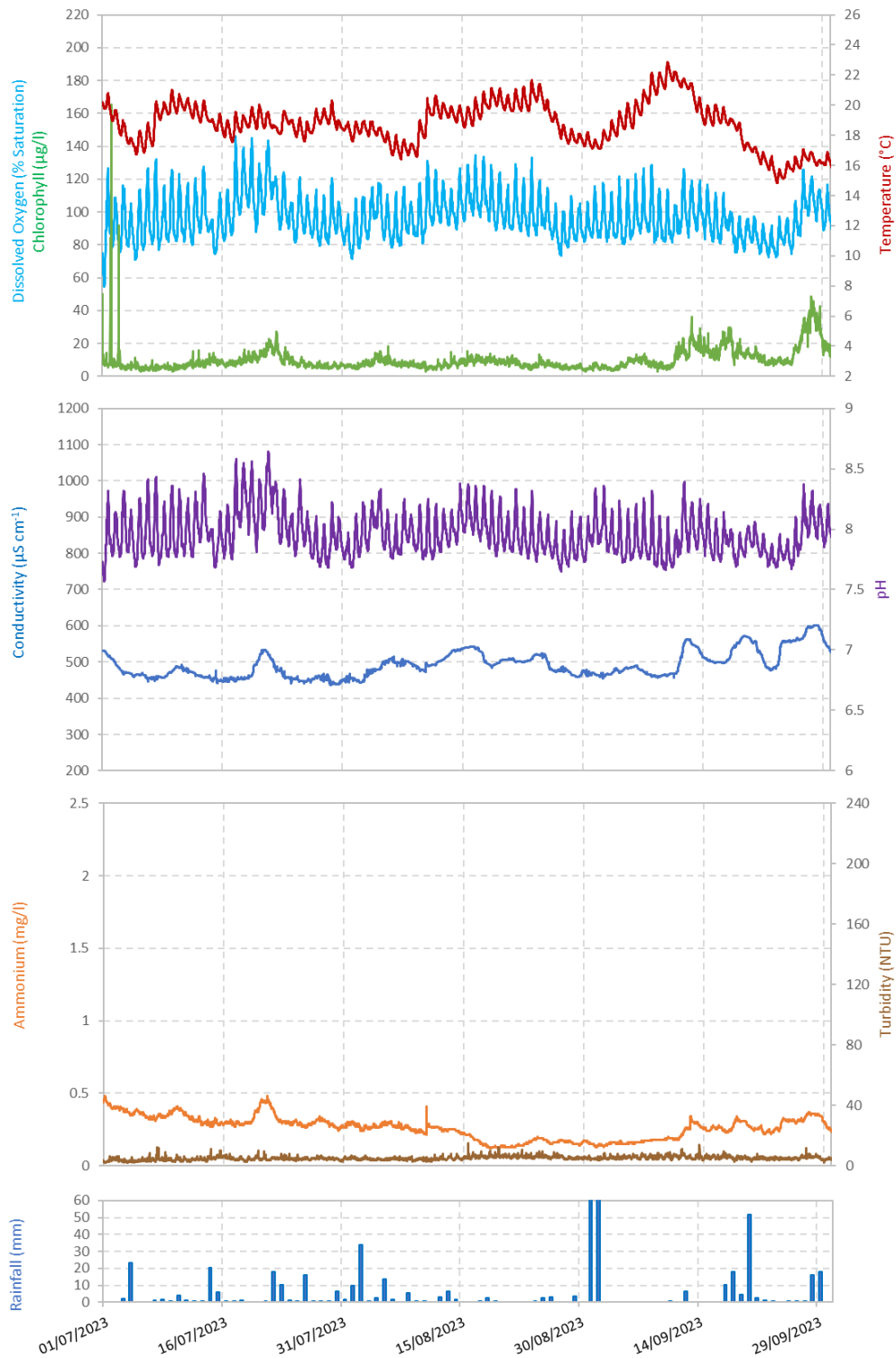


**Figure 3-2 – Continuous sonde data collected between 01/07/2023 to 30/09/2023 at Site 3 (GUC at Atherstone).**



**Figure 3-3 – Continuous sonde data collected between 01/07/2023 to 30/09/2023 at Site 6 (GUC Leighton Buzzard).**





**Figure 3-4 – Continuous sonde data collected between 01/07/2023 to 30/09/2023 at Site 16 (GUC at Marsworth).**

## 3.3 Spot sample drinking water quality standards comparison

### 3.3.1 Overview

Drinking water parameter analysis, assessed through their comparison to Prescribed Concentration Values (PCVs) is only undertaken to characterise the source water at Minworth WwRC (Site 1) and the downstream abstraction location (Site 6 Leighton Buzzard). A total of 21 months of DWSP data are available for Site 6 compared to 37 months at Site 1 (Minworth WwRC). This is a result of the site selection process for the example abstraction location.

It should be noted that the PCV standards are being applied to raw 'untreated' water where typically they would apply at the point of use e.g., a customer's tap. This had been undertaken to provide guidance on which substances may require targeted treatment when abstraction is operational. PCV exceedances in wastewater discharge and an operational canal are therefore expected.

### 3.3.2 Exceedances to date

At Site 1 (Minworth WwRC) 293 exceedances have been recorded to date. At Site 6, 199 PCV exceedances have been recorded. The distribution of these is detailed in Table 3-5. Several determinands exceeded PCVs in every, or almost every, sampling round. These determinands, along with the number of exceedances observed at Site 6 (the example abstraction location), are given below. It must be noted that these standards are applicable to drinking water at the point of consumption, and these are effluent (Minworth) and surface water (Atherstone) sites.

- Benzo(a)pyrene (total exceedances = 32)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 55)
- *Escherichia coli* (*E. coli*, total exceedances = 54)
- Iron – total (total exceedances = 29)
- Manganese dissolved (total exceedances = 28)
- Manganese total (total exceedances = 32)
- Nitrite (total exceedances = 36)
- Turbidity (total exceedances = 50)

*C. perfringens* (a sulphite-reducing species commonly associated with faecal contamination) is widely distributed in the environment and is regularly evaluated with the aim of understanding the microbiological safety of drinking water supplies. Ingestion of *C. perfringens* can result in gastrointestinal disease, and *C. perfringens* spores can persist longer than other indicators of contamination, such as Coliforms (which also demonstrated exceedances at all sites and is also an important indicator of faecal contamination). Sources of bacterial contamination can range from the

input of animal manures from farmyard runoff and the discharge of untreated, and even treated, sewage effluent.

*Cryptosporidium* was not detected at either site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward.

Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores. However, as canal networks often have shallow depths (<6ft), short lived events may be a result of localised disturbance of sediments by boats or wildlife causing disturbance in the vicinity of the sensor location.



**Table 3-5 – Number of drinking water PCV exceedances**

| Compound   | PCV  | Unit                    | Source    |           |
|--|------|-------------------------|-----------|-----------|
|  |      |                         | Site 1    | Site 6    |
| Aluminium – dissolved  | 200  | µg/l                    | 0         | 1         |
| Aluminium – total  | 200  | µg/l                    | 0         | 12        |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l as NH <sub>4</sub> | 3         | 3         |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 1         | 20        |
| Bisphenol A  | 2.5  | µg/l                    | 9         | 0         |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml                | 31        | 24        |
| Chlorate   | 0.25 | mg/l                    | 4         | 0         |
| Chloride   | 250  | mg/l                    | 1         | 0         |
| Chlorite   | 0.25 | µg/l                    | 0         | 10        |
| Chromium – total   | 50   | µg/l                    | 1         | 0         |
| Clopyralid   | 0.1  | µg/l                    | 1         | 0         |
| Coliform – total   | 0    | MPN/100ml               | 31        | 23        |
| Colour   | 20   | mg/Pt/Co                | 23        | 2         |
| <i>E. coli</i>   | 0    | MPN/100ml               | 23        | 23        |
| Iron – dissolved   | 200  | µg/l                    | 0         | 1         |
| Iron total   | 200  | µg/l                    | 7         | 22        |
| Manganese – dissolved  | 50   | µg/l                    | 27        | 1         |
| Manganese – total  | 50   | µg/l                    | 28        | 4         |
| Mercury – total  | 1    | µg/l                    | 1         | 0         |
| Metribuzin   | 0.1  | µg/l                    | 0         | 1         |
| Nickel – dissolved   | 20   | µg/l                    | 9         | 0         |
| Nickel – total   | 20   | µg/l                    | 10        | 0         |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 21        | 2         |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 26        | 10        |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | 0         | 4         |
| PAH sum*   | 0.1  | µg/l                    | 0         | 10        |
| Propyzamide  | 0.1  | µg/l                    | 1         | 0         |
| Sodium – dissolved   | 200  | mg/l                    | 0         | 1         |
| Sulphate   | 250  | mg/l SO <sub>4</sub>    | 0         | 1         |
| Tebuconazole   | 0.1  | µg/l                    | 0         | 1         |
| Turbidity  | 1    | NTU                     | 26        | 24        |
| Vinyl chloride   | 0.5  | µg/l                    | 0         | 1         |
| <b>Total samples</b>   |      |                         | <b>43</b> | <b>31</b> |

Orange text indicates an indicates new PCV exceedances this quarter.

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

\*\* Data at Site 1 (Minworth WwRC) covers May 20 – September 23 and data at Site 6 covers April 21 – September 23.

# Total number of samples collected = 31 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 31.

**Table 3-6 – Maximum concentrations of compounds responsible for drinking water PCV exceedances<sup>9</sup>**

| Compound   | PCV  | Unit                    | Source    |           |
|--|------|-------------------------|-----------|-----------|
|  |      |                         | Site 1    | Site 6    |
| Aluminium - dissolved  | 200  | µg/l                    | 50.0      | 67.00     |
| Aluminium - total  | 200  | µg/l                    | 125.0     | 530.00    |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l as NH <sub>4</sub> | 1.2       | 1.9       |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 0.02      | 0.1       |
| Bisphenol A  | 2.5  | µg/l                    | 137.0     | <0.01**   |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml                | 100.0     | 1000.0    |
| Chlorate   | 0.25 | mg/l                    | 2.0       | 0.7       |
| Chloride   | 250  | mg/l                    | 610.0     | 75.0      |
| Chlorite   | 0.25 | µg/l                    | 3.0       | 15.0      |
| Chromium - total   | 50   | µg/l                    | 140.0     | 15.0      |
| Clopyralid   | 0.1  | µg/l                    | 0.2       | 0.0       |
| Coliform - total   | 0    | MPN/100ml               | 2420.0    | 2420.0    |
| Colour   | 20   | mg/Pt/Co                | 43.0      | 26.0      |
| <i>E. coli</i>   | 0    | MPN/100ml               | 2420.0    | 2420.0    |
| Iron - dissolved   | 200  | µg/l                    | 100.0     | 1700.0    |
| Iron total   | 200  | µg/l                    | 310.0     | 2600.0    |
| Manganese - dissolved  | 50   | µg/l                    | 130.0     | 120.0     |
| Manganese - total  | 50   | µg/l                    | 160.0     | 360.0     |
| Mercury - total  | 1    | µg/l                    | 3.7       | 0.7       |
| Metribuzin   | 0.1  | µg/l                    | 0.1       | 0.2       |
| Nickel - dissolved   | 20   | µg/l                    | 61.0      | 7.1       |
| Nickel - total   | 20   | µg/l                    | 61.0      | 9.4       |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 120.0     | 100.0     |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 3.6       | 2.5       |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | N/A       | 0.4       |
| PAH sum*   | 0.1  | µg/l                    | 0.1       | 0.6       |
| Propyzamide  | 0.1  | µg/l                    | 0.3       | 0.1       |
| Sodium - dissolved   | 200  | mg/l                    | 78.0      | 510.0     |
| Sulphate   | 250  | mg/l SO <sub>4</sub>    | 180.0     | 690.0     |
| Tebuconazole   | 0.1  | µg/l                    | 0.1       | 0.2       |
| Turbidity  | 1    | NTU                     | 14.0      | 210.0     |
| Vinyl chloride   | 0.5  | µg/l                    | 0.5       | 1.0       |
| <b>Total number of samples</b>   |      |                         | <b>40</b> | <b>28</b> |

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

\*\* LoD reduced to 0.01 µg/l from April 2022 onwards.

<sup>9</sup> Dark blue shading indicates PCV exceedance, maximum reported concentrations are shown.



### 3.3.3 Source water/canal section comparison

#### Notable concentration changes in the last quarter (July 2023 – September 2023).

This quarter there were no additional substances exceeding PCV at any site.

- Clopyralid exceeds PCV (0.1 µg/l) at Minworth WwRC by a larger margin this quarter measuring 0.25 µg/l (previously 0.19 µg/l).

#### 3.3.3.1 Minworth vs. example abstraction location (site 6)

The following substances were found to have concentrations above their respective PCVs in the Minworth WwRC final effluent, however, were below PCVs in-canal at Site 6 (GUC at Grove, Leighton Buzzard). While it is beyond the scope of this report to infer if an instream PCV exceedance would occur at Site 6 if effluent discharge were re-directed into the GUC, these compounds of note should be subject to future analysis.

- Bisphenol A
- Chlorate
- Chloride
- Chromium – total
- Clopyralid
- Mercury – total
- Nickel – bioavailable
- Nickel – total
- Propyzamide

Bisphenol A and chlorate measured above PCV at Minworth but below PCV at Site 6 noting the LoD for Bisphenol A is higher than the PCV. As such, concentrations in the canal cannot currently be accurately assessed against the discharge, however, values are assumed low at present. Chloride exceeds PCV concentration at Minworth with 91 mg/l on average while measuring 38 µg/l on average (max 75 µg/l) at Site 6. This suggests concentrations were well below the PCV of 250 µg/l but could be at risk of exceedance if a Minworth discharge were introduced. Chlorite by contrast exceeded PCV at Site 6 measuring 15 µg/l. Chromium (total) exceeded PCV at Minworth WwRC at 140 µg/l while measuring a maximum of 15 µg/l at Site 6. This is below the PCV of 50 µg/l. Concentrations in the canal could be at risk of exceedance following introduction of a Minworth discharge given the PCV is exceeded by a significant margin. Clopyralid exceeded PCV (0.1 µg/l) by a larger margin this quarter measuring 0.25 µg/l at Minworth WwRC while being well below PCV at Site 6 (0.02 µg/l). There may be some risk to in-canal concentrations from a Minworth discharge. Mercury (total) at Site 6 was only slightly below the PCV of 1 µg/l (mean = 0.71 µg/l). This substance may be at risk of PCV exceedance following the introduction of a Minworth discharge given the high discharge concentrations (3.7 µg/l). Mean concentrations of nickel (total and dissolved) were both close to exceeding the PCV of 20 µg/l at Site 6. Consequently, these substances are highly likely to exceed PCV following a Minworth discharge. Mean concentrations of propyzamide exceed the PCV of 0.1 µg/l at Minworth WwRC but did not at Site 6. There is moderate risk to the propyzamide PCV being breached at Site 6 following a Minworth discharge. These substances may be influenced at Site 6

with the addition of the Minworth discharge and as such, in the absence of additional treatment at Minworth WwRC, these substances may require additional treatment following abstraction.



# CONCLUSIONS



## 4. Conclusions

At present, the following determinands demonstrated the greatest number of WFD AA EQS exceedances on an individual sample basis across all sampling rounds to date and pose a potential risk at the discharge location:

- **Minworth WwRC** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - ANC (a total of 30 individual occurrences)
  - Benzo(a)pyrene (a total of 43 individual occurrences)
  - BOD - 5-day (a total of 5 individual occurrences)
  - Dissolved Oxygen (a total of 24 individual occurrences)
  - Cypermethrin (a total of 33 individual occurrences)
  - PFOS (a total of 50 individual occurrences)
  - SRP (a total of 32 individual occurrences)
  - Sulphide or hydrogen sulphide (a total of 15 individual occurrences)
  - Zinc – bioavailable (a total of 15 individual occurrences)
  
- **GUC**
  - ANC (10 sites, a total of 214 individual occurrences)
  - Benzo(a)pyrene (10 sites, a total of 299 individual occurrences)
  - BOD - 5-day (6 sites, a total of 33 individual occurrences)
  - Dissolved Oxygen (6 sites, a total of 49 individual occurrences)
  - Fluoranthene (10 sites, a total of 190 individual occurrences)
  - PFOS (10 sites, a total of 210 individual occurrences)
  - SRP (7 sites, a total of 109 individual occurrences)
  - Sulphide or hydrogen sulphide (10 sites, a total of 138 individual occurrences)

In addition, the following determinands exceeded WFD / EQSD MAC values:

- **Minworth WwRC** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - Sulphide or hydrogen sulphide (total individual exceedances = 15)
  - Bromine - total residual oxidant (total individual exceedances = 30)
  - Nickel - dissolved (total individual exceedances = 2)
  - Cypermethrin (total individual exceedances = 5)
  - Formaldehyde (total individual exceedances = 1)
  - Mercury - dissolved (total individual exceedances = 2)
  - Mercury - total (total individual exceedances = 2)
  - Triphenyltin compounds (as triphenyltin cation) (total individual exceedances = 2)
  - Maneb (total individual exceedances = 1)
  - benzo(g,h,i)perylene (total individual exceedances = 1)



- **GUC**

- Benzo(a)pyrene (total individual exceedances = 67)
- Benzo(b)fluoranthene (total individual exceedances = 10)
- Benzo(g,h,i)perylene (total individual exceedances = 18)
- Benzo(k)fluoranthene (total individual exceedances = 4)
- Cadmium total (total individual exceedances = 2)
- Cadmium dissolved (total individual exceedances = 2)
- Sulphide or hydrogen sulphide (total individual exceedances = 138)
- Bromine - total residual oxidant (total individual exceedances = 30)
- Nickel - dissolved (total individual exceedances = 16)
- Cypermethrin (total individual exceedances = 12)
- Mercury - dissolved (total individual exceedances = 15)
- Mercury - total (total individual exceedances = 18)
- Triphenyltin compounds (as triphenyltin cation) (total individual exceedances = 2)

Some concentrations in the Minworth WwRC effluent were greater than the EQS in the receiving water at Site 3, Coventry Canal, Atherstone (noting these standards do not directly apply to effluent and discharge standards are set through the permitting regime). These include chlorothalonil (an organic fungicide), cypermethrin (a synthetic pyrethroid), diazinon, formaldehyde, benzo(g,h,i)perylene and dissolved oxygen. It should be noted that cypermethrin exceeded the annual average EQS at all other canal sites as of last quarter. As a result, if Minworth WwRC final effluent was diverted to the example discharge location without any additional treatment applied, additional in-canal exceedances may occur, resulting in a future WFD compliance risk as the new discharge would prevent the water quality of the receiving body from achieving Good Status in future. Benzo(g,h,i)perylene was identified above the MAC EQS at Site 1 (Minworth WwRC) for the first time but did not exceed the annual average. Further assessment is required to determine the level of confidence if this is indeed the case (e.g., through modelling or pairwise assessment of samples). Additional treatment or other removal at works will be required in order to provide a resolution to this issue.

Minworth WwRC treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of these 'high risk' compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permitting risk (e.g., due to within class deterioration).

Some substances were found to be higher in concentrations within the canal sites compared to Minworth, therefore for these substances a reduction in concentrations in the upper GUC may be seen following the introduction of a Minworth WwRC. These include Cadmium total, cobalt dissolved, manganese and nickel bioavailable and tributyltin compounds. Tributyltin compounds most commonly exceed in the middle GUC which may see an improvement following introduction of a Minworth WwRC discharge.

As discussed in Section 3.3.1, PCVs apply only to treated drinking water, and not raw source waters. However, the monitoring of these determinands and regular comparison with drinking water standards enables a threshold for screening out determinands that may be considerably elevated in raw water, thus helping to inform treatment design at the example abstraction location. With that in mind, the following determinands are currently routinely exceeding PCV targets at Site 6.

- Benzo(a)pyrene (total exceedances = 20)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 23)
- *Escherichia coli* (*E. coli*, total exceedances = 23)
- Iron - total (total exceedances = 22)
- Nitrite (total exceedances = 10)
- Turbidity (total exceedances = 24)

*C. perfringens* exceeded PCV values at both sites as it is widely distributed across the environment and as such, is regularly evaluated to monitor the microbiological safety of drinking water supplies. Sources of bacterial contamination can range from the input of animal manures from farmyard runoff to discharge from untreated or treated sewage effluent. *Cryptosporidium* was not detected at any site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores or localised disturbance events.

All sensor data is within ranges typical of freshwater environments a summer autumn period. Temperatures were stable across all sites with a notable decrease from mid-September. Rainfall events appear to have driven several peaks in ammonium concentration at Site 1 (Minworth WwRC) however later peaks cannot be linked to rainfall due the absence of rainfall data. Algal blooms appear to be occurring at Site 6 which, in turn, appear to subside in mid-September indicated by a reduction in average chlorophyll concentration and dissolved oxygen saturation.

With respect to WFD EQS, in the upper GUC chloronathonil, cypermethrin, diazinon, dissolved oxygen, formaldehyde, permethrin and SRP are the substances most at risk. For the middle and lower sections zinc bioavailable is at risk. SRP is only at risk in the middle section as this regularly exceeds EQS in the lower section however exceedances in the middle section are becoming more common.

With respect to PCVs, the following substances are potentially at risk from the Minworth WwRC discharge to the GUC:

- Bisphenol A
- Chlorate
- Chloride
- Chromium total
- Clopyralid
- Mercury - total
- Nickel - bioavailable
- Nickel - total
- Propyzamide

## 4.1 Next steps

We will continue to analyse water quality data collected as part of the GUC water quality monitoring programme which will continue through to November 2024. As part of this process, we will continue



providing quarterly updates which will be communicated to the GUC project team and the Minworth WwRC and abstraction treatment engineers to understand the feasibility of designing treatment for any 'high risk' compounds. We will also work with the team to identify any changes that may be required to the monitoring programme i.e., the addition or removal of sites and/or parameters.

Our water quality analysis will continue to investigate environmental and drinking water risks, comparing results to individual EQS and PCVs. Our analysis will also continue to investigate whether there is a potential risk of water quality deterioration by comparing Minworth WwRC final effluent with canal sites.

We will also update the drinking water quality risk assessment for Gate 3 following the All Company Working Group (ACWG) methodology. This was previously undertaken for Gate 1 and subsequently updated for Gate 2, with the caveat that this assessment is based on raw water before treatment, so PCV breaches are expected.

Lastly, we will undertake a new assessment of all determinands by hydrological year (October to September) to assess annual average exceedances against appropriate time scales to facilitate a comparison between years.



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# Gate 3 Water Quality Monitoring: Quarter 7 Results

Severn Trent, Affinity Water and Canal & River  
Trust

28 March 2024

5222090 / 7 / DG / 036

# GRAND UNION CANAL STRATEGIC RESOURCE OPTION

# Notice

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## Client signoff

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# INTRODUCTION



# 1. Introduction

## 1.1 Purpose of this document

The purpose of this document is to provide an update of data collected over the monitoring period spanning October to December 2023, and where available, set these data in the context of longer-term monitoring data collected to date. Data collection for the Grand Union Canal (GUC) Strategic Resource Option (SRO) is ongoing. This report provides stakeholders an update on the data, as it is collected and draws comparisons, when possible, to environmental, and drinking water standards.

**Key changes in spot and continuous data observed in-quarter seven are highlighted in callouts for clarity.**



# METHODOLOGY



## 2. Methodology

### 2.1 Site locations

#### Key changes to site locations.

There were no changes to the monitoring site locations this quarter.

For the purpose of conceptualising the monitoring programme, the GUC network has been split into three main geographical sections. An overview map of the Upper, Middle, and Lower section is supplied below in Tables 2-1 and Figure 2-1 below. Further detail on these sections along with the section maps are provided in the Gate 3 GUC Water Quality Monitoring report with a summary below:

- **Upper section** – Covering the discharge from Minworth Wastewater Recycling Centre (WwRC) to the example discharge location (Coventry Canal at Atherstone).
- **Middle section** – GUC from the Braunston Junction to the Aylesbury Arm (Marsworth, North of Tring).
- **Lower section** – GUC from the Aylesbury Arm to Hanwell, London. This section includes the example abstraction location (GUC at Grove Lock, Leighton Buzzard).

**Table 2-1 - Summary of monitoring locations across each phase plus analysis suites**

| Section             | Site no. | Location description           |
|---------------------|----------|--------------------------------|
| GUC: Upper Section  | 1        | Minworth WwRC Final Effluent   |
|                     | 3        | Coventry Canal at Atherstone   |
| GUC: Middle Section | 10       | Coventry Canal at Bedworth     |
|                     | 5        | GUC at Welton Lane, Daventry   |
|                     | 11       | GUC at Long Buckby             |
|                     | 12       | GUC at Gayton                  |
|                     | 13       | GUC at Stoke Bruerne           |
|                     | 14       | GUC at Cosgrove                |
|                     | 15       | GUC at Stoke Hammond           |
| GUC: Lower Section  | 6        | GUC at Grove, Leighton Buzzard |
|                     | 16       | GUC at Marsworth               |



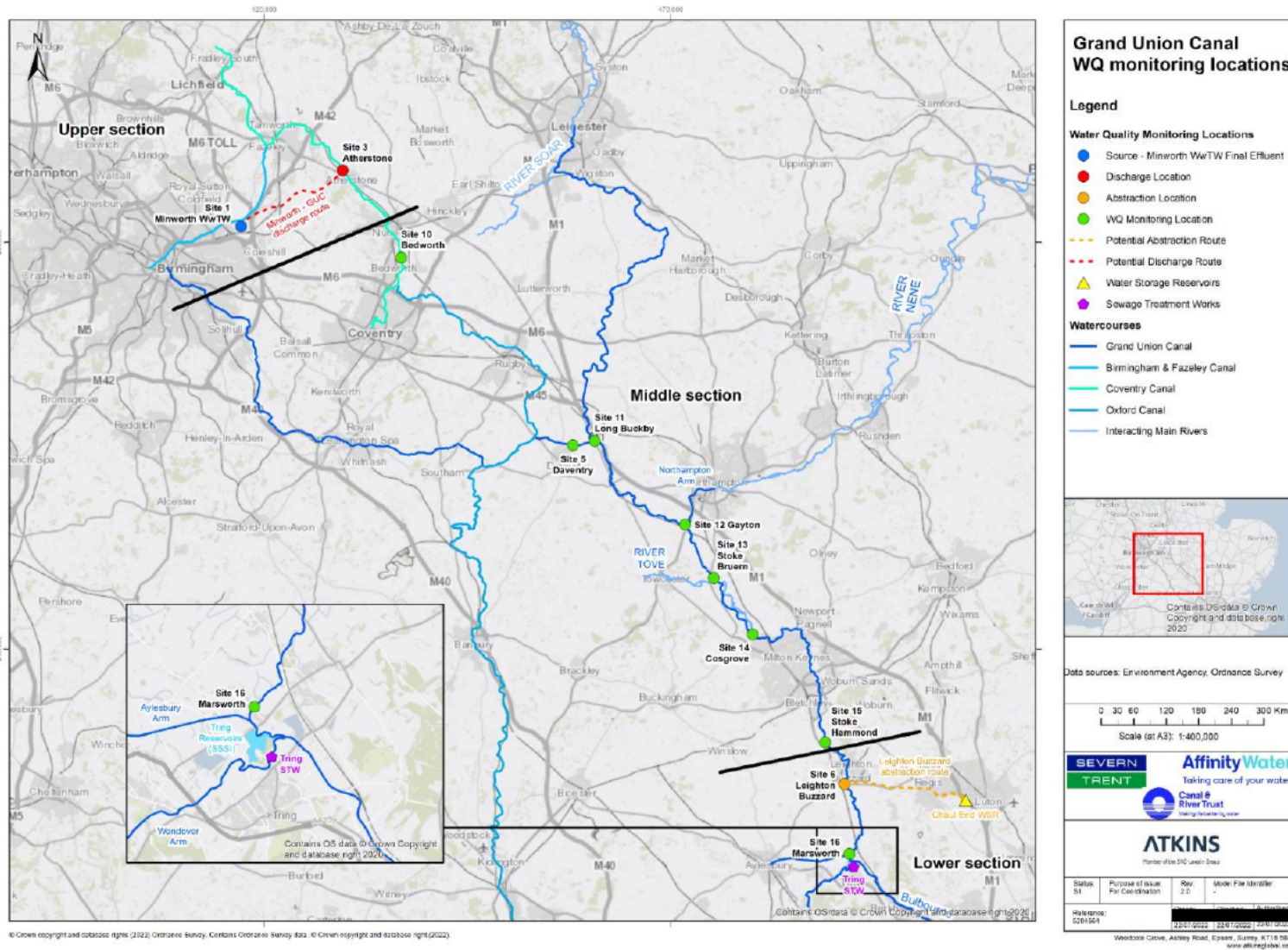


Figure 2-1 Key elements/ reaches of the GUC scheme (black lines note the upper, middle and lower sections)

Author names redacted



## 2.2 Monitoring, sampling, and analysis procedures

### Key changes to monitoring programme.

There were no changes to the monitoring programme this quarter. Data were downloaded for all monitoring sondes for all parameters as well as monthly spot samples in October, November and December. Data added in the most recent summary report covers the period October – December 2023.

### 2.2.1 Spot water quality sampling

Spot water quality samples were taken in line with the programme and operating procedures outlined in the GUC Gate 3 Water Quality Monitoring report. No sites or samples were omitted due to access or safety issues this quarter.

The samples for the October 2023 round were taken on 16<sup>th</sup> October 2023.

The samples for the November 2023 round were taken on 14<sup>th</sup> November 2023.

The samples for the December 2023 round were taken on 11<sup>th</sup> December 2023.

The water quality suites selected for analysis are based on 4 key legislative and design drivers. These include:

- **Environmental risks as required by the Water Framework Directive (WFD)** (WFD Suite).
- **Environmental permitting risks as required by the Environmental Quality Standards Directive (EQSD)** (EQSD suite).
- **Drinking Water risks as required by DWI (Drinking Water Inspectorate)** (Drinking water suite).
- **Emerging substances** (Emerging substances suite).

### 2.2.2 Rainfall data

Rainfall data was available from the Environment Agency (EA) for multiple locations along the GUC covering most of the monitoring period. For the Upper GUC, data have been compared to Lea Marston gauge (Station ID: 096781), for the Middle reach of the GUC, data have been compared to Quinton rain gauge (EA Station ID: 170945), and for the Lower GUC data from Dancers End Reservoir have been used (EA Station ID: 261602). Data for all gauges for this quarter were available from 1<sup>st</sup> October 2023 to 31<sup>st</sup> December 2023.



# RESULTS



## 3. Results

### 3.1 Spot sample environmental quality standards comparison

#### Notable concentration changes in the last quarter (October 2023 – December 2023).

- BOD exceeded EQS at Site 12 (Gayton) for the first time.
- Chlorothalonil and diazinon exceeded EQS at Site 3 (Atherstone) for the first time.
- First individual exceedance of 3,4-dichloroaniline, fenitrothion, malathion and triazophos at Site 3 (Atherstone)
- First individual exceedance of azinphos-methyl, dissolved at Site 1 (Minworth WwRC)

Other substances which frequently exceed EQS have seen the following changes this quarter:

- Benzo(a)pyrene exceeded MAC EQS at Sites 12 (Gayton), 14 (Cosgrove) and 6 (Leighton Buzzard) while Benzo(b)fluoranthene exceeded MAC EQS at Site 6 (Leighton Buzzard) only and Benzo(g,h,i)perylene exceeded MAC EQS at Site 1 (Minworth WwRC) and 6 (Leighton Buzzard) only.
- Bromine - total residual oxidant exceeded MAC EQS at Sites 1 (Minworth WwRC) and 3 (Atherstone).
- Sulphide or hydrogen sulphide Exceeded MAC EQS at all sites

#### 3.1.1 Overview

In order to determine parameters of risk, values have been compared against the relevant Environmental Quality Standard (EQS) as detailed by the 2015 WFD Directions and the EA Surface Water Pollution Risk Assessment Parameters EQSD<sup>1</sup>. It is important to note that standards or condition limits for certain parameters under the WFD (e.g., dissolved oxygen, BOD, ammoniacal nitrogen, and ANC), are determined by categorising the water body by type, dependent on its altitude and alkalinity. ANC standards are determined by annual mean dissolved organic carbon concentrations. In addition, soluble reactive phosphorus (SRP) standards are determined by the water body's altitude and alkalinity, cadmium standards are determined by categorising the water body, by type, dependent on the hardness of the water, and zinc standards are determined by the ambient background concentration (ABC) of dissolved zinc. EA site specific standards (where available) were used (e.g. SRP), Where these were not available, site-specific standards have been calculated using the available data.

Whilst we have used site-specific EQS or WFD Good standards for the Minworth WwRC final effluent for indicative purposes, it is important to note that these standards should not be routinely applied to final effluent samples as they are in-river standards (these standards do not directly apply to effluent and discharge standards are set through the permitting regime). It is also important to note that all data on record are considered when comparing against the environmental standards which are applied, under a formal assessment, as Annual Averages (AA), Maximum Allowable Concentrations (MAC), or specified percentiles. Compliance statistics can only be undertaken by the Environment Agency using data from a single calendar year. Samples at the limit of detection were included in the analysis and used at face value to adhere to discharge permitting assessment guidance. Any significant outliers were removed from the analysis.

<sup>1</sup> EA Guidance. Environmental Quality Standards Directive (EQSD) list for WFD assessments. Published 15 December 2016



Based on the available data across all sites, there have been a total of 113 EQS exceedances. A discussion of exceedances along with source water and canal section comparisons can be found in sections 3.1.2 and 3.1.3.

### 3.1.2 Exceedances to date

A list of all compounds that exceeded the quoted EQS split by site, are presented in Table 3-1. Maximum allowable concentration (MAC) values were examined separately and have been applied to individual results and not mean or percentile data.

Two polycyclic aromatic hydrocarbons (PAH), benzo(a)pyrene and fluoranthene, exceeded at all of the eleven sites with the exception of fluoranthene at Site 5. These substances are commonly found in fuels and oils and commonly associated with combustion. For Biochemical Oxygen Demand (BOD) there was one exceedance this quarter at Site 12. Elevated PFOS concentrations also resulted in AA EQS exceedances at all 11 sites this quarter.

Bromine (total residual oxidant) resulted in EQS exceedances at Sites 1 and 3 by several orders of magnitude, note bromine is only measured at these two sites as part of the EQSD analysis suite.

Lastly, low 10<sup>th</sup> percentile dissolved oxygen saturation values resulted in EQS exceedances at seven sites this quarter (Sites 1, 3, 5, 6, 10, 14 and 16). Site 1 (Minworth WwRC) was below the dissolved oxygen standard in all samples, noting this is sewage effluent and the EQS does not directly apply, whereas Sites 5, 6, 10 and 14 are canal sites with lower dissolved oxygen observed more frequently in summer at these sites. Dissolved oxygen decreases were likely driven by increased water temperatures, which reduces water's ability to hold oxygen combined with increases in algal activity which may be resulting in temporary oxygen drawdowns during the daytime.

Table 3-2 shows the data as it corresponds to the test statistics for all compounds in exceedance of the EQS. As with Table 3-1, this table indicates overall EQS exceedances as well as new exceedances occurring this quarter. This table allows identification of compounds that may exceed EQS if the final effluent from Minworth WwRC were discharged into the GUC without additional treatment. This may result in a future WFD compliance risk as the new discharge may result in a deterioration of instream quality and may prevent the water quality of the receiving body from achieving Good Status in the future. Compounds that exceed AA EQS at Minworth WwRC with no comparable exceedance instream include chlorothalonil (organic fungicide), cypermethrin (synthetic pyrethroid), permethrin (insecticide), and zinc (bioavailable).

In total there were 458 instances of MAC exceedances across all sites. Overall, four PAHs (i.e. benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene) accounted for 106 (25%) of these exceedances. Bromine (total residual oxidant) accounted for 66 exceedances in the 'Upper GUC', Sites 1 and 3. Sulphate (or hydrogen sulphide) exceeded MAC values on 202 occasions (accounting for 44% of all exceedances). A list of total exceedances split by compound can be seen in Table 3-3.



Table 3-1 Number of EQS (WFD and EQSD) exceedances <sup>4, 5</sup>.

| Compound                         | Standard | Unit | Statistic <sup>+</sup> | Upper GUC       |                 | Middle GUC |           |           |           |           |           |           | Lower GUC       |           |
|----------------------------------|----------|------|------------------------|-----------------|-----------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------------|-----------|
|                                  |          |      |                        | Source          | Discharge       | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Abstraction     | Site 16   |
|                                  |          |      |                        | Site 1          | Site 3          |            |           |           |           |           |           |           | Site 6          |           |
| Acid neutralisation capacity     | 40       | mg/l | AA                     | 33 <sup>#</sup> | 34 <sup>#</sup> | 21         | 33        | 20        | 21        | 21        | 21        | 21        | 35              | 21        |
| Benzo(a)pyrene                   | 0.00017  | µg/l | AA                     | 46              | 45              | 21         | 33        | 20        | 21        | 21        | 21        | 12        | 35              | 21        |
| BOD (5 day)                      | *        | mg/l | 90 <sup>th</sup>       | 5               | 5               | 1          | 6         | 1         | 1         | 0         | 2         | 4         | 9               | 4         |
| Bromine                          | 0.002    | mg/l | AA                     | 33              | 33 <sup>#</sup> |            |           |           |           |           |           |           |                 |           |
| Cadmium - total                  | 0.25     | µg/l | AA                     | 0               | 16              | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| Chlorothalonil                   | 0.035    | µg/l | AA                     | 1               | 1               |            |           |           |           |           |           |           |                 |           |
| Cobalt – dissolved               | 3        | µg/l | AA                     | 0               | 21 <sup>#</sup> |            |           |           |           |           |           |           |                 |           |
| Cypermethrin                     | 0.00008  | µg/l | AA                     | 36              | 5               | 4          | 2         | 2         | 3         | 5         | 10        | 10        | 14              | 10        |
| Diazinon                         | 0.01     | µg/l | AA                     | 2               | 1               |            |           |           |           |           |           |           | 0               |           |
| Dissolved oxygen                 | *        | %    | 10 <sup>th</sup>       | 5               | 8               | 8          | 10        | 5         | 1         | 0         | 6         | 2         | 6               | 3         |
| Fluoranthene                     | 0.0063   | µg/l | AA                     | 3               | 37              | 20         | 12        | 18        | 15        | 18        | 19        | 19        | 31              | 21        |
| Formaldehyde                     | 0.25     | µg/l | AA                     | 1               | 0               |            |           |           |           |           |           |           |                 |           |
| Manganese – bioavailable**       | 123      | µg/l | AA                     | 0 <sup>#</sup>  | 37              | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0 <sup>##</sup> | 0         |
| Nickel - bioavailable**          | 4        | µg/l | AA                     | 4               | 29              | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| Perfluorooctane sulfonic acid    | 0.00065  | µg/l | AA                     | 56              | 45              | 20         | 32        | 19        | 19        | 20        | 20        | 15        | 26              | 20        |
| Permethrin                       | 0.001    | µg/l | AA                     | 20 <sup>#</sup> | 1               |            |           |           |           |           |           |           |                 |           |
| Soluble reactive phosphorus      | *        | µg/l | AA                     | 34              | 7               | 18         | 12        | 5         | 5         | 16        | 10        | 3         | 29              | 19        |
| Sulphide or hydrogen sulphide    | 0.25     | mg/l | AA                     | 19              | 31              | 17         | 18        | 15        | 15        | 18        | 15        | 15        | 26              | 13        |
| Total anions                     | 250      | µg/l | AA                     | 10 <sup>#</sup> | 20 <sup>#</sup> |            |           |           |           |           |           |           | 1               |           |
| Tributyltin compounds            | 0.0002   | mg/l | AA                     | 1               | 3               | 3          | 1         | 1         | 9         | 0         | 18        | 2         | 3               | 1         |
| Zinc - bioavailable**            | *        | µg/l | AA                     | 15              | 14              | 2          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| Cadmium dissolved                | 0.25     | µg/l | AA                     | 0               | 4               | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| di(2-ethylhexyl)phthalate (DEHP) | 1.3      | µg/l | AA                     | 1               | 1               | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 1               | 1         |
| 3,4-dichloroaniline              | 1        | µg/l | AA                     | 0               | 1               |            |           |           |           |           |           |           |                 |           |
| azinphos-methyl, dissolved       | 0.2      | µg/l | AA                     | 1               | 0               |            |           |           |           |           |           |           |                 |           |
| fenitrothion                     | 0.01     | ug/l | AA                     | 0               | 1               |            |           |           |           |           |           |           |                 |           |
| malathion                        | 0.01     | ug/l | AA                     | 0               | 1               |            |           |           |           |           |           |           |                 |           |
| Triazophos                       | 0.005    | ug/l | AA                     | 0               | 1               | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0               | 0         |
| <b>Total number of samples</b>   | -        | -    | -                      | <b>45</b>       | <b>34</b>       | <b>21</b>  | <b>34</b> | <b>21</b> | <b>21</b> | <b>21</b> | <b>21</b> | <b>21</b> | <b>34</b>       | <b>21</b> |

<sup>4</sup> Blue shading indicates EQS (WFD and EQSD) exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of individual EQS exceedances is also given.

<sup>5</sup> Values in orange indicate the addition of new individual exceedances this quarter.

\*AA = Annual Average. Numbers of exceedances are shown for illustrative purposes only and reflect individual samples being compared to an AA or percentile derived EQS.

\*\* Site specific EQS determinand. \*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT) <sup>6</sup>.

<sup>#</sup> Total number of samples collected = 34 (not included in Phase 1 dataset). <sup>##</sup> Drinking water suite parameters added to this site in October 2021 so total number of samples = 24.



Table 3-2 Concentrations of compounds responsible for EQS (WFD and EQSD) exceedance<sup>2,3</sup>

| Compound                         | Standard | Unit | Stat*            | Upper GUC |           | Middle GUC |         |         |         |         |          |         | Lower GUC |         |             |
|----------------------------------|----------|------|------------------|-----------|-----------|------------|---------|---------|---------|---------|----------|---------|-----------|---------|-------------|
|                                  |          |      |                  | Source    | Discharge | Site 1     | Site 3  | Site 10 | Site 5  | Site 11 | Site 12  | Site 13 | Site 14   | Site 15 | Abstraction |
| Acid neutralisation capacity     | 40       | mg/l | AA               |           | 1812      | 2544       | 3400    | 2874    | 3620    | 4433    | 4624     | 3710    | 3319      | 3429    | 3171        |
| Benzo(a)pyrene                   | 0.00017  | µg/l | AA               |           | 0.002     | 0.015      | 0.054   | 0.006   | 0.016   | 0.019   | 0.019    | 0.028   | 0.033     | 0.023   | 0.024       |
| BOD (5 day)                      | *        | mg/l | 90 <sup>th</sup> |           | 2.66      | 2.82       | 2.76    | 3.00    | 2.59    | 2.82    | 2.52     | 4.41    | 4.15      | 4.10    | 3.49        |
| Bromine                          | 0.002    | mg/l | AA               |           | 0.204     | 1.492      |         |         |         |         |          |         |           |         |             |
| Chlorothalonil                   | 0.035    | µg/l | AA               |           | 0.044     | 0.044      |         |         |         |         |          |         |           |         |             |
| Cobalt - dissolved               | 3        | µg/l | AA               |           | 1.71      | 12.0       |         |         |         |         |          |         |           | 0.3     |             |
| Cypermethrin                     | 0.00008  | µg/l | AA               |           | 0.00026   | 0.00007    | 0.00009 | 0.00008 | 0.00014 | 0.00022 | 0.00014  | 0.00018 | 0.00025   | 0.00017 | 0.00028     |
| Diazinon                         | 0.01     | µg/l | AA               |           | 0.0106    | 0.0126     |         |         |         |         |          |         |           | 0.0100  |             |
| Dissolved oxygen                 | *        | %    | 10 <sup>th</sup> |           | 47.20     | 70.64      | 37.67   | 60.35   | 58.38   | 52.23   | 72.28    | 57.82   | 80.66     | 74.70   | 79.84       |
| Fluoranthene                     | 0.0063   | µg/l | AA               |           | 0.003     | 0.016      | 0.025   | 0.006   | 0.017   | 0.011   | 0.012    | 0.016   | 0.024     | 0.017   | 0.024       |
| Cadmium - total                  | 0.25     | µg/l | AA               |           | 0.024     | 0.383      | 0.056   | 0.024   | 0.020   | 0.021   | 0.020    | 0.022   | 0.032     | 0.037   | 0.020       |
| Formaldehyde                     | 5        | µg/l | AA               |           | 50.91     | 50.0000    |         |         |         |         |          |         |           |         |             |
| Manganese - bioavailable**       | 123      | µg/l | AA               |           | 10.3      | 1599       |         |         |         |         |          |         |           | 10      |             |
| Nickel - bioavailable**          | 4        | µg/l | AA               |           | 2.9       | 9.9        | 0.63    | 0.80    | 0.41    | 0.76    | 0.53     | 0.58    | 0.72      | 0.60    | 0.55        |
| Perfluorooctane sulfonic acid    | 0.00065  | µg/l | AA               |           | 0.87      | 0.0758     | 0.0048  | 0.0142  | 0.0073  | 0.0243  | 0.0321   | 0.0087  | 0.0012    | 0.0459  | 0.0022      |
| Permethrin                       | 0.001    | µg/l | AA               |           | 0.0023    | 0.0010     |         |         |         |         |          |         |           |         |             |
| Soluble reactive phosphorus      | *        | µg/l | AA               |           | 0.360     | 0.99       | 0.111   | 0.089   | 0.049   | 0.054   | 0.117    | 0.083   | 0.033     | 0.160   | 0.19        |
| Sulphide or hydrogen sulphide    | 0.25     | mg/l | AA               |           | 11.58     | 16.04      | 19.00   | 14.94   | 18.50   | 19.76   | 23.95    | 20.00   | 18.86     | 27.49   | 17.38       |
| Total anions                     | 250      | µg/l | AA               |           | 234       | 355        |         |         |         |         |          |         |           | 177     |             |
| Tributyltin compounds            | 0.0002   | µg/l | AA               |           | 0.00010   | 0.000091   | 0.00016 | 0.00005 | 0.00009 | 0.00024 | 0.000052 | 0.00035 | 0.00012   | 0.00015 | 0.000074    |
| Zinc - bioavailable**            | *        | µg/l | AA               |           | 14.0      | 16.4       | 7.15    | 2.02    | 1.51    | 1.62    | 1.08     | 3.01    | 1.94      | 1.78    | 1.53        |
| Cadmium dissolved                | 0.25     | µg/l | AA               |           | 0.023     | 0.218      | 0.025   | 0.020   | 0.020   | 0.020   | 0.020    | 0.020   | 0.020     | 0.025   | 0.020       |
| di(2-ethylhexyl)phthalate (DEHP) | 1.3      | µg/l | AA               |           | 0.24      | 0.26       | 0.17    | 0.16    | 0.15    | 0.15    | 0.15     | 0.15    | 0.15      | 0.19    | 1.29        |
| 3,4-dichloroaniline              | 1        | µg/l | AA               |           | 1.00      | 1.23       |         |         |         |         |          |         |           |         |             |
| azinphos-methyl, dissolved       | 0.2      | µg/l | AA               |           | 0.022     | 0.02       |         |         |         |         |          |         |           |         |             |
| fenitrothion                     | 0.01     | ug/l | AA               |           | 0.010     | 0.013      |         |         |         |         |          |         |           |         |             |
| malathion                        | 0.01     | ug/l | AA               |           | 0.020     | 0.025      |         |         |         |         |          |         |           |         |             |
| triazophos                       | 0.005    | ug/l | AA               |           | 0.020     | 0.025      |         |         |         |         |          |         |           |         |             |
| <b>Total number of samples</b>   | -        | -    | -                |           | 45        | 34         | 21      | 34      | 21      | 21      | 21       | 21      | 21        | 34      | 21          |

<sup>2</sup> Blue shading indicates EQS exceedance and grey shading indicates where failures relate to EQSD target compounds (not monitored at all sites, and as such not directly comparable across all sites). Concentrations corresponding to test statistic are also shown.

\*AA = Annual Average. \* Site specific EQS determined. \*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT)

<sup>3</sup> [Rivers & Lakes - Metal Bioavailability Assessment Tool \(M-BAT\) | wfd uktag](#)

**Table 3-3 Compounds responsible for WFD and EQSD MAC exceedances<sup>9</sup>.**

| Compound                         | Standard | Unit                 | Statistic | Upper GUC       |           | Middle GUC |           |           |           |           |           |           | Lower GUC        |           |
|----------------------------------|----------|----------------------|-----------|-----------------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|------------------|-----------|
|                                  |          |                      |           | Source          | Discharge | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Abstraction      |           |
|                                  |          |                      |           | Site 1          | Site 3    | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Site 6           | Site 16   |
| Benzo(a)pyrene                   | 0.027    | µg/l                 | MAC       | 0               | 6         | 14         | 1         | 2         | 4         | 5         | 11        | 10        | 11               | 7         |
| Benzo(b)fluoranthene*            | 0.017    | µg/l                 | MAC       | 0               |           |            |           |           |           |           |           |           | 11 <sup>##</sup> |           |
| Benzo(g,h,i)perylene*            | 0.0082   | µg/l                 | MAC       | 2               |           |            |           |           |           |           |           |           | 20 <sup>##</sup> |           |
| Benzo(k)fluoranthene*            | 0.017    | µg/l                 | MAC       | 0               |           |            |           |           |           |           |           |           | 4 <sup>##</sup>  |           |
| Bromine - total residual oxidant | 0.005    | mg/l                 | MAC       | 33 <sup>#</sup> | 33        |            | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Cadmium - dissolved              | 1.5      | µg/l                 | MAC       | 0               | 2         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Cadmium - total                  | 1.5      | µg/l                 | MAC       | 0               | 2         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Cypermethrin                     | 0.0006   | µg/l                 | MAC       | 5               | 0         | 0          | 0         | 1         | 2         | 2         | 1         | 2         | 1                | 2         |
| Formaldehyde                     | 50       | µg/l                 | MAC       | 1               | 0         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Mercury - dissolved              | 0.07     | µg/l                 | MAC       | 2               | 1         | 2          | 1         | 2         | 1         | 1         | 2         | 1         | 2                | 2         |
| Mercury - total                  | 0.07     | µg/l                 | MAC       | 2               | 2         | 2          | 2         | 2         | 1         | 1         | 2         | 2         | 2                | 2         |
| Nickel - dissolved               | 34       | µg/l                 | MAC       | 2               | 16        | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Sulphide or hydrogen sulphide    | 1        | µg/l                 | MAC       | 19              | 31        | 17         | 18        | 15        | 15        | 18        | 15        | 15        | 26               | 13        |
| Tributyltin compounds            | 0.02     | µg/l                 | MAC       | 2               | 2         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| Maneb                            | 30       | µg/l CS <sub>2</sub> | MAC       | 1               | 0         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0                | 0         |
| <b>Total number of samples</b>   | -        | -                    | -         | <b>45</b>       | <b>34</b> | <b>21</b>  | <b>34</b> | <b>21</b> | <b>21</b> | <b>21</b> | <b>21</b> | <b>21</b> | <b>34</b>        | <b>21</b> |

<sup>9</sup> Blue shading indicates MAC EQS exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of exceedances also given. Orange highlighting indicates exceedances this quarter.

\* While these determinands have a MAC, as per the WFD there is no corresponding AA statistic as benzo(a)pyrene should be considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water.

# Total number of samples collected = 31 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 24.



### 3.1.3 Source water and canal section comparisons

In this section the quality of treated effluent discharged from Minworth WwRC is directly compared with all respective sections of the GUC. The key changes identified this quarter are discussed below.

#### 3.1.3.1 Minworth vs. GUC Upper Section (Site 3)

The majority of substances which exceeded EQS at Minworth also exceed at Site 3, the example discharge location (Atherstone). Exceptions include chlorothalonil, cypermethrin, dissolved oxygen, diazinon, formaldehyde and azinphos methyl, dissolved which do not exceed AA EQS at Site 3. This suggests these parameters may be at increased risk of EQS exceedance in-canal if discharge from Minworth is received without additional treatment. While permethrin and SRP have exceeded EQS on occasion, these occur more frequently in the Minworth WwRC final effluent suggesting EQS failures would become more likely without additional treatment. By contrast, cobalt - dissolved, fluoranthene, manganese and nickel (bioavailable), sulphide or hydrogen sulphide, total anions, cadmium – total, 3,4-dichloroaniline, fenitrothion, malathion and triazophos exceed EQS at Site 3 with no exceedances observed in the Minworth WwRC final effluent, suggesting a wider catchment source. The introduction of a Minworth discharge could reduce concentrations in the GUC.

#### 3.1.3.2 Minworth vs. GUC Middle Section (Sites 5,10,11,12,13,14 and 15)

The following substances exceeded EQS in Minworth WwRC discharge but do not currently exceed EQS at any site in the Middle section of the GUC:

- Zinc - bioavailable

The following substances exceed EQS in the Minworth WwRC discharge but are not currently monitored under the currently agreed monitoring suites in the Middle Section of the GUC:

- Bromine - total residual oxidant
- Chlorothalonil
- Cobalt - dissolved
- Formaldehyde
- Permethrin

These substances may be at risk of exceeding their respective EQS should a Minworth WwRC discharge be introduced in the Upper GUC depending on in-canal concentrations, however this is currently unknown due to lack of data.

Site 12 and 13 are the only sites where BOD has not exceeded the annual average EQS. SRP exceeds EQS at Sites 10, 5, 13 and 14. Given SRP has regularly exceeded at these sites they are at risk from the introduction of Minworth discharge. Tributyltin (TBT) compounds continue to exceed at the Middle GUC sites 12 and 14 with new detections above EQS at Sites 10, 12 and 14. There were no additional detections at Minworth WwRC suggesting a wider catchment source. TBT was historically used as an antifouling agent in paints and binds strongly to sediments and bioaccumulates in biota. As such this may be present and easily released in a canal when sediment is disturbed.

#### 3.1.3.3 Minworth vs. GUC Lower Section (Sites 6 and 16)

Dissolved oxygen exceeded annual average EQS this quarter at Site 6. The following substances in the Minworth discharge do not currently exceed EQS at any site in the Lower section:

- Diazinon
- Cadmium - total
- Tributyltin compounds



- Nickel – bioavailable
- Zinc – bioavailable

The following substances exceed EQS in the Minworth WwRC discharge but are not monitored in the Lower GUC:

- Bromine - total residual oxidant
- Chlorothalonil
- Formaldehyde
- Permethrin
- azinphos-methyl, dissolved

These substances are most at risk from deterioration following the introduction of a Minworth WwRC discharge to the GUC, noting that for the second list, their current status in the GUC against WFD EQS is unknown due to lack of monitoring data.

## 3.2 Continuous monitoring data

### Notable sonde changes in the last quarter (October 2023 – December 2023)

Below are key changes in the last quarter of data, these events are described in detail in subsequent section (3.2.1 to 3.2.7).

**Temperature** - Temperatures decreased during this period at all sites as we moved from autumn to winter.

**Conductivity** - Reductions in conductivity were observed at Site 1 (Minworth WwRC) and Site 6 following most rainfall events.

**Dissolved Oxygen** – There were no notable changes to Dissolved oxygen saturation this quarter.

**pH** - No notable changes in quarter. A calibration error occurred between late October and late November at Site 16 at Marsworth.

**Ammonium** – Ammonium peaked at Sites 1 (Minworth WwRC) following most rainfall events throughout the period. There was also a notable peak at Site 6 around the 14<sup>th</sup> October during a rainfall event between the 13<sup>th</sup> and 15<sup>th</sup> October.

**Turbidity** – Peaks in turbidity at Site 1 (Minworth WwRC) are linked to rainfall, notably around 10<sup>th</sup> October and 5<sup>th</sup> and 10<sup>th</sup> December.

**Chlorophyll** – Decreasing concentrations low at all sites from mid October.

Rainfall data used for Marsworth appears to contain errors between mid to late November. However, this has been included for completeness as this data is currently reported by the EA.

This section describes patterns observed in parameters monitored by the continuous sondes and highlights any noteworthy changes observed in the reporting period. Running means of all historical continuous monitoring data along with this quarters averages (means) for each sampling location and parameters are provided in Table 3-14. Symbols (increase '↑', decrease '↓' and no change '–') indicate the in period mean relative to the long-term mean. The in quarter continuous sonde data collected can be seen for all sites in Figure 3-1 to Figure 3-4.



## 3.2.1 Temperature

Over the monitoring period, temperatures typically range from 9-22°C in the Minworth discharge. By contrast the canal at Atherstone ranges from 4-23°C. Temperatures between Minworth and Atherstone are similar in summer months however the Minworth discharge is up to 8°C warmer than the canal in winter. As there is potentially a risk of a >3°C temperature increase in the receiving waterbody due to the temperature differences seen at this time of year, appropriate considerations must be made at the design stage to reduce potential impacts to fish<sup>4</sup>.

This quarter, temperatures were highest at Site 1 (Minworth WwRC) measuring 15.3°C. In the canal itself the highest temperature was Site 16 with 10.1°C and lowest at Site 3 with 9.3°C. Temperatures at Site 1 (Minworth WwRC) decreased across the monitoring period with the same observed in the GUC itself as the seasons progressed from autumn to early winter. This quarter, temperatures at all sites were cooler on average than last quarter. All sites were below the thresholds for fish stress.

## 3.2.2 Conductivity

Conductivity is a measure of the ability of a water body to conduct an electrical charge and reflects the concentration of ions in solution (e.g., sodium, calcium etc). Instream conductivity is primarily controlled by underlying geology. Temporary increases and reductions in conductivity can be observed in response to pulses of mineral rich material from catchment sources (e.g., agricultural runoff). Conversely, instream reductions in conductivity can occur when rainfall/runoff from the surrounding area results in an instream dilution. Long term increases in conductivity, above what would be considered typical for a particular catchment can be indicative of nutrient enrichment from the surrounding landscape from point (e.g., STW) or diffuse (e.g., agricultural) sources.

Conductivity in the GUC was greatest at Site 6 (616  $\mu\text{S cm}^{-1}$ ) and lowest at Site 3 (584  $\mu\text{S cm}^{-1}$ ). The Minworth WwRC discharge measured 679  $\mu\text{S cm}^{-1}$ . There was a strong response to rainfall at Site 6 with notable reduction in conductivity following most rainfall events.

## 3.2.3 Dissolved oxygen

Dissolved Oxygen (DO), typically reported in percent saturation (%) or concentration (mg/l) describes the amount of oxygen that is dissolved in water. It is essential for aquatic life, with low DO saturation resulting in anoxia and subsequent fish kills and is associated with the development of eutrophic conditions. The pattern of DO saturation in watercourses varies seasonally. A typically well aerated river or stream will have a DO % saturation of ~100%. Canals typically experience lower DO saturation than rivers. This is partly due to the slow flowing nature of canals and lack of natural aeration from turbulent water as it travels downstream. Diurnal variability is highest during the summer months driven largely by photosynthesis-respiration dynamics. DO can however, exceed 100% instream due to the production of oxygen from photosynthetic aquatic organisms and non-ideal equilibration of dissolved oxygen between the water and the air above it.

This quarter, average dissolved oxygen saturation measured highest at Site 6 (85.1%) while measuring lowest at Site 1 (Minworth WwRC) at 51.1%, this was a slight reduction relative to last quarter for Site 1. All sites were comparable to their long-term means.

## 3.2.4 pH

The pH of a watercourse is a measure of how acidic or basic the water is. The pH is mainly driven by geology (and resultant soil type) however, can be influenced by catchment factors such as pollutant discharges and the leaching of soil horizons under differing flow conditions. As pH is recorded on a logarithmic scale, slight changes in pH can have significant impacts on the organisms that live in a watercourse. The optimum pH for water to sustain fish and invertebrate life, is between 6 to 9. Across all sites, pH was within acceptable limits for fish and invertebrates. It

<sup>4</sup> The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 Part 1, Section 1 (6)



should be noted that pH at Minworth WwRC (6.7) is more acidic (lower) than the example discharge location at Site 3 (7.4). The example abstraction location at Site 6 as well as Site 16 are slightly more basic measuring 7.9 each. This suggests pH may decrease along the proposed transfer route.

This quarter, all sites measured comparably to their long-term means. Mean pH was lowest in the Minworth WwRC discharge (Site 1) at 6.7. In the canal, Site 3 measured the lowest at 7.5 while highest at Site 16 with a pH of 8.0.

### 3.2.5 Ammonium

Ammonium is a type of nitrogenous compound that is naturally present in water but can also be released into rivers from a variety of sources, including agricultural runoff, sewage treatment and industrial wastewater discharges. High concentrations of ammonium in rivers can be harmful to aquatic life, particularly fish, as it can disrupt their metabolism and respiration. This is most toxic to fish in the form of ammonia. In some cases, it can even be fatal. Ammonium can also contribute to the formation of algal blooms, which can further degrade water quality and make it unsafe for drinking, swimming, and fishing. Average ammonium concentrations were highest at Site 1 (Minworth WwRC) and lowest at the example discharge location (Site 3 Atherstone).

Ammonium peaked at Sites 1 and 6 on 13<sup>th</sup> October measuring 7.1 mg/l at Site 1 (Minworth WwRC) and 1.4 mg/l at Site 6. Several other peaks in concentrations were noted at Site 1 this quarter. These appear to be driven by corresponding rainfall. When compared to laboratory derived concentrations, in-situ measurements of ammonium commonly miss report ammonium concentrations at higher concentrations without regular calibration. As such, it is important to use this data to infer catchment trends rather than absolute concentrations.

### 3.2.6 Turbidity

Turbidity is a measure of how cloudy water is and can be used as a proxy for suspended sediment concentrations. It is caused by the presence of suspended particles in the water, such as sediment, algae, or other organic matter. Turbidity can make it difficult for sunlight to penetrate the water, which can reduce the amount of photosynthesis that takes place. A high loading of suspended sediment, when combined with reduced flow velocities can result in sediment deposition causing damage to macrophytes and reducing hydrological exchanges with river bed and surrounding groundwater. Increased sediment loading can result in the unintended substance transport. For example, the dominant form of phosphorus exported from agricultural systems is particulate phosphorus, which when exported from the terrestrial to aquatic systems has the potential to desorb and become available to in stream heterotrophic organisms.

Increases in turbidity can be caused by a number of factors, including erosion, runoff from agricultural fields following poor land and soil management practises, stormwater runoff and point source pollution, such as from sewage treatment plants. Turbidity values are typically highest at Site 1 (Minworth WwRC) measuring 43.6 NTU on average. At the example discharge location (Site 3), the average is 27.2 NTU. The lowest mean turbidity value is recorded at Site 3 measuring 8.3 NTU.

During this quarter turbidity was low across most sites with regular turbidity spikes at Site 3 and 6. Three notable turbidity peaks occurred at Site 1 (Minworth WwRC) occurring on 13<sup>th</sup> October (1398 NTU), 4<sup>th</sup> (808 NTU) and 6<sup>th</sup> December (1082 NTU). At Site 3 (Atherstone) base line turbidity values seem to increase following peaks associated with rainfall. This is most notable around 20<sup>th</sup> October and 5<sup>th</sup> December 2023, suggesting that inputs into the canal at this location affect turbidity values for a period of time after.

Historically, turbidity spikes occur across all sites following rainfall events. Average concentrations increased at Site 16 (Marsworth) this quarter but were below the long term average for this site. The reason for this increase is unknown.



### 3.2.7 Chlorophyll

Chlorophyll is a green pigment found in algae and plants. It is essential for photosynthesis, the process by which plants convert sunlight into energy. Chlorophyll can be used as a measure of the quantity of algae in a river. Higher levels of chlorophyll indicate more algae, which can lead to problems such as algal blooms, decreased oxygen levels, and the production of toxins. There are a number of factors that can affect the level of chlorophyll in a river, including nutrient levels, sunlight levels, temperature and flow. Chlorophyll concentrations are generally highest at Site 6 and have been observed to peak with a number of algal blooms events observed during the Spring and Summer months.

Recent data collected covering October to December 2023 falls within the usual levels monitored during the late autumn/early winter period. Algal activity this quarter was very low as this falls outside the typical algal bloom period.



Table 3-4 - Overall mean and quarterly mean values observed at continuous monitoring locations

| Determinand      | Unit                | 1. Minworth WwRC Final Effluent <sup>1</sup> |                |                  | 3. GUC at Atherstone <sup>2</sup> |                |                  | 6. GUC at Grove, Leighton Buzzard <sup>3</sup> |                |                  | 16. GUC at Marsworth <sup>2</sup> |                |                  |
|------------------|---------------------|--|----------------|------------------|-----------------------------------|----------------|------------------|--|----------------|------------------|-----------------------------------|----------------|------------------|
|                  |                     | Overall Mean                                 | Quarterly Mean | Change in period | Overall Mean                      | Quarterly Mean | Change in period | Overall Mean                                   | Quarterly Mean | Change in period | Overall Mean                      | Quarterly Mean | Change in period |
| Temperature      | °C                  | 16.2   | 15.3           | ↓                | 12.5                              | 9.3            | ↓                | 12.1   | 9.78           | ↓                | 14.1                              | 10.1           | ↓                |
| Conductivity     | µS cm <sup>-1</sup> | 771  | 679            | ↓                | 1068                              | 584            | ↓                | 631  | 616            | ↑                | 561                               | 586            | ↑                |
| Dissolved Oxygen | %                   | 53.4   | 51.1           | ↓                | 78.3                              | 79.2           | ↑                | 81.6   | 85.1           | ↑                | 96.6                              | 82             | ↑                |
| pH               | pH units            | 6.71   | 6.68           | —                | 7.44                              | 7.45           | —                | 7.87   | 7.91           | —                | 7.9                               | 8.00           | —                |
| Ammonium         | mg N/l              | 1.89   | 1.51           | ↓                | 0.42                              | 0.23           | ↓                | 0.50   | 0.36           | ↓                | 0.40                              | 0.35           | ↑                |
| Turbidity        | NTU                 | 43.6   | 16.1           | ↓                | 27.2                              | 29.3           | ↑                | 31.6   | 31.5           | ↑                | 4.28                              | 3.0            | ↓                |
| Chlorophyll      | µg/l                | -  | -              |                  | 8.3                               | 4.99           | ↓                | 27.9   | 11.4           | ↓                | 11.0                              | 4.7            | ↓                |

<sup>1</sup> Site 1 (Minworth WwRC) sonde data monitoring for conductivity, temperature, and dissolved oxygen commenced at the start of Phase 2 monitoring on 18/05/2022.

Additional parameters including pH, ammonium, and turbidity were added on 05/04/2022.

<sup>2</sup> Site 3 and Site 16 sondes were deployed on 11/05/22 and 24/05/22 respectively.

<sup>3</sup> Site 6 sonde was deployed on 25/11/21.



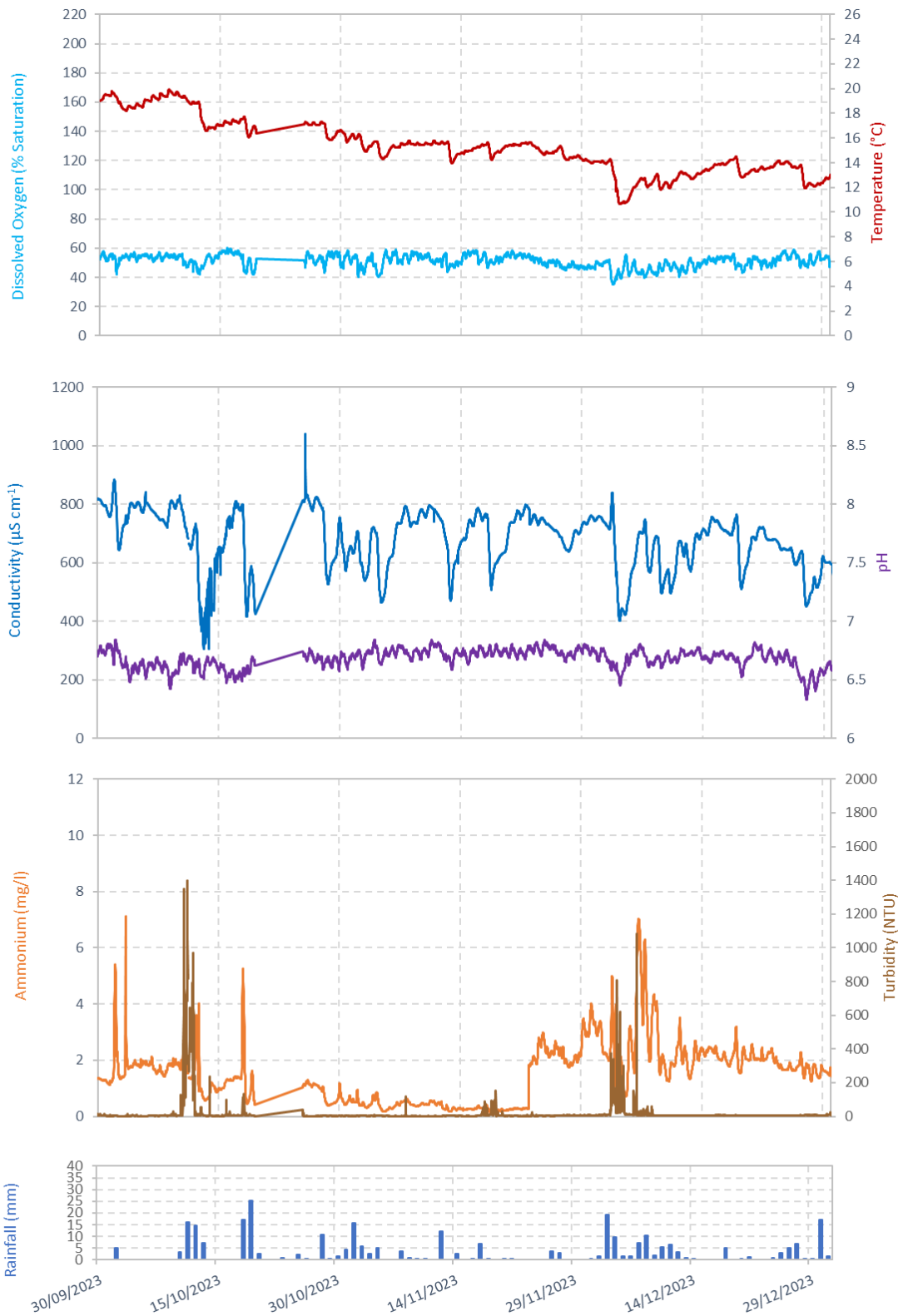
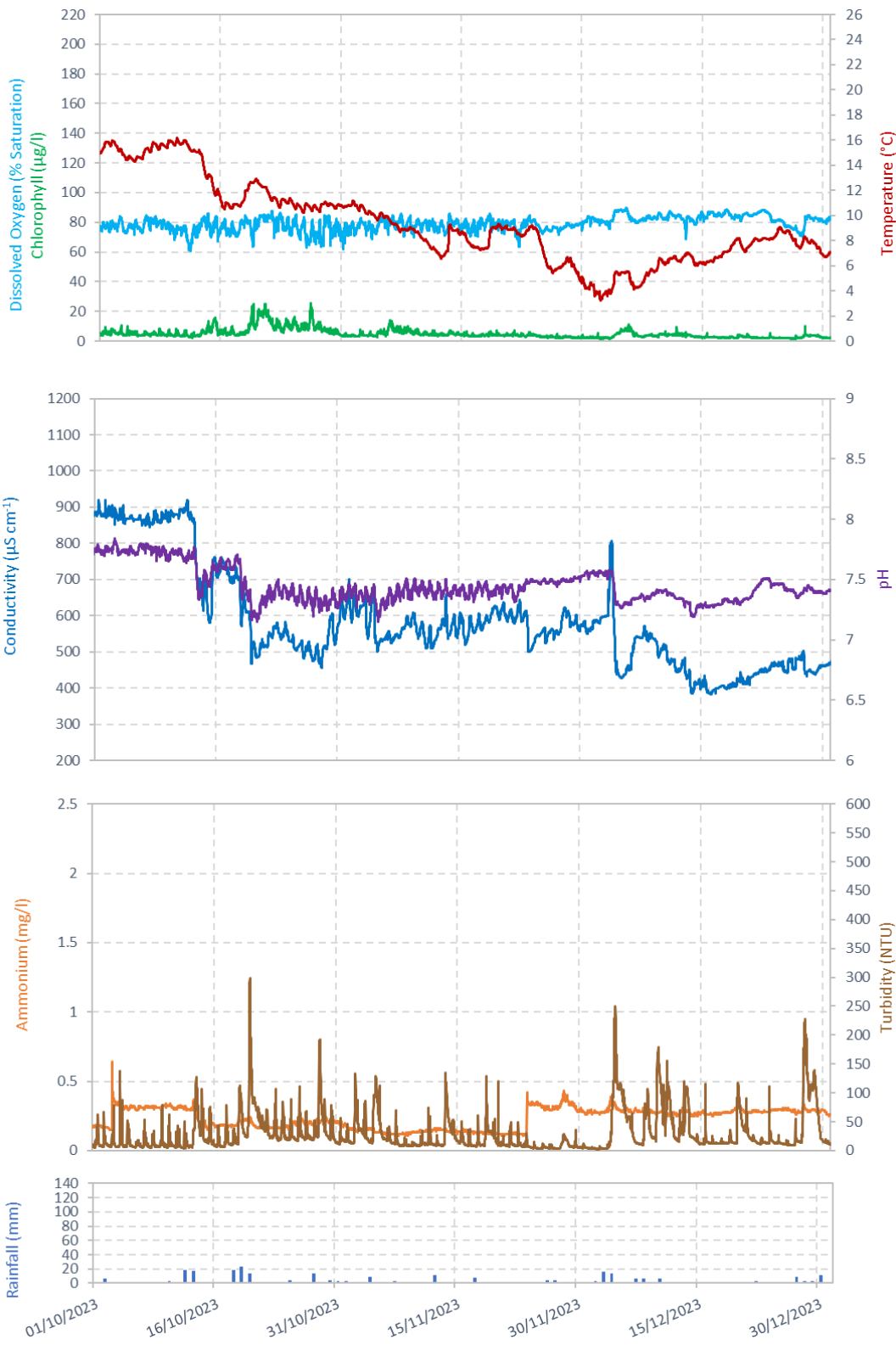
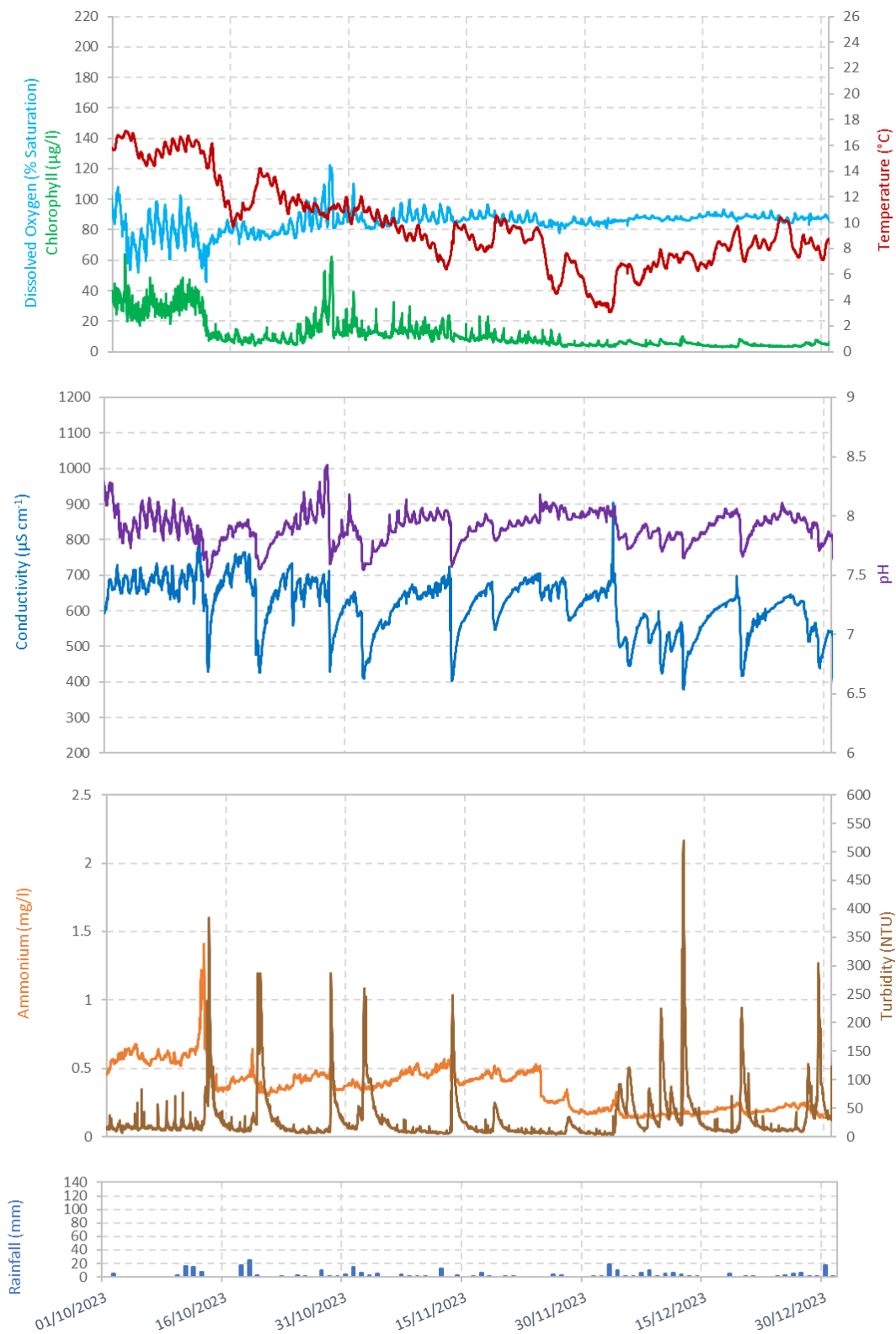


Figure 3-1 – Continuous sonde data collected between 01/10/2023 to 31/12/2023 at Site 1 (Minworth WwRC).



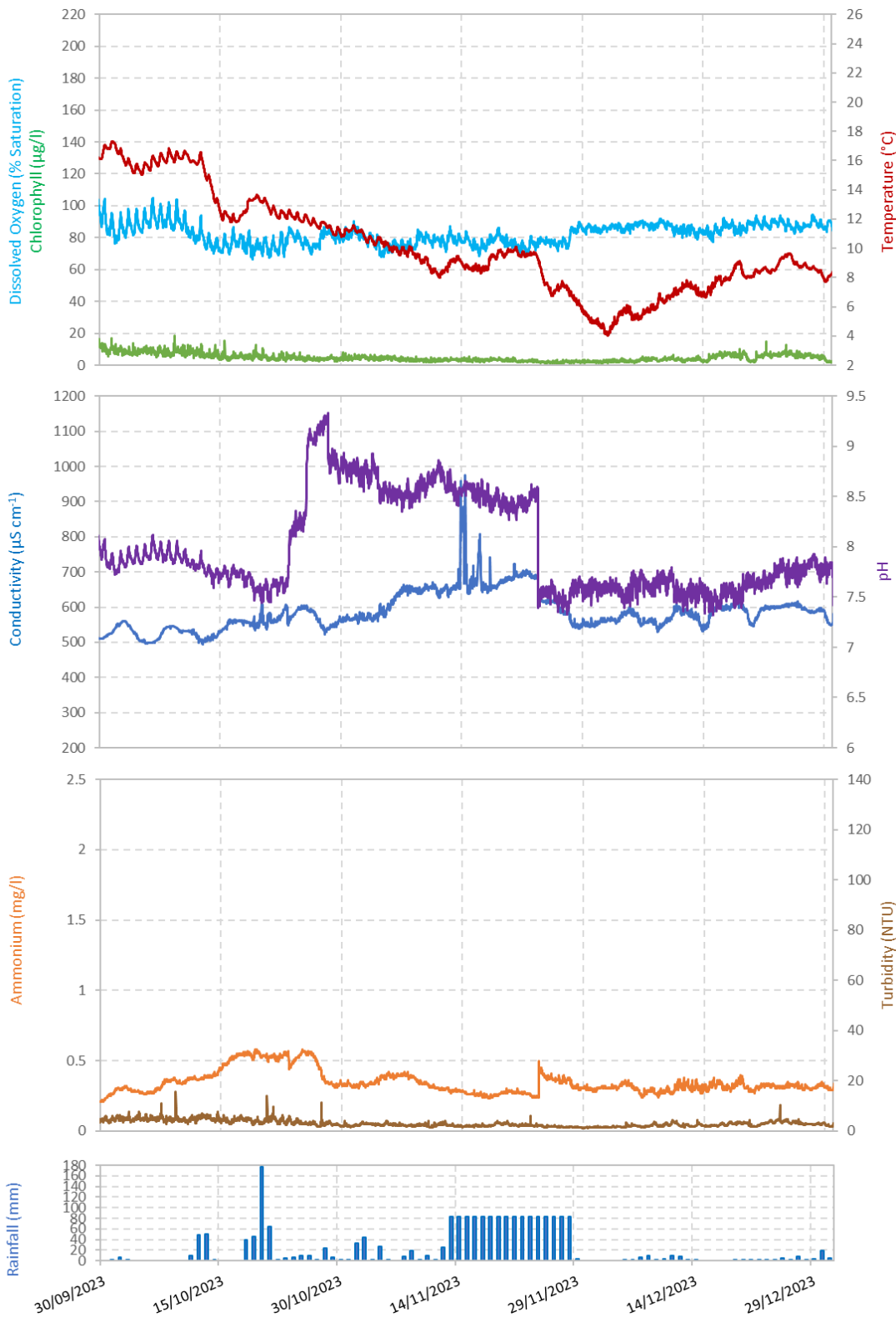
**Figure 3-2 – Continuous sonde data collected between 01/10/2023 to 31/12/2023 at Site 3 (GUC at Atherstone).**





**Figure 3-3 – Continuous sonde data collected between 01/10/2023 to 31/12/2023 at Site 6 (GUC Leighton Buzzard).**





**Figure 3-4 – Continuous sonde data collected between 01/10/2023 to 31/12/2023 at Site 16 (GUC at Marsworth).**



## 3.3 Spot sample drinking water quality standards comparison

### 3.3.1 Overview

Drinking water parameter analysis, assessed through their comparison to Prescribed Concentration Values (PCVs) is only undertaken to characterise the source water at Minworth WwRC (Site 1) and the downstream abstraction location (Site 6 Leighton Buzzard). A total of 23 months of DWSP data are available for Site 6 compared to 41 months at Site 1 (Minworth WwRC). This is a result of the site selection process for the example abstraction location.

It should be noted that the PCV standards are being applied to raw 'untreated' water where typically they would apply at the point of use e.g., a customer's tap. This had been undertaken to provide guidance on which substances may require targeted treatment when abstraction is operational. PCV exceedances in wastewater discharge and an operational canal are therefore expected.

### 3.3.2 Exceedances to date

At Site 1 (Minworth WwRC) 325 exceedances out of 3,434 results have been recorded to date. At Site 6, 239 PCV exceedances have been recorded out of 2,610 results. The distribution of these is detailed in Table 3-5. Several determinands exceeded PCVs in every, or almost every, sampling round. These determinands, along with the number of exceedances observed at Site 6 (the example abstraction location), are given below. It must be noted that these standards are applicable to drinking water at the point of consumption, and these are effluent (Minworth) and surface water (Atherstone) sites.

- Benzo(a)pyrene (total exceedances = 24)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 61)
- *Escherichia coli* (*E. coli*, total exceedances = 60)
- Iron – total (total exceedances = 36)
- Manganese dissolved (total exceedances = 34)
- Manganese total (total exceedances = 40)
- Nitrite (total exceedances = 27)
- Turbidity (total exceedances = 56)

*C. perfringens* (a sulphite-reducing species commonly associated with faecal contamination) is widely distributed in the environment and is regularly evaluated with the aim of understanding the microbiological safety of drinking water supplies. Ingestion of *C. perfringens* can result in gastrointestinal disease, and *C. perfringens* spores can persist longer than other indicators of contamination, such as Coliforms (which also demonstrated exceedances at all sites and is also an important indicator of faecal contamination). Sources of bacterial contamination can range from the input of animal manures from farmyard runoff and the discharge of untreated, and even treated, sewage effluent.



*Cryptosporidium* was not detected at either site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward.

Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores. However, as canal networks often have shallow depths (<6ft), short lived events may be a result of localised disturbance of sediments by boats or wildlife causing disturbance in the vicinity of the sensor location.

**Table 3-5 – Number of drinking water PCV exceedances**

| Compound   | PCV  | Unit                    | Source    |           |
|--|------|-------------------------|-----------|-----------|
|  |      |                         | Site 1    | Site 6    |
| Aluminium – dissolved  | 200  | µg/l                    | 0         | 3         |
| Aluminium – total  | 200  | µg/l                    | 0         | 16        |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l as NH <sub>4</sub> | 3         | 3         |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 1         | 23        |
| Bisphenol A  | 2.5  | µg/l                    | 9         | 0         |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml                | 34        | 27        |
| Chlorate   | 0.25 | mg/l                    | 4         | 0         |
| Chloride   | 250  | mg/l                    | 1         | 0         |
| Chlorite   | 0.25 | µg/l                    | 0         | 13        |
| Chromium – total   | 50   | µg/l                    | 1         | 0         |
| Clopyralid   | 0.1  | µg/l                    | 1         | 0         |
| Coliform – total   | 0    | MPN/100ml               | 34        | 26        |
| Colour   | 20   | mg/Pt/Co                | 25        | 3         |
| <i>E. coli</i>   | 0    | MPN/100ml               | 35        | 26        |
| Iron – dissolved   | 200  | µg/l                    | 0         | 3         |
| Iron total   | 200  | µg/l                    | 8         | 28        |
| Manganese – dissolved  | 50   | µg/l                    | 33        | 1         |
| Manganese – total  | 50   | µg/l                    | 34        | 6         |
| Mercury – total  | 1    | µg/l                    | 1         | 0         |
| Metribuzin   | 0.1  | µg/l                    | 0         | 2         |
| Nickel – dissolved   | 20   | µg/l                    | 9         | 0         |
| Nickel – total   | 20   | µg/l                    | 10        | 0         |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 25        | 2         |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 27        | 10        |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | 0         | 4         |
| PAH sum*   | 0.1  | µg/l                    | 0         | 11        |
| Propyzamide  | 0.1  | µg/l                    | 1         | 0         |
| Sodium – dissolved   | 200  | mg/l                    | 0         | 1         |
| Sulphate   | 250  | mg/l SO <sub>4</sub>    | 0         | 1         |
| Tebuconazole   | 0.1  | µg/l                    | 0         | 1         |
| Turbidity  | 1    | NTU                     | 29        | 27        |
| Vinyl chloride   | 0.5  | µg/l                    | 0         | 1         |
| <b>Total samples</b>   |      |                         | <b>46</b> | <b>34</b> |

Orange text indicates an indicates new PCV exceedances this quarter.

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

\*\* Data at Site 1 (Minworth WwRC) covers May 20 – September 23 and data at Site 6 covers April 21 – September 23.

# Total number of samples collected = 46 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 34.



**Table 3-6 – Maximum concentrations of compounds responsible for drinking water PCV exceedances<sup>5</sup>**

| Compound   | PCV  | Unit                    | Source    |           |
|--|------|-------------------------|-----------|-----------|
|  |      |                         | Site 1    | Site 6    |
| Aluminium - dissolved  | 200  | µg/l                    | 66.0      | 67.00     |
| Aluminium - total  | 200  | µg/l                    | 125.0     | 530.00    |
| Ammonium as NH <sub>4</sub>  | 0.5  | mg/l as NH <sub>4</sub> | 1.2       | 1.5       |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 0.02      | 0.13      |
| Bisphenol A  | 2.5  | µg/l                    | 137.0     | <0.01**   |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml                | 100.0     | 1000.0    |
| Chlorate   | 0.25 | mg/l                    | 2.0       | 0.7       |
| Chloride   | 250  | mg/l                    | 610.0     | 91.0      |
| Chlorite   | 0.25 | µg/l                    | 3.0       | 15.0      |
| Chromium - total   | 50   | µg/l                    | 140.0     | 15.0      |
| Clopyralid   | 0.1  | µg/l                    | 0.2       | 0.03      |
| Coliform - total   | 0    | MPN/100ml               | 2420.0    | 2420.0    |
| Colour   | 20   | mg/Pt/Co                | 43.0      | 26.0      |
| <i>E. coli</i>   | 0    | MPN/100ml               | 2420.0    | 2420.0    |
| Iron - dissolved   | 200  | µg/l                    | 100.0     | 1700.0    |
| Iron total   | 200  | µg/l                    | 310.0     | 2600.0    |
| Manganese - dissolved  | 50   | µg/l                    | 130.0     | 120.0     |
| Manganese - total  | 50   | µg/l                    | 160.0     | 360.0     |
| Mercury - total  | 1    | µg/l                    | 3.7       | 0.7       |
| Metribuzin   | 0.1  | µg/l                    | 0.1       | 0.2       |
| Nickel - dissolved   | 20   | µg/l                    | 61.0      | 7.1       |
| Nickel - total   | 20   | µg/l                    | 61.0      | 9.4       |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 120.0     | 100.0     |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 3.6       | 2.5       |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | N/A       | 0.4       |
| PAH sum*   | 0.1  | µg/l                    | 0.1       | 0.6       |
| Propyzamide  | 0.1  | µg/l                    | 0.3       | 0.1       |
| Sodium - dissolved   | 200  | mg/l                    | 78.0      | 510.0     |
| Sulphate   | 250  | mg/l SO <sub>4</sub>    | 180.0     | 690.0     |
| Tebuconazole   | 0.1  | µg/l                    | 0.1       | 0.2       |
| Turbidity  | 1    | NTU                     | 15.0      | 210.0     |
| Vinyl chloride   | 0.5  | µg/l                    | 0.5       | 1.0       |
| <b>Total number of samples</b>   |      |                         | <b>40</b> | <b>28</b> |

\* Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).

\*\* LoD reduced to 0.01 µg/l from April 2022 onwards.

<sup>5</sup> Dark blue shading indicates PCV exceedance, maximum reported concentrations are shown.



### 3.3.3 Source water/canal section comparison

#### Notable concentration changes in the last quarter (October 2023 – December 2023).

This quarter there were no additional substances exceeding PCV at any site.

- Turbidity exceeds PCV (1 NTU) at Minworth WwRC by a larger margin this quarter measuring 16 NTU (previously 14 NTU).

#### 3.3.3.1 Minworth vs. example abstraction location (Site 6)

The following substances were found to have concentrations above their respective PCVs in the Minworth WwRC final effluent, however, were below PCVs in-canal at Site 6 (GUC at Grove, Leighton Buzzard). While it is beyond the scope of this report to infer if an instream PCV exceedance would occur at Site 6 if effluent discharge were re-directed into the GUC, these compounds of note should be subject to future analysis.

- Bisphenol A
- Chlorate
- Chloride
- Chromium – total
- Clopyralid
- Mercury – total
- Nickel – bioavailable
- Nickel – total
- Propyzamide

Bisphenol A and chlorate measured above PCV at Minworth but below PCV at Site 6 noting the LoD for Bisphenol A is higher than the PCV. As such, concentrations in the canal cannot currently be accurately assessed against the discharge, however, values are assumed low at present. Chloride exceeds PCV concentration at Minworth with 91 µg/l on average while measuring 38 µg/l on average (max 91 µg/l) at Site 6. This suggests concentrations were well below the PCV of 250 µg/l but could be at risk of deterioration if a Minworth discharge were introduced. Chlorite by contrast exceeded PCV at Site 6 measuring 15 µg/l. Chromium (total) exceeded PCV at Minworth WwRC at 140 µg/l while measuring a maximum of 15 µg/l at Site 6. This is below the PCV of 50 µg/l. Concentrations in the canal could be at risk of exceedance following introduction of a Minworth discharge given the PCV is exceeded by a significant margin. Clopyralid exceeded PCV (0.1 µg/l) this quarter measuring 0.19 µg/l at Minworth WwRC while being well below PCV at Site 6 (0.02 µg/l). There may be some risk to in-canal concentrations from a Minworth discharge. Mercury (total) at Site 6 was only slightly below the PCV of 1 µg/l (mean = 0.71 µg/l). This substance may be at risk of PCV exceedance following the introduction of a Minworth discharge given the high discharge concentrations (3.7 µg/l). Mean concentrations of nickel (total and dissolved) were both close to exceeding the PCV of 20 µg/l at Site 6. Consequently, these substances are highly likely to exceed PCV following a Minworth discharge. Mean concentrations of propyzamide exceed the PCV of 0.1 µg/l at Minworth WwRC but did not at Site 6. There is moderate risk to the propyzamide PCV being breached at Site 6 following a Minworth discharge. These substances may be influenced at Site 6 with the addition of the Minworth discharge and as such, in the absence of additional treatment at Minworth WwRC, these substances may require additional treatment following abstraction.



# CONCLUSIONS



## 4. Conclusions

At present, the following determinands demonstrated the greatest number of WFD AA EQS exceedances on an individual sample basis across all sampling rounds to date and pose a potential risk at the discharge location:

- **Minworth WwRC** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - ANC (a total of 33 individual occurrences)
  - Benzo(a)pyrene (a total of 46 individual occurrences)
  - BOD - 5-day (a total of 5 individual occurrences)
  - Dissolved Oxygen (a total of 24 individual occurrences)
  - Cypermethrin (a total of 36 individual occurrences)
  - PFOS (a total of 56 individual occurrences)
  - SRP (a total of 34 individual occurrences)
  - Sulphide or hydrogen sulphide (a total of 19 individual occurrences)
  - Zinc – bioavailable (a total of 19 individual occurrences)
  
- **GUC**
  - ANC (10 sites, a total of 248 individual occurrences)
  - Benzo(a)pyrene (10 sites, a total of 259 individual occurrences)
  - BOD - 5-day (6 sites, a total of 33 individual occurrences)
  - Dissolved Oxygen (6 sites, a total of 49 individual occurrences)
  - Fluoranthene (10 sites, a total of 210 individual occurrences)
  - PFOS (10 sites, a total of 236 individual occurrences)
  - SRP (7 sites, a total of 183 individual occurrences)
  - Sulphide or hydrogen sulphide (10 sites, a total of 138 individual occurrences)

In addition, the following determinands exceeded WFD / EQSD MAC values:

- **Minworth WwRC** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - Sulphide or hydrogen sulphide (total individual exceedances = 19)
  - Bromine - total residual oxidant (total individual exceedances = 33)
  - Nickel - dissolved (total individual exceedances = 2)
  - Cypermethrin (total individual exceedances = 5)
  - Formaldehyde (total individual exceedances = 1)
  - Mercury - dissolved (total individual exceedances = 2)
  - Mercury - total (total individual exceedances = 2)
  - Triphenyltin compounds (as triphenyltin cation) (total individual exceedances = 2)
  - Maneb (total individual exceedances = 1)
  - benzo(g,h,i)perylene (total individual exceedances = 2)



- **GUC**

- Benzo(a)pyrene (total individual exceedances = 71)
- Benzo(b)fluoranthene (total individual exceedances = 11)
- Benzo(g,h,i)perylene (total individual exceedances = 20)
- Benzo(k)fluoranthene (total individual exceedances = 4)
- Cadmium total (total individual exceedances = 2)
- Cadmium dissolved (total individual exceedances = 2)
- Sulphide or hydrogen sulphide (total individual exceedances = 183)
- Bromine - total residual oxidant (total individual exceedances = 30)
- Nickel - dissolved (total individual exceedances = 16)
- Cypermethrin (total individual exceedances = 12)
- Mercury - dissolved (total individual exceedances = 15)
- Mercury - total (total individual exceedances = 18)
- Triphenyltin compounds (as triphenyltin cation) (total individual exceedances = 2)

Some concentrations in the Minworth WwRC effluent were greater than the EQS in the receiving water at Site 3, Coventry Canal, Atherstone (noting these standards do not directly apply to effluent and discharge standards are set through the permitting regime). These include chlorothalonil (an organic fungicide), cypermethrin (a synthetic pyrethroid), diazinon, formaldehyde, benzo(g,h,i)perylene, azinphos methyl, dissolved and dissolved oxygen. As a result, if Minworth WwRC final effluent was diverted to the example discharge location without any additional treatment applied, additional in-canal exceedances may occur, resulting in a future WFD compliance risk as the new discharge would affect 'No deterioration' criteria and prevent the water quality of the receiving body from achieving Good Status in future. Benzo(g,h,i)perylene was identified above the MAC EQS at Site 1 (Minworth WwRC) for the first time but did not exceed the annual average. Further assessment is required to determine the level of confidence if this is indeed the case (e.g., through modelling or pairwise assessment of samples). Additional treatment or other removal at works will be required in order to provide a resolution to this issue.

Minworth WwRC treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of these potential 'high risk' compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permitting risk (e.g., due to within class deterioration).

As discussed in Section 3.3.1, PCVs apply only to treated drinking water, and not raw source waters. However, the monitoring of these determinands and regular comparison with drinking water standards enables a threshold for screening out determinands that may be considerably elevated in raw water, thus helping to inform treatment design and inform Drinking Water Safety Plans at the example abstraction location. With that in mind, the following determinands are currently routinely exceeding PCV targets at Site 6.

- Benzo(a)pyrene (total exceedances = 23)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 27)
- *Escherichia coli* (*E. coli*, total exceedances = 26)
- Iron - total (total exceedances = 28)
- Nitrite (total exceedances = 10)
- Turbidity (total exceedances = 27)



*C. perfringens* exceeded PCV values at both sites as it is widely distributed across the environment and as such, is regularly evaluated to monitor the microbiological safety of drinking water supplies. Sources of bacterial contamination can range from the input of animal manures from farmyard runoff to discharge from untreated or treated sewage effluent. *Cryptosporidium* was not detected at any site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores or localised disturbance events.

All sensor data is within ranges typical of freshwater environments within a late autumn winter period. Temperatures decreased steadily across all sites throughout the period. Rainfall events appear to have driven several peaks in ammonium concentration at Site 1 (Minworth WwRC). No algal blooms appear to be occurring at any location indicated by low average chlorophyll concentrations.

With respect to WFD EQS, in the Upper GUC chloronathonil, cypermethrin, diazinon, dissolved oxygen, formaldehyde, permethrin, azinphos methyl, dissolved and SRP are the substances most at risk. For the Middle and Lower sections zinc bioavailable is at risk. SRP is only at risk in the Middle section as this regularly exceeds EQS in the Lower section however exceedances in the Middle section are becoming more common.

With respect to PCVs, the following substances are potentially at risk of increasing in concentration within the GUC from the Minworth WwRC discharge to the GUC:

- Bisphenol A
- Chlorate
- Chloride
- Chromium total
- Clopyralid
- Mercury - total
- Nickel - bioavailable
- Nickel - total

## 4.1 Next steps

We will continue to analyse water quality data collected as part of the GUC water quality monitoring programme which will continue through to November 2024. As part of this process, we will continue providing quarterly updates which will be communicated to the GUC project team and the Minworth WwRC and abstraction treatment engineers to understand the feasibility of designing treatment for any 'high risk' compounds. We will also work with the team to identify any changes that may be required to the monitoring programme i.e., the addition or removal of sites and/or parameters.

Our water quality analysis will continue to investigate environmental and drinking water risks, comparing results to individual EQS and PCVs. Our analysis will also continue to investigate whether there is a potential risk of water quality deterioration by comparing Minworth WwRC final effluent with canal sites.

We will also update the drinking water quality risk assessment for Gate 3 following the All Company Working Group (ACWG) methodology. This was previously undertaken for Gate 1 and subsequently updated for Gate 2, with the caveat that this assessment is based on raw water before treatment, so PCV breaches are expected.

Lastly, we will undertake a new assessment of all determinands by hydrological year (October to September) to assess annual average exceedances against appropriate time scales to facilitate a comparison between years.



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# Gate 3 Water Quality Monitoring: Quarter 8 Results

Severn Trent, Affinity Water and Canal & River  
Trust

26 July 2024

5222090 / 7 / DG / 042

# GRAND UNION CANAL STRATEGIC RESOURCE OPTION



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# INTRODUCTION



# 1. Introduction

## 1.1 Purpose of this document

Data collection for the Grand Union Canal (GUC) Strategic Resource Option (SRO) is ongoing. The purpose of this document is to provide an update of data collected over the monitoring period spanning January to March 2024, and where available, set in the context of the entire data record. This report provides stakeholders an update on the data as it is collected and draws comparisons, when possible, to environmental, and drinking water standards.

**Key changes in spot and continuous data observed in-period eight are highlighted in callouts for clarity.**



# METHODOLOGY



## 2. Methodology

### 2.1 Site locations

#### Key changes to site locations.

From 14<sup>th</sup> February 2024, there were two new monitoring locations added:

- Site 17 – Daventry Reservoir
- Site 18 – Drayton Reservoir

These new sites have been added to characterise baseline water quality in the reservoirs. The reservoirs are intended to supply water to the GUC when the Minworth WwRC final effluent is diverted to the River Tame. Water from the reservoirs may be subject to a discharge permit.

For the purpose of conceptualising the monitoring programme, the GUC network has been split into three main geographical sections. An overview map of the upper, middle, and lower section is supplied below in Figure 2-1, with a summary of the monitoring sites located within each section in Tables 2-1. Further detail along with detailed section maps are provided in the GUC Gate 3 Water Quality Monitoring report. A description of each location is provided below.

- **Upper section** – Covering the discharge from Minworth Wastewater Recycling Centre (WwRC) to the example discharge location (Coventry Canal at Atherstone).
- **Middle section** – GUC from the Braunston Junction to the Aylesbury Arm (Marsworth, North of Tring).
- **Lower section** – GUC from the Aylesbury Arm to Hanwell, London. This section includes the example abstraction location (GUC at Grove Lock, Leighton Buzzard).

Table 2-1 – Summary of monitoring locations in each section of the GUC

| Section             | Site no. | Location description           |
|---------------------|----------|--------------------------------|
| GUC: Upper Section  | 1        | Minworth WwRC Final Effluent   |
|                     | 3        | Coventry Canal at Atherstone   |
|                     | 10       | Coventry Canal at Bedworth     |
| GUC: Middle Section | 5        | GUC at Welton Lane, Daventry   |
|                     | 11       | GUC at Long Buckby             |
|                     | 12       | GUC at Gayton                  |
|                     | 17       | Daventry Reservoir             |
|                     | 18       | Drayton Reservoir              |
|                     | 13       | GUC at Stoke Bruerne           |
|                     | 14       | GUC at Cosgrove                |
| GUC: Lower Section  | 15       | GUC at Stoke Hammond           |
|                     | 6        | GUC at Grove, Leighton Buzzard |
|                     | 16       | GUC at Marsworth               |

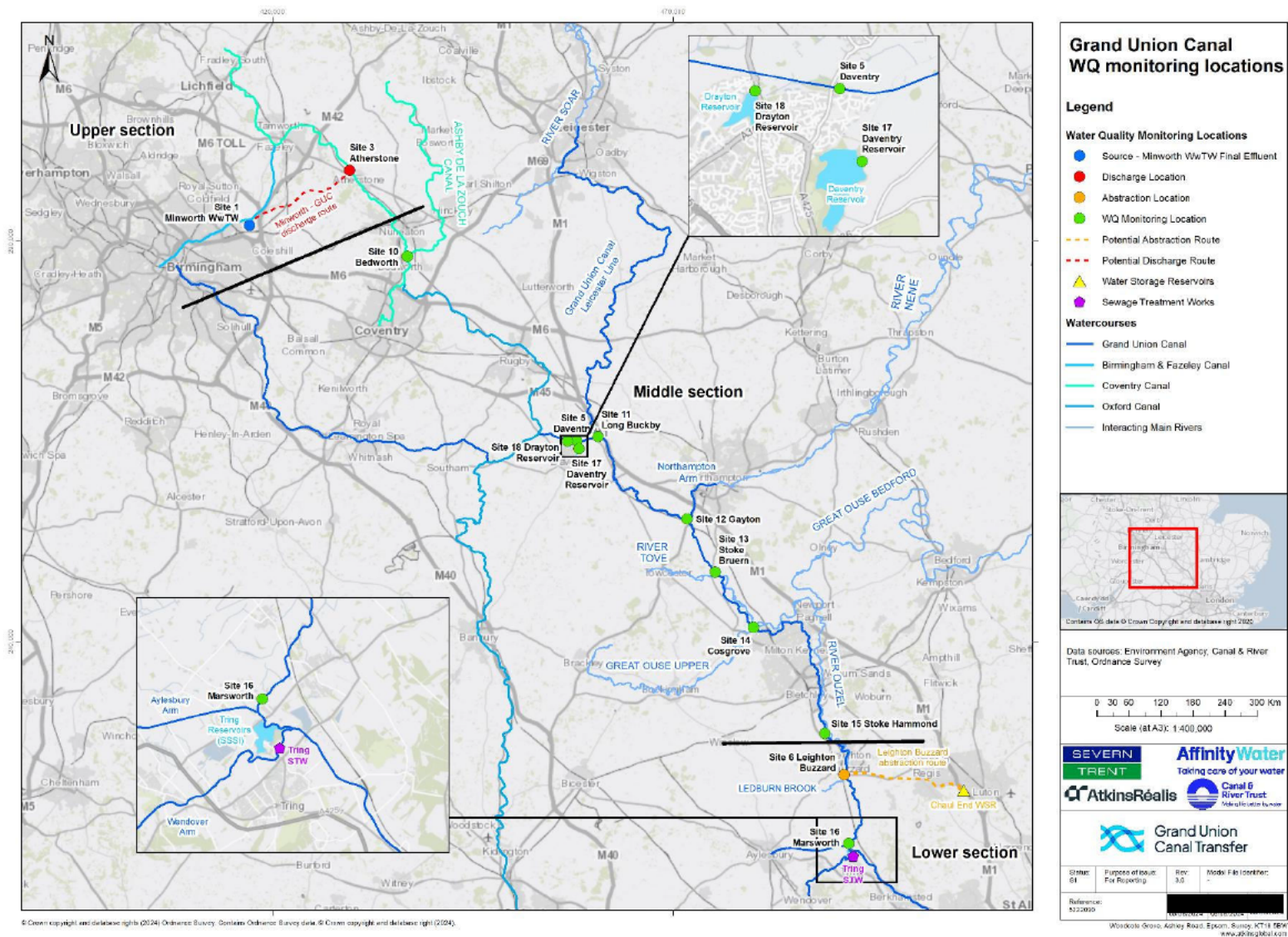


Figure 2-1 – Overview map of the GUC scheme (black lines note the upper, middle and lower sections)

Author names redacted



## 2.2 Monitoring, sampling, and analysis procedures

### Key changes to monitoring programme.

The following changes to the monitoring programme were made this quarter (Q8 2024):

- From February 2024 the new reservoir sites Site 17 – Daventry Reservoir and Site 18 – Drayton Reservoir have been analysed for EQSD and WFD determinands.
- From January 2024 changes have also been made to Site 5 – Daventry. The analysis at this site has been moved from WFD only to also include EQSD parameters.
- From February 2024 Site 3 – Atherstone and Site 1 – Minworth WwRC now includes EQSD parameters.
- From February 2024 Site 6 – Leighton Buzzard now includes WFD and modelling parameters.
- PFAS54 parameters have also been included at Sites 5, 6, 10, 11, 12, 13, 14 and 15.

Data was downloaded for all monitoring sondes for all parameters as well as monthly spot samples in January, February and March 2024. Data reported in this report covers the period January – March 2024.

### 2.2.1 Spot water quality sampling

Spot water quality samples were taken in line with the programme and operating procedures outlined in the GUC Gate 3 Water Quality Monitoring report. No sites or samples were omitted due to access or safety issues this quarter.

- The samples for the January 2024 round were taken on 15<sup>th</sup> January 2024.
- The samples for the February 2024 round were taken on 14<sup>th</sup> February 2024.
- The samples for the March 2024 round were taken on 12<sup>th</sup> March 2024.

The analysis suites selected are based on 4 key legislative and design drivers. These include:

- **Environmental risks as required by the Water Framework Directive (WFD)** (WFD suite).
- **Environmental permitting risks as required by the Environmental Quality Standards Directive (EQSD)** (EQSD suite).
- **Drinking Water risks as required by DWI (Drinking Water Inspectorate)** (Drinking water suite).
- **Emerging substances** (Emerging substances suite).

### 2.2.2 Rainfall data

Rainfall data were available from the Environment Agency (EA) for multiple locations along the GUC covering the Q8 monitoring period. For the Upper GUC, data have been compared to Lea Marston gauge (EA Station ID: 096781), for the Middle reach of the GUC data have been compared to Quinton rain gauge (EA Station ID: 170945), and for the lower GUC data from Dancers End Reservoir have been used for comparison (EA Station ID: 261602). Data for all gauges for this quarter were available from 1<sup>st</sup> January 2024 to 31<sup>st</sup> March 2024.



# RESULTS



## 3. Results

### 3.1 Spot sample environmental quality standards comparison

#### Notable concentration changes in the last quarter (January 2024 – March 2024).

- Cadmium (total) at Site 1 (Minworth WwRC) was detected above the Environmental Quality Standard (EQS) for the first time.
- Cadmium (dissolved) and TBT identified above EQS at Sites 5, 11 and 15.
- ANC, SRP, BOD and PFOS exceeded EQS at Site 18 (Drayton Reservoir).
- The same substances plus BOD and bromine (total residual oxidant) also exceed EQS at Site 17 (Daventry Reservoir).
- Chloronathonil, diazinon, fenitrothion and malathion were identified above EQS at Site 3 for the first time.
- Coumaphos, Fenchlorphos, Mevinphos (mixture of isomers), Pirimiphos-methyl and Propetamphos exceeded MAC EQS at Site 3 for the first time.
- For the first time new MAC EQS exceedance of Benzo(b)fluoranthene, Benzo(g,h,i)perylene and Benzo(k)fluoranthene at Site 10. Benzo(b)fluoranthene and Benzo(g,h,i)perylene also exceeded MAC EQS for the first time at Site 5.

Other substances which frequently exceed EQSs have seen the following changes this quarter:

- Benzo(a)pyrene exceeded MAC EQS at Sites 10 (Bedworth), 15 (Stoke Hammond), Site 18 (Daventry Reservoir) and 6 (Leighton Buzzard), while Benzo(b)fluoranthene, Benzo(g,h,i)perylene exceeded MAC EQS at Site 3 (Atherstone) and Site 6 (Leighton Buzzard).
- Bromine (total residual oxidant) exceeded MAC EQS at Site 1 (Minworth WwRC), Site 3 (Atherstone) and Site 17 (Daventry Reservoir).
- Sulphide or hydrogen sulphide exceeded MAC EQS at all sites except Site 17 (Daventry Reservoir) and Site 18 (Daventry Reservoir).

#### 3.1.1 Overview

In order to determine parameters of risk, values have been compared against the relevant EQS as detailed by The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 (WFD) and the EA Surface Water Pollution Risk Assessment Parameters EQSD<sup>1</sup>. It is important to note that standards or condition limits for certain parameters under the WFD (e.g., dissolved oxygen, BOD, ammoniacal nitrogen, and ANC), are determined by categorising the water body by type, dependent on its altitude and alkalinity. ANC standards are determined by annual mean dissolved organic carbon concentrations. In addition, soluble reactive phosphorus (SRP) standards are determined by the water body's altitude and alkalinity, cadmium standards are determined by categorising the water body, by type, dependent on the hardness of the water, and zinc standards are determined by the ambient background concentration (ABC) of dissolved zinc. EA site specific standards (where available) were used (e.g. SRP), Where these were not available, site-specific standards have been calculated using the available data.

Whilst we have used site-specific EQS or WFD Good standards for the Minworth WwRC final effluent for indicative purposes, it is important to note that these standards should not be routinely applied to final effluent samples as they are in-river standards (these standards do not directly apply to effluent and discharge standards are set through the permitting regime. It is also important to note that all data on record is considered when comparing

<sup>1</sup> EA Guidance. Environmental Quality Standards Directive (EQSD) list for WFD assessments. Published 15 December 2016



against the environmental standards which are applied, under a formal assessment, as Annual Averages (AA), Maximum Allowable Concentrations (MAC), or specified percentiles. Compliance statistics can only be derived by the Environment Agency using data from a single calendar year. Samples at the limit of detection were included in the analysis and used at face value to adhere to discharge permitting assessment guidance. Any significant outliers were removed from the analysis.

Based on the available data across all sites, there have been a total of 119 EQS exceedances. A discussion of exceedances along with source water and canal section comparisons can be found in sections 3.1.2 and 3.1.3.

### 3.1.2 Exceedances to date

A list of all compounds that exceeded the quoted EQS split by site, are presented in Table 3-1. MAC values were examined separately and have been applied to individual results and not mean or percentile data.

Two polycyclic aromatic hydrocarbons (PAH), benzo(a)pyrene and fluoranthene exceeded AA EQS at 11 of 13 sites with the exception of Sites 10, 17 and 18. These substances are commonly found in fuels and oils and are biproducts of fossil fuel combustion. At all thirteen sites, Perfluorooctane sulfonic acid (PFOS) concentrations were also above the AA EQS.

Individual exceedances of cadmium (total) occurred at Site 3 only.

Bromine (total residual oxidant) concentrations exceeded AA EQS at Sites 1 and 3 by several orders of magnitude, note bromine is only measured at these two sites as part of the EQSD analysis suite.

For Biochemical Oxygen Demand (BOD) there was one exceedance at Site 17 this quarter (Q8 2024).

Low 10<sup>th</sup> percentile dissolved oxygen saturation values resulted in EQS exceedances at seven sites this quarter (Sites 1, 5, 6 and 10). Site 1 (Minworth WwRC) was below the dissolved oxygen standard in all samples, noting this is sewage effluent and the EQS does not directly apply, whereas Sites 3, 5, 6, 10, 14 and 16 are canal sites with comparatively lower dissolved oxygen. In-period dissolved oxygen 10<sup>th</sup> percentile exceedances were likely driven by temporary increased water temperatures, which reduces water's ability to hold oxygen, combined with increases in algal activity which may result in temporary oxygen drawdowns during the daytime.

Table 3-2 shows the data as it corresponds to the test statistics for all compounds in exceedance of the EQS. As with Table 3-1, this table indicates overall EQS exceedances as well as new exceedances occurring this quarter. This table allows identification of compounds that may exceed EQS if the final effluent from Minworth WwRC were discharged into the GUC without additional treatment. This may result in a future WFD compliance risk as the new discharge may result in a deterioration of instream quality and may prevent the water quality of the receiving body from achieving Good Status. Compounds that exceed AA EQS at Minworth WwRC with no comparable exceedance in-canal include chlorothalonil (organic fungicide), cypermethrin (synthetic pyrethroid), permethrin (insecticide), diazinon and zinc (bioavailable).

In total there were 528 instances of MAC exceedances across all sites across the entire monitoring period. Overall, four PAHs (benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene) accounted for 146 (25%) of these exceedances. Bromine (total residual oxidant) accounted for 74 exceedances in the 'upper GUC', Sites 1 and 3. Sulphate (or hydrogen sulphide) exceeded MAC values on 208 occasions (accounting for 44% of all exceedances). A list of total exceedances split by compound can be seen in Table 3-3.



Table 3-1 – Number of EQS (WFD and EQSD) exceedances <sup>1, 2</sup>

| Compound  | Standard   | Unit     | Statistic <sup>+</sup> | Upper GUC       |                 | Middle GUC |           |           |           |           |           |           |          |          |                 | Lower GUC |    |
|---|------------|----------|------------------------|-----------------|-----------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|-----------------|-----------|----|
|   |            |          |                        | Source          | Discharge       | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Site 17  | Site 18  | Abstraction     |           |    |
|   |            |          |                        | Site 1          | Site 3          |            |           |           |           |           |           |           |          |          | Site 6          | Site 16   |    |
| 3,4-dichloroaniline   | 1          | µg/l     | AA                     | 0               | 1               |            |           |           |           |           |           |           |          | 0        | 0               |           |    |
| Acid neutralisation capacity  | 40         | mg/l     | AA                     | 36 <sup>#</sup> | 37 <sup>#</sup> | 24         | 38        | 23        | 24        | 24        | 24        | 24        | 24       | 2        | 1               | 37        | 24 |
| Azinphos-methyl (dissolved)   | 0.2        | µg/l     | AA                     | 2               | 0               |            |           |           |           |           |           |           |          |          |                 |           |    |
| Benzo(a)pyrene  | 0.00017    | µg/l     | AA                     | 49              | 48              | 24         | 38        | 23        | 24        | 24        | 24        | 24        | 2        | 1        | 37              | 24        |    |
| BOD (5 day)   | *          | mg/l     | 90 <sup>th</sup>       | 5               | 5               | 1          | 0         | 1         | 1         | 0         | 2         | 4         | 0        | 0        | 9               | 4         |    |
| Bromine (total residual oxidant)  | 0.002      | mg/l     | AA                     | 35              | 36 <sup>#</sup> |            | 2         |           |           |           |           |           | 1        | 0        |                 |           |    |
| Cadmium (total)   | 0.25       | µg/l     | AA                     | 0               | 16              | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 0               | 0         | 0  |
| Chlorothalonil  | 0.035      | µg/l     | AA                     | 1               | 1               |            |           |           |           |           |           |           |          |          |                 |           |    |
| Chromium (III) dissolved  | 5          | µg/l     | AA                     | 2               | 0               |            |           |           |           |           |           |           | 0        | 1        |                 |           |    |
| Cobalt (dissolved)  | 3          | µg/l     | AA                     | 0               | 21 <sup>#</sup> |            |           |           |           |           |           |           |          |          |                 |           |    |
| Copper (bioavailable)**   | 1          | µg/l     | AA                     | 29              | 46              | 18         | 13        | 14        | 11        | 15        | 16        | 14        | 1        | 1        | 23              | 24        |    |
| Cypermethrin  | 0.00008    | µg/l     | AA                     | 39              | 6               | 4          | 4         | 2         | 3         | 7         | 10        | 11        | 0        | 0        | 16              | 10        |    |
| Dissolved oxygen  | *          | %        | 10 <sup>th</sup>       | 28              | 1               | 16         | 17        | 14        | 7         | 1         | 2         | 0         | 0        | 0        | 5               | 2         |    |
| Diazinon  | 0.01       | µg/l     | AA                     | 3               | 1               |            |           |           |           |           |           |           |          |          |                 |           |    |
| Fenitrothion  | 0.01       | µg/l     | AA                     | 0               | 1               | 0          |           |           |           |           |           |           | 0        | 0        |                 |           |    |
| Fluoranthene  | 0.0063     | µg/l     | AA                     | 3               | 39              | 23         | 16        | 21        | 18        | 20        | 22        | 21        | 0        | 0        | 33              | 24        |    |
| Malathion   | 0.01       | µg/l     | AA                     | 0               | 1               |            |           |           |           |           |           |           |          |          |                 |           |    |
| Mancozeb  | 2          | µg/l CS2 | AA                     | 8               | 0               |            |           |           |           |           |           |           |          |          | 1               |           |    |
| Maneb   | 3          | µg/l CS2 | AA                     | 3               | 0               |            |           |           |           |           |           |           |          |          | 1               |           |    |
| Manganese (bioavailable)**  | 123        | µg/l     | AA                     | 2               | 35              | 2          |           |           |           |           |           |           |          |          | 0 <sup>##</sup> | 0         |    |
| Nickel (bioavailable)**   | 4          | µg/l     | AA                     | 48              | 46              | 6          | 6         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 2               | 0         |    |
| Perfluorooctane sulfonic acid (PFOS)  | 0.00065    | µg/l     | AA                     | 58              | 48              | 23         | 36        | 22        | 22        | 23        | 23        | 18        | 2        | 1        | 26              | 23        |    |
| Permethrin  | 0.001      | µg/l     | AA                     | 22              | 1               | 0          | 0         |           |           |           |           |           | 0        | 0        |                 |           |    |
| Soluble reactive phosphorus   | *          | µg/l     | AA                     | 37              | 7               | 17         | 13        | 5         | 5         | 18        | 11        | 4         | 1        | 1        | 30              | 21        |    |
| Sulphide or hydrogen sulphide   | 0.25       | µg/l     | AA                     | 19              | 32              | 17         | 19        | 16        | 15        | 19        | 16        | 16        | 0        | 0        | 26              | 13        |    |
| Total anions (sum of Br, Cl, F, NO <sub>2</sub> , NO <sub>3</sub> , PO <sub>4</sub> , SO <sub>4</sub> ) | 250        | mg/l     | AA                     | 10              | 20              |            | 0         |           |           |           |           |           | 0        | 0        | 1               |           |    |
| Triazophos  | 0.01       | µg/l     | AA                     | 0               | 1               |            | 0         |           |           |           |           |           | 0        | 0        | 0               |           |    |
| Tributyltin compounds (as tributyltin cation)   | 0.001      | µg/l     | AA                     | 1               | 3               | 3          | 1         | 1         | 9         | 0         | 0         | 2         | 0        | 0        | 3               | 1         |    |
| Zinc (bioavailable)**   | 12.3-14.9* | µg/l     | AA                     | 47              | 22              | 7          | 3         | 0         | 2         | 0         | 0         | 1         | 0        | 0        | 2               | 0         |    |
| <b>Total number of samples</b>  | -          | -        | -                      | <b>48</b>       | <b>37</b>       | <b>24</b>  | <b>37</b> | <b>24</b> | <b>24</b> | <b>24</b> | <b>24</b> | <b>24</b> | <b>2</b> | <b>2</b> | <b>37</b>       | <b>24</b> |    |

<sup>1</sup> Blue shading indicates EQS (WFD and EQSD) exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of individual EQS exceedances is also given.

<sup>2</sup> Values in orange indicate the addition of new individual exceedances this quarter.

+AA = Annual Average. Numbers of exceedances are shown for illustrative purposes only and reflect individual samples being compared to an AA or percentile derived EQS.

\* Site specific EQS determinand. \*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT) <sup>6</sup>

# Total number of samples collected = 34 (not included in Phase 1 dataset). ## Drinking water suite parameters added to this site in October 2021 so total number of samples = 24.

Table 3-2 – Concentrations of compounds responsible for EQS (WFD and EQSD) exceedance<sup>1, 2</sup>

| Compound  | Standard   | Unit     | Statistic*       | Upper GUC |           | Middle GUC |           |           |           |           |           |           |          |          |             | Lower GUC |         |
|---|------------|----------|------------------|-----------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|-------------|-----------|---------|
|   |            |          |                  | Source    | Discharge | Site 10    | Site 5    | Site 11   | Site 12   | Site 13   | Site 14   | Site 15   | Site 17  | Site 18  | Abstraction | Site 6    | Site 16 |
| 3,4-dichloroaniline   | 1          | µg/l     | AA               | 0.959     | 1.2       |            | 1.000     |           |           |           |           |           |          | 1.000    | 1.000       | 0.667     |         |
| Acid neutralisation capacity  | 40         | mg/l     | AA               | 1840.5    | 2491.9    | 3345.8     | 2944.7    | 3617.4    | 4370.8    | 4575.0    | 3766.7    | 3316.7    | 3050.0   | 1700.0   | 3365.8      | 3275.000  |         |
| Azinphos-methyl (dissolved)   | 0.2        | µg/l     | AA               | 0.024     | 0.0       |            | 0.020     |           |           |           |           |           |          | 0.020    | 0.020       | 0.013     |         |
| Benzo(a)pyrene  | 0.00017    | µg/l     | AA               | 0.002     | 0.015     | 0.050      | 0.007     | 0.016     | 0.018     | 0.020     | 0.027     | 0.033     | 0.002    | 0.001    | 0.025       | 0.023     |         |
| BOD (5 day)   | *          | mg/l     | 90 <sup>th</sup> | 2.7       | 2.8       | 2.717      | 3.0       | 2.504     | 2.733     | 2.525     | 4.1       | 4.0       | 4.4      | 3.5      | 3.9         | 3.342     |         |
| Bromine   | 0.002      | mg/l     | AA               | 0.2       | 1.5       |            | 0.160     |           |           |           |           |           | 0.065    | 0.050    |             |           |         |
| Cadmium (total)   | 0.25       | µg/l     | AA               | 0.02      | 0.4       | 0.054      | 0.027     | 0.019     | 0.021     | 0.022     | 0.020     | 0.032     | 0.030    | 0.040    | 0.037       | 0.020     |         |
| Chlorothalonil  | 0.035      | µg/l     | AA               | 0.04      | 0.0       |            | 0.035     |           |           |           |           |           | 0.035    | 0.035    | 0.018       |           |         |
| Chromium (III) dissolved  | 5          | µg/l     | AA               | 2.28      | 2.0       |            | 1.000     |           |           |           |           |           | 1.0      | 11.0     | 0.5         |           |         |
| Cobalt (dissolved)  | 3          | µg/l     | AA               | 1.71      | 11.1      |            | 0.260     |           |           |           |           |           | 0.19     | 0.16     | 0.29        |           |         |
| Cypermethrin  | 0.00008    | µg/l     | AA               | 0.00027   | 0.00007   | 0.00008    | 0.00008   | 0.00013   | 0.00020   | 0.00014   | 0.00016   | 0.00023   | 0.00008  | 0.00008  | 0.00017     | 0.00026   |         |
| Dissolved oxygen  | *          | %        | 10 <sup>th</sup> | 39        | 69.5      | 41.1       | 60.0      | 59.0      | 53.3      | 78.4      | 68.0      | 73.4      | 85.6     | 80.6     | 73.1        | 78.5      |         |
| Diazinon  | 0.01       | µg/l     | AA               | 0.011     | 0.012     |            | 0.010     |           |           |           |           |           | 0.010    | 0.010    | 0.010       |           |         |
| Fenitrothion  | 0.01       | µg/l     | AA               | 0.010     | 0.01      |            | 0.010     |           |           |           |           |           | 0.010    | 0.010    | 0.007       |           |         |
| Fluoranthene  | 0.0063     | µg/l     | AA               | 0.003     | 0.02      | 0.025      | 0.007     | 0.016     | 0.011     | 0.014     | 0.016     | 0.025     | 0.005    | 0.003    | 0.019       | 0.023     |         |
| Malathion   | 0.01       | µg/l     | AA               | 0.019     | 0.02      |            | 0.020     |           |           |           |           |           | 0.020    | 0.020    | 0.019       |           |         |
| Mancozeb  | 2          | µg/l CS2 | AA               | 1.400     | 0.2       |            | 0.100     |           |           |           |           |           | 0.1      | 0.1      | 1.95        |           |         |
| Maneb   | 3          | µg/l CS2 | AA               | 2.22      | 0.3       |            | 0.200     |           |           |           |           |           | 0.1      | 0.1      | 3.05        |           |         |
| Manganese (bioavailable)**  | 123        | µg/l     | AA               | 90.5      | 4774.0    | 206.0      | 206.00    | 21.0      | 12.4      | 8.4       | 4.0       | 9.2       | 6.7      | 4.0      | 16.8        | 9.23      |         |
| Nickel (bioavailable)**   | 4          | µg/l     | AA               | 17.0      | 33.8      | 3.142      | 3.142     | 2.348     | 1.933     | 1.4       | 1.9       | 2.3       | 2.7      | 0.8      | 2.2         | 1.35      |         |
| Perfluorooctane sulfonic acid (PFOS)  | 0.00065    | µg/l     | AA               | 0.012     | 0.004     | 0.005      | 0.005     | 0.001     | 0.018     | 0.067     | 0.013     | 0.001     | 0.020    | 0.004    | 0.000       | 0.001     |         |
| Permethrin  | 0.001      | µg/l     | AA               | 0.002     | 0.001     |            |           |           |           |           |           |           | 0.001    | 0.001    | 0.001       |           |         |
| Soluble reactive phosphorus   | *          | µg/l     | AA               | 0.37      | 0.9       | 0.107      | 0.107     | 0.049     | 0.053     | 0.117     | 0.081     | 0.039     | 0.115    | 0.120    | 0.154       | 0.175     |         |
| Sulphide or hydrogen sulphide   | 0.25       | µg/l     | AA               | 11.1      | 15.6      | 17.25      | 17.25     | 17.04     | 18.33     | 22.17     | 18.4      | 17.8      | 10.000   | 10.0     | 25.6        | 16.46     |         |
| Total anions (sum of Br, Cl, F, NO <sub>2</sub> , NO <sub>3</sub> , PO <sub>4</sub> , SO <sub>4</sub> ) | 250        | mg/l     | AA               | 226.7     | 333.4     |            |           |           |           |           |           |           | 122.2    | 68.0     | 177.3       |           |         |
| Triazophos  | 0.01       | µg/l     | AA               | 0.019     | 0.024     |            |           |           |           |           |           |           | 0.020    | 0.020    | 0.015       |           |         |
| Tributyltin compounds (as tributyltin cation)   | 0.001      | µg/l     | AA               | 0.0001    | 0.00009   | 0.00014    | 0.0001    | 0.00009   | 0.00022   | 0.00005   | 0.0003    | 0.0001    | 0.00003  | 0.00003  | 0.00013     | 0.0001    |         |
| Zinc (bioavailable)**   | 12.3-14.9* | µg/l     | AA               | 42.1      | 37.9      | 21.7       | 5.2       | 4.7       | 7.0       | 2.4       | 7.8       | 5.1       | 1.1      | 1.0      | 5.27        | 3.45      |         |
| <b>Total number of samples</b>  | -          | -        | -                | <b>48</b> | <b>37</b> | <b>24</b>  | <b>37</b> | <b>24</b> | <b>24</b> | <b>24</b> | <b>24</b> | <b>24</b> | <b>2</b> | <b>2</b> | <b>37</b>   | <b>24</b> |         |

<sup>1</sup> Blue shading indicates EQS (WFD and EQSD) exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of individual EQS exceedances is also given.

<sup>2</sup> Values in orange indicate the addition of new individual exceedances this quarter.

\*AA = Annual Average. Numbers of exceedances are shown for illustrative purposes only and reflect individual samples being compared to an AA or percentile derived EQS.

\* Site specific EQS determinand. \*\* Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT) <sup>6</sup>

# Total number of samples collected = 34 (not included in Phase 1 dataset). ## Drinking water suite parameters added to this site in October 2021 so total number of samples = 27.

Table 3-3 – Compounds responsible for WFD and EQSD MAC exceedances<sup>1</sup>.

| Compound                         | Standard | Unit                    | Statistic | Upper GUC       |           | Middle GUC |           |           |           |           |           |           |          |          |                  | Lower GUC |             |
|----------------------------------|----------|-------------------------|-----------|-----------------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|------------------|-----------|-------------|
|                                  |          |                         |           | Source          | Discharge | Site 1     | Site 3    | Site 10   | Site 5    | Site 11   | Site 12   | Site 13   | Site 14  | Site 15  | Site 17          | Site 18   | Abstraction |
| Benzo(a)pyrene                   | 0.027    | µg/l                    | MAC       | 0               | 6         | 15         | 1         | 2         | 4         | 6         | 11        | 12        | 0        | 0        | 13               | 7         |             |
| Benzo(b)fluoranthene*            | 0.017    | µg/l                    | MAC       | 0               | 1         | 2          |           | 1         |           | 2         |           | 3         |          |          | 13 <sup>##</sup> |           |             |
| Benzo(g,h,i)perylene*            | 0.0082   | µg/l                    | MAC       | 2               | 7         | 3          | 3         | 3         | 2         | 3         | 3         | 3         |          |          | 22 <sup>##</sup> |           |             |
| Benzo(k)fluoranthene*            | 0.017    | µg/l                    | MAC       | 0               |           | 1          |           | 1         |           | 2         |           |           |          |          | 6 <sup>##</sup>  |           |             |
| Bromine - total residual oxidant | 0.005    | mg/l                    | MAC       | 35 <sup>#</sup> | 36        |            | 2         | 0         | 0         | 0         | 0         | 0         | 1        | 0        | 0                | 0         |             |
| Cadmium (dissolved)              | 1.5      | µg/l                    | MAC       | 0               | 2         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 0                | 0         |             |
| Cadmium (total)                  | 1.5      | µg/l                    | MAC       | 0               | 2         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 0                | 0         |             |
| Coumaphos                        | 0.1      | µg/l                    | MAC       | 0               | 1         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 0                | 0         |             |
| Cypermethrin                     | 0.0006   | µg/l                    | MAC       | 6               | 0         | 0          | 0         | 1         | 2         | 2         | 2         | 2         | 0        | 0        | 1                | 2         |             |
| Fenchlorphos                     | 0.1      | µg/l                    | MAC       | 0               | 1         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 0                | 0         |             |
| Mercury (dissolved)              | 0.07     | µg/l                    | MAC       | 2               | 1         | 2          | 1         | 2         | 1         | 1         | 2         | 0         | 0        | 0        | 2                | 2         |             |
| Mercury (total)                  | 0.07     | µg/l                    | MAC       | 2               | 2         | 2          | 4         | 2         | 1         | 1         | 2         | 0         | 2        | 1        | 2                | 2         |             |
| Mevinphos (mixture of isomers)   | 0.02     | µg/l                    | MAC       | 0               | 1         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 0                | 0         |             |
| Nickel (bioavailable)            | 34       | µg/l                    | MAC       | 2               | 16        | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 0                | 0         |             |
| Pirimiphos-methyl                | 0.05     | µg/l                    | MAC       | 0               | 1         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 0                | 0         |             |
| Propetamphos                     | 0.1      | µg/l                    | MAC       | 0               | 1         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 0                | 0         |             |
| Sulphide or hydrogen sulphide    | 1        | µg/l                    | MAC       | 19              | 32        | 17         | 19        | 16        | 15        | 19        | 16        | 16        | 0        | 0        | 26               | 13        |             |
| Formaldehyde                     | 0.02     | µg/l                    | MAC       | 1               | 0         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 0                | 0         |             |
| Maneb                            | 50       | µg/l<br>CS <sub>2</sub> | MAC       | 1               | 0         | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0        | 0        | 0                | 0         |             |
| <b>Total number of samples</b>   | -        | -                       | -         | <b>48</b>       | <b>37</b> | <b>24</b>  | <b>37</b> | <b>24</b> | <b>24</b> | <b>24</b> | <b>24</b> | <b>24</b> | <b>2</b> | <b>2</b> | <b>37</b>        | <b>24</b> |             |

<sup>1</sup> Blue shading indicates MAC EQS exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of exceedances also given. Orange highlighting indicates exceedances this quarter.

\* While these determinands have a MAC, as per the WFD there is no corresponding AA statistic as benzo(a)pyrene should be considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water.

# Total number of samples collected = 36 (not included in Phase 1 dataset).

## Drinking water suite parameters added to this site in October 2021 so total number of samples = 27.

### 3.1.3 Source water and canal section comparisons

In this section the quality of treated effluent discharged from Minworth WwRC is directly compared with all respective sections of the GUC. The key changes identified this quarter are discussed below.

#### 3.1.3.1 Minworth vs. GUC Upper Section (Site 3)

The majority of substances which exceeded AA EQS at Minworth also exceed at Site 3, the example discharge location (Atherstone). Exceptions include chlorothalonil, cypermethrin, dissolved oxygen, diazinon, formaldehyde and azinphos methyl (dissolved) which do not exceed AA EQS at Site 3. This suggests these parameters may be at increased risk of AA EQS exceedance in-canal if discharge from Minworth is received without additional treatment. While permethrin and Soluble Reactive Phosphorus (SRP) have exceeded AA EQS on occasion, these exceedances occur more frequently in the Minworth WwRC final effluent suggesting AA EQS exceedances would become more likely without additional treatment. By contrast, cobalt (dissolved), fluoranthene, manganese and nickel (bioavailable), sulphide or hydrogen sulphide, total anions, cadmium (total), 3,4-dichloroaniline, fenitrothion, malathion and triazophos exceed AA EQS at Site 3 with no exceedances observed in the Minworth WwRC final effluent, suggesting a wider catchment source. The introduction of a Minworth discharge could reduce concentrations of these substances in the GUC owing to increased dilution.

#### 3.1.3.2 Minworth vs. GUC Middle Section (Sites 5,10,11,12,13,14 and 15)

The following substances exceeded AA EQS in Minworth WwRC discharge but do not currently exceed AA EQS at any site in the middle section of the GUC:

- Zinc (bioavailable)

The following substances exceed AA EQS in the Minworth WwRC discharge but are not currently monitored under the currently agreed monitoring suites in the Middle Section of the GUC:

- Chlorothalonil
- Cobalt (dissolved)
- Chromium (iii) (dissolved)
- Permethrin
- Azinphos-methyl (dissolved)

These substances may be at risk of exceeding their respective AA EQS should a Minworth WwRC discharge be introduced in the Upper GUC depending on in-canal concentrations, however this is currently unknown due to lack of data.

Sites 12 and 13 are the only sites where BOD has not exceeded the AA EQS. SRP has exceeded AA EQS at all Sites excluding Site 10 this quarter. Given SRP regularly exceeds AA EQS at these sites they are at risk from the introduction of Minworth discharge due to increased loading. Tributyltin (TBT) compounds did not exceed in the Middle GUC this quarter. TBT was historically used as an antifouling agent in paints and binds strongly to sediments and bioaccumulates in biota. As such this may be present and easily released in a canal when sediment is disturbed and may be frequently detected in the future. Fluoranthene exceeded AA EQS at all sites except Site 10. This substance does not however currently exceed AA EQS in the Minworth WwRC discharge.

#### 3.1.3.3 Minworth vs. GUC Lower Section (Sites 6 and 16)

Dissolved oxygen was lower than the AA EQS this quarter at Site 6. The following substances in the Minworth discharge which exceed EQS do not currently exceed EQS at any site in the lower section:

- Diazinon
- Cadmium (total)



- Tributyltin compounds
- Nickel (bioavailable)
- Zinc (bioavailable)

The following substances exceed EQS in the Minworth WwRC discharge but are not monitored in the Lower GUC:

- Bromine (total residual oxidant)
- Chlorothalonil
- Formaldehyde
- Permethrin
- Azinphos-methyl (dissolved)

These substances are, hypothetically, most at risk of deterioration following the introduction of a Minworth WwRC discharge to the GUC due to increased loading. Reservoirs vs. GUC Site 5 (Sites 17 and 18)

The following substances exceed AA EQS at Site 5 but do not currently exceed AA EQS at either reservoir site:

- Fluoranthene
- Dissolved oxygen
- Sulphide or hydrogen sulphide

Bromine – total residual oxidant exceeded MAC EQS at Site 17 only. There are no substances which exceed EQS in the reservoir discharges that are not monitored in the Middle GUC.

#### **3.1.3.4 Minworth WwRC vs. Reservoirs (Sites 17 and 18)**

The following substances exceeded AA EQS at Site 1 (Minworth WwRC) but do not currently exceed EQS at any reservoir site:

- Azinphos-methyl (dissolved)



## 3.2 Continuous monitoring data

### Notable sonde changes in the last quarter (January 2024 – March 2024)

Below are key changes in the last quarter of data, these events are described in detail in subsequent sections (3.2.1 to 3.2.7).

**Temperature** - Temperatures decreased during this period at all sites as we moved through winter and early spring.

**Conductivity** - Reductions in conductivity were observed at Site 6 (Leighton Buzzard) following most rainfall events.

**Dissolved Oxygen** – There were no notable changes to dissolved oxygen saturation this quarter.

**pH** - No notable changes in-period.

**Ammonium** – Ammonium peaked at Site 1 (Minworth WwRC) following rainfall events around the 6<sup>th</sup> February and 27<sup>th</sup> March. An in-period increase was also noted at Atherstone.

**Turbidity** – Peaks in turbidity at Site 1 (Minworth WwRC) are linked to rainfall, notably around 17<sup>th</sup> March.

**Chlorophyll** – Increasing concentrations at Site 6 (Leighton Buzzard) from mid-February to mid-March. Similar but shorter peak seen at Site 16 (Marsworth)

This section describes patterns observed in parameters monitored by the continuous sondes and highlights any noteworthy changes observed in the reporting period. Running means of all historical continuous monitoring data along with this quarter's mean for each sampling location provided in Table 3-4. Symbols (increase '↑', decrease '↓' and no change '-') indicate the in-period mean relative to the long-term mean. The in-period continuous sonde data collected can be seen for all sites in Figure 3-1 to Figure 3-4.

### 3.2.1 Temperature

Over the entire period of record (March 2021 – March 2024), temperatures typically ranged between 9-22°C in the Minworth discharge. By contrast the canal at Atherstone ranged from 4-23°C. Temperatures between Minworth and Atherstone are similar in summer months however the Minworth discharge is up to 8°C warmer than the canal in winter. As there is potentially a risk of a >3°C temperature increase relative to 98<sup>th</sup> percentile values in the receiving waterbody due to the temperature differences seen at this time of year, appropriate considerations must be made at the design stage to reduce potential impacts to fish<sup>2</sup>. Further considerations around the potential for additional risk of algal blooming in the canal should also be made, as the warmer temperatures and higher flows could lead to increase algal blooms.

This quarter (Q8 2024), temperatures were highest at Site 1 (Minworth WwRC) measuring 12.8°C on average. In the canal itself the highest temperature observed was 8.1°C at Site 16 and lowest at 7.8°C at Site 3. Temperatures at Site 1 (Minworth WwRC) decreased across the monitoring period with the same observed in the GUC itself. This quarter (Q8 2024), temperatures at all sites were cooler on average than last quarter (Q7 2023). All sites were below the thresholds for fish stress.

<sup>2</sup> The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 Part 1, Section 1 (6)



## 3.2.2 Conductivity

Conductivity is a measure of the ability of a water body to conduct an electrical charge and reflects the concentration of ions in solution (e.g., sodium, calcium etc). Instream conductivity is primarily controlled by underlying geology. Temporary increases and reductions in conductivity can be observed in response to pulses of mineral rich material from catchment sources (e.g., agricultural runoff). Conversely, instream reductions in conductivity occurred when rainfall runoff from the surrounding area results in an instream dilution. Long term increases in conductivity, above what would be considered typical for a particular catchment can be indicative of nutrient enrichment from the surrounding landscape from point (e.g., WwRC) or diffuse (e.g., agricultural) sources.

Conductivity in the GUC was greatest at Site 16 ( $611 \mu\text{S cm}^{-1}$ ) and lowest at Site 3 ( $510 \mu\text{S cm}^{-1}$ ). The Minworth WwRC discharge measured  $653 \mu\text{S cm}^{-1}$ . There was a strong response to rainfall at Site 6 with notable reduction in conductivity following most rainfall events.

## 3.2.3 Dissolved oxygen

Dissolved oxygen (DO), typically reported in percent saturation (%) or concentration (mg/l), describes the amount of oxygen that is dissolved in water. It is essential for aquatic life, with low DO saturation resulting in anoxia and subsequent fish kill as well as being associated with the development of eutrophic conditions. The pattern of DO saturation in watercourses varies seasonally. A typically well aerated river or stream will have a DO % saturation of ~100%. Canals typically experience lower DO saturation than rivers. This is partly due to the slow flowing nature of canals and lack of natural aeration from turbulent water as it travels downstream. Diurnal variability is highest during the summer months driven largely by photosynthesis-respiration dynamics. DO can, however, exceed 100% instream due to the production of oxygen from photosynthetic aquatic organisms and non-ideal equilibration of dissolved oxygen between the water and the air above it. It should be noted that supersaturation can lead to fish distress and fish kills with high enough saturation.

This quarter (Q8 2024), mean DO saturation measured highest at 97.6% at Site 16 with the lowest measurement of 53.0% at Site 1 (Minworth WwRC), this was a slight reduction relative to last quarter (Q7 2023) for Site 1. All sites were comparable to their long-term means.

## 3.2.4 pH

The pH of a watercourse is a measure of how acidic or basic the water is. The pH is mainly driven by geology (and resultant soil type) however can be influenced by catchment factors such as pollutant discharges and the leaching of soil horizons under differing flow conditions. As pH is recorded on a logarithmic scale, slight changes in pH can have significant impacts on the organisms that live in a watercourse. The optimum pH for water to sustain fish and invertebrate life, is between 6 and 9. Across all sites, pH was within acceptable limits for fish and invertebrates. It should be noted that mean pH at Minworth WwRC (6.7) is more acidic (lower) than the example discharge location at Site 3 (7.4) this quarter (Q8 2024). The example abstraction location at Site 6 as well as Site 16 are slightly more basic measuring 7.9 each. This suggests pH may decrease along the proposed transfer route.

This quarter (Q8 2024), all sites measured comparably to their long-term means. Mean pH was lowest in the Minworth WwRC discharge (Site 1) measuring 6.7. In the canal, Site 3 measured the lowest at 7.4 while highest at Site 6 with a pH of 8.0.

## 3.2.5 Ammonium

Ammonium is a type of nitrogenous compound that is naturally present in water but can also be released into rivers from a variety of sources, including agricultural runoff, sewage treatment and industrial wastewater discharges. High concentrations of ammonium in rivers can be harmful to aquatic life, particularly fish, as it can disrupt their metabolism and respiration. Ammonium is most toxic to fish in its un-ionised form, ammonia. The



ammonia/ammonium equilibrium is largely pH and temperature dependant with un-ionised ammonia becoming prevalent above a pH of 8. In some cases, it can even be fatal. Ammonium can also contribute to the formation of algal blooms, which can further degrade water quality and make it unsafe for drinking, swimming, and fishing. Mean ammonium concentrations were highest at Site 1 (Minworth WwRC) with 1.96 mg/l observed and lowest at the example discharge location Site 3 (Atherstone) with 0.21 mg/l.

Ammonium peaked at Sites 16 (Marsworth) on 21<sup>st</sup> February measuring 0.8 mg/l. Several other peaks in concentrations were noted at Site 1 (Minworth WwRC) this quarter (Q8 2024); 11.4 mg/l and 9.0 mg/l were measured on the 7<sup>th</sup> February and 27<sup>th</sup> March. These appear to be driven by corresponding rainfall. When compared to laboratory derived concentrations, in-situ measurements of ammonium commonly incorrectly report high concentrations of ammonium concentrations without regular calibration. As such, it is important to use these data to infer catchment trends rather than absolute concentrations.

### 3.2.6 Turbidity

Turbidity is a measure of how cloudy water is and can be used as a proxy for suspended sediment concentrations. It is caused by the presence of suspended particles in the water, such as sediment, algae, or other organic matter. Turbidity can make it difficult for sunlight to penetrate the water, which can reduce the amount of photosynthesis that takes place. A high loading of suspended sediment, when combined with reduced flow velocities, can result in sediment deposition causing damage to macrophytes and reducing hydrological exchanges with river bed and surrounding groundwater. Increased sediment loading can result in the unintended substances being transported. For example, the dominant form of phosphorus exported from agricultural systems is particulate phosphorus, which when exported from the terrestrial to aquatic systems has the potential to desorb and become available to in-stream heterotrophic organisms.

Increases in turbidity can be caused by a number of factors, including erosion, runoff from agricultural fields following poor land and soil management practises, stormwater runoff and point source pollution, such as from WwRCs. Turbidity values are typically highest at Site 1 (Minworth WwRC) with a mean of 48.4 NTU. At the example discharge location (Site 3) the mean is 28.6 NTU. The lowest mean turbidity value to date was recorded at Site 3 measuring 3.6 NTU.

During this quarter (Q8 2024) turbidity was low across most sites with regular turbidity spikes at Site 3 and Site 6. The largest turbidity peak occurred at Site 6 (Leighton Buzzard) on 4<sup>th</sup> January 2024 (943 NTU). Historically, turbidity spikes have occurred across all sites following rainfall events. Mean concentrations increased at Site 16 (Marsworth) this quarter but were below the long-term mean for this site. The reason for this increase is unknown.

### 3.2.7 Chlorophyll

Chlorophyll is a green pigment found in algae and plants. It is essential for photosynthesis, the process by which plants convert sunlight into energy. Chlorophyll can be used as a measure of the quantity of algae in a river. Higher levels of chlorophyll indicate more algae, which can lead to problems such as algal blooms, decreased oxygen levels, and the production of toxins. There are a number of factors that can affect the level of chlorophyll in a river, including nutrient levels, sunlight levels, temperature and flow. Chlorophyll concentrations are generally highest at Site 6 and have been observed to peak with a number of algal blooms events observed during the Spring and Summer months.

Recent data collected covering January to March 2024 falls within the usual levels monitored during the late autumn/early winter period. Algal activity this quarter (Q8 2024) was very low, falling outside the typical algal bloom period however increases were noted at Site 6 and Site 16.



Table 3-4 – Overall mean and quarterly mean values observed at continuous monitoring locations

| Determinand      | Unit                | 1. Minworth WwRC Final Effluent <sup>1</sup> |                |                  | 3. GUC at Atherstone <sup>2</sup> |                |                  | 6. GUC at Grove, Leighton Buzzard <sup>3</sup> |                |                  | 16. GUC at Marsworth <sup>2</sup> |                |                  |
|------------------|---------------------|--|----------------|------------------|-----------------------------------|----------------|------------------|--|----------------|------------------|-----------------------------------|----------------|------------------|
|                  |                     | Overall Mean                                 | Quarterly Mean | Change in-period | Overall Mean                      | Quarterly Mean | Change in-period | Overall Mean                                   | Quarterly Mean | Change in-period | Overall Mean                      | Quarterly Mean | Change in-period |
| Temperature      | °C                  | 16.1   | 12.8           | ↓                | 12.1                              | 7.0            | ↓                | 11.8   | 7.25           | ↓                | 13.6                              | 8.1            | ↓                |
| Conductivity     | µS cm <sup>-1</sup> | 776  | 653            | ↓                | 1006                              | 510            | ↓                | 625.4  | 553            | ↓                | 566                               | 611            | ↑                |
| Dissolved Oxygen | %                   | 53.0   | 48.4           | ↓                | 79.4                              | 87.1           | ↑                | 82.67  | 94.6           | ↑                | 97.6                              | 100            | ↑                |
| pH               | pH units            | 6.7  | 6.7            | —                | 7.4                               | 7.4            | —                | 7.9  | 8.0            | —                | 7.9                               | 7.8            | —                |
| Ammonium         | mg N/l              | 1.96   | 2.4            | ↑                | 0.43                              | 0.43           | ↑                | 0.49   | 0.31           | ↓                | 0.38                              | 0.21           | ↓                |
| Turbidity        | NTU                 | 41.5   | 5.6            | ↓                | 28.6                              | 36.9           | ↑                | 32.8   | 47.8           | ↑                | 4.2                               | 2.9            | ↓                |
| Chlorophyll      | µg/l                | -  | -              |                  | 7.8                               | 3.6            | ↓                | 21.7   | 12.3           | ↑                | 11.4                              | 12.1           | ↑                |

<sup>1</sup> Site 1 (Minworth WwRC) sonde data monitoring for conductivity, temperature, and dissolved oxygen commenced at the start of Phase 2 monitoring on 18/05/2022.

Additional parameters including pH, ammonium, and turbidity were added on 05/04/2022.

<sup>2</sup> Site 3 and Site 16 sondes were deployed on 11/05/22 and 24/05/22 respectively.

<sup>3</sup> Site 6 sonde was deployed on 25/11/21.



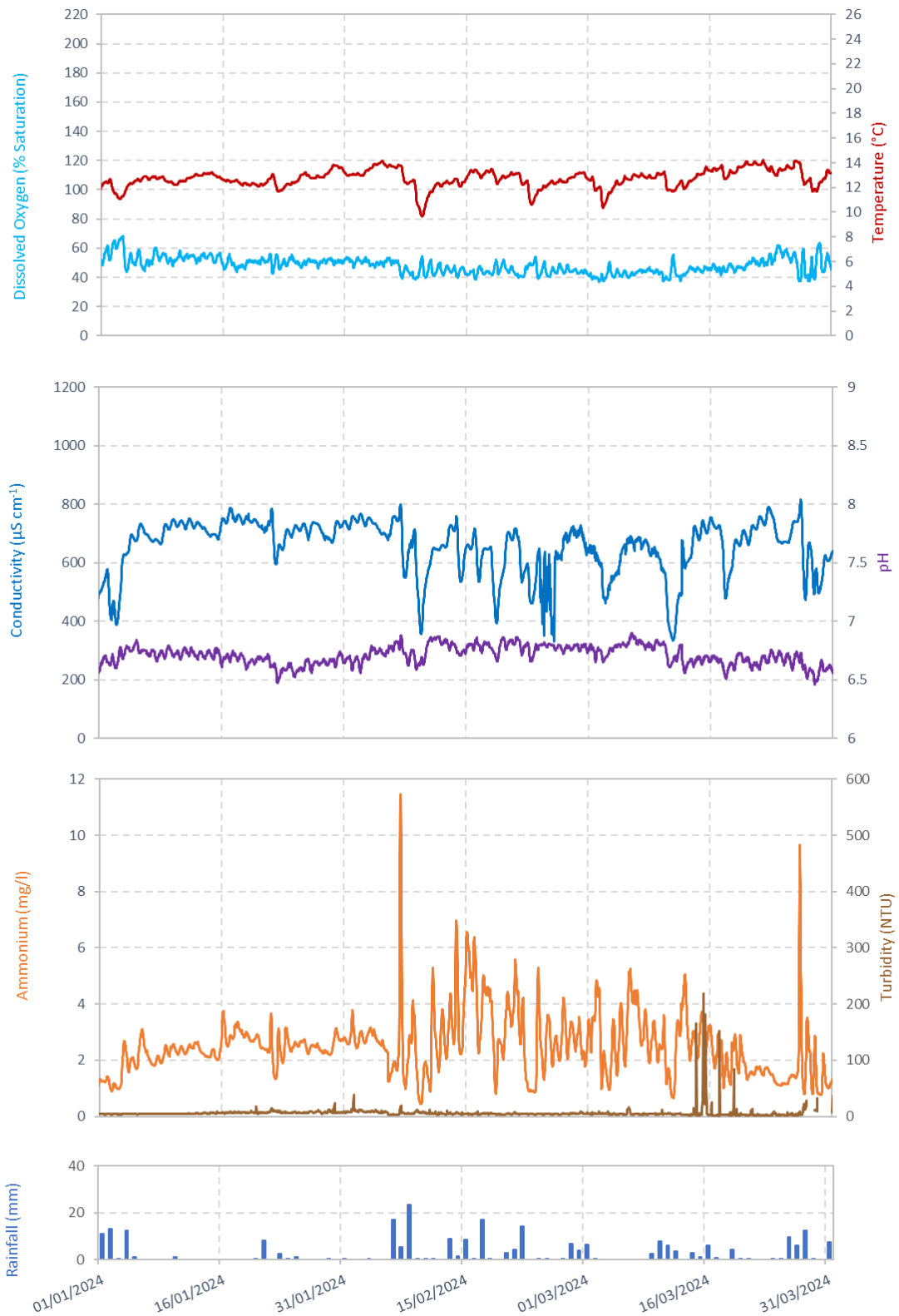
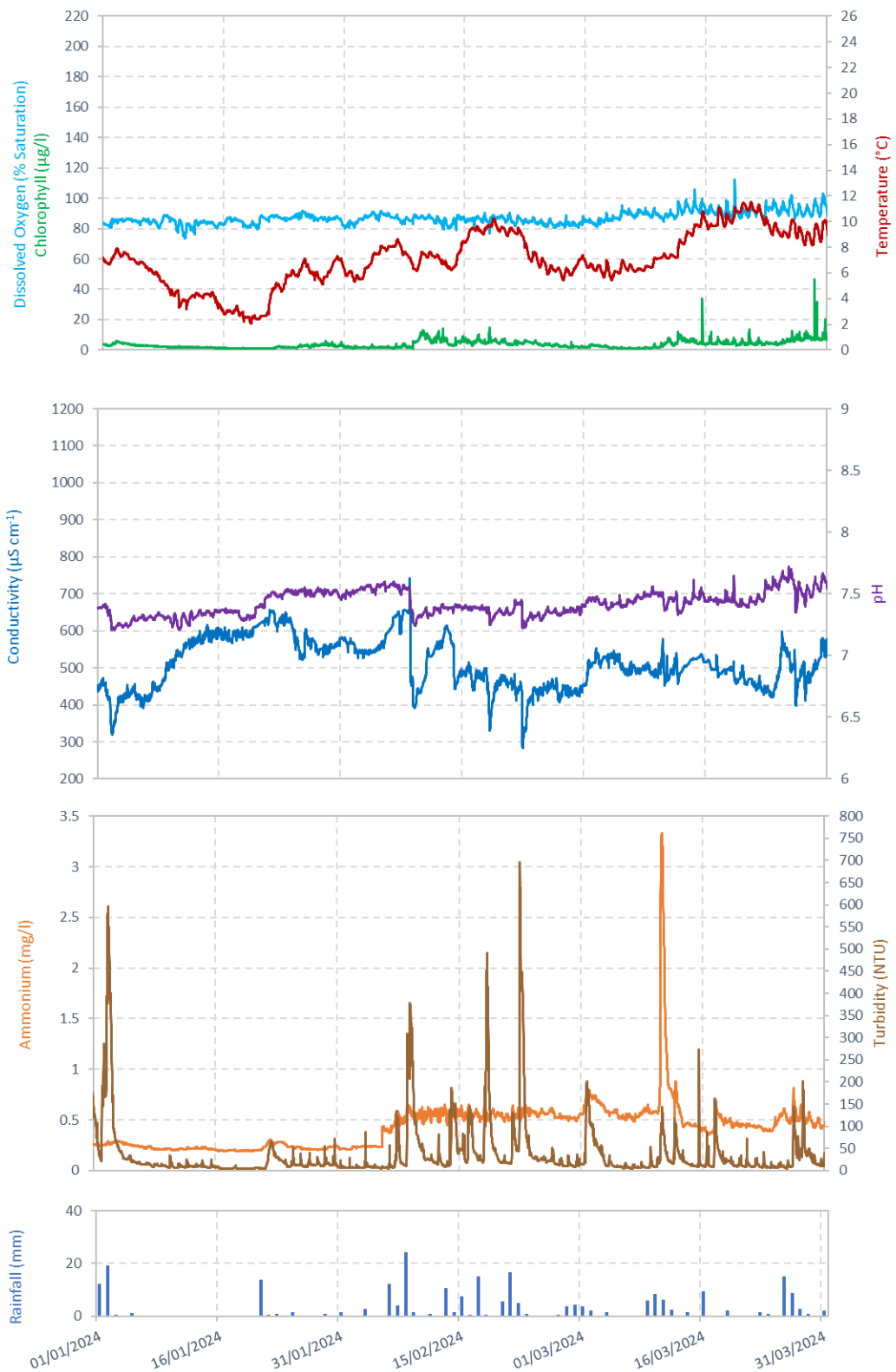


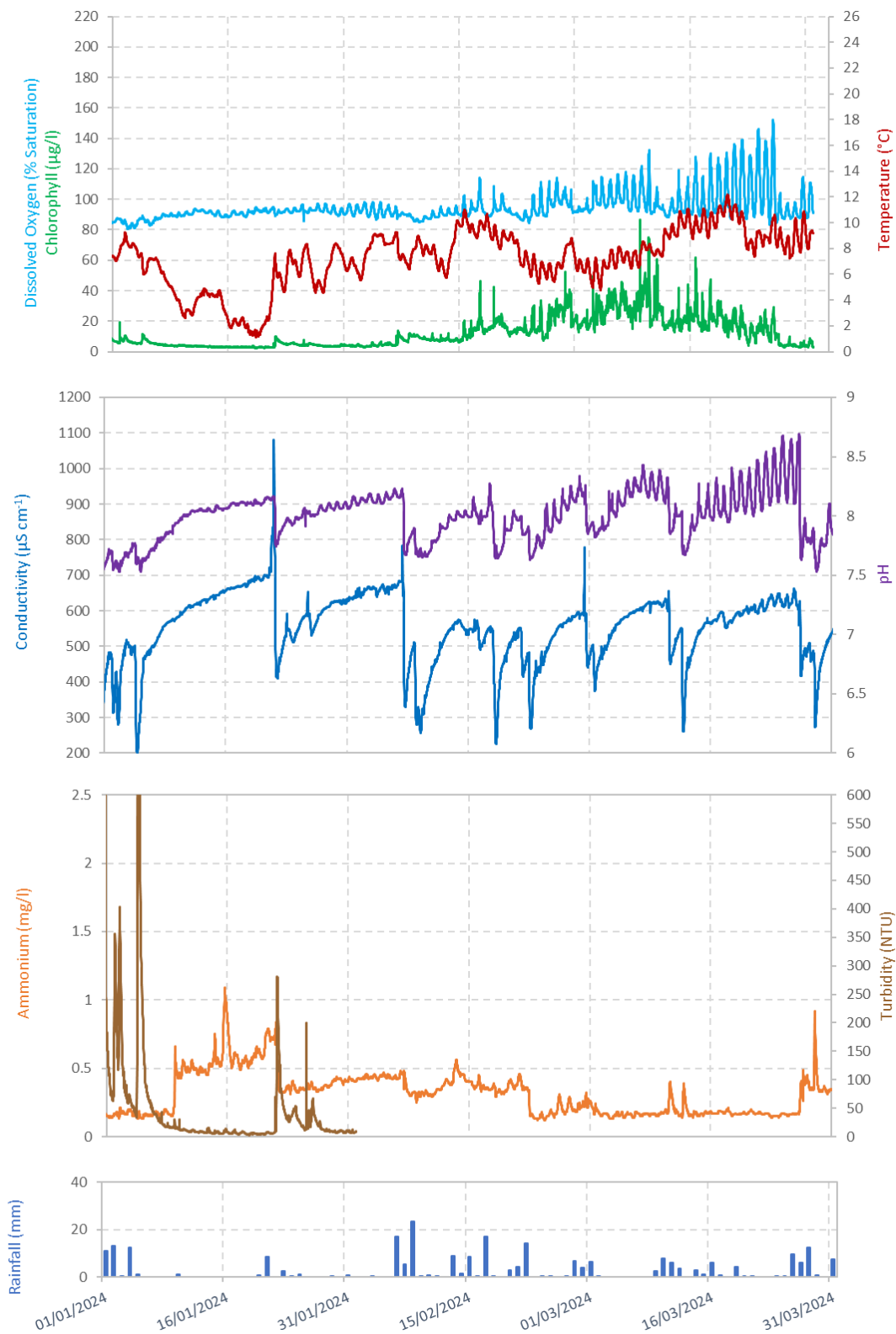
Figure 3-1 – Continuous sonde data collected between 01/01/2024 to 31/03/2024 at Site 1 (Minworth WwRC)





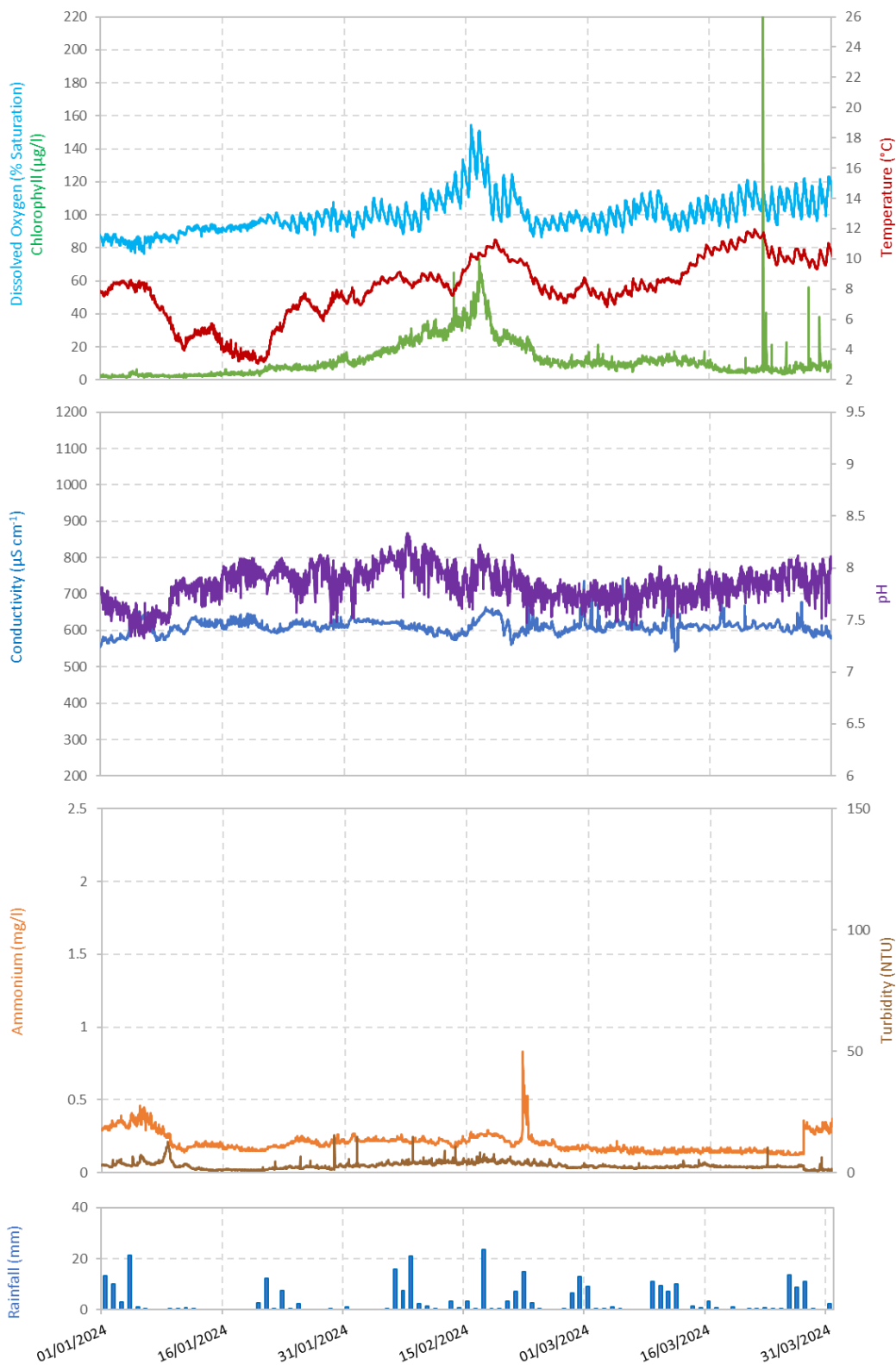
**Figure 3-2 – Continuous sonde data collected between 01/01/2024 to 31/03/2024 at Site 3 (GUC at Atherstone)**





**Figure 3-3 – Continuous sonde data collected between 01/01/2024 to 31/03/2024 at Site 6 (GUC Leighton Buzzard)**





**Figure 3-4 – Continuous sonde data collected between 01/01/2024 to 31/03/2024 at Site 16 (GUC at Marsworth)**

## 3.3 Spot sample drinking water quality standards comparison

### 3.3.1 Overview

Drinking water parameter analysis, assessed through their comparison to Prescribed Concentration Values (PCVs) is only undertaken to characterise the source water at Minworth WwRC (Site 1) and the downstream abstraction location (Site 6 Leighton Buzzard). A total of 26 months of Drinking Water Safety Plan data are available for Site 6 compared to 44 months at Site 1 (Minworth WwRC). This is a result of the site selection process for the example abstraction location.

It should be noted that the PCV standards are being applied to raw 'untreated' water where typically they would apply at the point of use e.g., a customer's tap. This had been undertaken to provide guidance on which substances may require targeted treatment when abstraction is operational. PCV exceedances in wastewater discharge and an operational canal are therefore expected.

### 3.3.2 Exceedances to date

At Site 1 (Minworth WwRC) 354 exceedances out of 17,124 results have been recorded to date. At Site 6, 250 PCV exceedances have been recorded out of 11,648 results. The distribution of these is detailed in Table 3-5. 32 determinands have exceeded their PCVs to date. These determinands, along with the number of exceedances observed at each site are given below. The most frequently exceeding substances are:

- Benzo(a)pyrene (total exceedances = 27)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 67)
- *Escherichia coli* (*E. coli*, total exceedances = 66)
- Iron – total (total exceedances = 38)
- Manganese - dissolved (total exceedances = 37)
- Manganese - total (total exceedances = 43)
- Nitrite (total exceedances = 28)
- Turbidity (total exceedances = 62)
- PAH sum (total exceedances = 15)
- Chlorite (total exceedances = 12)

*C. perfringens* (a sulphite-reducing species commonly associated with faecal contamination) is widely distributed in the environment and is regularly evaluated with the aim of understanding the microbiological safety of drinking water supplies. Ingestion of *C. perfringens* can result in gastrointestinal disease, and *C. perfringens* spores can persist longer than other indicators of contamination, such as Coliforms (which also demonstrated exceedances at all sites and is also an important indicator of faecal contamination). Sources of bacterial contamination can range from the input of animal manures from farmyard runoff and the discharge of untreated, and even treated, sewage effluent.



*Cryptosporidium* was not detected at either site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward.

Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores. However, as canal networks often have shallow depths (<2m), short lived events may be a result of localised disturbance of sediments by boats or wildlife causing disturbance in the vicinity of the sensor location.

**Table 3-5 – Number of drinking water PCV exceedances**

| Compound   | PCV  | Unit                    | Abstraction site |           |
|--|------|-------------------------|------------------|-----------|
|  |      |                         | Source Site 1    | Site 6    |
| Aluminium (dissolved)  | 200  | µg/l                    | 0                | 2         |
| Aluminium (total)  | 200  | µg/l                    | 1                | 16        |
| Ammonium   | 0.5  | mg/l as NH <sub>4</sub> | 4                | 3         |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 1                | 25        |
| Bisphenol A  | 2.5  | µg/l                    | 9                | 0         |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml                | 37               | 30        |
| Chlorate   | 0.25 | mg/l                    | 4                | 0         |
| Chloride   | 250  | mg/l                    | 1                | 0         |
| Chlorite   | 0.25 | µg/l                    | 0                | 13        |
| Chromium (total)   | 50   | µg/l                    | 1                | 0         |
| Clopyralid   | 0.1  | µg/l                    | 1                | 0         |
| Coliform (total)   | 0    | MPN/100ml               | 37               | 29        |
| Colour   | 20   | mg/Pt/Co                | 27               | 3         |
| <i>E. coli</i>   | 0    | MPN/100ml               | 37               | 29        |
| Iron (dissolved)   | 200  | µg/l                    | 0                | 3         |
| Iron total   | 200  | µg/l                    | 8                | 29        |
| Manganese (dissolved)  | 50   | µg/l                    | 36               | 1         |
| Manganese (total)  | 50   | µg/l                    | 37               | 6         |
| Mercury (total)  | 1    | µg/l                    | 1                | 0         |
| Metribuzin   | 0.1  | µg/l                    | 0                | 2         |
| Nickel (dissolved)   | 20   | µg/l                    | 10               | 0         |
| Nickel (total)   | 20   | µg/l                    | 12               | 0         |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 26               | 2         |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 29               | 10        |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | 1                | 13        |
| Propyzamide  | 0.1  | µg/l                    | 1                | 1         |
| Sodium (dissolved)   | 200  | mg/l                    | 0                | 1         |
| Sulphate   | 250  | mg/l SO <sub>4</sub>    | 0                | 1         |
| Tebuconazole   | 0.1  | µg/l                    | 0                | 1         |
| Turbidity  | 1    | NTU                     | 32               | 29        |
| Vinyl chloride   | 0.5  | µg/l                    | 0                | 1         |
| <b>Total samples</b>   |      |                         | <b>46</b>        | <b>34</b> |

Orange text indicates a new PCV exceedance this quarter.

**Table 3-6 – Maximum concentrations of compounds responsible for drinking water PCV exceedances\***

| Compound   | PCV  | Unit                    | Source    |                            |
|--|------|-------------------------|-----------|----------------------------|
|  |      |                         | Site 1    | Abstraction site<br>Site 6 |
| Aluminium (dissolved)  | 200  | µg/l                    | 66        | 67                         |
| Aluminium (total)  | 200  | µg/l                    | 125       | 530                        |
| Ammonium   | 0.5  | mg/l as NH <sub>4</sub> | 0.1       | 1.5                        |
| Benzo(a)pyrene   | 0.01 | µg/l                    | 0.02      | 0.13                       |
| Bisphenol A  | 2.5  | µg/l                    | 137       | <0.01**                    |
| <i>C. perfringens</i> veg & spores, confirmed  | 0    | No/100ml                | 100       | 1000                       |
| Chlorate   | 0.25 | mg/l                    | 2.0       | 0.7                        |
| Chloride   | 250  | mg/l                    | 610       | 91                         |
| Chlorite   | 0.25 | µg/l                    | 3         | 15                         |
| Chromium (total)   | 50   | µg/l                    | 140       | 15                         |
| Clopyralid   | 0.1  | µg/l                    | 0.2       | 0.03                       |
| Coliform (total)   | 0    | MPN/100ml               | 2420      | 2420                       |
| Colour   | 20   | mg/Pt/Co                | 43        | 26                         |
| <i>E. coli</i>   | 0    | MPN/100ml               | 2420      | 2420                       |
| Iron (dissolved)   | 200  | µg/l                    | 100       | 1700                       |
| Iron total   | 200  | µg/l                    | 310       | 2600                       |
| Manganese (dissolved)  | 50   | µg/l                    | 130       | 120                        |
| Manganese (total)  | 50   | µg/l                    | 160       | 360                        |
| Mercury (total)  | 1    | µg/l                    | 3.7       | 0.7                        |
| Metribuzin   | 0.1  | µg/l                    | 0.1       | 0.2                        |
| Nickel (dissolved)   | 20   | µg/l                    | 61        | 7.1                        |
| Nickel (total)   | 20   | µg/l                    | 61        | 9.4                        |
| Nitrate  | 50   | mg/l NO <sub>3</sub>    | 120       | 100                        |
| Nitrite  | 0.5  | mg/l NO <sub>2</sub>    | 3.6       | 2.5                        |
| PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene) | 0.1  | µg/l                    | 0.05      | 0.37                       |
| Propyzamide  | 0.1  | µg/l                    | 0.3       | 0.5                        |
| Sodium (dissolved)   | 200  | mg/l                    | 78        | 510                        |
| Sulphate Tebuconazole  | 250  | mg/l SO <sub>4</sub>    | 180       | 690                        |
| Tebuconazole   | 0.1  | µg/l                    | 0.05      | 0.2                        |
| Turbidity  | 1    | NTU                     | 16        | 290                        |
| Vinyl chloride   | 0.5  | µg/l                    | 0.5       | 1                          |
| <b>Total number of samples</b>   |      |                         | <b>46</b> | <b>34</b>                  |

\* Light blue shading indicates PCV exceedance, maximum reported concentrations are shown.

\*\* LoD reduced to 0.01 µg/l from April 2022 onwards.

### 3.3.3 Source water/canal section comparison

#### Notable concentration changes in the last quarter (January 2024 - March 2024).

- At Site 6 (Leighton Buzzard) propyzamide exceeded PCV for the first time

#### 3.3.3.1 Minworth vs. example abstraction location (Site 6)

The following substances were found to have concentrations above their respective PCVs in the Minworth WwRC final effluent, however, were below PCVs in-canal at Site 6 (Leighton Buzzard). While it is beyond the scope of this report to infer if an instream PCV exceedance would occur at Site 6 if effluent discharge were re-directed into the GUC, the compounds shown below should be subject to future analysis.

- Bisphenol A
- Chlorate
- Chloride
- Chromium (total)
- Clopyralid
- Mercury (total)
- Nickel (bioavailable)
- Nickel (total)
- Propyzamide

Bisphenol A and chlorate measured above PCV at Minworth but below PCV at Site 6. Importantly the LoD for Bisphenol A is higher than the PCV, as such concentrations in the canal cannot currently be accurately assessed against the discharge. Chloride exceeded PCV concentration at Minworth with 92 mg/l on average while measuring 40 mg/l on average (max 91 mg/l) at Site 6 over the entire monitoring period. This suggests concentrations were well below the PCV of 250 mg/l but could be at risk of deterioration if a Minworth discharge were introduced. Chlorite by contrast exceeded PCV at Site 6 measuring a mean of 15 µg/l. Chromium (total) exceeded PCV at Minworth WwRC at 140 µg/l while measuring a maximum of 15 µg/l at Site 6, this is below the PCV of 50 µg/l. Concentrations in the canal could be at risk of exceedance following introduction of a Minworth discharge given the PCV is exceeded by a large margin. There may also be some risk to in-canal concentrations from a Minworth discharge. Mercury (total) at Site 6 was only slightly below the PCV of 1 µg/l (mean = 0.71 µg/l). This substance may be at risk of PCV exceedance following the introduction of a Minworth discharge to the GUC given the high discharge concentrations (3.7 µg/l). Mean concentrations of nickel (total and dissolved) were both well below the PCV of 20 µg/l at Site 6 with 9.4 µg/l and 7.1 µg/l respectively. Consequently, these substances are highly likely to exceed PCV following a Minworth discharge due to the concentrations present. Concentrations of propyzamide exceeded the PCV of 0.1 µg/l at Site 6 for the second time this quarter (Q8 2024) measuring up to 0.19 µg/l; however, this measures lower in the Minworth discharge on average (mean = 0.018 µg/l) suggesting potential dilution of this substance. The substance listed above may be influenced at Site 6 with the addition of the Minworth discharge and as such, in the absence of additional treatment at Minworth WwRC, water containing these substances may require additional treatment following abstraction.

# CONCLUSIONS



## 4. Conclusions

At present, the following determinands have demonstrated the greatest number of WFD AA EQS exceedances, (or in the case of dissolved oxygen, failure to attain 90<sup>th</sup> percentile saturation), on an individual sample basis across all sampling rounds to date and pose a potential risk at the discharge location:

- **Minworth WwRC (Site 1)** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - ANC (a total of 36 individual occurrences)
  - Benzo(a)pyrene (a total of 49 individual occurrences)
  - BOD - 5-day (a total of 5 individual occurrences)
  - Dissolved Oxygen (a total of 28 individual occurrences)
  - Cypermethrin (a total of 39 individual occurrences)
  - PFOS (a total of 58 individual occurrences)
  - SRP (a total of 37 individual occurrences)
  - Sulphide or hydrogen sulphide (a total of 19 individual occurrences)
  - Zinc (bioavailable) (a total of 47 individual occurrences)
  
- **GUC (all sites)**
  - ANC (10 sites, a total of 279 individual occurrences)
  - Benzo(a)pyrene (10 sites, a total of 290 individual occurrences)
  - BOD - 5-day (6 sites, a total of 27 individual occurrences)
  - Dissolved Oxygen (6 sites, a total of 63 individual occurrences)
  - Fluoranthene (10 sites, a total of 237 individual occurrences)
  - PFOS (10 sites, a total of 256 individual occurrences)
  - SRP (7 sites, a total of 131 individual occurrences)
  - Sulphide or hydrogen sulphide (12 sites, a total of 189 individual occurrences)

In addition, the following determinands exceeded WFD / EQSD MAC values:

- **Minworth WwRC (Site 1)** (noting EQS standards do not directly apply to effluent and discharge standards are set through the permitting regime)
  - Sulphide or hydrogen sulphide (total individual exceedances = 19)
  - Bromine (total residual oxidant) (total individual exceedances = 35)
  - Nickel (dissolved) (total individual exceedances = 2)
  - Cypermethrin (total individual exceedances = 6)
  - Formaldehyde (total individual exceedances = 1)
  - Mercury (dissolved) (total individual exceedances = 2)
  - Mercury (total) (total individual exceedances = 2)
  - Maneb (total individual exceedances = 1)
  - Benzo(g,h,i)perylene (total individual exceedances = 3)



- **GUC (all sites)**
  - Benzo(a)pyrene (total individual exceedances = 77)
  - Benzo(b)fluoranthene (total individual exceedances = 22)
  - Benzo(g,h,i)perylene (total individual exceedances = 49)
  - Benzo(k)fluoranthene (total individual exceedances = 10)
  - Cadmium (total) (total individual exceedances = 2)
  - Cadmium (dissolved) (total individual exceedances = 2)
  - Sulphide or hydrogen sulphide (total individual exceedances = 189)
  - Bromine (total residual oxidant) (total individual exceedances = 38)
  - Nickel (dissolved) (total individual exceedances = 16)
  - Cypermethrin (total individual exceedances = 12)
  - Mercury (dissolved) (total individual exceedances = 14)
  - Mercury (total) (total individual exceedances = 18)
- **Daventry Reservoir (Site 17)**
  - Bromine (total residual oxidant) (total individual exceedances = 1)
  - Mercury (total) (total individual exceedances = 2)
- **Drayton Reservoir (Site 18)**
  - Mercury (total) (total individual exceedances = 2)

Some concentrations in the Minworth WwRC effluent were greater than the EQS in the receiving water at Site 3, Coventry Canal, Atherstone (noting these standards do not directly apply to effluent and discharge standards are set through the permitting regime). These include chlorothalonil (an organic fungicide), cypermethrin (a synthetic pyrethroid), diazinon, formaldehyde, benzo(g,h,i)perylene, azinphos methyl (dissolved) and dissolved oxygen. As a result, if Minworth WwRC final effluent was diverted to the example discharge location without any additional treatment applied, additional in-canal exceedances may occur, resulting in a future WFD compliance risk as the new discharge would affect No Deterioration criteria and prevent the water quality of the receiving body from achieving Good Status in future. This quarter (Q8 2024) benzo(g,h,i)perylene was identified above the MAC EQS at Site 1 (Minworth WwRC) for the first time but did not exceed the annual average.

Further assessment is required to determine the level of confidence in the exceedances if this is indeed the case (e.g., through modelling or pairwise assessment of samples). Additional treatment at Minworth WwRC will be required in order to provide a resolution to this issue.

Minworth WwRC treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of the potential 'high risk' compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permitting risk (e.g., due to within class deterioration).

As discussed in Section 3.3.1, PCVs apply only to treated drinking water, and not raw source waters. However, the monitoring of these determinands and regular comparison with drinking water standards enables a threshold for screening out determinands that may be considerably elevated in raw water, thus helping to inform treatment design and Drinking Water Safety Plans at the example abstraction location. With that in mind, the following determinands are currently routinely exceeding PCV targets at Site 6:

- Benzo(a)pyrene (total exceedances = 26)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances = 30)
- *Escherichia coli* (*E. coli*, total exceedances = 30)
- Iron (total) (total exceedances = 30)



- Chlorite (total) (total exceedances = 13)
- Nitrite (total exceedances = 10)
- PAH sum (total exceedances = 14)
- Turbidity (total exceedances = 30)

*C. perfringens* exceeded PCV values at both sites as it is widely distributed across the environment and as such, is regularly evaluated to monitor the microbiological safety of drinking water supplies. Sources of bacterial contamination can range from the input of animal manures from farmyard runoff to discharge from untreated or treated sewage effluent. *Cryptosporidium* was not detected at any site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores or localised disturbance events.

All sensor data is within ranges typical of freshwater environments within a late winter, early spring period. Temperatures increased steadily across all sites throughout the period. Rainfall events appear to have driven several peaks in ammonium concentration at Site 1 (Minworth WwRC). No algal blooms appear to be occurring at any location indicated by low average chlorophyll concentrations.

With respect to WFD EQS, in the upper GUC chloronathonil, cypermethrin, diazinon, dissolved oxygen, permethrin and azinphos methyl (dissolved) are the substances most at risk as these exceed in the Minworth WwRC discharge but not in the Upper GUC. For the Middle and Lower sections zinc (bioavailable) is at risk. SRP is mostly at of risk additional EQS exceedances in the middle section however exceedances in the middle section are becoming more common. Exceedances in the Lower GUC already occur.

With respect to PCVs, the following substances are potentially at risk of increasing in concentration within the GUC from the Minworth WwRC discharge to the GUC:

- Bisphenol A
- Chlorate
- Chloride
- Chromium total
- Clopyralid
- Mercury (total)
- Nickel (bioavailable)
- Nickel (total)
- Propyzamide

## 4.1 Next steps

We will continue to analyse water quality data collected as part of the GUC water quality monitoring programme which will continue through to November 2024. As part of this process, we will continue providing quarterly updates which will be communicated to the GUC project team and the Minworth WwRC and abstraction treatment engineers to understand the feasibility of designing treatment for any 'high risk' compounds. We will also work with the team to identify any changes that may be required to the monitoring programme i.e., the addition or removal of sites and/or parameters.

Our water quality analysis will continue to investigate environmental and drinking water risks, comparing results to individual EQS and PCVs. Our analysis will also continue to investigate whether there is a potential risk of water quality deterioration by comparing Minworth WwRC final effluent with canal sites.



We will also update the drinking water quality risk assessment for Gate 3 following the All Company Working Group (ACWG) methodology. This was previously undertaken for Gate 1 and subsequently updated for Gate 2, with the caveat that this assessment is based on raw water before treatment, so PCV breaches are expected.



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