

"WATER SAFETY PLAN"

Incorporating *Legionella* "safe" hot water, cold water, drinking water and
ventilation systems Management and Control

BOOK 3

PROJECTS & CAPITAL MANAGEMENT

This document was formally approved by The
University Health and Safety Committee on:

Date: 17th June 2016

Name David Howell Director of Facilities Services

Signed:

Version 1 Issue 3

Date of Review: July 2019

Date of next review July 2022

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i. DISTRIBUTION CONTROL

This Water Safety Plan (WSP) has a controlled circulation and should not be copied or circulated without the permission of the Water Safety Group (WSG) Chair.

Confirmation that each Departmental Responsible Person and their Deputy have read and understood this WSP and recorded on each 'Letter of Nomination' enclosed in [Appendix 1](#). While the WSG have delegated responsibility to department leads and framework contractors to ensure that information contained herein is disseminated to all appropriate parties; including at induction via specific instruction to work to the WSP.

ii. DOCUMENT MANAGEMENT

Whilst this document is developed in such a way as to ensure that all aspects of Water Quality Management are addressed, its construction is such as to allow for ease of use and it is thus divided into the following sections which can be considered in isolation:

Document No.	Document Title	Targeted Departments						
		FM Services		H&S	Schools & Sports	Contractors	Commercial	Imago & Campus Services
		Hard FM	Soft FM					
Book 1	General Considerations	✓	✓	✓	✓	✓	✓	✓
Book 2	FM Services Management	✓	✓	✓	✓	✓	✓	✓
Book 3	Projects & Capital Management	✓	✓	✓		✓		
Book 4	Contingency Measures	✓	✓	✓	✓		✓	✓

NB – Hard FM Services are related to Building mechanical and electrical services. While Soft FM Services are related to but not limited to cleaning, catering, accommodation, security, landscaping, waste management.

This WSP shall be used in conjunction with current version of the following University Policies:

i. Domestic Services

<http://www.lboro.ac.uk/services/fm/services/domestic/>

ii. General Sport Policy –

<http://www.lboro.ac.uk/departments/ssehs/research/social-sciences-and-sport/sport-policy-and-management/>

iii. Catering equipment and Irrigation systems (Grounds and Gardening) –

<http://www.lboro.ac.uk/services/fm/services/grounds/>

iv. H&S policy

<http://www.lboro.ac.uk/services/fm/services/fmhs/policies/>

1. DESIGN INSTALLATION AND COMMISSIONING OF REFURBISHED AND NEW-BUILD FACILITIES

1.1 Process Management:

The design, installation and commissioning of all new-builds and refurbished areas shall be carried out in accordance with the University's current Policy: LU Building Services Specification (current edition)

1.2 Legislation, standards and guidance:

As well as complying with the recommendations outlined in this the design, installation, commissioning and hand-over of the hot and cold water services, new, extended or refurbished, in any University premises shall also comply with:

- i. The Construction (Design and Management) Regulations 2015 (CDM)
- ii. the Building Regulations 2010 (and associated amendments)
- iii. The Water Regulations Advisory Scheme's (WRAS) 'Water Regulations Guide', and any other requirements of the local water undertaker
- iv. The Water Supply (Water fittings) Regulations 1999
- v. The Water Supply (Water Quality) Regulations 2000
- vi. CIBSE Guide G Public Health and Plumbing Engineering
- vii. BS 1710 - 1984 - Specification for identification of pipeline services
- viii. BS 8558:2015 provides complimentary guidance to BS EN 806 . It is a guide to the design, installation, testing, operation and maintenance of services supplying water for domestic use within buildings and their curtilages
- ix. BS EN 806-5:2012 Specification for installations inside buildings conveying water for human consumption - Operation and maintenance
- x. BS EN 806-1:2000 Specifications for installations inside buildings conveying water for human consumption -General
- xi. BS EN 806-2:2005 Specifications for installations inside buildings conveying water for human consumption - Design
- xii. BS EN 806-3:2006 Specifications for installations inside buildings conveying water for human consumption - Pipe sizing. Simplified method
- xiii. BS EN 806-4:2010 Specifications for installations inside buildings conveying water for human consumption - Installation
- xiv. BS7592:2008 - Sampling for Legionella bacteria in water systems - Code of practice
- xv. BS 8580:2010 - Water Quality - Risk assessments for Legionella Control - Code of Practice
- xvi. BS8554:2015 - Code of practice for the sampling and monitoring of hot and cold water services in buildings
- xvii. BSi PD 855468:2015 - Guide to the flushing and disinfection of services supplying water for domestic use within buildings and their curtilages: September 2015

1.3 Design Verification:

In order to ensure that all designs are developed in accordance with the requirements detailed above, all designs, before offered for Tender, the Projects Team and Independent Consultants shall review each design for compliance, suitability and correctness of specification.

The Projects Team and Independent Consultants shall verify and ratify each design and confirm that it is suitable for tendering purposes and issue a suitably completed '[Certificate of Design Compliance](#)' shall be issued when each submitted design has been found to be compliant with all requirements stipulated above.

1.4 Installation Verification:

The system shall be regularly checked during installation to ensure that it is being carried in accordance with the requirements detailed above and as specified in the relevant scheme design specifications and contractual agreements.

In the absence of a scheme Clerk-of Works, the FM Responsible Person/Team Leaders should verify and ratify each installation (or stage thereof) and confirm that it is found to be compliant with all requirements stipulated above and issue a suitably completed '[Certificate of Installation Compliance](#)' shall be issued when each completed installation has been found to be compliant with all requirements stipulated above.

1.5 Commissioning:

Correct commissioning is vitally important for the satisfactory operation of the hot and cold water systems. The designer should prepare a commissioning brief for use by the contractor's commissioning engineer. This brief should specify fully and clearly the extent of the commissioning and the objectives which must be achieved, and should include:

- i. full design data on temperatures, chemical levels, water flow rates and pressures;
- ii. plant and equipment data;
- iii. number commissioning procedures for thermostatic mixing valves in accordance with specification;
- iv. drawings and schematics;
- v. microbiological activity levels;
- vi. a list of test certificates to be provided;
- vii. water quality (Legionella) risk Assessment.

The designer shall prepare for inclusion in the contract documents a list of tests and measurements that are to be taken by the contractor and recorded by him/her. These shall be witnessed by the contract supervising officer or project engineer on his/her behalf and he/she, if approved, will circulate the results, in accordance with the client's instructions. The installation, on completion, shall be operated by the contractor as a whole, and subjected to functional or performance tests as specified by the designer.

The commissioning manual shall be prepared by the contractor and submitted to the client's commissioning adviser for review before being issued in final form. Typical schedules of

checks and performance tests shall be included in the commissioning manual together with record sheets. These shall be amended and supplemented as the designer considers necessary. Once the client's commissioning adviser is satisfied that the system meets the design intent, the final accordance record sheets should be completed. If performance is not acceptable, the matter should be dealt with in accordance with the contract requirements.

The supervising officer or project engineer, who shall countersign any relevant test record documents, shall witness commissioning and testing. "As installed" record drawings, schematic diagrams, operating and maintenance instructions must be supplied at the time of handover. Certified records of pressure testing and disinfection shall also be made available. The whole commissioning procedure shall be carried out under the guidance of a single authority, although the involvement of specialists or manufacturers may be required for specific items of plant. Valid calibration certificates shall be submitted and checked for all measuring equipment to be used by the commissioning engineers prior to commencement of commissioning. The commissioning should be carried out in a logical and methodical manner.

The installation, on completion, shall be operated by the contractor as a whole, and subjected to specified functional or performance tests. Once the system meets the design intent, the final completion record sheet(s) shall be completed. In the event of performance not being acceptable, the matter should be dealt with in accordance with the contract requirements.

It is essential that a full report of all commissioning and testing activities is compiled and handed over to be incorporated within the operation and maintenance manuals. These commissioning and testing records will be required so that subsequent maintenance and periodic checks can be made to ensure that the installation continues to operate as intended.

In the absence of a scheme Clark-of Works, the Projects Team and Independent Consultants shall verify and ratify each installation (or stage thereof) and confirm that it is found to be compliant with all requirements stipulated above and issue a suitably completed ['Certificate of Installation Compliance'](#) shall be issued when each completed installation has been found to be compliant with all requirements stipulated above.

1.6 Hand-Over:

Following any alteration to the Water system the installation will be accepted back by FM by the nominated representative of the appropriate FM department. This person will be trained and competent in Water Management and appointed by the University to carry out such tasks.

Hand-over of all new-builds and refurbishments must not be carried out until all of the requirements detailed in the relevant processes described below are satisfied and the appropriate process and permit ([Permit No. 5 'Permit for Hand-over and Occupation of new-builds'](#) and [Permit No. 6 'Permit for Hand-over and Occupation of Refurbished Facilities'](#)) are completed and duly signed:

A. System Flushing

Once filled, systems should not be drained unless full disinfection is to be carried out prior to building occupancy and use. However, allowing water in newly installed plumbing to stagnate can result in water borne bacteria (biofilm) growing and proliferating in the storage vessels and peripheral parts of the domestic water system. To reduce the risk of this, it is recommended that flushing should take place on a on a Weekly basis (2xWeekly or more frequently if deemed necessary) to introduce fresh water throughout the system.

To prevent the accumulation of biofilm during construction and testing, continuous dosing of water systems with appropriate biocides should be considered. Such treated systems should be regularly flushed to ensure that the biocide reaches all parts of the systems, and particularly outlets.

Dosing with an appropriate level of biocide as soon as water hits a pipe or storage vessel, along with regular flushing, can control the accumulation of biofilm more effectively. Once started, this procedure has to be sustained and logged, as lapses can result in a critical increase in water borne bacteria at the outlet.

Incoming Mains (MCWS)	Confirmation that the incoming mains supply was flushed at least 2 x weekly prior to connection to system
Distribution System and all outlets	Confirmation that, once wetted for pressure testing, all parts of the system have been subject to a Weekly (2xWeekly or more frequently if deemed necessary) flushing programme or that the level of biocide dosed was within recommended levels during this period (ClO ₂ @ minimum of 1 ppm (mg/L). Alternatively, where pressure testing was carried out 'dry', this needs to adequately certificated by the project supervisor
	Confirmation required that the flushing included locations which may be capped-off whilst awaiting future connection to equipment and/or other facilities and that any machines (such as washing machines etc.) already connected to the system are removed during the disinfection process to allow for disinfectant solution to be drawn and made available to these areas.
	Confirmation that the system has been subject to at least 2 x weekly flushing following disinfection.

B. System disinfection:

The required water quality shall be achieved by the use of shot-dosing of a suitable disinfecting agent, the levels of which must be maintained within the recommended limits for achieving disinfection as specified within the current edition of BS8558:2015: Clause 5.2.3 Flushing and Disinfection and L8 – The Control of Legionella bacteria in water systems – Approved Code of Practice & Guidance 2013.

Proprietary solutions of disinfectant should be used in accordance with the manufacturers' instructions. The COSHH Regulations require that the risks from using the disinfectant for each task be assessed to ensure that the control procedures adopted are suitable for the particular application.

Disinfection should not be undertaken before materials, for example linings in cisterns, have fully cured. Advice should be sought from equipment manufacturers to ensure that proposed disinfection chemicals will not adversely affect performance. No heat source should be applied during the disinfection procedure, including final flushing. The disinfection must be carried out as close to hand-over (and occupation) as practicable.

Incoming Mains (MCWS)	Confirmation that the incoming mains supply has been suitably disinfected prior to connection to system.
Water Storage Tanks/Hot water Generation Vessels	Confirmation that all storage tanks and hot water generation vessels/equipment have been suitably disinfected
Outlet Fittings	Confirmation that all taps, shower heads, TMVs, associated strainers and aerators have been dip-disinfected prior to final connection.
Distribution System and all outlets	Confirmation that disinfection was carried out in accordance with the relevant specifications listed above and that it included all parts and outlets of the system.
	Confirmation required that the disinfection included locations which may be capped-off whilst awaiting future connection to equipment and/or other facilities and that any machines (such as washing machines etc.) already connected to the system are removed during the disinfection process to allow for disinfectant solution to be drawn and made available to these areas.
	Confirmation that suitable water samples have been collected and submitted for microbiological analysis not earlier than 48hrs following disinfection.
<p>Guidance Note 1: Chlorine dioxide will normally be used as the hyper-chlorination disinfectant agent throughout. This process must only be carried out by suitably equipped and trained personnel from approved contractors who are members of the Legionella Control Association or by suitably equipped and trained University personnel. Where alternative disinfection agents are intended for use, a written proposal outlining the reasons why an alternative disinfection agent is proposed for use, the proposed disinfection agent, COSHH sheets, risk assessment and methodology shall be presented to the FM Department Responsible Person for written authorisation. Alternative disinfection agents shall not be used without prior written consent from the Responsible Person (FM). Although chlorine dioxide is known to be more effective in the destruction of biofilm in domestic water systems, sodium hypochlorite is easier and safer to handle at high concentrations (used for hyper-chlorination).</p>	

C. Temperature/CIO₂/Cl Profiles

These tests shall be performed prior to contractual handover and bringing the system into use. Separate thermostatic measuring and recording equipment should be used, that is, independent of any building management system. It will be necessary to have systems fully operational and to simulate typical draw-off of water. Once disinfection has taken place, it is essential to put in place measures to ensure that hot and cold water temperatures are maintained. This will require regular flushing, at least weekly, and possibly more frequently during periods of hot weather.

Water temperatures and CIO₂/CL levels to be recorded three times equally spaced over 24 hours, under simulated maximum usage requirements, to demonstrate that the recommended temperatures are being achieved. Temperature and CIO₂/Cl measurement equipment and water sampling equipment shall be suitably calibrated via UKAS calibration and accredited to ISO 17025 and calibration certificate made available.

Incoming MCWS	After 2 minutes of running cold water the temperature to be reached
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	shall be maximum 20°C
Cold Water Storage	Measure and record the Incoming MCWS. Temperature not to exceed 20°C.
	Measure and record the stored water. Temperature not to exceed 20°C.
Hot Water Generation and Storage	Measure and record the Set temperature setting of the thermostat (if fitted and calibrated). Temperature to exceed 60°C.
	Measure and record the "Flow" temperature using a contact thermometer or fitted gauge. Temperature to be taken from Flow pipework as close to the Calorifier as possible. Temperature to exceed 60°C
	Measure and record the Return temperature using a contact thermometer or fitted gauge. Temperature to be taken from Return pipework as close to the Calorifier as possible. Temperature to exceed 55°C in clinical areas and 50°C in all "other" areas.
	Isolate Cold Feed and open drain point and measure and record temperature. Temperature to exceed 60°C within 1 minute.
	Measure and record the Cold Feed temperature using a contact thermometer or fitted gauge. Temperature to be taken from cold feed pipework within one metre from the Calorifier. Temperature <u>NOT</u> to exceed 20°C.
	Where the unit is monitored using BMS, collect the readings of all the fields listed above, for at least a 24hr period and consider the results. Adjust control parameters as necessary.
HWS	After 1 minute of running hot water the temperature to be reached shall be minimum 55°C in clinical areas and 50°C in all "other" areas.
MCWS/CWS	After 2 minutes of running cold water the temperature to be reached shall be maximum 20°C
	Maximum 2°C higher than that at the point of supply.
Blended	HWS to the TMV minimum 55°C in clinical areas and 50°C in all "other" areas.
	CWS to TMV maximum 20°C
	41°C (+ 1°C) for showers
	41°C (+ 1°C) for basins
	44°C(+ 1°C) for baths
	38°C (+ 1°C) for bidets
ClO2	Point of injection – between 0.25 and 0.8ppm (Note: 0.8ppm must be consider as the maximum allowed level at point of injection and it is only allowed at this level at this point in order to allow for the minimum levels to be achieved at the point of delivery). Any level fluctuations must only be tolerated within this range and care must be exercised to ensure that the level of ClO2 at the nearest outlet does not exceed 0.5ppm.
	Point of delivery (measured at sentinel outlets) – between 0.25 and 0.5ppm
Chlorine (Microchem M101)	Point of injection – between 0.6 and 1ppm at dissolver tank. Any level fluctuations must only be tolerated within this range and care must be exercised to ensure that the level of Cl2 at the nearest outlet does not exceed 1ppm.
	Point of delivery (measured at sentinel outlets) – between 0.33 and 0.8ppm but aim to achieve a minimum level of 0.33ppm where possible
Guidance Note 2: Where designated sentinel outlets are fitted with TMV/TMT, the temperature of the hot and cold supply must be measured by surface (contact) temperature measurement. If contact probe is to be used for temperature monitoring through copper pipework, Temperatures must be collected as described in BSRIA Application Guide AG 4/94 – Guide to Legionellosis – Temperature measurements for hot and cold water services. The temperature measurements shall be carried out at different times during the day in order to allow indicative temperature monitoring of the system during a typical daily usage profile.	

D. Microbiological Analysis

Microbiological sampling shall be carried out in order to consider two distinct areas of water quality management & control:

- a. Incoming Mains bacterial contamination pre and post-disinfection.
- b. Localised bacterial contamination pre and post-disinfection.
- b. systemic bacterial contamination pre and post-disinfection.

Microbiological Sampling must be carried out in accordance with the PHE "Examining food, water and environmental samples from healthcare environments – Microbiological Guidelines: April 2013" and BS 7592:2008 – Sampling for Legionella bacteria in water systems – Code of practice.

Incoming MCWS	Pre-disinfection
	post-disinfection
Cold Water Storage	Pre disinfection
	post-disinfection
Hot Water Generation and Storage	Pre disinfection (drain)
	Post disinfection (drain)
HWS/CWS/MCWS	Pre-disinfection (post-flush samples only) at sentinel outlets (direct supply outlets only)
	Post-disinfection (post-flush samples only) at sentinel outlets (direct supply outlets only)
	Pre-disinfection (pre-flush samples only) at all outlets (direct and blended supply outlets)
	Post-disinfection (pre-flush samples only) at all outlets (direct and blended supply outlets)
<p>Guidance Note 4: Water samples shall have been taken for microbiological analysis (<i>Legionella</i>, TVCC, <i>E. coli</i>, coliforms in accordance with Section 9.1 "Microbiological Sample Collection protocol. <i>Legionella</i> spp. results will normally be received after 10 days of sampling, which may be after the area has been opened. Results to be discussed with the WSG / H&S, (if on receipt they are outside agreed parameters agree remedial action with WSG) Samples to be collected no earlier than 48 hours following disinfection.</p>	

1.7 Occupation:

Occupation of all new-builds and refurbishments must not be carried out until all of the requirements detailed in the relevant processes described below are satisfied and the appropriate process and pro-forma ([Permit No. 5 'Permit for Hand-over and Occupation of new-builds'](#) and [Permit No. 6 'Permit for Hand-over and Occupation of Refurbished Facilities'](#)) are completed and duly signed.



Water Quality Management And Control PPM Programme

Permit No.	5
Task:	Permit for Hand-over and occupation of new builds

Application submitted by: Date

Scheme Reference:

Facility/Phase proposed for hand-over at this time:

Facility/Phase handed-over previously: Date

Facility/Phase to be handed-over in the future: Date

Are the works in the Section/Area complete?	YES	NO	N/A
Is the domestic water installation complete?	YES	NO	N/A
Have all the commissioning data in accordance with BS 8558:2011 been received?	YES	NO	N/A
Have all material and fittings WRAS certificates been received?	YES	NO	N/A
Are all water borne bacterial control measures employed operating within recommended and agreed parameters	YES	NO	N/A
If Yes, have the pertinent logbooks been received?	YES	NO	N/A
Has the installation been surveyed and Risk Assessed prior to hand-over?	YES	NO	N/A
If Yes, have any faults/short-falls been identified?	YES	NO	N/A
If Yes, have all these faults been rectified?	YES	NO	N/A
Has the system been disinfected in accordance with BS 8558:2011?	YES	NO	N/A
If Yes, When? Date:	<input type="text"/>		
If Yes, have the disinfection certificates been received?	YES	NO	N/A
Have bacteriological samples been taken following disinfection?	YES	NO	N/A
If Yes, When? Date:	<input type="text"/>		
Are all results within acceptable parameters?	YES	NO	N/A
Sample results received?	YES	NO	N/A
Has the system been flushed at daily since disinfection?	YES	NO	N/A
If Yes, have flushing records been received?	YES	NO	N/A

Date of proposed occupation: To be occupied by:

This section to be completed by University Nominated FM Representative:

Hand-over approved? YES/NO Occupation approved? YES/NO

H&S (COMPLIANCE MANAGER): Signed:

NOTE: TO ALLOW FOR OCCUPATION OF FACILITY/PHASE THIS FORM MUST BE ACCOMPANIED BY ALL APPROPRIATE RECORDS AND CERTIFICATES



Water Quality Management And Control PPM Programme

Permit No.	6
Task:	Permit for Hand-over and occupation of refurbished facilities

Application submitted by: Date

Scheme Reference:

Facility/Phase proposed for occupation at this time:

Are the works in the Section/Area complete?	YES	NO	N/A
Is the domestic water installation complete?	YES	NO	N/A
Have all the commissioning data in accordance with BS 8558:2011 been received?	YES	NO	N/A
Have all material and fittings WRAS certificates been received?	YES	NO	N/A
Are all bacterial control measures employed operating within recommended and agreed parameters	YES	NO	N/A
If Yes, have the pertinent logbooks been received?	YES	NO	N/A
Has the installation been surveyed and Risk Assessed prior to hand-over?	YES	NO	N/A
If Yes, have any faults/short-falls been identified?	YES	NO	N/A
If Yes, have all these faults been rectified?	YES	NO	N/A
Has the system been disinfected in accordance with BS 8558:2011?	YES	NO	N/A
If Yes, When? Date:	<input type="text"/>		
If Yes, have the disinfection certificates been received?	YES	NO	N/A
Have bacteriological samples been taken following disinfection?	YES	NO	N/A
If Yes, When? Date:	<input type="text"/>		
Are all results within acceptable parameters?	YES	NO	N/A
Sample results received?	YES	NO	N/A
Has the system been flushed daily since disinfection?	YES	NO	N/A
If Yes, have flushing records been received?	YES	NO	N/A

Date of proposed occupation:

To be occupied by:

This section to be completed by University Nominated FM Representative:

Occupation approved?

H&S (COMPLIANCE MANAGER): Signed:

NOTE: TO ALLOW FOR OCCUPATION OF FACILITY/PHASE THIS PRO-FORMA MUST BE ACCOMPANIED BY ALL APPROPRIATE RECORDS AND CERTIFICATES



Water Quality Management And Control PPM Programme

Certificate of Design Compliance

No	Tasks	Yes/No	Comments	Signature
1	Does the design specification comply with all the relevant Regulation, Guidelines, Codes of Practice, detailed in Section 10.2 'Legislation, standards and Guidance' and 'Best Practice'?			
2	Does the design specification comply with the requirements of Section 9 of the WSP - 'Water System and Plant Design Installation and Maintenance'?			
3	Does the design specification comply with the requirements of Section 10 of the WSP - Installation and Commissioning of Major Refurbishments and New Build Facilities'?			
4	Does the design specification comply with the requirements of the Trust's current 'Policy for Capital Schemes'?			
5	Have all the relevant departments been adequately consulted during the development of the design specification?			
6	<u>Has the design taken into consideration the impact on the potential risk of Legionellosis and <i>P. aeruginosa</i> infections by carrying out an 'Impact Assessment' in accordance with the Trust's 'Premises Assurance Scheme'?</u>			

Additional Notes:

I can confirm my verification that the design proposals, if undertaken as proposed, including and recommended changes would, in my opinion, be compliant with the current Regulations, Guidelines, Codes of Practice and 'Best Practices', requirements for the Management & Control of Water Quality.

Signed: Name: Date



Water Quality Management And Control PPM Programme

Certificate of Installation Compliance

No	Tasks	Yes/No	Comments	Signature
1	Has the installation been completed in accordance with the design specification agreed and approved by the pertinent issuing of the 'Certificate of Design Compliance'?			
2	Has the installation been completed in accordance with the requirements of Section 9 of the WSP - 'Water System and Plant Design Installation and Maintenance'?			
3	Has the installation been completed in accordance with the requirements of Section 10 of the WSP - Installation and Commissioning of Major Refurbishments and New Build Facilities'?			
4	Has the installation been completed in accordance with the requirements of the Trust's current 'Policy for Capital Schemes'?			
5	Have accurate 'as fitted' drawings been made available for inspection?			
6.	Have accurate asset registers been made available for inspection?			
7	Have manufacturer's operating manuals and maintenance instructions been made available for inspection?			

Additional Notes:

I can confirm my verification that the installation is, in my opinion, compliant with the current Regulations, Guidelines, Codes of Practice and 'Best Practices', requirements for the Management & Control of Water Quality.

Signed: Name: Date

DOCUMENT CONTROL

Issue No	Version	Revised by	Summary of revision	Date of revision
1	v1	DH	Original draft	June 2016
1	v2	DH	Document control element added to rear of book	July 2017
1	V3	DH	General review with minor updates	July 2019