REVIEW OF WATER QUALITY INSTRUMENTATION

APRIL 1995

NRA-REV

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FINAL
10 April 1995

EXECUTIVE SUMMARY

1.0 INTRODUCTION

The primary purpose of this review is to facilitate Regions to implement an efficient, effective and consistent field instrumentation strategy. The key points addressed are:-

- Selection of instruments and determinands suitable for instrument monitoring.
- The present position, key areas of concern and a suggested way forward to progress the aims of the Instrumentation Strategy.
- Legal implications of the use of field instruments.
- Operational procedures for both hand-held and portable instrumentation.

A Project Team was set up in January 95 with members drawn from Head Office, Regions and the National Centre for Instrumentation to undertake the review.

2.0 WATER QUALITY MONITORING INSTRUMENTS

A brief explanation of the selection of instruments and determinands suitable for instrumentation monitoring is included.

3.0 THE CURRENT POSITION

The results of a national survey to establish the present utilisation and requirements is provided. This includes the key issues and concerns expressed by Area field staff, along with a summary of the investment to date. It is concluded, that the breadth of current available information and experience is inadequate as a basis for the decision making on the best way forward. Thus, these issues need to be addressed before consideration is given to committing any additional capital expenditure on the project. To this end, a comprehensive field trial is proposed.

4.0 COMPREHENSIVE TRIAL

A 6-month field trial involving one Area from each of the eight Regions is proposed, where the selected Areas will fully adopt the use of portable and hand-held instruments for their routine monitoring and pollution investigation work. The object of the trial will be to establish a base of information (eg. performance, durability, training needs, calibration and maintenance requirements) upon which the examination of options and arrangements to deliver and/or revise the Instrumentation Strategy can be based.

Each Area in the trial will equip all their samplers with a Grant YSI 3800 meter to undertake all routine monitoring of temperature, pH, dissolved oxygen, conductivity and turbidity. In addition, two of the Area pollution control staff will be equipped ours?

with YSI 3800 meter fitted with the upgraded ammonia probe for use in pollution investigations during the trial period. Laboratory analysis will continue in parallel in order to facilitate a data quality comparison between field instruments and laboratory analysis.

The trial will be carried out under the NRA management procedures; supervised by a Project Manager and Project Assurance teams reporting to a Project Board. A Project Team will implement and manage the trial, with each selected Area having its own Area Co-ordinator to link between the users and the Project Team.

The Users will report back on the operational, technical, financial and data quality aspects of using the meters, to provide for an evaluation of field instrumentation.

On completion of the trial the Project Board and Project Team will suggest a recommendation as to the way forward and prepare a business case for this.

5.0 RESOURCE REQUIREMENT

It is recognised that having a dedicated instrumentation technician is critical for the success of the trial. Three of the selected Areas have their own, so an additional 4 FTE will be required for an 8 month period to span both phases of the trial. In addition, the National Centre for Instrumentation will provide and co-ordinate all technical support during the trial. The current cost estimate to implement the trial is approximately £86k.

6.0 LEGAL IMPLICATIONS OF THE USE OF FIELD INSTRUMENTATION

The legal implications of using field instrumentation is addressed. In particular, the reliability, accuracy and admissibility of results are discussed.

7.0 OPERATIONAL PROCEDURES

Operational guidelines, procedures and quality assurance manuals for the Grant YSI 3800 hand-held meters and the Sherlock portable sampler are presented.

8.0 RECOMMENDATION

The Operations Team are asked to support the recommendation to progress a comprehensive Area trial, so that the supporting Form A can be put to the EG finance sub-group for approval.

1. INTRODUCTION

1.1 Background

As part of the Authority's Water Quality Strategy, it is recognised that there are major benefits to be derived from a more widespread use of instrumentation in our monitoring, surveillance and investigation work. In November 1994, an Instrumentation Strategy was produced which outlines these benefits and identified the areas where instrumentation could be deployed. As a result of this, a Business Case was initiated by the National Centre for Instrumentation, which reported in December 1994. The principle recommendation from this study was that the option for a National Centre supporting Regions to meet the Authority's needs described in the Instrumentation Strategy was the most suitable way forward. This was not, however, generally accepted and it is recognised that a more detailed look at requirements, costs and benefits should be taken. Thus, although there is a general acceptance that instrumentation and new technology will play an increasing role in our future monitoring ethos, there is continuing uncertainty as to how best to achieve this. Hence, this initiative to produce recommendations and operating protocols to implement progress towards the aims of the Instrumentation Strategy.

1.2 Terms of Reference and Objectives

The Terms of Reference for this review are listed in the Director of Operations memorandum dated 21 December 1994 and given in Appendix A. The overall project aim was to facilitate Regions implement an efficient, effective and consistent field instrumentation strategy.

1.3 Methodology

A Project Team was set up in January 1995 with the following members:

David King (Chairman) - Area Manager (Eastern), Anglian Region

Gill Clayton - Pollution Control Officer, Severn Trent Region

Rob Somers - Operations Assistant, Headquarters

Dale Eynon - Operations Assistant Headquarters

Terry Long - Lab Co-ord Officer, Headquarters

Paul Williams - Instrumentation Manager, National Centre for Instrumentation

Additional support was sought in March 1995, when Anne Brosnan, Principal Solicitor, Anglian Region and Adrian D'Cruz, Project Accountant, Headquarters joined the Project Team.

Members of the team were drawn from Head Office, Regional, Area and Catchment Teams. Thus, through consultation with colleagues they represent the views, experience and opinions of various user groups and acted as the forum for the collection, collation and distillation of the information for the report.

A national review of water quality procedures by the Operations Directorate included a questionnaire and visits to all area offices to obtain data on current monitoring programmes, sampling resources and field instrumentation usage and requirements. A questionnaire to the National Laboratory Service addressed the issue of current laboratory workload and costs in the relevant area. Use was also made of informal discussion and written responses from NRA regions to the strategy proposals. Procedures have been developed by the National Centre for Instrumentation for operation, performance testing, maintenance and quality assurance.

The report addresses:-

- *Selection of instruments and determinands suitable for instrument monitoring.*
- *The present position, key areas of concern and a suggested way forward to progressing the aims of the Instrumentation Strategy.*
- *Legal implications of use of field instrumentation.*
- *Operational procedures for both hand held and portable instrumentation.*

2 WATER QUALITY MONITORING INSTRUMENTATION

2.1 Background

The water quality monitoring activities of the NRA are divided into four main areas:-

- *Statutory monitoring*
- *Effluent discharge compliance monitoring*
- *General quality assessment*
- *Operational monitoring*

The first three categories are defined by national policy, and the last is permissive monitoring planned by individual Regions to meet their local needs, by reference to national guidelines.

The monitoring workload comprises some half-million samples per year, each one being analysed for ten or more determinands from a total of several hundred specified determinands. Although field monitoring is impractical for much of this requirement there is potential to transfer a considerable volume of routine measurements from laboratories to field instruments. This is additional to the established use of instrumentation for pollution prevention, pollution investigations and river quality management.

2.2 National Monitoring Strategy

At present the only applications of field instrumentation to statutory monitoring *is* the measurement of temperature and dissolved oxygen. The major uses of instrumentation, pollution incident monitoring and "real time" water quality management, lie outside of routine monitoring. Two future uses for field instrumentation arise from self monitoring for the Urban Waste Water Treatment Directive (UWWTD) and IPC/Environment Agency developments. Specifications are being developed for automatic composite samplers for self monitoring of sewage works to meet UWWTD requirements, and future Agency instrument requirements are being discussed with HMIP and WRA representatives, particularly the role of instruments in audit monitoring dischargers' self monitoring systems.

2.3 Determinands Suitable for Instrument Monitoring

Determinands for instrument monitoring were selected because:-

i) *Their measurement performance requirements can be met or approached by present instruments.*

ii) *They are unstable and thus present problems in their sampling and transit to laboratories.*

iii) *They have a high short-term variability that could be better characterised by site measurement than by spot sampling.*

Details of determinands currently selected are given below.

Dissolved Oxygen

Dissolved oxygen values can range from 0% to 200% saturation. Its statutory reporting requirements can be met with a measurement performance of 10% precision and 10% accuracy. In practice both laboratory and field instruments are capable of considerably better performance.

pH

Statutory reporting requirements are 10% precision, 10% accuracy and 0.05 pH units limit of detection, but ammonia calculation may require tighter limits. Both laboratory and field instruments are capable of this performance, but pH is unstable in a bottle and field pH measurement is generally specified for Directives reporting.

Ammonia

The statutory reporting requirements for total ammonia monitoring are 10% precision, 10% accuracy and a limit of detection of 0.03 mg/l ammoniacal nitrogen for both total ammonia and unionised ammonia. The laboratory method can achieve these criteria but sampling and pH errors may be significant. Field instrumentation fails the accuracy criterion because of interference from potassium, and cannot be used for statutory purposes until suitable sensors are available.

Turbidity

There is a limited statutory requirement for turbidity measurement, where the performance criteria are 10% precision, 10% accuracy and a limit of detection of 1.0 NTU/FTU (standard turbidity units). Both laboratory and field instruments can exceed these performance criteria. Turbidity is related to suspended solids and correlates better with BOD in sewage treatment effluents than does any other determinant, and is a useful field indicator of both parameters.

Conductivity

Conductivity is required for some statutory reporting responsibilities with performance criteria of 10% precision, 10% accuracy and a limit of detection of 10 uS/cm (microSeimens per centimetre). Both laboratory and field instruments can exceed these criteria and only require occasional verification of accuracy.

Temperature

Acceptable performance would be a total uncertainty of plus or minus 0.2 degrees Celsius with proven traceability to the National Standard. Laboratories and field instruments easily achieve the performance requirements and only require occasional verification of accuracy. Laboratories measure temperature for calculation purposes only and not, of course, for statutory reporting requirements.

2.4 Selection of Instruments

2.4.1 Permanently Sited Instruments

There are some 130 fixed monitoring stations used within the NRA, with major networks in Thames, Severn Trent and Anglian Regions. These stations produce high quality continuous information but are of high cost, and are limited to critical applications such as rivers that are subject to conflicting demands of high potable extraction, high sewage effluent discharge, intensive agricultural use, urban runoff etc. Reasons for their deployment are often specific to each application but, in general, cost savings can be claimed against more expensive civil engineering alternatives. Thames Region has developed a new type of low cost permanent monitor, the minimonitor, and are assessing a network of such instruments. If proven to be effective the minimonitor's low cost may significantly widen the scope for permanent instrument usage. R&D studies to clarify the benefits of continuous monitoring are being undertaken by water quality and hydrometry functions and it is suggested the strategy for fixed stations should be reviewed when these studies are completed.

2.4.2 Portable Sampler/Monitors

This category comprises Merlin, Sherlock and Cyclops instruments. These are all in-house instrument developments by South Western Region that led to licencing agreements with external manufacturers. Their applications are defined and support is available from the manufacturers or the National Centre for Instrumentation. No further work on selection of this category of instruments is required for the immediate future.

2.4.3 Hand Held Meters

Currently a wide variety of hand held meters are in use for field monitoring, with a focus on temperature and dissolved oxygen. Development of six-parameter hand held instruments was initiated by Severn Trent Region in 1989 as an aid to pollution investigation. As no suitable instruments were commercially available at the time the NRA stimulated their development by issuing a specification and evaluating manufacturers prototypes. The Grant/YSI 3800 instrument was selected after an intensive competitive evaluation by an independent consultancy, and some 200 were purchased in line with National Procurement Procedures.

3 THE CURRENT POSITION

3.1 Level of Present Use

Appendix B contains the results of Operation Directorate's questionnaire and review of the current holdings of each Area's hand-held & portable instruments as at Feb 95.

The detailed breakdown of how the hand-held GRANT YSI 3800 meters are distributed within the NRA is given in Appendix C. It is estimated that only 45-50% of the 214 meters distributed are currently being utilised. In addition, their frequency and use varies greatly from not used at all in 7 Areas, to daily use for routine sampling and pollution incidents in 7 Areas.

Appendix D gives the detailed breakdown of the deployment and utilisation of the portable types of instruments across the 26 NRA Areas. As with the hand-held meters the deployment of portable instruments varies across Areas. Of the 26 Sherlocks and 9 Merlins purchased, currently their use is limited to 15 and 2 respectively. In addition, of the 30 Cyclops purchased, only 7 are currently successfully deployed.

3.2 Key Issues and Concerns

3.2.1 Grant YSI 3800 Hand-held Meters

The spectrum of usage of these meters, across different Areas and Regions, appears to be dependant on level of management and user acceptance and the level of maintenance support available within that Area.

In particular, significant concerns were expressed that:

- The equipment was issued without market research of the internal customer groups and with little instructions, training or maintenance/calibration support. Although this was not the case, it is, however, a perception that is held by a significant number of AEQMs and their staff.

- The YSI 3800 are too big and bulky to use, and the ammonia probe is not reliable.

- A lack of confidence regarding the reliability of the data.

There is, therefore, a resistance by operation staff in some Areas to change from their established work method, and to wider instrument usage. Accordingly, there is a significant barrier to overcome if we are to promote the more widespread use of field instrumentation by water quality staff.

3.2.2 Cyclops

There are two major issues that were consistently voiced by AEQMs over the use and deployment of Cyclops:

(i) *Communications*

Difficulties have arisen due to poor signal strength, i.e. it is not always possible to make a radio transmission by Cellnet. This can be helped by the use of a high gain aerial, which have been provided to Areas experiencing problems. Where there is inadequate Cellnet coverage, this can be overcome by investing in a different communication system. Obviously, this has cost implications.

(ii). *Consent Types*

As Cyclops can only be used on continuous discharges with absolute consents, this limits the number of sites where it can be used. In addition, due to the physical size of the Cyclops sonde it cannot be used on small discharges with a pipe of 6" diameter or less.

It should be noted that clause 93 of The Environment Bill requires that the need for tripartite sampling required by S.209 of the Water Resources Act 1990, will no longer have effect. This may impact on any further development of the Cyclops system.

3.2.3 Investment to Date

The National Centre for Instrumentation has provided the following breakdown of estimated costs spent to date on purchasing hand-held and portable meters:

Grant YSI 3800	£0.75m	plus £0.1m for spares/test equipment
Cyclops	£0.50m	
Sherlock Merlins	£0.50m	plus £0.05m for spares

Clearly, a substantial amount has already been invested. This investment, however, will be largely wasted if the existing resources are not more fully utilised. Moreover, any progress to the Instrumentation Strategy will be severely impeded.

3.3 The Way Forward

As already stated, the existing usage of field instruments for water quality monitoring in the NRA Regions shows wide variation. Expertise, resource utilised, and attitudes towards its use depend on the extent to which opportunities for field monitoring have arisen. There have also been differences in the emphasis of applications between activities such as routine monitoring and pollution detection.

These regional variations in the base situation will limit the opportunities for rapid development of the Instrumentation Strategy at a uniform national rate. Furthermore, the breadth of current available information and experience is inadequate as a basis for the decision making on the best way forward. Thus, these issues need to be addressed before we consider committing any additional capital expenditure on the project. To this end, a comprehensive field trial is proposed.

4. COMPREHENSIVE TRIAL

4.1 Background

To progress the current situation a 6-month field trial is proposed, involving one Area from each of the eight Regions. The trial will involve the implementation of the Instrument Strategy in the selected Areas i.e. fully adopting the use of portable and hand-held instruments for routine monitoring and pollution investigations.

4.2 Objectives

The overall objective of the trial will be to provide a base of information (eg. performance and durability, training needs, calibration and maintenance requirements) upon which the examination of options and arrangements to deliver and/or revise the Instrumentation Strategy can be based.

4.3 Area Selection and Participation

4.3.1 Selected Areas

The table overleaf shows the Areas from each Region which is suggested should participate in the trial. These have been picked to ensure that the trial includes an even spread of Areas (from those that currently do not use the instruments at all, through to those that use them for routine sampling as well as pollution investigation work). In addition, it is recognised that having a dedicated instrumentation technician is critical for the success of the trial, and so selections were based, where possible, to include Areas with this existing resource to minimise the number of additional FTEs needed as instrumentation technicians during the trial. It is envisaged that the additional FTE's will be used to release appropriate permanent saff to undertake the work of the Instrument Technician.

As the Thames Region's South East Area is the most advanced Area for using the Grant YSI 3800 meters for all its pollution incidents and routine sampling, it will also be included in the trial, to act as a benchmark for inter-Area comparison.

Region	Area	Numbers to take part in the Trail			No of Existing YSI 3800 meters in Area	No & source of additional meters needed for Trial	No of additional FTE needed as Instrument Technician during trial
		Samplers	Pollution Control Staff	Area* Total/ (No of meters needed)			
Anglian	Eastern	6	2	10	6	4 from Anglian Northern Area	none needed use existing resource
North West	Northern	2	2	5	2	3 from North West Southern Area	1 (split between these Areas)
NU/Yorks	Northumbria	2	2	4	10	0	
Severn Trent	Lower Trent	4	2	8	0	8 from Severn Trent's regional holdings	1
Southern	Sussex	4	2	8	4	4 from Southern Regional holding	1
South Western	Cornwall	6	2	10	2	8 from Severn Trent's regional holdings	none needed use existing resource
Thames	West	5	2	7	10	0	none needed use existing resource
	South East (As bench mark)	3	2	5	16	0	none needed use existing resource
Welsh	South Western	8	2	10	31	0	1
				Total Meters in trial = 67			Total additional FTEs need for trial = 4

* Includes a contingency for meters being calibrated during the trial

4.3.2 Concept of the Trial

Each selected Area will equip all their samplers and two of their pollution control staff with a Grant YSI 3800 meter, in order for them to undertake all their routine monitoring and pollution investigation work over the trial period of 6-months. The two pollution control staff's meters will be fitted with the updated new ammonia probe in order to facilitate their use for ammonia detection in pollution investigations during the trial period.

4.4 Phasing & Timescale

The trial will be split into two stages:

Phase 1 - Implementation Planning , Preparatory and Training

Phase 2 - Implementation

4.4.1 Phase 1 - Implementation Planning , Preparatory and Training

Serial	Date	Event	Remarks
1	4 April 95	Instrumentation Report to *Project Board*	
2	1-18 Apr 95	Produce Form A Confirm that the proposed Selected Areas are the most suitable to undertake the trial in terms of the facilities existing in the Area to set up a maintenance workshop and, if the Area already has the use of an Instrument Technician.	
2	18 Apr 95	O/T Meeting, aims and benefits of the trial discussed with RGMs Present Form A to EG Sub-Group on 19 April '95.	
3	21 Apr 95	Issue memo to the Selected Areas informing them of the trial Start recruitment of additional 4 Area Instrument Technicians	
4	21-30 Apr 95	Representatives from the Trial Project Team to visit all Selected Areas to "sell" the trial to both Area management and to users: outline the National Instrumentation Strategy; the reasons/objectives of the trial; the scope of the trial.	Senior Representative from NHO Water Quality/National Operations Manager to present to Area Management NHO Operations Assistant to brief all on administration of trial. Matthew Lowenthal (Thames Instrument Technician) to present to all the Area users.
5	May-Jun 95	National Centre to provide training for Area Instrument Technicians + users Re-allocate meters to Selected Area Return meters to National Centre for service/checking to ensure all meters are fit for use and serviceable Area Instrumentation Technician to establish maintenance & calibration facilities within each Selected Area	2.5 day training package National Centre to provide spares pack for each Area. 2nd line maintenance support for servicing meters to be provide by the National Centre
6	Jul-Dec 95	Trial Period	NLS to provide: calibration solutions to all Areas during trial period

4.4.2 Phase 2 - Implementation

This will involve the full deployment of hand-held and portable instruments as follows:

Hand-held Meters *These will be used within each the of Selected Areas by:*

- *All sampling staff for all routine measurements of temperature, pH, dissolved oxygen, conductivity and turbidity on all routine sampling occasions for each of these parameters normally measured.*
- *Two Area pollution control staff for use on pollution investigation work.*

Portable Instruments *These will be utilised in the trial for appropriate applications as opportunities arise. As a minimum, all selected Areas will:*

- *Identify sites suitable for deploying Cyclops and Merlin &/or Sherlock.*
- *Deploy these instruments on, at least, two occasions during the trial period to enable evaluation as per the Cyclops Operations & Maintenance Manual.*

For Areas currently not using meters, Laboratory analysis will continue, in parallel, for the duration of the trial in order to facilitate appropriate data comparisons between field instruments and laboratory analysis.

4.5 Organisation & Responsibilities

The trial will be carried out under NRA Project Management Procedures; supervised by a Project Manager and Project Assurance team and reporting to a Project Board.

4.5.1 Project Board

A Project Board will be formed to provide overall direction and guidance to the staff involved in managing the project.

The Project Board should consist of the following members:

- Project Executive - Kevin Bond, Director of Operations
- Senior User - Mick Pearson, Regional Water Quality Manager
- Senior User - Martin Booth, Regional Technical Manager
- Senior Technical -Dave Palmer, National Centre for Marine Monitoring & Instrumentation Manager
- WQ Strategy - Jacqui Gough, Water Quality, Head Office

- Legal - Anne Brosnan, Principal Solicitor

The Project Board will identify a suitable qualified team to QA the trial as a project.

4.5.2 Project Team

A project team will implement and manage the trial in the Selected Areas, and provide a consistent national approach.

The Project Team should consist of the following members:

-	Project Manager	-Bill Forbes, National Operations Manager
-	Sr Area Users	-Leslie Hughes, Area EQ Manager, N West (Northern)
-	Sr Area Users	-Keith Selby, Area EQ Manager, Severn Trent (Lower Trent)
-	Technical Assessment	-Peter Lloyd, Env Services Manager, Thames (SEast)
-	WQPlainning & Data Assessment	-Tony Warn, Regional WQ Planning Manager, Anglian Region

4.5.3 Each Selected Area

Area Co-ordinator	-	Organise the operation of the trial in their Area and act as the central contact point for all aspects of it (Area EQ Manager). Collate all user feed back on instruments liaise with Project Team.
Area Instrument Technician	-	Additional resource for duration of trial only. Trained to maintain + calibrate all meters during the trial. Initial inspection and service of all meters will be carried out at the National Centre to ensure all are in a fit state for operational use.
All Area samplers + 2 pollution control staff	-	Receive training on using meters. Trial the meter for all routine monitoring and pollution investigation work over a 6 month per (for DO, temp pH, conductivity, and ammonia as necessary). Complete weekly user proforma to report on performance of the meter, pass these on to the Area Representative.

4.5.4 The National Centre for Instrumentation

The National Centre will:

- Provide training to all Area Instrumentation Technicians and User/Operators.

- Inspect all hand-held meters to be used in the trial, service and modify where necessary to ensure that they are all fit for use. Modify two meters per Area with the new ammonia probe to allow meters to be evaluated during pollution incidents.

- Provide Areas with a maintenance spare pack and 2nd line maintenance support to all Areas.

- Provide a HELP desk telephone support for all technical aspects.

4.6 Information to be Sought

As the Thames Region's South East Area currently uses Grant YSI 3800 meters for all its pollution incidents and routine sampling, it will act as the benchmark during the trail for the other Areas to be compared against.

A detailed product description will be undertaken by the Project Team. It is envisaged, however, that all Area Users, and the Area Instrumentation Technicians will complete weekly, a standard questionnaire proforma which shall be returned to their Area Co-ordinator for forwarding to the Project Team (NHO Operations Assistant). These proformas will gather the data to monitor the following:

- Operational Aspects

  Impact on user, easy of use, time difference between using the meter and taking a sample.

  The type and level of support is required by the Area (and Region) to achieve the most efficient maintenance support.

- Technical Aspects

  Types and frequency of any breakdowns or operational failures including calibration failute/drift etc.

- Financial Aspects

Estimated cost of maintenance

Calibration costs, storage facilities, accommodation for the Area labs.

- Data Aspects

Appropriate analysis of the generated data set will be undertaken eg to assess the impact, if any, on the classification of river water quality in England and Wales.

4.7 Training Requirements

4.7.1 Area Instrumentation Technician

Prior to the trial all the Area Instrumentation Technicians will attend a two day course at the National Centre for Instrumentation covering calibration, fault finding and quality assurance methods of the Grant YSI 3800 hand-held meters, and the Merlin & Sherlock portable instruments.

4.7.2 Trial Users/Operators

All trial users/operators (all the selected Areas's samplers + 2 pollution control staff) will receive a half day training course on using the Grant YSI 30800 meter from the National Centre for Instrumentation.

4.8 Trial Monitoring & Post-Trial Review

The trial will be controlled within a formal framework and will be monitored during the trial period by members of the Project Team. The first stage will be to draw up a project plan for acceptance by the Project Board, detailing the intermediate products and the timetable to which they will be produced.

The Project Team will ensure that trial information is obtained and fed back via the Project Manager to the Project Board, to allow assessment of progress. The Project Manager will supply a monthly report with respect to the trial objectives.

The Project Board will meet bimonthly, or as required by significant developments during the trial or proposed changes as recommended by the monthly meetings of the Project Team.

It will be the responsibility of the Project Team to ensure adequate information is collected to provide an evaluation of field instrumentation, a recommendation as to the way forward and the preparation of a business case for this.

5 RESOURCE REQUIREMENTS

5.1 Manpower

5.1.1 Areas

It is recognised that having a dedicated instrumentation technician is critical for the success of the trial. Three of the selected Areas have their own instrumentation technicians so an additional 4 FTEs will be required, during the trial, to ensure the remaining selected Areas are fully resourced. It is expected that these additional FTEs will be contracted in for 8-month period to span both phases of the trial.

The table in section 4.3.1 of this report shows which Areas these FTEs will be allocated to.

5.1.2 National Centre for Instrumentation

The National Centre of Instrumentation will provide and co-ordinate all technical and training support during the trial. As they only have one hand held instrument technician, it is proposed that Matthew Lowenthal (the Thames Region Instrument Technician) should be attached to the National Centre for one month during phase one of the trial.

5.2 Finance

The current estimate cost for the trial is £86k which is made up from:

Project Team	£12.2k
Qty 4 additional FTEs employed for 8 -months	£62.0k
Training Cost	£ 7.5k
Cost of Couriers etc for repairs	£ 4.0k

Total	£ 85.7k

A detailed breakdown of the full costs for the trial will be included in the Form A to be presented to the EG Sub-Group on 19 April 1995.

6 LEGAL IMPLICATIONS OF USE OF FIELD INSTRUMENTATION

6.1 Background

Analytical results from routine and investigative monitoring are used for to establish compliance with water quality objectives, Directive reporting and as evidence in legal proceedings.

Currently, results of samples are largely obtained by laboratory based analytical methods which if challenged can be substantiated by the NLS by reference to the use of standard approved methods, quality assurance systems and NAMAS accreditation. It is necessary, therefore, to consider how a challenge to results obtained through the use of field instrumentation technology would be met. In this connection, results obtained from instruments must be capable of withstanding challenge from industry, - dischargers with access to similar equipment and technology and, within the context of legal proceedings, to technical legal points from defence lawyers. In all cases, therefore, it is imperative to demonstrate that results obtained from field instruments are accurate, reliable and admissible.

6.2 Accuracy

6.2.1 Quality Assurance

During the trial period, it is proposed that a selection of field test results will be cross checked by analysis of samples to validate data being collected by meters. The results and findings arising from the trial will be retained to show the correlation between instrumentation results and laboratory based analytical results.

Provision for a continuing programme of quality assurance checks has been made and this is an important aid to demonstration of the reliability of instrumentation results. Until such time as a decision is taken as to whether instrumentation is introduced universally across the Authority it will be prudent to cross check regularly (particularly in pollution investigation cases) with laboratory based results in order to provide confidence in the accuracy of instrumentation derived results.

6.3 Reliability

6.3.1 Calibration

Generally reliability (of results) can be demonstrated by correct use of the instrument and regular calibration. A manufacturer's certificate or log showing regular maintenance and a record of subsequent calibration should be maintained in relation to each machine. Instruments should, therefore, be identifiable by unique serial numbers.

Those undertaking calibration should be a position to demonstrate competence by reference to an appropriate training course and a certificate of satisfactory completion of training. Individuals should record calibration details in their own notebooks during use.

A record of results obtained prior to and subsequent to calibration should be kept to ensure that the performance of instruments can be evaluated and demonstrated.

6.3.2 Operational Procedures

It is imperative that correct use of instruments can be demonstrated by all users. To this end, training will be given to ensure familiarity with instruments and procedures. Furthermore, user guides for each instrumentation type have been produced and must be followed in the use and deployment of each instrument. (Appendix H to J).

6.4 Admissibility

6.4.1 General

For evidence to be admissible (i.e. accepted or admitted by a court) it must be relevant, and it must not fall foul of the various rules and exceptions which would allow a court to exclude it.

In water quality cases a general rule exists, established by S.209 Water Resources Act 1991 as follows:-

> " .... the result of the analysis of any sample taken on behalf of the Authority in exercise of any power conferred by the Act shall not be admissible in any legal proceedings .... unless the person who took the sample -
>
> (a) on taking the sample notified the occupier of the land .... of his intention to have it analysed;
>
> (b) there and then divided the sample into three parts and caused each part to be placed in a container which was sealed and marked;
>
> (c) delivered one part of the occupier of the land .... and retained one part, apart from the one be submitted to be analysed, for future comparison".

The effect of this section is to exclude evidence unless the tripartite procedure has been followed. This requirement, however, has been the subject of much recent judicial interpretation. The case of R -V- CPC (UK) Limited The Times 8th Feb 1995 is the fullest most recent indication of the courts requirements when analysis of samples is undertaken by field instrumentation. In this case, the court held that no sample is taken unless some part of the waters or discharge is physically separated from the whole. If no part of the water or discharge is collected or kept by the instrument, it is impossible to comply with the requirements of S.209 WRA 1991.

The court held that where there was no such separation, as with the use of a hand held probe, this would not involve the taking of a sample within the meaning of S.209 W.R.A. 1991. This means that sampling devices such as Cyclops must continue to comply with s.209 WRA 1991 whereas continuous recording devices, Sherlock & Merlin, and hand held meters, such as the Grant YSI 3800, do not. It is interesting to note that Clause 93 of the Environment Bill provides that s.209 WRA 1991 shall cease to have effect. It remains to be seen whether this clause will be enacted.

6.4.2 Admissibility Requirements

Field Instruments are generally deemed to be computers for the purposes of the Police & Criminal Evidence Act 1984 (PACE), though not all hand held meters are considered so. Simple recording/measuring devices may fall outside of the requirements of S.69 PACE. Not only are most instruments computers in the literal sense, but they also store and retrieve information captured by them as well as computing their own calculations. On this basis, most field instruments fall within the meaning of "computers" for the purposes for PACE 1984. see R - v- Minors (1989) 89 Cr App R.102 [1989] 2 A11ER 208. It should be noted that PACE wisely contains no definition of "computer" to allow for any future technical innovation.

The effect of s69 PACE, see Appendix E, is to render documentary evidence produced from computers inadmissible unless the relevant criteria are satisfied. It is important, therefore, to ensure that the evidence in all cases is in order at the outset.

The evidential requirements of s.69 PACE are briefly a statement from the instrument user and a certificate by a responsible person in relation to the instrument to state that the machine was working correctly. In most circumstances these will be one and the same person. To this end, a draft statement and certificate to comply with PACE (and also to comply with the requirements of s.24 Criminal Justice Act 1988 where the user and responsible person are not one and the same) and included at Appendix H & I. It is desirable that draft or general statements are sent out to all Regions to assist users.

Provision has also been made in the draft statements for the proposed transfer of results data by down loading onto P.C.

If full implementation of the instrument strategy is progressed following completion of the comprehensive trial, copies of the users guides and quality assurance manuals should be supplied to Prosecuting Solicitors in each Region.

6.4.3 Deployment

S.169 WRA 1991 allows for the deployment of monitoring and other apparatus and accordingly there are no legal barriers to the use of field instrumentation.

6.4.4 Future Challenges

Even where evidence is admissible, the weight the court attaches to such evidence will depend upon how reliable and accurate the evidence is shown to be. It is reasonable to assume, that evidence generated through the use of instrumentation will be challenged in due course. Accordingly, it is likely that at some future date expert evidence will have to be given by a representative of the National Instrumentation Centre and hence training records, calibration records, quality assurance records and trial period data should be retained for that eventuality.

In conclusion, it is suggested that a decision as to tolerance levels and the ability of the various instruments to be used in given situations can be made with greater confidence after the conclusion of the comprehensive trial period.

7 OPERATIONAL PROCEDURES

The following guidelines, procedures and quality assurance manuals have been produced and are bound as separate documents.

Grant YSI 3800 Hand-Held Meter Operators Guide	Appendix	H
Grant YSI 3800 Hand-Held Meter Quality Assurance	Appendix	I
Sherlock Water Quality Monitor Quality Assurance Manual	Appendix	J

8 RECOMMENDATION

The Operations Team are asked to support the recommendation to progress a comprehensive Area trial, so that the supporting Form A can be put to the EG finance sub-group for approval.

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MEMORANDUM

To: Grainger Davies
Doug Rainbow

From: Dr Kevin Bond

Our Ref: KB/mlg/Q1/1/2-1_2112
Your Ref:

Date: 21 December 1994

Subject: FIELD INSTRUMENTATION

Further to December Ops Team this note is to confirm the formation of a Project Team to:

1 Identify the number and type of field instrumentation necessary, by region, to fully implement the instrumentation strategy.

2 To develop, to the point of regional use guidelines, the full use of field instrumentation, by type. These guidelines to include the protocol necessary for:

(i) AQC; and
(ii) Legal use of evidence acquired (as per Cyclops procedure).

3 To advise on the requirement and way in which information acquired from field instrumentation should be entered onto registers.

4 To evaluate and propose the most effective and efficient means by which instrumentation should be maintained.

In order to fulfil this remit, I would ask that RGM's support this review by the provision and support of information. In particular, I would ask that David King (AM, Anglian East), act as Project Team Leader to be supported by Jill Clayton (Pollution Control, Severn-Trent), a nominee from Water Quality (HO) and a nominee from the National Instrumentation Centre. In addition I will make available Mark Liddiard and Rob Somers (Operations). This team should report by Monday, 20 February.

A Project Team Board will oversee the work, to be chaired by myself and to include Mick Pearson, Ian Adams, Martin Booth and Dave Palmer together with a nominee from HO Water Quality (Terry Long?). Two meetings of the Board will be arranged, one at the end of January and one in mid-February.

M Gladstone
for Dr Kevin Bond
Director of Operations

copy to Dr Clive Swinnerton
RGM's
Mick Pearson
Ian Adams
Martin Booth
(1) Sue Slack – Mark/Rob.

APPENDIX B RESULTS OF THE FEB 95 SURVEY OF INSTRUMENTATION HOLDINGS ACROSS THE REGIONS

1. ANGLIAN REGION - PORTABLE, HAND-HELD & MOBILE INSTRUMENTATION

1.1 NORTHERN AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	3		Not in regular use		Meters Calibrated by field staff All faults are returned to the manufacturer
YSI 33 SCT	4	Conductivity		2/5	
YSI 50	4	DO Pollution Incidents		>5	
YSI 51	1			5	
YSI 51 B	6			5	
YSI 55	1			2	
Cyclops	1		Not deployed		

1.2 CENTRAL AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	4		Rarely		Calibrated field staff, maintained by instrument technician
Phox 62D/YSI 55	11		Daily Use	2-3	
Tow a van	2	WQMS	Continuous		
Sherock	2				
Cyclops	1		Not deployed		

1.3 EASTERN AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	6	River/effluent/ marine monitoring	weekly	2	Calibrated & routine maintenance by field staff 2nd line maintenance by Area technician
DO meters	33		Daily		
pH meters	8		Weekly		
Conductivity meters	6		Weekly		Factory set no calibration. Trouble shooting by Area Technician
Temp meters	1		Weekly		
Turbidity meters	2		Weekly		
DMP Waterlogger	1		once	4	
Sherlock	2	rivers/effluent	> Monthly	2	Area technician services following each deployment & calibrates weekly during each deployment
Cyclops	1	Waiting suitable site	Operational		

2. NORTH WEST REGION- PORTABLE, HAND-HELD & MOBILE INSTRUMENTS

2.1 SOUTHERN AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	3	Pollution incident investigations	Occasional	1-2	By Calibration Officer at Regional Head Office every month
YSI 55	33	DO	Weekly by Sampler Drivers, Monthly by PCOs	1	Daily calibration by field staff, 2nd line maintenance by Calibration Officer at Regional Head Office as required.
Cyclops	1		Not yet operational.	0	Routine calibration and maintenance by designated officer. 2nd line maintenance at NRA National Centre.

2.2 CENTRAL AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	3	Used, as a check on river monitoring & pollution investigation	Weekly	1	By Calibration Officer at Regional Head Office every fortnight.
YSI 55	20	DO, Temp. Used for Pollution incidents	Weekly by Sampler Drivers, Monthly by PCOs	1	Daily calibration by field staff, Weekly calibration by Technical Officer. 2nd line maintenance by Calibration Officer at Regional Head Office as required.
Whatman pH Sensor	12	pH	Not used regularly	3+	Calibration and maintenance at Regional Head Office as required.
Cyclops	1		Not yet operational, but to be used daily	0	Routine calibration and maintenance by designated officer. 2nd line maintenance at NRA National Centre.

2.3 NORTHERN AREA (North West Region)

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	2	Pollution investigation, not for sampling	Approx every 2 months	1	By Calibration Officer at Regional Head Office every fortnight. Field Staff can calibrate DO on site
YSI 55	15	DO	2-3 times weekly	1	Daily calibration by field staff. 2 nd line maintenance by Calibration Officer at Regional Head Office as required.
Whatman pH sensor	12	pH	Monthly	2	Area Technical Officer changes batteries as required. Monthly calibration and maintenance at Regional Head Office.
Chemlab	1	Chlorine Meter	Currently on trail,but to be used monthly	0	Factory calibrated, but Regional Calibration Officer will maintain as required.
Cyclops	1		Not yet operational, but to be used daily	0	Routine calibration and maintenance by designated officer. 2nd line maintenance at NRA National Centre.

REGIONAL MARINE & SPECIAL PROJECTS

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Mini Midas ME Mercury Probe	3	Anchored Buoy in shallow estuaries DO, Temp, pH, Conductivity, Chlorophyll	Continuous	3	Calibrated at Regional Head Office
Midas	1	Light Ship DO, Temp, pH, current velocity & direction + Met data	Continuous	2	Field Calibration 2nd line calibration / maintenance at Region Head Office
YSI 6000	9	Cumbrian Lakes Automated Monitoring	Continuous	1-2	
Sensordata Current meters	2			1-2	
WS Oceans Nitrate analysers	1			1-2	
Aquatracka Chlorophyll analysers	3			1-2	

3. NORTHUMBRIA & YORKSHIRE REGION - PORTABLE, HAND-HELD & MOBILE INSTRUMENTATION

3.1 NORTHUMBRIA AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	10	DO Temp	Rarely	3	All meters are presently calibrated and maintained by field staff following guidance by regional experts based in the Regional Field Data Services (FDS) department. Standards are provided by the laboratory. The shortcomings of the existing system are known, and has resulted in detailed discussions being held with the FDS department (most recent 2 Feb 95) to draft a service level agreement to provide maintenance of the meters from Apr 95.
WTW microprocessor oxy meter	8	DO Temp	Currently being purchased to be used daily	New	
Sherlock	2	Sampling	4 times a year	3	
Merlin	2	Sampling	4 times a year	3	
Cyclops	1		Not yet operational.	0	

3.2 DALES AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	9	DO + Temp of controlled waters. Indication of ammonia during a pollution incident. Salinity,turbidity, conductivity + pH for estuary survey.	Daily	2	All meters are presently calibrated and maintained by field staff following guidance by regional experts based in the Regional Field Data Services (FDS) department. Standards are provided by the laboratory. The shortcomings of the existing system are known, and has resulted in detailed discussions being held with the FDS department (most recent 2 Feb 95) to draft a service level agreement to provide maintenance of the meters from Apr 95.
YSI 55	9	DO & Temp of controlled waters	Daily	New	
YSI 58	16	DO & Temp of controlled waters	Daily	2	
pHox 62	3	DO (back up meter)	Infrequently	4	
pHox 67	4	DO (back up meter)	Infrequently	10	
pHox 905 multi meter	2	DO (back up meter)	Infrequently	5	
Centron pH meter	2	pH	Bathing water season	2	
WTW Conductivity meter	2	Salinity during bathing water sampling	Monthly	3	
Cyclops	1		Not yet operational, but to be used daily	0	Routine calibration and maintenance by designated officer. 2nd line maintenance at NRA National Centre

3.3 SOUTH YORKSHIRE AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	1		Rarely		All meters are presently calibrated and maintained by field staff following guidance by regional experts based in the Regional Field Data Services (FDS) department. Standards are provided by the laboratory. The shortcomings of the existing system are known, and has resulted in detailed discussions being held with the FDS department (most recent 2 Feb 95) to draft a service level agreement to provide maintenance of the meters from Apr 95.
YSI 50	36	DO, Temp	Daily	1-4	
pHox	2	DO, Temp	Daily	6	
Photometer	2	Conductivity	Daily	2	
D Lance LPG 124	2	Ammonia	Daily	2	
Cyclops	1		Not yet in operational use		

4. SEVERN TRENT REGION - PORTABLE, HAND-HELD & MOBILE INSTRUMENTATION

4.1 UPPER SEVERN AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	2	Survey and pollution incidents	Daily	2	Calibrated by users Maintenance by instrument technician based at Nottingham.
YSI 54	6	River and effluent monitoring (DO, Temp and pH) Pollution incident investigation	Daily	2 x 5+ 4 x 4	1. By user. 2. In-house Area technician. 3. Outside contractor
YSI 55	6		Daily	New	
YSI 57	7		Daily	10+	
pHox 62T	1		Spare/Rarely	11	
pHox 62D	8		4 x Daily 2 x infrequently 2 x spare	5 x 11 2 x 6 1 x 1	
pHox 67	8	Recording DO meter for groundwater monitoring		4 x 12 1 x 11 3 x 4	
Cyclops	1	Not deployed	Not yet operational		

4.2 LOWER SEVERN AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	0	Have tested 2 meters but have been returned			
YSI	22	DO, Temp	Daily	5	1. Self calibration. 2. 2nd line maintenance by the manufacturer.
YSI 6000	4	Submersible for DO, Temp, ammonia & conductivity	Daily/Weekly	10+	
Cyclops	1	Not deployed	Not yet operational		

4.3 UPPER TRENT AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	0	Have trailed 3 meters in area , all found to be too insensitive when it came to measuring ammonia. All meters have now been returned to Trentside for new ammonia probes to be fitted.			
YSI 50	3	DO, Temp	Daily, weekly.		DO meters are calibrated daily by the users and cross calibrated with other meters monthly. The Regional Instrumentation Team based at Trentside undertakes any 2nd line maintenance.
YSI 54	9				
YSI 55	7				
YSI 57	7				
YSI EL53	1				
Cyclops	1	Under trail	Not yet operational	0	

4.4 LOWER TRENT AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	0	Currently no meters in the Area. Following battery modifications and improvements to the ammonia probe, one meter will be issued to each of the 4 Pollution Control Teams, for use at pollution incidents. However, the ammonia result will not be used to replace the ammonia data obtained from the laboratory.			
YSI	28	DO, Temp	Daily		Daily maintenance by the field staff Referred to instrumentation or the manufacturer for repairs
Cyclops	1	Not deployed	Not yet operational	0	

4.5 REGIONAL ASSETS HELD BY TRENTSIDE

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	19	Simion Wills, the Regional instrument technician is fitting new ammonia probes the meters			

5. SOUTHERN REGION - PORTABLE, HAND-HELD & MOBILE INSTRUMENTATION

5.1 HAMPSHIRE AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	4	Routine sampling, Pollution investigations & marine surveys.	Weekly	<1	Meters returned to Waterlooville for calibration on a weekly basis
WTW OXI 196	8	D.O. investigations	Daily/weekly		By user
WTW OXI 96	4	"	"		"
WTW salinity meter	3				
Sherlock	1				
Cyclops	1	not yet used		0.5	By trained area staff

5.2 SUSSEX AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	4	Sampling	Daily	<1	Meters returned to Waterlooville for calibration on a weekly basis
YSI 6000	4	Investigational work	Weekly/Monthly		Service contract with Southern Science
WTW OXI 196	7	Sampling	Varies	3-5	By Area user
YSI 55	10	D.O. Surveys	Weekly	<1	"
Sherlock	2			2	
Cyclops	1		Under test (Uckfield STW)		By area trained staff

5.3 KENT AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	4	Incident response	Weekly	<2	Meters returned to Waterlooville for calibration on a weekly basis
WTW OXI	17	D.O.	Daily	<2	Field calibrated and base - maintained
pHOX	3	"	Weekly	>5	"
Sherlock	1			2	
Merlin	1			2	
Cyclops	1	Communication problems have hampered use		<1	Trained area staff

5.4 CENTRAL HELD AT REGION OR LABS

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	20	One held by region 7 held at Labs (waterlooville) for Special Investigation Team 12 new meters to be handed out to Areas		New	

6. SOUTH WESTERN REGION - PORTABLE, HAND-HELD & MOBILE INSTRUMENTATION

6.1 CORNWALL AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	2	Pollution.incident & investigational work	Weekly	1.5	Maintained by Investigations team
WTW OXI 196	28	DO readings	Daily	2-4	Survey staff/Investigations technicians
WTW OXI 320	4	"	"	0.5	"
WTW LF 196	8	Conductivity surveys	"	2-4	"
PHOX 100 dpm	4		Weekly	3	"
PHOX 962	3		"	1	"
PHOX 901	3		"	1	"
PHOX 201	7		"	1-3	"
Hydrolab DS3	1		"	new	"
WTW 196	16	pH	Daily /monthly	2-4	"
WTW 320	4	"	Daily	0.5	"
Jenway 4071	10	Conductivity	Daily	1	"
Solamat	1	Turbidity	Weekly	new	
Hydrolab recorders	4		"	"	"
Cyclops	1	Communication problems have hindered use		<1	Trained Area staff

6.2 SOUTH WESSEX AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	6	Discharge impact assessment, marine profiling, Not for sampling	Weekly	<1	Investigations section(area based)
LTH BOM1 D.O.	5		Monthly	6	By users
WTW OXI 196	4		Daily	4	"
YSI 50 B	8		Daily/Weekly	2	"
pHOX 62T	1		Monthly	8	"
Hydrolab datasonde	2		weekly	1	Investigations team
YSI 6000	2		"	1	"
Cyclops	1	Not yet deployed		1	"

6.3 DEVON AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	8	Biological investigations	Monthly	1-2	Area Investigations technician
WTW OXI 196		Pollution incidents, investigational work,sampling.	Daily	2-5	"
WTW pH 196		"	"	2-5	"
WTW LF 196					
WTW OXI 325		"	"	<1	"
WTW pH 325		"	"	"	"
pHOX 100 DPM		"	Depends on type of investigation	5	"
pHOX 200 series		"	"	2	"
pHOX Mk IV		"	"	3	"
pHOX 900/960		"	Very infrequently	1	"
pHOX 210		"	Monthly	1	"
Hydrolab Scout 2		"	Weekly	1	"
Piccolo pH Meter		"	Daily	<1	"
Cyclops	1	Still under trial	Weekly	0.5	Area Investigations technician

6.4 NORTH WESSEX AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	8	Water quality investigations	Daily/weekly	1.5	Investigations staff
LTH BOM 1	15	"	"	>4	"
Oxyguard Handy III	9	"	Daily	0.5	"
Other DO meters	25	"	Daily/Weekly		"
pHOX NH4 meters	4	"	Infrequently	>4	"
pHOX conductivity meters	2	"	"	>4	"
Sherlock DMP water logger	7	"	Weekly	2.5	"
Hydrolab DS3	3	"	Weekly/Monthly	<2	"
Cyclops	1	Not deployed			Investigations staff

7. THAMES REGION - PORTABLE, HAND-HELD & MOBILE INSTRUMENTATION

7.1 WEST AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	10	Routine river monitoring	Daily	1	Mobile van visits each office weekly to check, calibrate and repair as necessary
pHox	5	DO Temp			
Cyclops	1				

7.2 NORTH EAST AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	12	Mostly DO & temp. Some for pH in lieu of lab analysis Ammonia used only for pollution tracing 1 for groundwater monitoring	Daily		Mobile van visits each office weekly to check, calibrate and repair as necessary
pHox	7	DO backup meters			
Cyclops	1				

7.3 SOUTH EAST AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	16	Routine samples, Special surveys incidents	Daily		Mobile van visits each office weekly to check, calibrate and repair as necessary
pHox	8	DO, Temp Will be redundant by end of the year	Weekly		
Cyclops	1	In use 3 sites so far	Continuous	0	

7.4 HELD CENTRALLY AS REGIONAL ASSETS

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	12	4 with Biology 2 for student 6 new meter to be issue to Areas			

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8. WELSH REGION - PORTABLE, HAND-HELD & MOBILE INSTRUMENTATION

8.1 NORTHERN AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	4	Investigational work	Weekly	<1	Assistant Pollution Control Officer based in Mold
WTW pH meter	7			2-3	
Hydrolab datasonde DS3	9	Routine sampling, pollution. investigations, work		1-2	
WTW conductivity meter	3	"		2-3	
YSI DO meter 51B	7	"	Weekly	5	By user
WTW DO meter (196)	11	"	Daily/weekly	2-5	By user
Cyclops	1	"			Awaiting regional implementation strategy

8.2 SOUTH WESTERN AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	31	EIA's, surveys , special investigations, pollution incidents	Daily/weekly		Calibrated by user following EAU protocol
WTW DO meter 196	4		Rare	4-5	By user
WTW LF 196	1	Special Investigations	Rare		By user
Hydrolab DS3	7	EIA's, surveys , special investigations, pollution incidents	Weekly/monthly	1-3	By user
Cyclops	1				Awaiting regional implementation strategy

8.3 SOUTH EASTERN AREA

Make	Qty	Used For	Frequency of Use	Age in years	Current Method of Calibration & Maintenance
Grant YSI 3800	3	Pollution incidents, DO profiles of R. Wye	Monthly		Awaiting regional policy - no formal arrangements
WTW DO meter	20	Pollution.incidents	Monthly	5-6	No formal arrangements
Datasonde hydrolab DS3	10	Remote monitoring, EIA's, surveys	Daily/Weekly	3-4	Calibrate when required
Partec SS meter	2	Pollution.incident analysis	Rare		No formal arrangements
pHox ammonium meter	2				
Jenway 9060	1	DO Pollution incidents	Monthly	6	PC staff
pHox Conductivity meter	1				
Jenway 3061	2	DO, Pollution incidents	Monthly	6	PC staff
pHox 62	3		Monthly	6	"
Kans & May 7001	4	pH, pollution incidents	"	6	"
Cyclops	1				Awaiting regional implementation strategy

(a) Cyclops has not yet been deployed in Areas as they are awaiting a Regional strategy on their use.

APPENDIX C DEPLOYMENT & USAGE LEVELS OF THE GRANT YSI 3800 METERS AS AT FEB 95

Region	Area	GRANT YSI 3800 Meters			
		Number in Area	Used For	Level of usage	Method of Calibration & Maintenance
Anglian	Northern	3	Not Used	Rarely	-
	Central	4	Not used	Rarely	Area Technician
	Eastern	6	Pollution Control	Weekly	Area Technician
North West	Northern	2	Pollution Incidents	Rarely	Calibrated monthly by Technician based at Regional Head Office
	Central	3	Pollution Incidents	Rarely	
	Southern	3	Pollution Incidents	Rarely	
Yorks & NU	Northumbria	10	Not Used	Rarely	SLA with Regional Field Data Services for all instrumentation maintenance
	Dale	9	Sampling + Incidents	Daily	
	S Yorkshire	1	Not used	Rarely	
Severn Trent	U Severn	2	Sampling + Incidents	Daily	User Calibration , maintained by Regional Technician
	L Severn	0	Not Used	Not used	
	U Trent	0	Not Used	Not used	
	L Trent	0	Not Used	Not used	
	Regional Assets	19	-	Not Used	
Southern	Hampshire	4	Sampling + Incidents	Weekly	Calibrated weekly at Waterlooville Labs
	Sussex	4	Sampling	Daily	
	Kent	4	Pollution Incidents	Weekly	
	Region/Labs	20	Special Investigations	Rarely	
South Western	Cornwall	2	Pollution Incidents	Weekly	Area Technician
	Devon	8	Sampling + Incidents	Monthly	Area Technician
	N Wessex	8	Sampling	Daily	Area Technician
	S Wessex	6	Pollution Incidents	Weekly	Area Technician
Thames	West	10	Sampling + Incidents	Daily	Calibrated and maintained by Regional Technician in mobile van visiting Area offices
	North East	12	Sampling + Incidents	Daily	
	South East	16	Sampling + Incidents	Daily	
	Regional Asset	12	Bio' Investigation	-	
Welsh	Northern	4	Pollution Incidents	Weekly	By APCO
	S Western	31	Pollution Incidents	Weekly	By APCO
	S Eastern	3	Pollution Incidents	Monthly	By APCO
National Centre		2	-	-	Own technician
Known Modified/ Damaged		6	-	-	-
Total		214	-	-	-

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APPENDIX D DEPLOYMENT & USAGE LEVELS OF THE CYCLOPS, MERLINS & SHERLOCK INSTRUMENTATION METERS AS AT FEB 95

Region	Area	CYCLOPS		SHERLOCK		MERLIN	
		Number in Area	Status	Number in Area	Status	Number in Area	Status
Anglian	Northern	1	Not deployed	1	Not deployed	0	-
	Central	1	Not Deployed	2	Not Deployed	0	-
	Eastern	1	Deployed	2	Deployed	0	-
North West	Northern	1	Not deployed	0	-	0	-
	Central	1	Not deployed	0	-	0	-
	Southern	1	Not deployed	0	-	0	-
Yorks & NU	Northumbria	1	Not deployed	2	Deployed	2	Deployed
	Dale	1	Not Deployed	1	(2)	1	(2)
	S Yorkshire	1	Not deployed	0	-	0	-
Severn Trent	U Severn	1	Not deployed	0	-	0	-
	L Severn	1	Not deployed	0	-	0	-
	U Trent	1	Deployed	0	-	0	-
	L Trent	1	Deployed	0	-	0	-
	Regional Assets	0	-	1	Not deployed	0	-
Southern	Hampshire	1	Not deployed	1	Deployed	0	-
	Sussex	1	Deployed	2	Deployed	0	-
	Kent	1	Coms problem	1	(2)	1	(2)
South Western	Cornwall	1	Coms problem	0	-	0	-
	Devon	1	Coms problem	0	-	0	-
	N Wessex	1	Not deployed	5	Deployed	2	Rarely used
	S Wessex	1	Not deployed	3	(2)	1	(2)
Thames	West	1	Deployed	0	-	0	-
	North East	1	Deployed	0	-	0	-
	South East	1	Deployed	0	-	0	-
	Regional Asset	0	-	1	Not used	0	-
Welsh	Northern	1	Not deployed awiting regional implementation strategy	0	-	0	-
	S Western	1		1	On trial	0	-
	S Eastern	1		0	-	0	-
National Centre		5	-	2	-	2	-
Known Modified/ Damaged		0	-	1	-	0	-
Total		31	-	26	-	9	-

Notes. (1) Based on information from the National Centre for Instrumentation and confirmed with Regions.
(2) Information not confirmed.

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APPENDIX E SECTION 69 POLICE AND CRIMINAL EVIDENCE ACT 1984

69. Evidence from computer records.

1. In any proceedings, a statement in a document produced by a computer shall not be admissible as evidence of any fact stated therein unless it is shown -

   (a) that there are no reasonable grounds for believing that the statement is inaccurate because of improper use of the computer;

   (b) that at all material times the computer was operating properly, or if not, that any respect in which it was not operating properly or was out of operation was not such as to affect the production of the document or the accuracy of its contents; and

   (c) that any relevant conditions specified in rules of court under subsection (2) below are satisfied.

2. Provision may be made by rules of court requiring that in any proceedings where it is desired to give a statement in evidence by virtue of this section such information concerning the statementas may be required by the rules shall be provided in such form and at such time as may be so required.

Left blank intentionally

FINAL
10 April 1995

APPENDIX F

NATIONAL RIVERS AUTHORITY

DRAFT STATEMENT UNDER SECTIONS 24 OF CRIMINAL JUSTICE ACT 1988 AND 69 OF POLICE AND CRIMINAL EVIDENCE ACT 1984

NAME:

ADDRESS:

OCCUPATION:

DATE:

I am employed by the National Rivers Authority, Region, at their offices at . My responsibilities include measuring using a device known as a ( ). This device operates by [calculating the from that information using a program which contains formulae devised and tested by .] The information and the resulting calculation are stored in the memory of the ( ) and then copied by an external disc drive onto a floppy disc. That floppy disc is then taken or sent to the office at where the information stored in it is loaded by one of the clerical staff in the course of his or her duty onto the computer, namely a , which is kept there. The information and calculation of are retained in the memory of that computer for a period of . A hard copy is printed out which I produce as exhibit . Neither I, nor any other person using the device known as the ( ) to measure and calculate can reasonably be expected to recall the matters contained in the document exhibit .

If required, I can produce to the court an example of the ( ) to demonstrate how it operates.

Left blank intentionally

APPENDIX G

NATIONAL RIVERS AUTHORITY

DRAFT CERTIFICATE UNDER SECTION 69 OF POLICE AND CRIMINAL EVIDENCE ACT 1984

NAME:

ADDRESS:

OCCUPATION:

DATE:

1. The document exhibit has been produced by a computer, namely a . It was produced from information stored in the memory of that computer which had in turn been supplied with that information from a ( ) computer which had compiled the information contained in that document. That information was produced in the way set out in the statement of (ie the maker of the section 24 CJA statement).

2. I occupy a position of responsibility in relation to the operation of both computers.

3. I certify that to the best of my knowledge and belief -

   (a) there are no reasonable grounds for believing that the statement is inaccurate because of improper use of the computers or either of them; and

   (b) at all material times both the ( ) computer and the computer at the office of the National Rivers Authority at were operating properly, or if not, that any respect in which either of them was not operating properly or was out of operation was not such as to affect the production of the document or the accuracy of its contents.

signed

Left blank intentionally

REVIEW OF WATER QUALITY INSTRUMENTATION APRIL 1995

Appendix H - Grant YSI 3800 Hand-Held Meter Operators Guide

H/1

OPERATOR DAILY OPERATIONAL PROCEDURES

Operator Procedure

When first receiving the instrument check the date of calibration, this meter **MUST** be returned within two weeks of that date for recalibration by the technician.

Check that you have a spare set of batteries, clean water for rinsing the sonde and replacement DO% Membranes

Check the calibration date

Check the battery voltage

Clear the loggers memory

Check the time and date

Reconnect the logger and sonde

Check the calibration of the dissolved oxygen probe on site, if the calibration is out of the QA limits ie 95% - 105% inform your appointed technician, if it is recommended to recalibrate the probe follow the procedure on the page marked Dissolved Oxygen Calibration in this manual.

Place the sonde in the sample to be measured, whilst the sonde is responding and settling down the site identity can be recalled or entered. After approximately three minutes the logger can be switched on and if the readings are stable they can be recorded using the **RECORD** button. The slowest responding probe will most likely be the pH probe, and this can be used as an indicator as to when to record the readings. The logger will indicate if any of the probes are unstable with the message:

"Channel unstable please wait"

If this message is displayed allow more time for the probe to settle.

If any problems are encountered with the logger the majority of them can be resolved on site by pressing the **ON/METER** button, once the meter is responding in meter mode the procedure can be repeated. If any other difficulties occur then refer them to the authorised technician.

If the sample being measured is contaminated the sonde should be rinsed off after use with clean water before being restored into storage pot. The operator can then move onto the next site.

After the last site has been visited disconnect the cable between the logger and the sonde.

Clean the sonde and restore to its storage pot.

For the purpose of this exercise part of the data collection will be manual. Later the results will be down loaded to PC with direct data transfer to WAMS happening later. The form on page 5 should be photocopied and filled in at each site. The 3800 logger should be down loaded to a printer using the cable provided, a copy of the downloaded data must be kept by the technician.

The downloaded data and completed forms should be returned or faxed to Terry Long at Head Office.

DISSOLVED OXYGEN CALIBRATION

The probe must be exposed to air which is saturated with water, this is possible by two methods

1. Seal the end of the sonde with the prepared oxygen probe inside a clean chamber that contains water saturated air. This can be achieved by placing the sonde in a chamber with source of water such as a damp rag or sponge.

2. Alternatively, wrap a damp (not dripping) cloth around the probe guard so that all the holes are covered.

Allow the system to come to thermal equilibrium for approximately 5 minutes.

When the above requirements have been met switch on the logger and select the Secondary Mode of operation. (Press the **ON/METER** button and **FUNCTION GROUP** together to access Secondary Mode). Using the **FUNCTION GROUPS** button select **CALIBRATION.** Use the **FUNCTION** button to select Dissolved Oxygen calibration. The display will show:

O_2 calibration
SELECT: %,^{mg}/l

Use the **SELECT** button to move the cursor under "%" and then press the **SET/CONFIRM** button to confirm we are calibrating using %. The display will show the temperature, salinity and air pressure:

O_2 cal 18.4C
0.0% 100.6kPal

Press the **SET/CONFIRM** button and the current dissolved oxygen reading will be displayed.

O_2 cal 18.4C
100.0 122.6%

The reading should stabilise fairly quickly (1 to 2 minutes). When the reading has stabilised press the **SET/CONFIRM** button. The display will show:

O_2 100% cal
Press SELECT

Press the **SELECT** button and the display will show:

O_2 1 OF 1 cal
select: confirm

Press the **CONFIRM** button and the display will show:

Cal Confirmed
Press FUNCTION

Press the **FUNCTION** button and the display will return to the calibration menu.

You can exit the calibration menu by pressing the **ON/METER** button to return to meter mode. Refer to your technician if any problems occur.

REGIONAL HAND HELD METER TRIAL

Operator Name .... Contact Number ....

Meter Number ....

	3800 RUN NUMBER	SAMPLE IDENTITY
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

	3800 RUN NUMBER	SAMPLE IDENTITY
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		

To be returned to: Terry Long
Head Office — Telephone 01454 624400
Bristol — Fax 01454 624032

REVIEW OF WATER QUALITY
INSTRUMENTATION APRIL 1995

Appendix I - Grant YSI 3800 Hand-Held Meter
Quality Assurance

HAND HELD METER QUALITY ASSURANCE MANUAL

NATIONAL CENTRE FOR INSTRUMENTATION
&
MARINE SURVEILLANCE

CONTENTS

CHAPTER

CHAPTER 1	INTRODUCTION
CHAPTER 2	3800 OPERATION OVERVIEW
CHAPTER 3	CALIBRATION
CHAPTER 4	DISSOLVED OXYGEN CALIBRATION
CHAPTER 5	pH CALIBRATION
CHAPTER 6	AMMONIUM CALIBRATION
CHAPTER 7	TURBIDITY CALIBRATION
CHAPTER 8	CONDUCTIVITY CHECKS
CHAPTER 9	TEMPERATURE CHECKS
CHAPTER 10	DAILY OPERATIONAL PROCEDURES
CHAPTER 11	FORMS AND CHECKLISTS
CHAPTER 12	HEALTH AND SAFETY

CHAPTER 1

INTRODUCTION

CONTENTS

SECTION

1 PURPOSE

2 INTRODUCTION

3 GLOSSARY

CHAPTER 1

INTRODUCTION

1. Purpose

The purpose of this document is to provide users of the Grant/YSI 3800 hand held meter the approved procedures for calibrating and operating the instrument to give assured quality data. This document is a supplement to the manufacturers manual and not a replacement. Technical enquiries should be referred to the manufacturers manual. This document assumes that the user has recieved an NRA approved training course in the use of the 3800 Hand Held Meter.

2. Operational Deployment of the Hand Held Meter

With the advances in instrument technology over recent years the use of hand held water quality meters has become more reliable. A multi-parameter meter provides a simple, rapid and in some instances more accurate means of measuring and storing water quality data. The NRA evaluated a number of hand held instruments and chose the Grant/YSI 3800 as the best instrument capable of meeting the its requirements. The 3800 can measure the following parameters:

Dissolved Oxygen
pH
Ammonium/Ammonia
Conductivity / Salinity
Turbidity
Temperature

For the 3800 to provide quality data as a replacement to laboratory analysis it is essential that these meters be calibrated accurately on a regular basis and supported by a suitable maintenance and calibration protocol.

It is essential that these procedures are well established before the national introduction of the Water Archive Management System (WAMS). The 3800 will interface directly with WAMS and download its data directly onto the archive, this will allow data to be available for users far more rapidly than current procedures allows.

3. Glossary

Download	-	Transfer of data usually from a monitoring device to a computer, via local or remote communications
PC	-	Personal Computer
NTU	-	Nephlometric Turbidity Units
mg/l	-	Milligramme per litre
ml	-	MilliLitre
Sonde	-	A suite of sensor probes
$NH_4{+}$	-	Ammonium ion
NH_3	-	Ammonia
pH	-	Indicator unit of acidity/alkalinity
V	-	Volts

CHAPTER 2

3800 OPERATION OVERVIEW

CONTENTS

SECTION

1 INTRODUCTION

2 PRIMARY MODE

3 SECONDARY MODE

4 INITIAL SETUP

CHAPTER 2

3800 OPERATION OVERVIEW

1. Introduction

There are two modes of operation for the 3800, Primary Mode and Secondary Mode. Primary Mode is obtained at any time by pressing the **ON/METER** button, in this mode the unit can act as a meter or logger. In Primary Mode the information above the logger control buttons is applicable. In Secondary Mode the information below the buttons applies (see Figure 1).

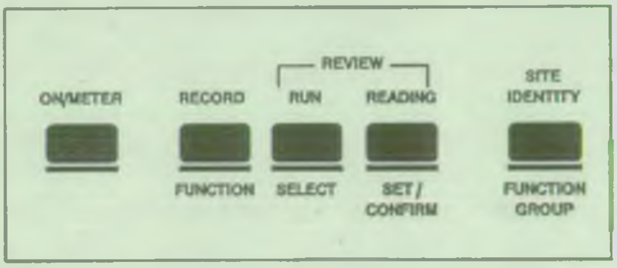

Figure 1

2. 3800 Primary Mode Control Buttons

2.1 On/Meter

Simply pressing the **ON/METER** button will switch the 3800 on, subsequent presses of the **ON/METER** button will display the current output from the probes sequentially. Taking no further action the meter will switch itself off automatically after a pre-set period of 10 minutes, however if the user repeatedly presses the **ON/METER** button until the LCD displays:

RUN 3
*Site***********

When the meter is displaying this message it will switch itself off automatically after 10 seconds.

2.2 Record

Pressing and holding the **RECORD** button will record and store all the probe outputs from the sonde. When the readings have been taken and stored by the 3800 it will respond with the message *READING TAKEN* on its display, the user can then press the **ON/METER** button to return to meter mode and switch off or record further readings.

Each set of readings will be assigned a unique run number, time and date and a site identity (if one has been allocated).

2.3 Run

Pressing the **RUN** button allows the user to recall recorded data on the LCD.

2.4 Reading

If the **ON/METER** button is pressed until a previous run number is displayed on the LCD, the **READING** button can be used to display the output from each individual probe for that recording.

2.5 Site Identity

The 3800 is capable of storing up to 99 site names. These site identities can be entered into the logger by the user, each site identity is assigned a number (01 to 99) and the site identity is allowed a maximum of 10 alpha numeric characters. By pressing the **SITE IDENTITY** button the user can scroll through these sites until the required site is displayed. Any data then recorded will be labelled with this site name. Site names can be entered or edited using the secondary mode function.

3. Secondary Mode

In Secondary Mode there are functions to check the status of the logger and sonde, calibrate the probes that require calibration, alter system settings and output data to a printer or computer. The Secondary Mode is split into FUNCTION GROUPS, within each of these function groups are FUNCTIONS (Similar to the Directory and File structure on computer). The functions allow the user to alter and input various settings within the logger software. The logger has 6 Function Groups, these are listed below.

FUNCTION GROUP	FUNCTION
STATUS	Battery Voltages Free Memory Identify logger model and serial number
CALIBRATION	Calibrate the various probes in the sonde
OUTPUT	Output recorded data

SETTINGS	Choose single or interval logging mode Interval logging time Input site identities Optional inputs Set date and time
CONFIGURATION	Automatic or manual buffer selection of pH buffer value. Units to be displayed for Temperature and Conductance. Whether or not to use temperature compensation for conductivity.
OPTIONAL PROBE SELECTION	Switch ISE's on or off. Set salinity compensation for Ammonium ISE on or off. Set turbidity probe on or off. Set depth sensor on or off. Units of depth. Calibration constants for depth. [Note : The standard NRA 3800 unit does not have a depth sensor fitted]

4. <u>Initial Set Up</u>

The 3800 is a versatile instrument and can be configured in a number of different ways to measure a variety of parameters and report them in different units. The configuration of the unit must be set to ensure uniformity of results. Listed below are a number of variables which must be checked prior to use. The variable function is set out on the left and the function group where it is found is set in the right hand column.

FUNCTION	FUNCTION GROUP
Check the last calibration	[STATUS]
Check the battery voltage	[STATUS]
Check the free memory	[STATUS]
Set to single recording	[SETTINGS]
Set the time and date	[SETTINGS]
Set the pH buffer value to AUTOMATIC	[SETTINGS]
Set the conductance units to Siemens	[CONFIGURATION]
Set the Temperature units Celsius	[CONFIGURATION]
Conductivity compensation ON	[CONFIGURATION]

CHAPTER 3

CALIBRATION

CONTENTS

SECTION

1 OVERVIEW

2 CALIBRATIONS STANDARDS

3 CALIBRATION MENU

CHAPTER 3

CALIBRATION

1. Overview

When the individual probes sense the presence of the specific parameter they respond to they react by producing a change in electrical output. This electrical output of the individual probes can then be logged by electronic methods. Probes measuring the same sample will produce a different value of electrical output to the concentration that it is measuring. Therefore instruments must have some means of translating the electrical signals they produce into known specified units, this procedure is called CALIBRATION.

As the individual probes age and are exposed to contaminants their response will change, this change (or drift as it is known) will vary from probe to probe, therefore it is essential that the response of the probes is checked on a regular basis, we can achieve this by checking the response of the probe when immersed in solutions of known concentrations. The important role of these meters in environmental monitoring means that standardised and reliable calibration procedures is essential.

Before proceeding with the calibration of the 3800 read the health and safety precautions necessary when dealing with chemicals. This topic is covered in the Health and Safety Section of this document. NRA Health and Safety procedures insist that users of dangerous/toxic substances must take the necessary precautions when dealing with such substances, in this instance gloves and protective eye gear MUST be used.

2. Calibration Standards

2.1 Overview

The accuracy of the calibration solutions is crucial to producing quality data and care must be taken throughout to reduce the introduction of errors into the calibration procedure, ie:

- contamination of standards
- cross contamination of standards
- accuracy of standards
- non-standardised procedures

The laboratory equipment must be of high quality and care must be taken to ensure cleanliness at all times. The calibration solutions must be of an assured quality (ie NAMAS, BS5750), this can be achieved by using a supplier who adheres to these systems such as the NRA Laboratory Service or Merck/BDH. It is useful to immobilise the sonde in a clamp this will make the procedure easier and eliminate the likelihood of spilt standards and damaging to the probes. (A suitable clamp can be acquired from the National Centre for Instrumentation)

2.2 Wash Solution

To ensure that the sonde is clean start by rinsing the sonde in de-ionised water if it is available. To minimise crossover and dilution of calibration standards a wash solution must be used to clean the probes before an exact calibration is carried out. If for example a pH probe is being calibrated to pH4, the probe would first be immersed in a wash solution of pH4 and then calibrated in the pH4 calibration standard. The wash solution will clean the probe and reduce crossover contamination.

2.3 Calibration Standard

The calibration standard is a known solution whose value can be guaranteed and should be free of contamination and within its current time and date stamp. Providing the standard does not become contaminated it is recommended that the standard be used a maximum of ten times before it is replaced. The used calibration standard can then be reused as the wash solution for the next series of calibrations

2.4 Check Standard

The check standard is a solution with a known specific value which can be used to check the performance of individual probes between calibrations.

The wash, calibration and check solutions should be changed regularly, the current calibration standard can become the wash solution for the next run of calibrations with a fresh supply of standard being used for calibration purposes.

3. Calibration Menu

As mentioned previously calibration is a function of the Secondary Mode of operation. To enter this mode press the **ON/METER** button and keeping it depressed press the **FUNCTION GROUP** button at the same time, the message ***STATUS*** should then be displayed on the LCD. The **FUNCTION GROUP** button can then be used to scroll through the various function groups mentioned earlier, when the option ***CALIBRATION*** is displayed press the **FUNCTION** button to display sequentially the probes which can be calibrated.

Note: The sonde can only be used with the logger unit it is has been calibrated with, using the sonde with another logger unit will produce invalid results

CHAPTER 4

DISSOLVED OXYGEN CALIBRATION

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SECTION

1 WHEN TO CALIBRATE THE OXYGEN PROBE

2 CALIBRATION IN AIR - %

3 ERRORS IN DISSOLVED OXYGEN CALIBRATION

CHAPTER 4

DISSOLVED OXYGEN CALIBRATION

1. When To Calibrate The Oxygen Probe

Before the oxygen probe can be calibrated the sonde must be connected to the logger unit for at least 15 minutes. This allows the dissolved oxygen probe to stabilize. Once this has been done the operator can commence calibration.

The dissolved oxygen probe should be calibrated every two weeks or after a new membrane is installed and checked daily. If environmental conditions are very different between one measurement and another it is recommended to recalibrate the probe to ensure the greatest accuracy. For instance, calibration of the probe sample at one temperature and the measurement of a sample at another more than 5°C away will increase the error in the output of the probe.

2. Calibration in Air - %

Dissolved oxygen calibration is to be carried out by the following method:

Calibration in air - measured in % of local.

Be sure that oxygen probe is properly prepared, ie the membrane is clean, there are no ruptures in the membrane and that the membrane is not loose. Rinse the probes in clean/de-ionised water and shake off any excess. Make sure that the tip of the dissolved oxygen probe and the tip of the temperature sensor do not have water droplets on them. If they do, remove the probe guard and gently blot the drops with a clean tissue and replace the probe guard. The probe should be calibrated at a temperature as close to the temperature of the sample it will be measuring (ie average temperature of the water course).

The probe must be exposed to air which is saturated with water, this is possible by two methods.

1 Seal the end of the sonde with the prepared oxygen probe inside a clean chamber that contains water saturated air. This can be achieved by placing in the chamber a source of water such as a damp rag or sponge. A sonde cup which encloses the end of the sonde is available from Grant Instruments or from the National Centre.

2 Alternatively, wrap a damp (not dripping) cloth around the probe guard so that all the holes are covered.

Allow the system to come to thermal equilibrium for approximately 5 minutes.

When the above requirements have been met switch on the logger and select the Secondary Mode of operation. Using the **FUNCTION GROUPS** button select **CALIBRATION.** Use the **FUNCTION** button to select Dissolved Oxygen calibration. The display will show:

O_2 calibration
SELECT: %, mg/l

Use the **SELECT** button to move the cursor under "%" and then press the **SET/CONFIRM** button to confirm we are calibrating using %. The display will show the temperature, salinity and air pressure:

O_2 cal 18.4C
0.0% 100.6kPal

Press the **SET/CONFIRM** button and the current dissolved oxygen reading will be displayed.

O_2 cal 18.4C
100.0 122.6%

The reading should stabilise fairly quickly (1 to 2 minutes). When the reading has stabilised press the **SET/CONFIRM** button. The display will show:

O_2 100% cal
Press SELECT

Press the **SELECT** button and the display will show:

O_2 1 OF 1 cal
select: confirm

Press the **CONFIRM** button and the display will show:

Cal Confirmed
Press FUNCTION

Press the **FUNCTION** button and the display will return to the calibration menu.

You can exit the calibration menu by pressing the **ON/METER** button or use the **FUNCTION** button to calibrate the next probe.

3. Errors in Dissolved Oxygen Calibration

If a "u" is displayed then the sonde and logger have not been connected long enough and must be left until this letter disappears.

Two situations will cause an "*" to be displayed to the left of the measured value on the display. One is that a calibration has not been performed since first powering up the instrument. In this case, the default calibration constants stored in the loggers memory are being used to ensure that a probe will give on-scale readings. These may be highly inaccurate, particularly when a probe can have a wide sensitivity range, but an on-scale reading is necessary to determine when a stable reading has been obtained.

Another situation that could cause an "*" to be seen on the display is that during subsequent use of the logger and sonde, readings go off scale using current calibration constants. The logger will again use the default constants to provide an onscale reading. This could be caused by a probes output deteriorating over time.

If a "*" is seen on the display it means that the readings cannot be trusted, but have been conditioned by the logger to allow a stable reading to be displayed. Return the logger to a qualified technician for refurbishment.

CHAPTER 5

pH CALIBRATION

CONTENTS

SECTION

1 WHEN TO CALIBRATE THE pH PROBE

2 pH PROBE PREPARATION

3 CALIBRATION WITH AUTOMATIC pH BUFFER SELECTION

4 ERRORS IN pH CALIBRATION

CHAPTER 5

pH CALIBRATION

1. When to calibrate the pH probe

Clean the probe daily after use, particularly if used in samples that are, highly basic or acidic or contain oils or anything else that can coat the probe. The pH probe **MUST** be calibrated at least once every two weeks.

The pH probe must be calibrated using a buffer solution with a known value and the probe must be properly prepared before calibration and use. The following text describes the procedure for calibrating the pH probe. It also includes information about the proper use of buffer solutions and troubleshooting information for problems encountered during pH measurement.

1.2 Three point calibration

To fully calibrate the pH probe, three buffer solutions are required. A three point calibration should be used. Three point calibration will give more accurate results over the full range of the probe. The three recommended buffer solutions with pH values of 4, 7 and 10 will be required.

2. pH Probe Preparation

This following procedure must be done for each calibration point. Be sure not to mix the different buffer solutions, dilute them or allow them to become contaminated. To reduce the introduction of errors in the calibration procedure it is recommended that the person calibrating the probe uses colour coded buffer solutions, ie

Red = pH4
Yellow = pH7
Blue = pH10

Remove the probe guard and rinse the probes in clean or de-ionised water if available. Shake off any excess water and then rinse the probes in a buffer sample (called the wash solution) of the pH buffer solution to be used for calibration. For example, if calibrating to pH4, use a buffer wash solution with a pH of 4. Shake off the excess liquid and blot gently dry before placing the probes into the pH buffer solution to be used for calibration.

3. Calibration with Automatic pH Buffer Selection

When the above requirements have been met switch on the logger and select the Secondary Mode of operation. Using the **FUNCTIONS GROUP** button to select **CALIBRATION.** Use the function button to select pH Calibration, use the **SELECT** button to move the cursor under 7 and press the **SET/CONFIRM** button to confirm we are calibrating the probe in a pH7 buffer solution. The display will show for example:

pH CAL 17.2C
7.04 7.17

Where: 7.04 is the temperature compensated calibration point
9.17 is the current value
17.2 is the current temperature

Following the stated health and safety procedures soak the pH probe in the pH7 wash solution, allow a minute for the probe to respond. Remove the wash solution and shake the sonde to remove any excess , if any solution remains blot the probe gently with a soft tissue. Place the pH probe in the pH7 calibration standard and allow the temperature and the pH probe response to stabilise. Allow three minutes minimum for this to occur, this may take longer as the response of the probe slows with age. Press the **SET/CONFIRM** button when the reading has stabilised and the display will show:

7.04pH cal
Press SELECT

Press the **SELECT** button and the display will show:

pH calibration
SELECT: 7, 4, 10pH

Rinse the sonde in clean water, shake dry and blot gently with a clean tissue.

With the cursor under the 4 press the **SET/CONFIRM** button and the current pH reading will be displayed:

pH CAL 17.2C
3.99 7.23

Rinse the pH probe with the pH4 wash solution, allow the probe to sit in this for a minute. Remove the wash solution and shake the sonde to remove any excess, if any solution still remains blot the probe gently with a soft tissue. Place the pH probe in the pH4 calibration standard. Allow three minutes minimum for the pH probe to stabilise. Press the **SET/CONFIRM** button when the reading has stabilised. The display will show:

3.99pH cal
Press SELECT

Press the **SELECT** button and the display will show:

pH calibration
SELECT: 7, 4, 10pH

Rinse the sonde in clean water, shake dry and blot gently with a clean tissue. With the cursor under the number 10 press the **SET/CONFIRM** button and the current pH reading will be shown. The display will show:

pH CAL 17.2C
10.08 7.23

Rinse the pH probe with the pH10 wash solution, allow the probe to sit in this for a minute. Remove the wash solution and shake the sonde to remove any excess, if any solution still remains blot the probe gently with a soft tissue. Place the pH probe in the pH10 calibration standard. Allow three minutes minimum for the pH probe to stabilise. Press the **SET/CONFIRM** button when the reading has stabilised. The display will show:

pH 3 of 3 cal
SELECT: confirm

Press the **SET/CONFIRM** button. The display will show:

Cal Confirmed
Press FUNCTION

Press the **FUNCTION** button and the display will return to the calibration menu.

You can exit the calibration menu by pressing the **ON/METER** button or press the **FUNCTION** button to calibrate the next probe.

4. Errors in pH Calibration

Two situations will cause an "*" to be displayed to the left of the measured value on the display. One is that a calibration has not been performed since first powering up the instrument. In this case, the default calibration constants stored in the loggers memory are being used to ensure that a probe will give onscale readings. These may be highly inaccurate, particularly when a probe can have a wide sensitivity range, but an onscale reading is necessary to determine when a stable reading has been obtained.

Another situation that could cause an "*" to be seen on the display is that during subsequent use of the logger and sonde, readings go off scale using current calibration constants. The logger will again use the default constants to provide an onscale reading. This could be caused by a probe's output deteriorating over time.

If an "*" is seen on the display, it means that the readings cannot be trusted, but have been conditioned by the logger to allow a stable reading to be displayed. Return the logger to a qualified technician for refurbishment.

4.1 Buffer Tips

The accuracy of a pH measurement is determined by several things. Some of the more important ones are: the accuracy of the buffer solution used in the calibration procedure, the difference between the calibration temperature and the measurement temperature, and the cleanliness of the pH probe. Some things to keep in mind while calibrating and making measurements are:

1. Do not use buffers after the expiration date marked on the bottles.

2. Do not use buffers with visible contamination.

3. Keep the buffer containers closed when not in use to prevent contamination and the absorbtion of CO_2.

4. Do not pour used buffer back into the unused buffer container.

5. Keep the calibration standards in a dark cupboard away from any sources of heat.

4.2 pH measurement problem solving

If problems are encountered when making pH measurements, several sources of trouble should be investigated before considering the instrument to be at fault. This can be a difficult task at times, since several things can be working together to cause the problem. The following lists some of the problems that may be encountered and possible solutions to them. These may be of help in troubleshooting your pH measurement system.

Problem	**Possible reason**
Drift of readings	Temperatures changing
Low slopes	Degraded or incorrect buffer used
No response	The same buffer solutions are labelled as different
Slow unstable readings	Ionic strengths are very low or very high
"Wrong" reading	Buffers of incorrect value are used

If you suspect a buffer solution, probe, or instrument to be at fault, substitution of a known good component for the suspected component can often determine if the assumption is correct, however substitution of probes should be done by a trained technician.

CHAPTER 6

AMMONIUM CALIBRATION

CONTENTS

SECTION

1 WHEN TO CALIBRATE THE AMMONIUM PROBE

2 AMMONIUM PROBE PREPARATION

3 CALIBRATION WITH AMMONIUM CHLORIDE

CHAPTER 6

AMMONIUM CALIBRATION

1. When to Calibrate the Ammonium Probe

If the ammonium probe is being calibrated for the first time or after a system reset it must be calibrated at three separate points. The probe must be calibrated at 1mg/l and 100mg/l at one temperature and then at 1mg/l in a solution that is at least 10 degrees higher or lower than the previous two calibration points. This procedure sets up a temperature compensation table for the probe which is stored in the logger. Once this table has been set up it in the logger it will only need repeating every two months as the probe response changes, subsequent calibrations in this intra-calibration period need only be at the 1mg/l and 100mg/l points at the same temperature.

2. Ammonium Probe Preparation

Remove the sonde guard. Rinse off the probe in clean water and remove any water droplets from it.

3. Calibration with Ammonium Chloride Standard

When the above requirements have been met switch on the logger and select the Secondary Mode of operation. Using the **FUNCTIONS GROUP** button to select **CALIBRATION.** Use the function button to select Ammonium Calibration and the following will be display will show;

NH4$^+$N calibration
SELECT : 01.00-t1

Following the stated health and safety procedures rinse the ammonium probe in the 1mg/l wash solution. Remove the wash solution and shake the sonde to remove any excess remaining on the probe. Use the **SELECT** button to move the cursor under the 1mg/l and press the **SET/CONFIRM** button to confirm we are calibrating the probe in a 1mg/l solution. The display will show:

NH4$^+$N cal 20.7C
0.5mS/cm^c 0.0%

Where:	20.7	=	current temperature
	0.50mS	=	current conductivity
	0.0%	=	current salinity

Place the probe in the 1mg/l calibration standard and stir the probe to dislodge any air bubbles. Press the **SET/CONFIRM** and the display will show:

$NH4^{+}$N cal 20.7C
01.00-t1 18.12^{mg}/l

Allow the probe to stabilise (two to three minutes). Press **SET/CONFIRM** button and the display will show:

$NH4^{+}$N 01.00^{mg}/l-t1
Press SELECT

Rinse the sonde in clean water, shake dry and blot gently with a clean tissue. Press the **SELECT** button.

$NH4^{+}$N calibration
SELECT : 100.0 -t1

Following the stated health and safety procedures rinse the ammonium probe in the 1mg/l wash solution. Remove the wash solution and shake the sonde to remove any excess remaining on the probe. Use the **SELECT** button to move the cursor under the 100mg/l and press the **SET/CONFIRM** button to confirm we are calibrating the probe in a 1mg/l solution. The display will show;

$NH4^{+}$N cal 20.7C
0.004mS/cm^{c} 0.0%

Place the probe in the 100mg/l calibration standard and stir the probe to dislodge any air bubbles. Press the **SET/CONFIRM** and the display will show:

$NH4^{+}$N cal 20.7C
100.0 -t1 118.12^{mg}/l

Allow the probe to stabilise (two to three minutes). Press **SET/CONFIRM** button and the display will show:

$NH4^{+}$N 100.0^{mg}/l - t1
Press SELECT

Press the SELECT button and the following will be displayed:

$NH4^{+}$N calibration
SELECT : 01.00-t2

Note the t2 which denotes that we are calibrating at the second temperature to create the temperature compensation table for the ammonium probe. Following the stated health and safety procedures rinse the ammonium probe in the 1mg/l wash solution which should be at a temperature 10°C higher or lower than the previous calibration points. Allow the probe to sit in this for a few minutes until the temperature stabilises. Remove the wash solution and shake the sonde to remove any excess remaining on the probe. Use the **SELECT** button to move the cursor under the 1mg/l and press the **SET/CONFIRM** button to confirm we are calibrating the probe in a 1mg/l solution. The display will show;

NH4⁺N cal 8.7C
0.004mS/cm^c 0.0%

Place the probe in the 1mg/l calibration standard and stir the probe to dislodge any air bubbles. Press the **SET/CONFIRM** and the display will show:

NH4⁺N cal 8.09C
01.00-t1 4.31mg/l

Allow the probe to stabilise (two to three minutes). Ensure that the temperature does not rise to a point that is within 10°C of the previous two calibration points or the calibration will be automatically aborted by the logger. Press the **SET/CONFIRM** button and the display will show:

NH4⁺N 3 of 4 cal
SELECT : confirm

Press the **CONFIRM** button and the logger will revert to the calibration menu. Rinse the sonde in clean water, shake dry and blot gently with a clean tissue. Press the **SELECT** button.

Note : To do a 2 point calibration precede up to the 1mg/l and 100mg/l calibration at the same temperature after which press the FUNCTION button and the display will show:

NH4⁺N 2 of 4 cal
SELECT : confirm

Press the CONFIRM button and continue as normal.

CHAPTER 7

TURBIDITY CALIBRATION

CONTENTS

SECTION

1 WHEN TO CALIBRATE THE TURBIDITY PROBE

2 TURBIDITY PROBE PREPARATION

3 CALIBRATION WITH FORMAZINE STANDARD

4 ERRORS IN TURBIDITY CALIBRATION

CHAPTER 7

TURBIDITY CALIBRATION

1. When to Calibrate the Turbidity Probe

The turbidity probe when being calibrated for the first time or after a system reset must be calibrated at three points, subsequent calibrations need only be at the 0ntu point unless the probe is suspect of being faulty. The turbidity probe once calibrated will remain constant as long as it is kept clean. The probe must be checked at its 200ntu point and calibrated at 0,200 and its 800ntu points every two weeks.

2. Turbidity Probe Preparation

Remove the sonde guard. Rinse off the probe in clean water and remove any water droplets from it.

3. Calibration with Formazine Standard

When the above requirements have been met switch on the logger and select the Secondary Mode of operation. Using the **FUNCTIONS GROUP** button to select **CALIBRATION.** Use the function button to select Turbidity Calibration the following will be displayed;

Turbidity cal
SELECT : 0, 200, 800

Following the stated health and safety procedures rinse the turbidity probe in the 0ntu wash solution. Remove the wash solution and shake the sonde to remove any excess solution, if any solution remains blot the probe gently with a soft tissue, but do not touch the tip of the probe or the inside of the cone. Use the **SELECT** button to move the cursor under the 0 and press the **SET/CONFIRM** button to confirm we are calibrating the probe in a 0ntu solution. The display will show:

Turbidity CAL
0 2NTU

Where: 0 = calibration point selected
2 = actual reading from the probe

Place the probe in the 0ntu calibration standard to a depth not less than 5cm (ensure both the cone and the tip of the sensor are fully submerged). Stir the probe to dislodge any air bubbles. Press the **SET/CONFIRM** button when the reading has stabilised and the display will show:

0 NTU cal
Press SELECT

Press the **SELECT** button and the display will show:

Turbidity cal
SELECT : 0, 200, 800

Rinse the sonde in clean water, shake dry and blot gently with a clean tissue.

With the cursor under the 200 press the **SET/CONFIRM** button and the current turbidity reading will be displayed:

Turbidity CAL
200 198NTU

Rinse the turbidity probe with the 200ntu wash solution, stir the probe in this for a few seconds. Remove the wash solution and shake the sonde to remove any excess, if any solution still remains the probe gently with a soft tissue. Place the Turbidity probe in the 200ntu calibration standard. Stir the probe to dislodge any air bubbles. Allow a few seconds for the probe to stabilise. Press the **SET/CONFIRM** button when the reading has stabilised. The display will show:

200 NTU cal
Press SELECT

Press the **SELECT** button and the display will show:

Turbidity cal
SELECT : 0, 200, 800

Rinse the turbidity probe with the 800ntu wash solution, stir the probe in this for a few seconds. Remove the wash solution and shake the sonde to remove any excess solution, if any solution still remains wipe the probe gently with a soft tissue. Place the Turbidity probe in the 800ntu calibration standard. Stir the probe to dislodge any air bubbles. Allow a few seconds for the probe to stabilise. Press the **SET/CONFIRM** button when the reading has stabilised. The display will show:

Turbidity CAL
800 805NTU

When the reading has stabilised press the **SET/CONFIRM** button. The display will show:

Turbidity 3 of 3 cal
SELECT: confirm

Press the **SET/CONFIRM** button. The display will show:

Cal Confirmed
Press FUNCTION

Press the **FUNCTION** button and the display will return to the calibration menu.

Rinse the probe in clean water and exit the calibration menu by pressing the **ON/METER** button or press the **FUNCTION** button to calibrate the next probe.

4. <u>Errors in Turbidity Calibration</u>

The turbidity probe operates by shining a light through a sample to the black deflector cone at the tip of the probe. This light is reflected back to a sensor in the probe body. Damage to the deflector cone may affect the operation of the probe and the subsequent readings. Bubbles in the calibration standard or on the cone will affect the reading.

If the readings are significantly off the probe may be damaged

CHAPTER 8

CONDUCTIVITY CHECKS

CONTENTS

SECTION

1. WHEN TO CHECK THE CONDUCTIVITY PROBE
2. CONDUCTIVITY PROBE PREPARATION
3. CHECKING THE CONDUCTIVITY
4. ERRORS IN CONDUCTIVITY MEASUREMENT

CHAPTER 8

CONDUCTIVITY CHECKS

1. When to Check the Conductivity Probe

Although it is not necessary to calibrate the conductivity probe it is important to check the cleanliness and response of the probe, a dirty probe will contaminate the sample being measured. The conductivity probe should be checked on a fortnightly interval, it is important that the probe is stored in clean water.

2. Conductivity Probe Preparation

Rinse the probe in clean water and check that there are no growths covering the electrodes, if necessary take a soft test tube brush and rub the electrodes gently to remove any build up. Rinse the probe in de-ionised water if available and blot dry.

3. Checking the Conductivity

Automatic temperature compensation is applied to the reading from the probe, with the logger this is set to 25°C, the calibration solution used to check the probe should be measured at 25°C. Some laboratories measure at 20°C, when ordering your standard ensure it is referred to 25°C otherwise large errors can be displayed. Prepare the probe in the manner prescribed manner, rinse the probe and blot the probe dry. Immerse the probe in the 500µS conductivity wash solution ensuring that the vent slots at the top of the probe are covered. Remove the probe and blot dry. Immerse the probe in the 500µS calibration solution and switch the logger on. Using the **ON/METER** button scroll through until the logger displays the conductivity. When the conductivity has been checked rinse the probe in clean water.

4 Errors in Conductivity Measurement

Several errors can be introduced into conductivity measurements:

Dirty electrodes

The presence of strong electrical fields

Cross contamination from other solutions

Calibration solutions not referenced to 25°C

CHAPTER 9

TEMPERATURE CHECKS

CONTENTS

SECTION

1. WHEN TO CHECK THE TEMPERATURE PROBE

CHAPTER 9

TEMPERATURE CHECKS

1. When to Check the Temperature Probe

The temperature probe requires little or no maintenance. Its response should be checked every two weeks against a calibrated temperature source that can be traced to a national calibration standard.

CHAPTER 10

DAILY OPERATIONAL PROCEDURES

CONTENTS

SECTION

1 OPERATOR PROCEDURE

2 QUALITY ASSURANCE TECHNICIAN PROCEDURES

CHAPTER 10

DAILY OPERATIONAL PROCEDURES

1. Operator Procedure

Reconnect the logger and sonde

Check the battery voltage

Clear the loggers memory

Check the time and date

Check the calibration of the dissolved oxygen probe on site

Place the sonde in the sample to be measured, whilst the sonde is responding and settling down the site identity can be recalled or entered, after approximately three minutes the logger can be switched on and if the readings are stable they can be recorded using the **RECORD** button. The slowest responding probe will most likely be the pH probe, and this can be used as an indicator as to when to record the readings. The logger will indicate if any of the probes are unstable with the message:

"Channel unstable please wait"

If this message is displayed allow more time for the probes to settle.

If the sample being measured is contaminated the sonde should be rinsed off afterwards with clean water before restoring in its storage pot.

Download the logger.

Disconnect the cable between the logger and the sonde overnight.

Clean the sonde and restore to its storage pot.

2. Quality Assurance Technician Procedures

2.1 Overview

To validate the data being collected by the meters a quality assurance system must be set in place whereby the data is verified or rejected. The technician will check the response of the probes when they are returned for the two weekly calibration. Any probe which fails to respond within the set limits then the data for that period must be rejected or marked to that effect.

The record will include date of calibration, record of the total drift between calibrations, record of daily check where appropriate, evidence that data measured in a period where the drift is exceeded is cancelled.

An example is included on the following page and a template for copying. The template can be photocopied onto the appropriate regional headed notepaper.

2.2 Dissolved Oxygen

The technician will clean the sensor and record the reading before recalibration to identify the total drift over the inter calibration period, the results will be recorded on the QA Checklist.

The sensor must be calibrated at least every two weeks by a technician using water - saturated air to set the meter to 100% using the procedure set down in this document.

Quality Assurance will be to reject all results measured in a period where the drift exceeds 10%, ie the check reading is less than 95% or greater than 105% saturation.

2.3 pH

The technician will clean the sensor and retest with pH7 buffer before recalibration to identify the total drift over the inter-calibration period, the results will be recorded on the QA Checklist.

The sensor must be calibrated at least every two weeks by a technician using three buffer solutions and correcting the nominal buffer pH for temperature.

Quality assurance will be to reject all results outside ±0.3pH units of the correct result (ie the buffer solution value corrected for temperature).

The technician will replace all sensors that do not achieve 95% reading within 3 minutes.

2.4 Ammonium

The technician will clean the sensor and record the 100mg/l reading before recalibration to identify the total drift over the intra-calibration period, the results will be recorded on the QA Checklist.

The sensor must be calibrated at least every two weeks by a technician using 1 and 100mg/l standard solutions.

Quality assurance will be to note all data collected over periods where the drift exceeds 20%, (ie where the 100mg/l standard reading is outside 90 - 110mg/l). The data client will be informed of the exceedence and will choose whether to accept the data. When the Ammonium measurement is improved to statutory/RQA application, any data outside ± 20% will be rejected.

2.5 Turbidity

The technician will clean the sensor and record the 200ntu reading before recalibration to identify the total drift over the intra-calibration period, the results will be recorded on the QA Checklist.

The sensor must be calibrated at least every two weeks by using a technician using 0, 200, 800 formazine standard solutions.

Quality assurance will be to note all data collected over periods where the drift exceeds 30ntu (ie where the 200ntu standard reading is outside 170 -230ntu). The data client will be informed of the exceedence and will choose whether to accept the data.

2.6 Conductivity

The technician will clean the sensor and record the 500µS reading. This will identify the total drift over the intra-calibration period, the results will be recorded on the QA Checklist.

Quality assurance will be to note all data collected over periods where the drift exceeds ±15% (ie where the 500µSstandard reading is outside 425 - 575µS). The data client will be informed of the exceedence and will choose whether to accept the data.

2.7 Temperature

The technician will clean the sensor and record the temperature measured by the logger against a known calibrated source. This will identify the total drift over the intra-calibration period, the results will be recorded on the QA Checklist.

Quality assurance will be to note all data collected over periods where the drift exceeds ±2°C. The data client will be informed of the exceedence and will choose whether to accept the data.

CHAPTER 11

FORMS AND CHECKLISTS

CONTENTS

SECTION

1	QA CHECKLIST FOR THE GRANT YSI 3800 METER	(Example)
2	QA CHECKLIST FOR THE GRANT YSI 3800 METER	(Master)

QA Checklist for the Grant/YSI 3800 Meter

Instrument Identification No ....

Operating Period

Calibration Date ....
Calibration Check Date ....

Technician ____________________ **Operator** ______________________

Instrument Checks

Clean Instrument ......
Clean Sensors ......
Check Batteries ...... Voltage ......
Check Controls ......
Check Memory ......

Calibration Checks

Dissolved Oxygen

Calibrant value ....% sat
Calibration reading ....% sat
Check reading ....% sat
Action taken ....

pH

Calibrant value pH..........
Calibration reading pH..........
Check reading pH..........
Action taken ....

Ammonium

Calibrant value ....mg/l ammoniacal N
Calibration reading ....mg/l ammoniacal N
Check reading ....mg/l ammoniacal N
Action taken ....

Turbidity

Calibrant value ntu..........
Calibration reading ntu..........
Check reading ntu..........
Action taken ....

Conductivity

Calibrant value	μS ....
Calibration reading	μS ....
Check reading	μS ....
Action taken	....

Temperature

Calibrant value	°C..........
Calibration reading	°C..........
Check reading	°C..........
Action taken	....

Comments ....
....
....
......

QA Checklist for the Grant/YSI 3800 Meter

Instrument Identification No ....

Operating Period

Calibration Date ....
Calibration Check Date ....

Technician ________________ **Operator** ________________

Instrument Checks

Clean Instrument ......
Clean Sensors ......
Check Batteries ...... Voltage ......
Check Controls ......
Check Memory ......

Calibration Checks

Dissolved Oxygen

Calibrant value ....% sat
Calibration reading ....% sat
Check reading ....% sat
Action taken ....

pH

Calibrant value pH..........
Calibration reading pH..........
Check reading pH..........
Action taken ....

Ammonium

Calibrant value ....mg/l ammoniacal N
Calibration reading ....mg/l ammoniacal N
Check reading ....mg/l ammoniacal N
Action taken ....

Turbidity

Calibrant value ntu..........
Calibration reading ntu..........
Check reading ntu..........
Action taken ....

Conductivity

Calibrant value	μS ....
Calibration reading	μS ....
Check reading	μS ....
Action taken	....

Temperature

Calibrant value	°C..........
Calibration reading	°C..........
Check reading	°C..........
Action taken	....

Comments ....
....
....
......

CHAPTER 12

HEALTH AND SAFETY

CONTENTS

SECTION

1 HEALTH AND SAFETY INFORMATION FOR CALIBRATION SOLUTIONS

CHAPTER 12

HEALTH AND SAFETY

1. Health and Safety Information for Calibration Solutions

1.1 Ammonium Calibration Solutions

Contents: Ammonium Chloride, Lithium Acetate Dihydrate, Lithium Chloride, Silver Nitrate, Sodium Azide, (some solutions), water.

Ammonium Chloride

CAUTION:AVOID INHALATION, SKIN CONTACT, EYE CONTACT, OR INGESTION

MAY EMIT TOXIC FUMES IN FIRE

May be harmful if inhaled or absorbed through skin. Causes severe eye, skin mucous membrane, and upper respiratory tract irritation.

FIRST AID:

INHALATION:	Remove from exposure area. If breathing becomes difficult, give oxygen. If not breathing, give artificial respiration.
SKIN CONTACT:	Remove contaminated clothing immediately. Wash affected areas immediately with large amounts of soap and water.
EYE CONTACT:	Wash eyes immediately with large amounts of water for at least 15 minutes.
INGESTION:	Wash out mouth thoroughly with large amounts of water if person is conscious. Call a physician.

1.2 pH Buffer Solutions

CAUTION: Avoid inhalation, skin contact, eye contact or ingestion. N.B may affect mucous membranes.

Inhalation may cause sever irritation and be harmful. Skin contact may cause irritation; prolonged or repeated exposure may cause dermatitis. Eye contact may cause irritation or conjunctivitis. Ingestion may cause nausea, vomiting and diarrhoea. Large doses may cause rigidity, convulsions and prostration.

FIRST AID

INHALATION: Remove from exposure area to fresh air immediately. If breathing has stopped, give artificial respiration. Keep warm and at rest. **Seek medical attention immediately.**

SKIN CONTACT: Remove contaminated clothing immediately. Wash affected area with soap or mild detergent and large amounts of water (approx 15-20 minutes). **Seek medical attention immediately.**

EYE CONTACT: Wash eyes immediately with large amounts of water (approx 15-20 minutes), occasionally lifting upper and lower lids. **Seek medical attention immediately.**

INGESTION: If victim is conscious give large quantities of water to dilute the alkali. Do NOT induce vomiting. **Seek medical attention immediately.**

1.3 Formazine Calibrator Solutions

Contents: Hexamethylenetetramine, Hydrazine Sulphate.

Hydrazine Sulphate

CAUTION: AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION.

Harmful by ingestion causing severe irritation and damage. Causes severe irritation to skin, eyes and respiratory system.

Suspected Carcinogen.

Wear suitable protective clothing, gloves, eye/face protection

Hexamethylenetetramine

CAUTION: AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR DIGESTION.

FLAMMABLE

Harmful by ingestion. Irritating to eyes and respiratory system. May irritate skin. If ingested in large quantities can cause gastro-intestinal upsets, cystitis, haematuria and renal lesions due to evolution of formaldehyde.

Keep away from sources of ignition, do not breathe dust, wear suitable gloves and eye/face protection.

REVIEW OF WATER QUALITY
INSTRUMENTATION APRIL 1995

Appendix J - Sherlock Water Quality Monitor
Quality Assurance

J/1

MERLIN & SHERLOCK QUALITY ASSURANCE MANUAL

NATIONAL CENTRE FOR INSTRUMENTATION
&
MARINE SURVEILLANCE

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CHAPTER

CHAPTER 1 INTRODUCTION

CHAPTER 2 CALIBRATION

CHAPTER 3 CALIBRATION STANDARDS

CHAPTER 4 QUALITY ASSURANCE TECHNICIAN PROCEDURES

CHAPTER 5 OPERATIONAL PROCEDURES

CHAPTER 6 FORMS AND CHECKLISTS

CHAPTER 7 HEALTH & SAFETY

CHAPTER 1

INTRODUCTION

CONTENTS

<u>SECTION</u>

1 PURPOSE

2 OPERATIONAL DEPLOYMENT OF SHERLOCK

3 GLOSSARY

CHAPTER 1
INTRODUCTION

1. Purpose

The purpose of this document is to supplement the Merlin and Sherlock Operation & Maintenance Manual. This document is set out to provide users of the Merlin & Sherlock systems the approved NRA procedures for calibrating and operating the instruments to give assured quality data. This document will refer to the manufacturers manual for the operation instructions of the systems such as calibraion. Thsi document assumes that the reader has undergone the necessary training in the use of Merlins and Shelrocks, thsi training can be supplied by the National Centre for Instruemntation upon request.

2. Operational Deployment of Sherlock

Instrumentation Strategy Document (Oct 1994) which has been signed by all 8 regions of the National Rivers Authority recommends the replacement of laboratory analysis of some water quality determinands with data captured electronically at the point of measurement where it can be assured that the quality of the data can:

Meet the NRA Laboratory performance specification

Provide cost benefits

With the advances in instrument technology over recent years the use of water quality instrumentation has become more reliable. A multi-parameter sonde provides a simple, rapid and in some instances more accurate means of measuring and storing water quality data. The NRA has developed a number of water quality instruments, ie Merlin, Sherlock and Cyclops which have been introduced within the 8 regions of the NRA. These systems are capable of measuring the following parameters:

Dissolved Oxygen
pH
Ammonium/Ammonia
Conductivity / Salinity
Turbidity
Conductivity
Temperature

Merlin and Sherlock operate in identical ways but are packaged differently to allow for different applicaitons. Merlin and Sherlock have been designed for two distinct roles, routine monitoring and investigative work for the detection of water quality failures. Both systems have the ability to take samples upon the breach of a pre-set alarm conditions or on a time interval basis. These samples however do not constitute a formal sample and the formal procedure would be have to be undertaken when the authorised officer arrives on site.

It is essential that these procedures are well established before the national introduction of the Water Archive Management System (WAMS). These systems will interface directly with WAMS and download its data directly onto the archive, this will allow data to be available far more rapidly than current procedures allows. The data will be accessible to a far wider range of users than has been possible historically. For the users to have confidence in the data produced it is necessary that the data has been audited by an approved quality assurance system.

For these water quality instruments to provide assured quality data as a replacement to laboratory analysis it is essential that these instruments be calibrated accurately on a regular basis and supported by a suitable maintenance and calibration protocol.

[WE NEED MORE ABOUT WAMS HERE]

3. Glossary

Download		Transfer of data usually from a monitoring device to a computer, via local or remote communications
PC		Personal Computer
NTU		Formazin Turbidity Units
mg/l		Milligramme per litre
ml		MilliLitre
Sonde		A suite of sensor probes
NH_4^+	-	Ammonium ion
NH_3	-	Ammonia
pH	-	Indicator unit of acidity/alkalinity
V	-	Volts

CHAPTER 2

CALIBRATION

SECTION

1 OVERVIEW

CHAPTER 2

CALIBRATION

1. Overview

When the individual probes sense the presence of the specific parameter they respond to they react by producing a change in electrical output. This electrical output of the individual probes can then be logged by electronic methods. Probes measuring the same sample will produce a different value of electrical output to the concentration being measured. Therefore instruments must have some means of translating the electrical signals they produce into known specified units, this procedure is called CALIBRATION.

As the individual probes age and are exposed to contaminants their response will change, this change (or drift as it is known) will vary from probe to probe, therefore it is essential that the response of the probes is checked on a regular basis, we can achieve this by checking the response of the probe when immersed in solutions of known concentrations. The important role of these water quality monitoring instruments in environmental monitoring means that standardised and reliable calibration procedures is essential.

Before proceeding with the calibration of the Sherlock read the health and safety precautions necessary when dealing with chemicals. This topic is covered in the Health and Safety Section of this document. NRA Health and Safety procedures insist that users of dangerous/toxic substances must take the necessary precautions when dealing with such substances, in this instance gloves and protective eye gear MUST be used.

CHAPTER 3

CALIBRATION STANDARDS

SECTION

1 OVERVIEW

2 WASH SOLUTION

3 CALIBRATION STANDARD

4 CHECK STANDARD

CHAPTER 3

CALIBRATION STANDARDS

1. Overview

The accuracy of the calibration solutions is crucial to producing quality data and care must be taken throughout to reduce the introduction of errors into the calibration procedure, ie

- contamination of standards
- cross contamination of standards
- accuracy of standards
- non standardised procedures

The laboratory equipment must be of high quality and care must be taken to ensure cleanliness at all times. The calibration solutions must be of an assured quality (ie NAMAS, BS5750), this can be achieved by using a supplier who adheres to these systems such as the NRA Laboratory Service or Merck/BDH.

2. Wash Solution

To minimise crossover and dilution of calibration standards a wash solution must be used to clean the probes before an exact calibration is carried out. Ensure that the sonde is clean by rinsing the sonde in de-ionised water if it is available. If, for example a pH probe is being calibrated to pH4, the probe would first be immersed in a wash solution of pH4 and then calibrated in the pH4 calibration standard. The wash solution will clean the probe and reduce crossover contamination.

3. Calibration Standard

The calibration standard is a known solution whose value can be guaranteed and should be free of contamination and within its current time and date stamp. Providing the standard does not become contaminated it is recommended that the standard be used a maximum of ten times before it is replaced. The used calibration standard can then be reused as the wash solution for the next series of calibrations.

4. Check Standard

The check standard is a solution with a known specific value which can be used to check the performance of individual probes between calibrations.

The wash, calibration and check solutions should be changed regularly, the current calibration standard can become the wash solution for the next run of calibrations with a fresh supply of standard being used for calibration purposes.

CHAPTER 4

QUALITY ASSURANCE TECHNICIAN PROCEDURES

SECTION

1 QUALITY ASSURANCE TECHNICIAN PROCEDURES

2 DISSOLVED OXYGEN

3 pH

4 AMMONIUM

5 TURBIDITY

6 CONDUCTIVITY

7 TEMPERATURE

8 QA CHECKLIST FOR SHERLOCK

CHAPTER 4

QUALITY ASSURANCE TECHNICIAN PROCEDURES

1. Quality Assurance Technician Procedures

To validate the data being collected by Sherlock units a quality assurance system must be set in place whereby the data is verified or rejected. The technician will check the response of the probes when they are returned for the two weekly calibration. Any probe which fails to respond within the quality assurance limits then the data for that period must be rejected or marked to that effect.

The record will include date of calibration, record of total drift between calibrations and evidence that data measured in a period where the drift is exceeded is cancelled.

An example is included on the following page and a template for copying is included on the following page. The template can be photocopied onto the appropriate regional headed notepaper.

2. Dissolved Oxygen

The technician will rinse the sensor in clean water and record the reading before recalibration to identify the total drift over the inter calibration period, the results will be recorded on the QA Checklist.

The sensor must be calibrated at least every two weeks by a technician using water - saturated air to set the meter to 100% using the procedure set down in this document.

Quality Assurance will be to reject all results measured in a period where the drift exceeds 10%, ie the check reading is less than 95% or greater than 105% saturation.*

3. pH

The technician will rinse the sensor and retest with pH7 buffer before recalibration to identify the total drift over the inter-calibration period, the results will be recorded on the QA Checklist.

The sensor must be calibrated at least every two weeks by a technician using three buffer solutions and correcting the nominal buffer pH for temperature.

Quality assurance will be to reject all results outside ± 0.3pH units of the correct result (ie the buffer solution value corrected for temperature.*

The technician will replace all sensors that do not achieve 95% reading within 3 minutes.*

4. **Ammonium**

The technician will clean the sensor and record the 40mg/l reading before recalibration to identify the total drift over the intra-calibration period, the results will be recorded on the QA Checklist

The sensor must be calibrated at least every two weeks by a technician using 5mg/l and 40mg/l standard solutions

Quality assurance will be to note all data collected over periods where the drift exceeds 20%, (ie where the 40mg/l standard reading is outside 38 - 42mg/l)*. The data client will be informed of the exceedence and will choose whether to accept the data. When the Ammonium measurement is improved to statutory/RQA application, any data outside ± 20% will be rejected.

5. **Turbidity**

The technician will clean the sensor and record the 500*ntu reading before recalibration to identify the total drift over the intra-calibration period, the results will be recorded on the QA Checklist

The sensor must be calibrated at least every two weeks by a technician using 0ntu and 500ntu solutions.

Quality assurance will be to reject all results outside ±(*)ntu units of the correct result (ie the 500 ntu solution).

6. **Conductivity**

The technician will clean the sensor and record the 500µS reading. This will identify the total drift over the intra-calibration period, the results will be recorded on the QA Checklist.

Quality assurance will be to note all data collected over periods where the drift exceeds +/-15% (ie where the 500µS standard reading is outside 425 - 575µS). The data client will be informed of the exceedence and will choose whether to accept the data.

7. **Temperature**

The technician will clean the sensor and record the temperature measured by the logger against a known calibrated source. This will identify the total drift over the intra-calibration period, the results will be recorded on the QA Checklist.

Quality assurance will be to note all data collected over periods where the drift exceeds +/-2°C. The data client will be informed of the exceedence and will choose whether to accept the data.

QA Checklist for the Sherlock

Instrument Identification No ....

Operating Period

Calibration Date ....
Calibration Check Date ....

Technician **Operator** ____________________

Instrument Checks

Clean Instrument
Clean Sensors ......
Check Batteries ...... Voltage...........
Check Controls ......
Check Memory ......

Calibration Checks

Dissolved Oxygen

Calibrant value ....% sat
Calibration reading ....% sat
Check reading ....% sat
Action taken ....

pH

Calibrant value pH..........
Calibration reading pH..........
Check reading pH..........
Action taken ....

Ammonium

Calibrant value ....mg/l ammoniacal N
Calibration reading ....mg/l ammoniacal N
Check reading ....mg/l ammoniacal N
Action taken ....

Turbidity

Calibrant value ....NTU
Calibration reading ....NTU
Check reading ....NTU
Action taken ....

Conductivity

Calibrant value	µS ....
Calibration reading	µS ....
Check reading	µS ....
Action taken	....

Temperature

Calibrant value	°C..........
Calibration reading	°C..........
Check reading	°C..........
Action taken	....

Comments ....
....
....

CHAPTER 5

OPERATIONAL PROCEDURES

SECTION

1 OVERVIEW

2 OPERATIONAL DEPLOYMENT OF MERLIN AND SHERLOCK WATER QUALITY MONITORS

3 MERLIN AND SHERLOCK WATER QUALITY MONITOR PROCEDURES FOR REGIONAL COMMUNICATIONS CENTRE

4 MERLIN AND SHERLOCK WATER QUALITY MONITOR CHECKLIST FOR REGIONAL COMMUNICATIONS CENTRE

5 MERLIN AND SHERLOCK WATER QUALITY MONITOR PROCEDURES FOR DUTY WATER QUALITY OFFICER

6 OPERATIONAL PROCEDURES MERLIN AND SHERLOCK WATER QUALITY MONITOR CHECKLIST FOR DUTY WATER QUALITY OFFICER

CHAPTER 5

OPERATIONAL PROCEDURES

1. Overview

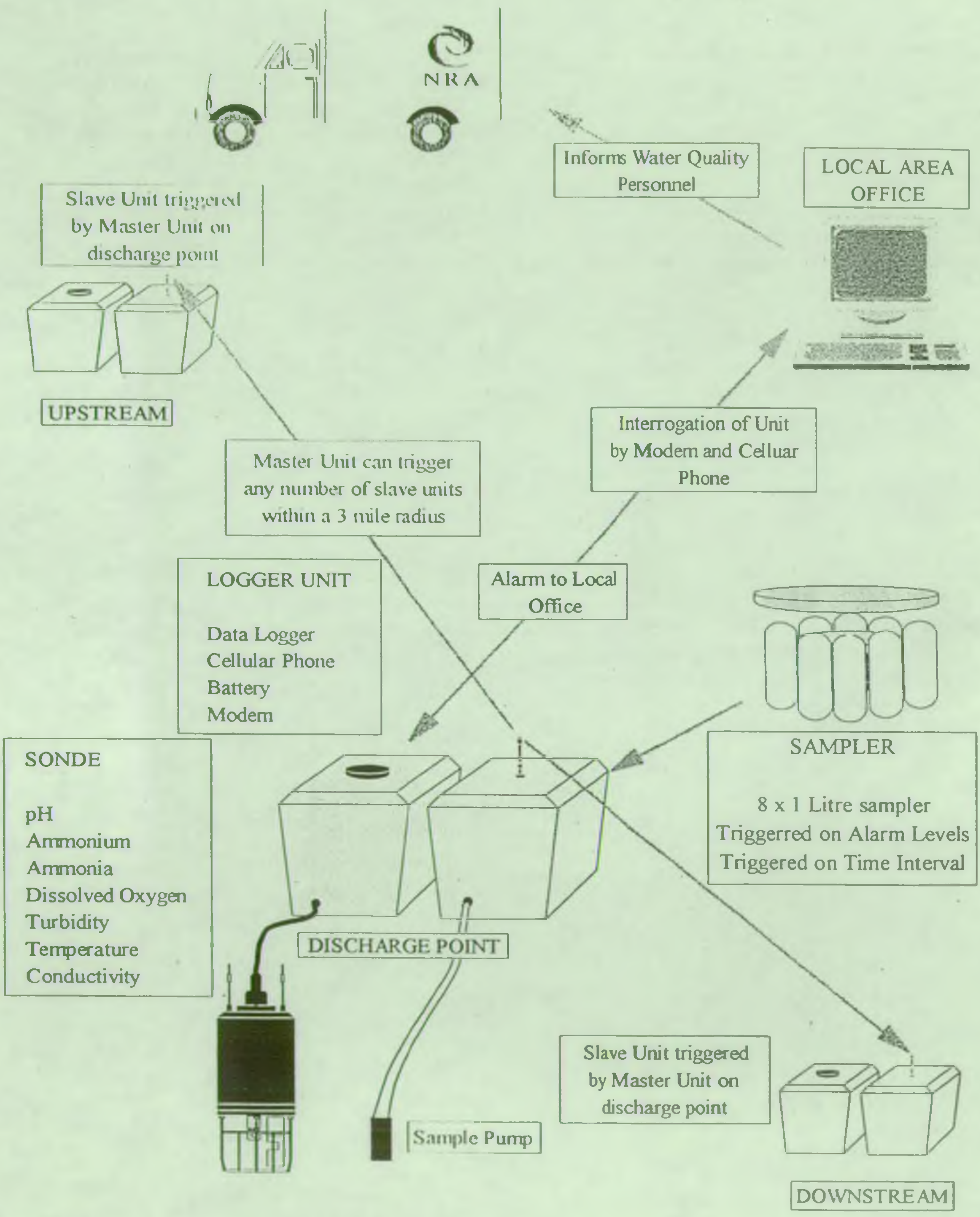
The Merlin and Sherlock systems have a role in both EQS and investigative monitoring, the AQC procedures should be applied to both roles. The operational application will differ slightly as it is unlikely that alarms will be set for EQS monitoring, and not likely to be configured in and upstream, discharge and down stream configuration see fig 2

The decision when and where to deploy the unit is a matter for the area oncerned. When deploying sherlock for EQS monitoring local factors need to be taken into consideration, ie,

- Site security
- Nature of watercourse
- Is the area prone to flooding
- Is the depth of the water enough to cover the sonde
- Mixing zones
- Other outfalls
- Boat traffic (Merlin)
- Signal strength
- Site access and access itme
- Flow speed (Faster flows will require a shorter logging interval)

If either instruemnts are being deployed in an area of consideralbe risk, exra security vdevices can be obtained through the Natrional Centre ofr Instruemntataion. It is also unlikely that any of the PACE considerations will need to be taken into considerations will apply when not doing investigative work, however the guidelines that follow entail good working practices.

SHERLOCK WATER QUALITY MONITORING SYSTEM



2. Operational Deployment of Merlin and Sherlock Water Quality Monitors

Sherlock has been developed to monitor discharges and water courses on a continuous basis for a number of days or weeks. Sherlock will monitor the following parameters, dissolved oxygen, temperature, turbidity, pH and ammonium by the use of five probes. A reading for ammonia is obtained by the internal use of an algorithm. These parameters can be used as triggers to detect a wide range of water quality failures. Once Sherlock detects a breach of a pre-set alarm level it will communicate with a pager in the regional Communications Centre. The duty water quality officer will then be informed.

The use of Sherlock must conform to the Water Resources Act 1991 (WRA) and the Police and Criminal Evidence Act 1984 (PACE). Sherlock is defined as a "computer" under section 69 of PACE; therefore evidence produced by it must be certified as being accurate. Only staff trained in the use of Sherlock are to produce statements relating to the calibration and use of Sherlock.

The decision of where and when to deploy the unit is a matter for the area concerned. The main uses of Sherlock should be to investigate known or suspected pollution from discharge points and general routine monitoring. Factors which should be taken into account will include:

- Failure of routine samples;
- Failure of downstream river samples;
- Biological quality downstream is poor or declining;
- Complaints received of poor water quality by riparian owners;
- Intermittent fish mortalities downstream.

Before the unit is deployed the functioning must be checked thoroughly and the battery fully charged. The unit should be calibrated using standards obtained from NRA accredited laboratories. These standards should be replaced monthly on a contract basis. An accurate thermometer should be used to check the unit's temperature probe. Contemporaneous notes of the calibration process should be kept. The alarm levels should be set as required according to the levels to be monitored and notes made of these settings. The status of the communication system should be checked prior to deployment.

The Sherlock unit should be deployed as soon after calibration as possible. The use of any monitoring device on a site is covered under section 169 WRA, but permission should be sought from the discharger first. If the discharger refuses to allow the unit on site then legal powers of entry will have to be explored. The discharger or their representative should be invited to witness the deployment of the unit. The Sherlock must be secured with a chain and padlock at all sites. At sites which are known to be vulnerable to vandalism extra security measures can be obtained from the National Centre. The Sherlock unit should be activated, the door locked and a note made of the time logging was started.

The location of each Sherlock deployed and its identification number should be given to the regional Communications Centre because this if the first point of call for the machine when it detects a breach of an alarm level. The Communications Centre must be able to relay messages sent by Sherlock to the relevant water quality officer. Similarly the details of each deployment must be given to the water quality officer on standby for the area. It is likely that Sherlock will detect breaches of alarm levels occurring outside of working hours and the standby officer must have the key to the Sherlock to recover any samples. Efforts should be made to obtain contact telephone numbers for the discharger on a 24 hour basis.

When a Sherlock unit detects a breach of alarm level then it will activate the control room pager dedicated to the use of that Sherlock. The Communications Centre will inform the area pollution control office or the duty water quality officer out of hours. To comply with section 209 WRA a person must serve a sample. At this point the discharger must be informed that a sample has been taken and the water quality officer should arrange to meet a representative on site as soon as practicable. If the discharger declines to meet the NRA officer this should be noted as should the times of the call and meeting. It is vital to note the course of events up to the serving of the sample in order to comply with the "soon as reasonably practicable" wording in section 209 WRA.

A unit left in the field should be checked and if necessary re-calibrated on a weekly basis. When a Sherlock unit is retrieved from the field then the sample containers and the hose must be cleaned. If serious contamination (oil, acid, etc) has occurred then these items should be replaced.

The data recorded by Sherlock for each breach of alarm failure should be downloaded onto floppy disc and kept for any possible court action, a copy of this disc should be made and kept in a secure place. Statements of evidence should be produced by the officer(s) setting up the unit, the Communications Centre operator(s) who dealt with the alarm messages and the laboratory analyst. There may be some delay in the process from setting up a unit and a sample being served therefore it is vital that contemporaneous notes are kept of all stages in an approved format.

3. Merlin and Sherlock Water Quality Monitor Procedures for Regional Communication Centre

Sherlock has been developed to monitor discharges and water courses on a continuous basis for a number of days or weeks. Sherlock will monitor dissolved oxygen, temperature, turbidity, pH and ammonium by the use of five probes. A reading for ammonia is obtained by the internal use of an algorithm. These parameters can be used as triggers to detect a wide range of water quality failures. Once Sherlock detects a water quality failure it will communicate with a pager in the Regional Communications Centre. The duty water quality officer will then be informed.

The use of Sherlock must conform to the Water Resources Act 1991 (WRA) and the Police and Criminal Evidence Act 1984 (PACE). The evidence produced by the NRA for any case involving the use of a Sherlock needs to be of a very high standard and consistent throughout the Authority. The NRA officer must be able to prove that the actions taken were carried out "as soon as reasonably practicable" in order to comply with Section 209 of WRA.

Each of the NRA's 8 Regions is equipped with a Sherlock unit which will be deployed at any location within that area. The unit will monitor that discharge/water course on a pre-set logging rate and is programmed with alarm levels to detect any water quality failure. If the unit detects a water quality failure it will activate the unique pager in the Communications Centre which is set up to communicate with that particular Sherlock unit. It is essential that this pager is not used for any other messages and that its number is not divulged to anyone outside the NRA. The Sherlock units will only communicate with the Communications Centre via this route and messages received should be treated as reports of ongoing pollution incidents. The messages received should be noted and retained safely as these will be needed as evidence should any legal action result. This pager should be checked at the start of each Communications Centre operator's shift and any problems communicated to the relevant officer or duty area water quality officer.

Each area office will inform the Communications Centre where it has its Sherlock deployed at any given time and who to contact inside office hours. Outside working hours the Communications Centre should contact the duty water quality officer for that area. When the Sherlock detects a water quality failure it will then send an alarm to the Communications Centre pager, the indication of this should be relayed to the relevant office or standby officer. The unit will continue to monitor the discharge.

4. Sherlock Water Quality Monitor Checklist for Regional Communications Centre

Each NRA Region is issued with a Sherlock monitor which can be deployed at outfalls/water courses. When a unit is deployed the Communications Centre will be informed of the unit's location, identification number and which water quality staff should be contacted.

If a deployed Sherlock unit detects a water quality failure it will activate a dedicated pager in the regional Communications Centre. The following actions should then be taken.

"Alarm" message received from the Sherlock unit which shows a parameter to have exceeded the preset level: Telephone the nominated contact officer if within working hours. Out of office hours telephone the standby officer for the relevant area.

All of the alarms should be noted and retained safely as they may be needed as legal evidence and a statement may be required from the operator(s).

The pager for receiving messages from Sherlock must not be used for any other purpose.

5. Sherlock Water Quality Monitor Procedure for Duty Water Quality Officer

5.1 Introduction

Sherlock has been developed to monitor discharges/water courses on a continuous basis for a number of days or weeks. Sherlock will monitor dissolved oxygen, temperature, turbidity, pH and ammonium by the use of five probes. A reading for ammonia is obtained by the internal use of an algorithm. These parameters can be used as triggers to detect a wide range of water quality failures. Sherlock is used to monitor discharges and water courses and can detect water quality failures. Once Sherlock detects a failure it will communicate with a pager in the regional Communications Centre. The duty water quality officer will then be informed.

5.2 Police and Criminal Evidence (PACE)

The use of Sherlock must conform with the Water Resources Act 1991 (WRA) and the Police and Criminal Evidence Act 1984 (PACE). The evidence produced by the NRA for any case involving the use of a Sherlock needs to be of a very high standard and consistent throughout the authority. The use of contemporaneous notes for recording the actions taken when dealing with a water quality failure detected by Sherlock is vital as there is likely to be a period of time to be accounted for. The NRA officer must be able to prove that the actions taken were carried out "as soon as reasonably practicable" in order to comply with Section 209 of WRA.

5.3 Operational Procedures

If Sherlock units are to be deployed at the discharge point it must be the one defined in the relevant consent. The unit must be secured. If the unit detects a water quality failure by preset alarm levels it will activate a dedicated pager in the Regional Communications Centre. The operator will inform the duty water quality officer if this occurs outside of working hours. The unit will continue to monitor the quality of the discharge unit. It is therefore essential that the duty officer is contactable at all times and has access to a telephone (home or cellular) in order to comply with Section 209 WRA. The duty officer at this point should attempt to contact the discharger or their representative. The location of the Sherlock unit(s) deployed in an area and contact numbers for the discharger should be given to the duty officer by the person deploying the unit. Once contacted the duty officer should meet the discharger or their representative at the site as soon as possible. The reasons for any delay in this meeting should be noted. If the discharger declines to meet the duty officer or refuses access to the site then this should be noted.

On arriving at the discharge point where Sherlock is positioned the duty officer should check the Sherlock unit for signs of damage or interference. The unit should be switched off and any samples in the unit removed. A formal sample should be taken in the approved manner to support the evidence collected by the Sherlock. The tripartite sample should then be served on the discharger in the normal manner, completing the receipt and obtaining the signature of the discharger or their representative. No other alterations to the settings or working of the unit should be made. A statement from the duty officer should be produced together with the relevant paperwork from the tripartite sampling process.

The duty water quality officer should have the following equipment and information when a Sherlock unit has been deployed in their area:

- Pocket notebook to record the times and actions taken;
- Location of the Sherlock and the key to open the unit lid;
- Any other keys (to gates etc) to gain access to the unit;
- Formal sampling equipment and contact telephone numbers for the discharger;
- The normal tripartite sampling equipment and forms.

6. Operational Procedures Sherlock Water Quality Monitor Checklist for Duty Water Quality Officer

Each region of the NRA is equipped with a Sherlock automatic monitor to be deployed at discharges and water courses. These will monitor the quality of the water/effluent on a 24 hour basis and it is likely water quality failures will occur out of hours. Therefore the duty water quality officer must be able to respond and serve a sample on the discharger.

When the Sherlock detects a pollution it will activate a pager in the regional Communications Centre. Out of hours the Communications Centre operator will contact the duty water quality officer who should take the following action:

The duty officer will receive an "alarm message" from Communications Centre. The date, time and content of these messages should be noted when received. On receiving the "alarm message" the duty officer will telephone the discharger.

The Sherlock unit will activate a pager in the Communications Centre which will be relayed to the officer. The duty officer must then contact the discharger as soon as possible, to comply with WRA '91 and inform them that the unit deployed at their outfall has taken a sample which the NRA intend to have analysed.

The duty officer will then arrange to meet the discharger or their representative at the site where to unit is deployed as soon as possible. The times of the above actions should be recorded and the reasons for any delays in the process noted.

On meeting the discharger check the unit for signs of damage or interference. Unlock the lid and switch off the unit. Remove the sample hose and the sonde and then remove any samples from the unit.

A sample can now be served in the presence of the discharger in the normal tripartite fashion. A signed receipt of the dischargers portion needs to be obtained. Of the two portions of the sample retained one will now be sent for analysis and one kept as evidence in the usual manner.

Once the unit has detected a water quality failure it can be retrieved and recalibrated before starting logging again, or left to monitor the event.

CHAPTER 6

FORMS AND CHECKLISTS

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CHAPTER 6

FORMS AND CHECKLISTS

1. Introduction

Because of the potential legal implications of deploying Sherlock at a consented discharge, care must be taken to record all information regarding the process of deploying Sherlock. The following forms have been created to aid the user in deploying Sherlock and maintaining records that may be admissible as evidence.

At the end of this chapter are 'Masters' of the forms which **MUST** be photocopied onto your regional headed note paper. These forms **MUST** be filled in and stored with the appropriate documents pertaining to the particular discharge at which Sherlock is being deployed.

Care must be taken that these forms are filled in clearly and at the correct time of the Sherlock deployment. They must be signed and dated, as they may be used as exhibits.

2. SHERLOCK PRE INSTALLATION CHECKS

Site Name ____________________

Contact Name on Site ____________________

24 hour Telephone Number ____________________

Will effluent channel/watercourse be running continuously ______

Is the sonde cable long enough ______

Cellular telephone signal strength ______

Is the site secure ______

Can Sherlock be padlocked to anything ____________________

Current Discharge Consent Levels (If applicable)

Dissolved Oxygen _____

pH _____

Ammonium _____

Turbidity _____

Temperature _____

Has a full risk assessment of the site been undertaken _____

Signed ______________________________ Date ______________

Title ______________________________

3. SHERLOCK PRE-DEPLOYMENT CHECKLIST

Authorised User	**Date**	________
Reset Logger Memory		_____
Calibration		

Alarms	Low 1	High 1
Dissolved Oxygen	______	______
pH	______	______
Ammonium	______	______
Turbidity	______	______
Temperature	______	______

Alarms Enabled	Low 1	High 1
Dissolved Oxygen	______	______
pH	______	______
Ammonium	______	______
Turbidity	______	______
Temperature	______	______
Sherlock ID	____________________	

Control Room Pager Number	____________________
Logging Rate	______ mins
Start logging time	______
Site Name	_______________
Logging Start Time	______
Switch Off	______
Sample containers clean	______

SHERLOCK PRE-DEPLOYMENT CHECKLIST (pt 2)

Sample containers connectors secure ______

Hoses Clean ______

Pump Working ______

Battery Voltage check ______ volts

Gloves & Plastic bag for Sherlock ______

Set Time/Date ______

4. **SHERLOCK ON SITE DEPLOYMENT CHECKS**

Authorised User **Date** ________

Sherlock pager number ______

Sherlock telephone number ______

Sonde cables connected ______

Check battery voltage ______ volts

Check sonde is submerged in the flow ______

Sonde door locked ______

Switch Sherlock on ______

Sherlock lid locked ______

Padlock Sherlock securely ______

Inform NRA control room Sherlock is active ______

Inform the designated discharge representative ______

Inform designated Water Quality Officer of Sherlock formal sample pager number ______

5. DECOMMISSIONING CHECKLIST

Inform the Regional Control Room that Sherlock is being removed	______
Inform discharger that Sherlock is being removed from site	______
Switch Sherlock Unit off	______
Remove the Sonde from final effluent channel following suggested Health and Safety procedures (place sonde and cables in a plastic bag and seal)	______
Return Sherlock to the Local Office for downloading	______

Signed ______________________ Date ________

Title ______________________

SHERLOCK PRE - INSTALLATION CHECKS

Site Name ____________________

Contact Name on Site ____________________

24 hour Telephone Number ____________________

Effluent channel/watercourse be running continuously ______

Is the sonde cable long enough ______

Cellular telephone signal strength ______

Is the site secure ______

Can Sherlock be padlocked to anything ____________________

Current Discharge Consent Levels (If Applicable)

Dissolved Oxygen ______

pH ______

Ammonium ______

Turbidity ______

Temperature ______

Has a full risk assessment of the site been undertaken ______

Signed ______________________________ Date ______________

Title ______________________________

SHERLOCK PRE-DEPLOYMENT CHECKLIST

Authorised User ______ ___ **Date**

Reset Logger Memory

Calibration

Alarms	Low 1	High 1
Dissolved Oxygen	______	______
pH	______	______
Ammonium	______	______
Turbidity	______	______
Temperature	______	______

Alarms Enabled	Low 1	High 1
Dissolved Oxygen	______	______
pH	______	______
Ammonium	______	______
Turbidity	______	______
Temperature	______	______

Sherlock ID ____________

Control Room Pager Number ____________________

Logging Rate ______ mins

Start Logging Time ______

Site Name ______________

Switch Off ______

Sample containers clean ______

SHERLOCK PRE-DEPLOYMENT CHECKLIST (pt 2)

Sample containers connectors secure ____

Hoses Clean ____

Pump Working ____

Battery Voltage check ____ volts

Gloves & Plastic bag for Sherlock ____

Set Time/Date ____

SHERLOCK ON SITE DEPLOYMENT CHECKS

Authorised User **Date** ________

Sherlock pager number ________________

Sonde cables connected ______

Check battery voltage ______ volts

Check sonde is submerged in the flow ______

Sonde door locked ______

Switch Sherlock on ______

Sherlock lid locked ______

Padlock Sherlock securely ______

Inform NRA control room Sherlock is active ______

Inform the designated discharge representative ______

Inform designated Water Quality Officer of Sherlock alarm pager number ______

Has the Regional Control Room been made aware of the Sherlock alarm procedure ______

DECOMMISSIONING CHECKLIST

Inform the Regional Control Room that Sherlock is being removed	______
Inform discharger that Sherlock is being removed from site	______
Switch Sherlock Unit off	______
Remove the Sonde from effluent/flow following suggested Health and Safety procedures (place sonde and cables in a plastic bag and seal)	______
Return Sherlock to the Local Office for downloading	______

Signed ____________________ Date ________

Title ____________________

QA CHECKLIST FOR SHERLOCK

Instrument Identification No ....

Operating Period

Calibration Date ....
Calibration Check Date ....

Technician **Operator** ____________________

Instrument Checks

Clean Instrument
Clean Sensors
Check Batteries Voltage ....
Check Controls
Check Memory

Calibration Checks

Dissolved Oxygen

Calibrant value	..........% sat
Calibration reading	..........% sat
Check reading	..........% sat
Action taken	....

pH

Calibrant value	pH..........
Calibration reading	pH..........
Check reading	pH..........
Action taken	....

Ammonium

Calibrant value	..........mg/l ammoniacal N
Calibration reading	..........mg/l ammoniacal N
Check reading	..........mg/l ammoniacal N
Action taken	....

Turbidity

Calibrant value	..........NTU
Calibration reading	..........NTU
Check reading	..........NTU
Action taken	....

Comments ....
....
....

CHAPTER 7

HEALTH & SAFETY

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1	SHERLOCK OVERVIEW
2	MANUAL HANDLING OPERATIONS REGULATIONS 1992
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4.2	pH Buffer Solutions
4.3	Formazine Calibrator Solutions

CHAPTER 6

HEALTH AND SAFETY

1. Sherlock Overview

Picture of Sherlock with relevant details of weight goes in here.

Height (excluding aerials)	676 mm
Width	694 mm
Depth	570 mm
Weight(Logger Unit)	48kg
Weight (Sampler Unit)	46Kg
Case Material	Polyurethane Material
Sealed to IP65	

2. Manual Handling Operations Regulations 1992

These regulations and associated approved codes of practice detail the requirements placed upon the Authority to manage manual handling operations in its activities.

Wherever possible hazardous manual handling must be avoided. If this is not possible the operation must be assessed and managed to minimise the risk of injury.

Although the work of the Authority is extremely varied, many activities have similar manual handling characteristics and it has been possible to group them together to produce generic risk assessments

These form the basis of the NRA strategy for compliance. Obviously situations will arise where the generic assessments is insufficient In these cases a supplementary assessment must be completed to identify the additional risks and required precautions.

It is almost impossible to give detailed advice on weights to be safely lifted because of the wide variations in working situations.

The adjacent diagram shows weights and positions that under good conditions should not cause problems to most employees. These are <u>not</u> maximum figures but indicate that weights in excess of these will require an assessment of risk to be undertaken.

THIS INFORMATION IS FOR GUIDANCE ONLY AND MUST NOT BE USED IN ISOLATION TO ASSESS MANUAL HANDLING OPERATIONS.

3. NRA Risk Assessment Record

3.1 Activity

MANUAL HANDLING OF LOADS SCIENTIFIC FIELD/SURVEY WORK

Range of tasks includes:

- Loading/unloading equipment from vehicles and trailers;
- Carrying equipment to river sites;
- Launching/recovering small boats.

3.2 Hazard Identification

Loads are often bulky but generally within known weight ranges with suitable hand grips.

Loads must often be handled on uneven and slippery ground. Works may be undertaken in wet and windy conditions and during both day and night.

3.3 Risk of Injury

Damage to muscles, ligaments and tendons is possible when lifting heavy equipment or manhole covers. Stretching to load/unload vehicles can also cause these injuries.

Hands and feet may possibly become trapped because they are difficult to grasp or because of underfoot conditions. Back injuries are possible from unsatisfactory technique, especially twisting the trunk or stooping.

3.4 Prevention Measures

Staff must be able to recognise hazardous handling activities and apply correct handling techniques.

Footwear must provide secure grip and protective toe caps will be necessary where the task involves a significant risk of toes being crushed.

Appropriate lifting aids will be provided for occasions where manhole inspection covers cannot be lifted by occupiers (keys, levers or patent lifters, dependant on site conditions).

Satisfactory co-ordination will be required in dual or team lifting operations.

Where possible loads of samples etc, should be arranged into manageable packages.

3.5 Validity of Assessment

The existence of any of the following risk factors will require further precautions determined on the basis of an individual risk assessment

- continuous physical effort (ie without frequent short pauses);
- over frequent handling operations (ie over 1 per minute);
- excessive weights or loads handled at arms length,
- large vertical lifting actions (ie greater than floor to waist height);
- the individual ability to perform non routine lifting tasks.

Review of the assessment should be made whenever there is a reason to suppose activities or conditions have changed

4. Health and Safety Information for Calibration Solutions

4.1 Ammonium Calibration Solutions

Contents: Ammonium Chloride, Lithium Acetate Dihydrate, Lithium Chloride, Silver Nitrate, Sodium Azide, (some solutions), water

Ammonium Chloride

CAUTION AVOID INHALATION, SKIN CONTACT, EYE CONTACT, OR INGESTION

MAY EMIT TOXIC FUMES IN FIRE

May be harmful if inhaled or absorbed through skin. Causes severe eye, skin mucous membrane, and upper respiratory tract irritation.

FIRST AID

INHALATION: Remove from exposure area. If breathing becomes difficult, give oxygen. If not breathing, give artificial respiration.

SKIN CONTACT: Remove contaminated clothing immediately. Wash affected areas immediately with large amounts of soap and water.

EYE CONTACT: Wash eyes immediately with large amounts of water for at least 15 minutes.

INGESTION: Wash out mouth thoroughly with large amounts of water if person is conscious. Call a physician.

4.2 pH Buffer Solutions

CAUTION: Avoid inhalation, skin contact, eye contact or ingestion. N.B may affect mucous membranes.

Inhalation may cause sever irritation and be harmful. Skin contact may cause irritation; prolonged or repeated exposure may cause dermatitis. Eye contact may cause irritation or conjunctivitis. Ingestion may cause nausea, vomiting and diarrhoea. Large doses may cause rigidity, convulsions and prostration.

FIRST AID

INHALATION: Remove from exposure area to fresh air immediately. If breathing has stopped, give artificial respiration. Keep warm and at rest. **Seek medical attention immediately.**

SKIN CONTACT: Remove contaminated clothing immediately. Wash affected area with soap or mild detergent and large amounts of water (approx 15-20 minutes). **Seek medical attention immediately.**

EYE CONTACT — Wash eyes immediately with large amounts of water (approx 15-20 minutes), occasionally lifting upper and lower lids. **Seek medical attention immediately.**

INGESTION — If victim is conscious give large quantities of water to dilute the alkali. Do NOT induce vomiting. **Seek medical attention immediately.**

4.3 Formazine Calibrator Solutions

Contents: Hexamethylenetetramine, Hydrazine Sulphate.

Hydrazine Sulphate

CAUTION: AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION.

Harmful by ingestion causing severe irritation and damage. Causes severe irritation to skin, eyes and respiratory system.

Suspected Carcinogen.

Wear suitable protective clothing, gloves, eye/face protection

Hexamethylenetetramine

CAUTION: AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION.

FLAMMABLE

Harmful by ingestion. Irritating to eyes and respiratory system. May irritate skin. If ingested in large quantities can cause gastro-intestinal upsets, cystitis, haematuria and renal lesions due to evolution of formaldehyde.

Keep away from sources of ignition, do not breathe dust, wear suitable gloves and eye/face protection.