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ENVIRONMENT AGENCY

ANGLIAN REGION

REGIONAL GROUNDWATER LEVEL MONITORING REVIEW

PROJECT REF NO 9013118

STRATEGY DOCUMENT



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Executive Summary

The aim of this project is to conduct a strategic review of the Region's groundwater level monitoring network at an estimated cost of £260k over a three year period.

The Region currently operates a groundwater level monitoring network that includes the collection and databasing of groundwater level measurements at over 1400. Each site consists of at least one monitoring borehole or well and in some cases additional piezometers. Each site is visited monthly or three monthly to record groundwater level measurements and in some cases servicing level recorders.

The estimated replacement cost of the current network is £7m with an estimated annual running cost of £257k, including site maintenance and databasing.

The groundwater level network provides important information which enables the Agency to manage the groundwater resources of the Region. Groundwater makes up nearly 50% of the licensed abstraction for the Region. More specifically, results from the groundwater level network are used in water resource planning, determining the overall resource availability, evaluating groundwater licence applications as well as monitoring the effects of existing licensed abstraction on protected rights, particularly rivers and wetlands.

The groundwater level monitoring network has evolved over the past 30 years in a piecemeal fashion. In many cases it is not clear what principles or functional objectives were adopted in the selection of individual boreholes within the network. There has been no regional strategic review that considers the objectives and efficiency of running the current network or as to the optimal network design which should be achieved.

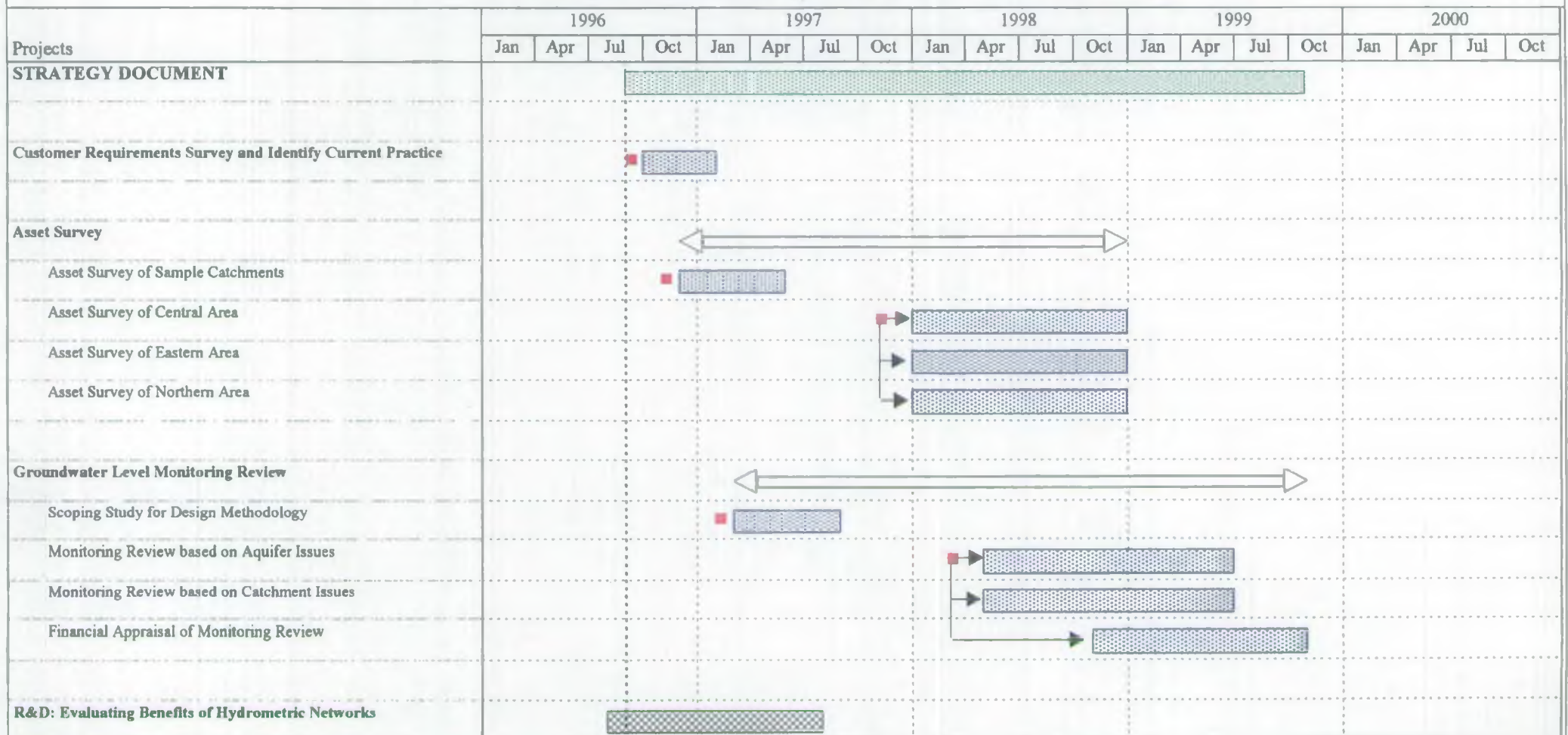
This strategic review would aim to:-

- review the use of groundwater level data, including current and anticipated customer requirements for data;
- undertake a full survey of the condition and ownership of the current borehole and site assets; and,
- undertake a review of the principles on which to design an efficiently run regional groundwater level network so as to review current and match future requirements.

This strategic review will take into account and build in the recommendations within the current R&D project "Evaluating Benefits of Hydrometric Networks". It will also take into account any possible overlaps with the groundwater quality network review as well as complimenting the hydrometric monitoring network review of surface water.

Various options have been identified within this document. The appraisal of these potential options clearly indicate that the strategic review must be completed. The consequences of Do Nothing option will mean that the Region will continue to operate a groundwater level network with a poor understanding of network efficiency and future data requirements. There would be no understanding of the condition of the assets and therefore, no planned programme for replacement. This would lead to a sub-optimal performance in the management of the Region's groundwater resources. At an extreme it may become that the Region will fail to meet its statutory responsibilities for managing and conserving groundwater resources.

Regional Groundwater Level Monitoring Review

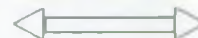


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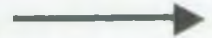
Summary



PAB Approval



Linked Approvals



1 Introduction

The Anglian Region is the driest in Britain. It has the fastest growing population and the fastest rising water demands, particularly for public supply and irrigation. Its water environment, though far from natural, is a finite resource which needs proper management and long term planning.

The hydrometric network, which records quality and quantity measurements for both surface water and groundwater, underpins resource management and long term sustainable development. An efficient and effective network is required for the Agency to meet its statutory duties and responsibilities. The surface water hydrometric network has been reviewed while the groundwater, on a regional basis, has not been reviewed. The measurements of groundwater levels are needed for the following purposes:-

- Monitoring the availability of groundwater resources
 - Long-term trends, due mainly to abstraction patterns;
 - Seasonal fluctuations, due mainly to meteorological variations;
 - Effects of regional groundwater development schemes;
 - Determine yield from test pumping
- Determining patterns of groundwater flow
 - Definition of groundwater resource budgeting units;
 - Movement of pollutants and definition of protection zones;
 - Disturbance to groundwater drainage;
 - Enables understanding of stream/aquifer interaction.
- Abstraction licence determination and control
 - Baseline studies for impact assessment;
 - Regional and local effects of pumping;
 - Cessation levels and salinity control.
- Advising on engineering aspects of groundwater abstraction
 - Effect on borehole yield of variations in water levels - and vice-versa;
 - Design of boreholes (depth, casing, positioning of pump).
- Flow modelling

Reliable and spatially distributed groundwater level data are essential for the development of flow models, especially those which provide an assessment of water resources together with strategic allocation and management. Although the data requirement is generally needed for operational uses, the use of the data for modelling is of great importance. As water resources become more intensively utilised and people become more aware of the impacts of abstraction, models are becoming increasingly important as aquifer management tools, and as such good data is needed to underpin them.

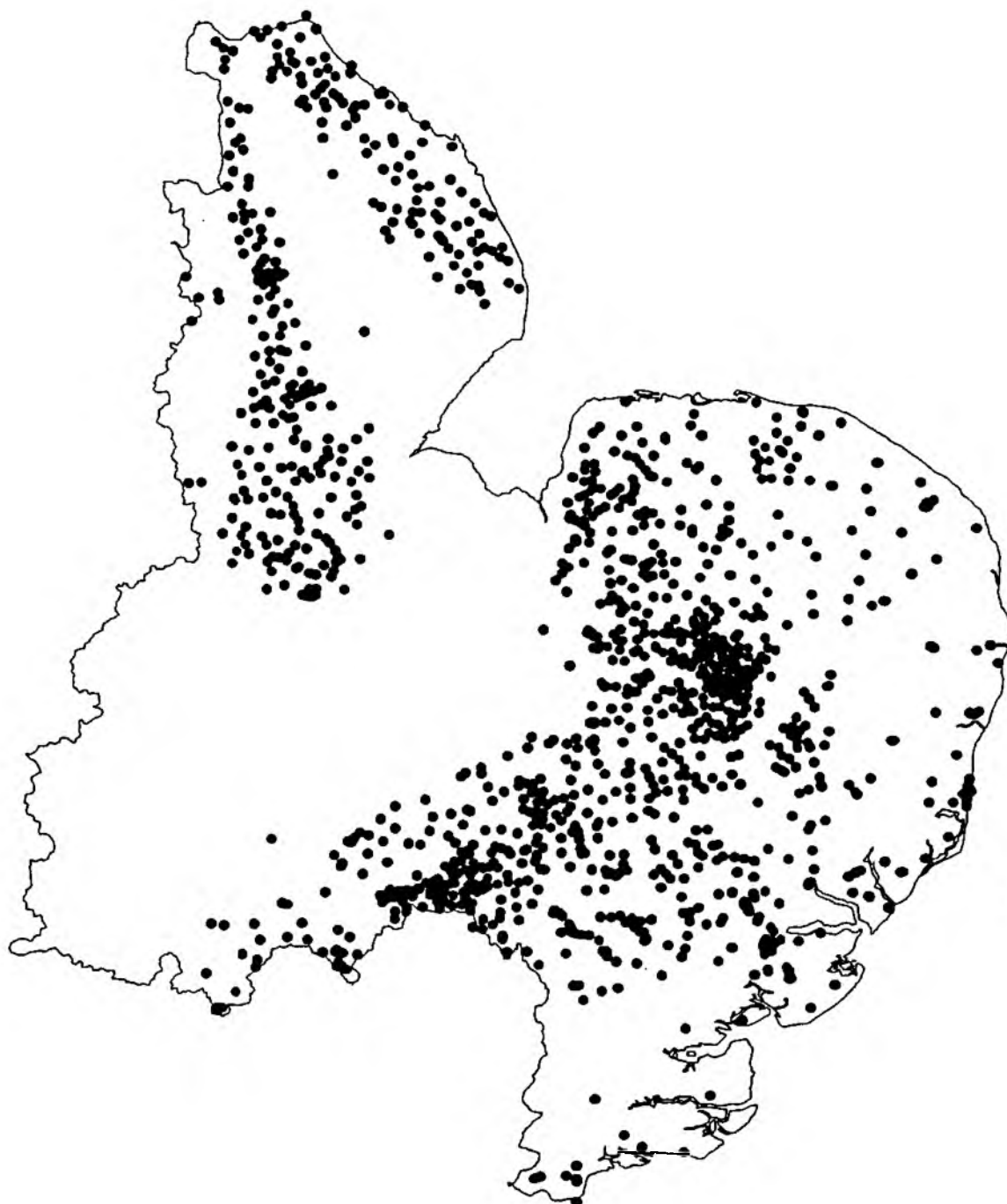
The use of groundwater level data also provides an understanding of the uncertainties in modelling. Analysis of the groundwater levels can produce error bars which can subsequently be carried through the modelling process to identify the uncertainty in prediction from the error in heads. In addition, groundwater levels are of paramount consideration to model calibration.

The Anglian Region has nearly 1400 observation boreholes monitoring water levels (primarily) and water quality (to a lesser extent). All the major aquifers, and some of the more important minor aquifers are covered by networks of varying density - see Figure 1. However, Figure 1 does not show whether the inferred coverage is adequate for regional, aquifer or catchment monitoring.

To date the development of a groundwater level monitoring network has been piecemeal with some catchment networks initiated through project based studies and investigations. There have been a limited number of previous reviews of the monitoring network but these have primarily been on a per catchment basis. Other studies have concentrated on a broad density relationship to geology unit and have taken no real consideration of use, type of use and other specific conditions or issues.

It is now necessary to review the networks in relation to business efficiency and the needs for data, bearing in mind the increase in the demand for groundwater, the high profile of water resources issues, and in light of both recent and current droughts.

Figure 1 - Groundwater Level Monitoring Network



2 Project Brief

2.1 Scope

The Agency needs to achieve and maintain an efficient and effective groundwater level monitoring network in order to support its core statutory duties and responsibilities on a local or regional basis. Currently, the groundwater level monitoring network has no formalised strategy for development, maintenance or decommissioning. It is the intention of this review to detail which monitoring boreholes are currently active, review the standard of record, determine the functional need, and then propose an optimum network which will address the needs of long term and short term monitoring in conjunction with efficiencies in the hydrometric network.

2.2 Description of the Problem

An NRA Internal Audit of Hydrometry (January 1994) reported:-

NRA hydrometric networks are largely inherited from water authorities; few stations have been built since the NRA was formed. Capital expenditure has mainly been directed at improving instrumentation and structures at existing sites.

Additionally, operational and other uses of hydrometric data change over time, as uses of the water environment change. It is not possible to predict the future uses of hydrometric data over its period of use; data collected thirty years ago is regularly used today

Hydrometric records are of more value as the length of the period over which data is collected increase. Stations which can provide forty years data are more valuable than those which have only been operating for five years. This is because a longer period of operation is more likely to encompass extreme hydrological events, such a one in twenty year flood. This makes long term average figures more accurate.

The Anglian Region's groundwater level monitoring network is typical of the above statement. The Anglian Region has a complex network of boreholes of different origins, designs and constructions. There is uncertainty if adequate detail is known of the boreholes or even which aquifer some boreholes are monitoring.

A recent report by BGS for the NRA - National Groundwater levels Monitoring Network Review (September 1994) - recommended a classification scheme be developed which will allow an accurate assessment of the relative effectiveness, in both scientific and financial terms, of regional monitoring programmes. The report recommended a three tier classification scheme to cover national monitoring sites, local monitoring sites as well as reference monitoring sites. The categories are as

follows:-

National monitoring sites. This network provides the groundwater level data needed to monitor resource variations and to effectively manage the groundwater resources. It has to be able to provide data to meet users' demands.

Reference monitoring sites. These sites are a subset of the national network and are used to provide the detailed, long-term perspective that is vital for resource management. The sites are located, as far as possible, in areas not subject to short-term fluctuations caused by abstractions. They will form the basis for the routine monitoring of natural groundwater level fluctuations.

Local monitoring sites. These sites will form an important part of any network as local projects will be wide ranging in scale and duration.

It is considered that the name "national" monitoring sites would be less ambiguous if it were replaced by the name "regional" monitoring sites as this better reflects the nature of this level of network - covering both aquifer and catchment. As such this project shall refer to the latter name.

The BGS report also recommends that the Agency should develop criteria for classification of existing boreholes and that this should be implemented using pilot Regions to test the protocol. However, as highlighted within the BGS report, there is no established criteria for network density as well as no protocol for the use of such methodology for apportioning boreholes to various levels of network design.

It is considered that an area density methodology is inadequate at meeting the objectives of a monitoring network. Such an approach does not consider such issues as whether the aquifer is concealed/outcrop, confined/unconfined, fluvial/interfluvial, or whether the site is required for specific purposes. A formal review must have a framework and methodology from which to work; and at present there are no such mechanisms regionally employed within the Agency.

The Implementation of the Hydrometric Efficiency Review PID recommended that each Region must improve its customer focus and to provide a mechanism to agree the amount of hydrometric data required, the standards required for such data, and the resultant cost of a defined service. This underpins Service Level Agreements between data providers and data users. With the current network, or even a network based on area density, it may be difficult to determine the impact on service delivery of a reduction in revenue expenditure for comparisons of performance measures.

The NRA Internal Audit of Hydrometry also noted that the effect of *cuts are difficult to determine because the benefit of hydrometric data have not been quantified. As a result, users have had little chance to influence the location of sites. We [auditors] also gained the impression that users accept the data from the existing sites rather than question whether the site which provided it is in the right location. This is turn may be the result of a lack of defined requirements of data.*

The recommendations of the Hydrometric Efficiency review and the findings of the NRA Internal Audit of Hydrometry are relevant to the Anglian Region. For the Anglian Region to address such questions raised a full review of groundwater level monitoring network and an established rigorous methodology will be required.

2.3 Objectives

The objective of this review are:-

- Review customer requirements so as to strategically focus the monitoring network and to establish the current and future uses of groundwater level data;
- To establish and describe the value of data collected from the groundwater network to its customers;
- Initiate an asset survey of boreholes within the current network so as to cross-check the quality of data within the asset register as well as having a robust database for the monitoring network review;
- To prepare estimates of the replacement value and running costs of the current groundwater level network;
- Determine the most appropriate methods for reviewing the network;
- Review the adequacy of the network;
- Determine the most appropriate monitoring frequency for each aquifer and catchment;
- Consider options for groundwater level monitoring networks of varying extent, including options as to where further development or decommissioning could be targeted;
- Identify the running costs and maintenance programme associated with these options;

- Determine the costs of drilling new boreholes and/or decommissioning associated with these options;
- Present the costs and benefits of various options to end users of hydrometric data. This review should make recommendations as to the list of groundwater level sites from which data will be collected and processed to agreed standards as part of Service Level Agreements.

By undertaking a full review of the groundwater level monitoring network the Agency will have a comprehensive asset register, a detailed programme for borehole drilling and decommissioning, as well as an effective and efficient network which will target both current and future needs.

2.4 Project Organisation and Responsibilities

The project Organisation will be as follows:-

Project Board

David Burgess, Groundwater Manager - **Project Executive**
 Glenn Watts, Hydrological Services Manager
 Cameron Thomas, Water Resources Planning Manager
 Andy Baxendale, Area Flood Defence Manager

Project Team

David Seccombe, Hydrogeologist - **Project Manager**
 Angela Wallis, Hydrologist
 Paul Hart, Regional Groundwater Protection Officer
 Chris Taylor, Senior Hydrogeologist - Central
 Giles Bryan, Hydrogeologist - Eastern
 Peter McConvey, Hydrogeologist - Northern

Quality Review Panel

David Burgess, Groundwater Manager
 Pat Sones, Area Water Resources Manager - Central
 Barrie Harbott, Regional Quality Planner
 Sarah Evers, EA Groundwater & Contaminated Land Centre

As detailed, this document is intended to show the scope and direction of a formal review of the groundwater level monitoring network. It will be the remit of the Project Board and Project Team to determine the scope, detail and cost of each project in-line with the overall strategy.

3 Background to Project

3.1 Historical

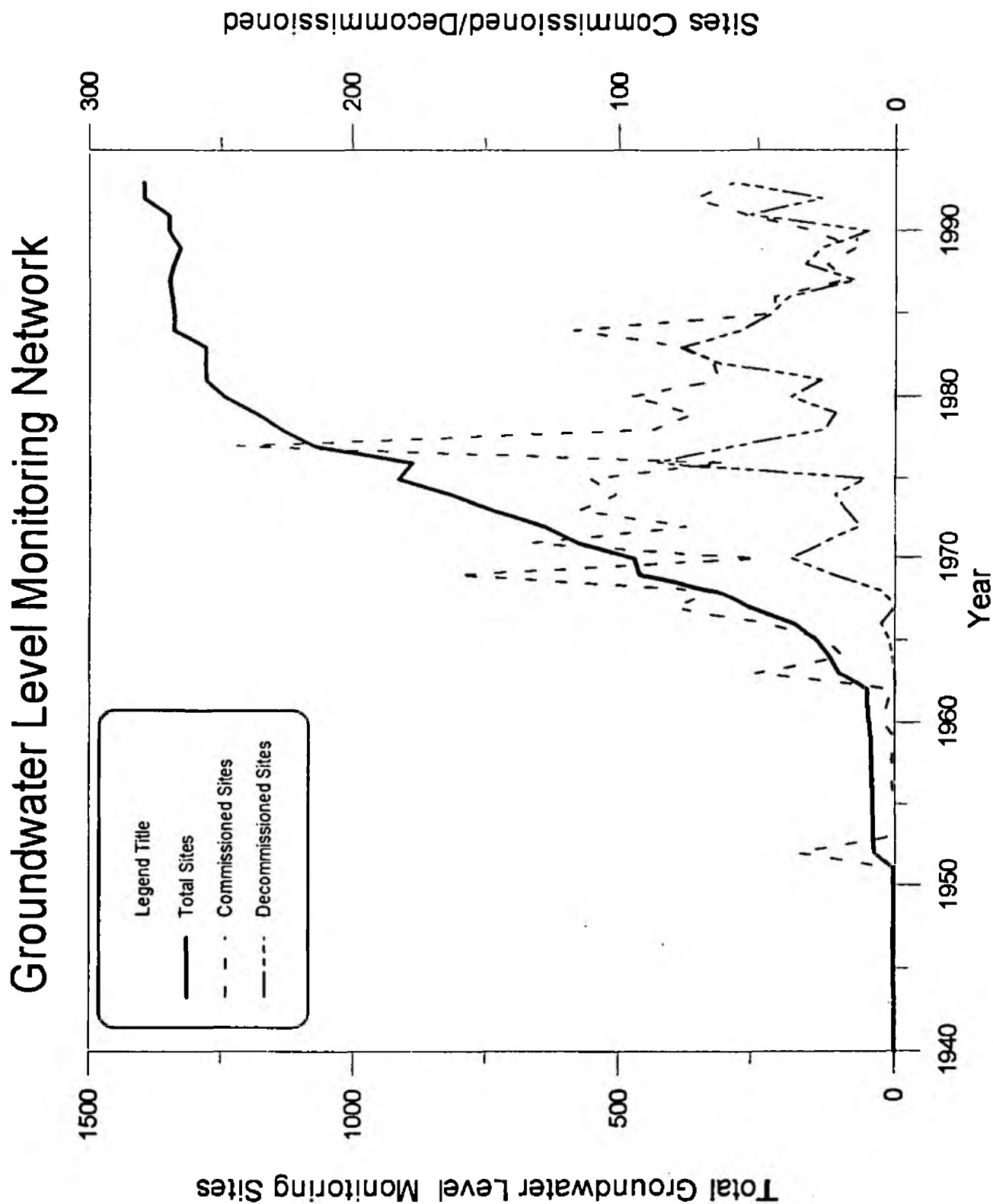
The groundwater level monitoring network has evolved over several decades principally through Acts of Parliament. Prior to 1945 there was no statutory framework for the assessment of groundwater resources. Generally, those boreholes which were monitored were affected by abstraction in the vicinity of the borehole. Disused production boreholes did provide genuine data if observers could be found to read them. The Water Act (1948), which gave the responsibility for conservation and proper use of water resources to the Ministry of Housing and Local Government, and the River Boards Act (1948) gave some statutory framework for the provision of groundwater level monitoring. It was not until the Water Resources Act (1963), from which groundwater hydrometric schemes were to be prepared by the newly formed River Authorities and submitted for approval by the Water Resources Board, that greater impetus was given to groundwater level monitoring.

From 1963 the groundwater level monitoring network has developed on a piecemeal basis with the majority of monitoring specifically for groundwater schemes. The network within the Anglian Region has grown as shown in Figure 2 and summarised in Table 1.

Table 1: Groundwater Level Monitoring Network Growth

Period	Commissioned	Decommissioned	Total
Prior to 1963	50	0	50
1963 to 1965	69	1	118
1965 to 1970	375	35	458
1970 to 1975	471	117	812
1975 to 1980	575	203	1184
1980 to 1985	418	261	1341
1985 to 1990	147	159	1329
1990 to present	216	148	1397

Figure 2 - Historical trend of Groundwater Level Monitoring Sites



3.2 Initial Investigations

There have been a limited number of previous reviews of the groundwater level monitoring network but these have primarily been on a per catchment basis and have concentrated on an area density relationship to geology unit. There has been little consideration to use, type of use and other specific conditions or issues.

3.3 Relationship to Other Schemes/Projects

This project is similar in objective to the review of the groundwater quality monitoring network. After discussions with the Project Manager for the quality monitoring review it appears that both projects may complement each other. The quality monitoring project has undertaken an asset survey of all quality monitoring boreholes. The groundwater quality borehole asset data may be used directly into this project. Similarly, in determining areas for level monitoring the same mechanism may be used to determine areas for quality monitoring. This project may, therefore, also be able to propose a network based on operational needs as opposed to empirical relationships.

The relationship between this project and the NRA Internal Audit of Hydrometry and the Hydrometric Efficiency Review is detailed within Section 3.2. Both have clearly indicated the need and objectives for a full and formal review of the regional groundwater monitoring network. As a result of the Hydrometric Efficiency Review the NRA initiated the process of Service Level Agreements (SLAs) for hydrometry. Within the Anglian Region the SLA for hydrometry has been ratified and the Water Resources Section, as Providers, have detailed the number sites and related monitoring frequency of data which will be maintained, collated, processed and archived. The three Area Management Teams have signed up to the SLA for hydrometry and will be responsible for maintaining the monitoring network. Therefore, any results from this project will have a clear impact on the SLA for hydrometry. However, with good liaison and communication throughout this project there should be no concern regarding any proposed changes to the monitoring network.

An important aspect which is embedded within the Anglian Region's SLA for the Provision of Hydrometric Data is a breakdown of the costs for the provision of groundwater level data. The total cost for the provision of data includes data collection, site maintenance and databasing. The summary costs are as follows:-

Central Area	£114,000
Eastern Area	£81,000
Northern Area	£62,000
Total	£257,000

Therefore, the Anglian Regions spends over £250k per year on the provision of groundwater level data alone. This highlights the commitment that the Anglian Region has given to groundwater level data.

The R&D project: "Evaluating Benefits of Hydrometric Networks" has been initiated with the overall objective *to develop standard practicable procedures to assess the benefits of data from gauging stations and individual sites, so that a comparison can be made with the costs of running the networks.* The R&D will provide a detailed framework for economic appraisals and will assist this review in determining cost efficiencies and in quantifying the benefits. The project commenced on the 1 August 1996 and is set to last one year. The Project Leader has indicated that the R&D on completion is likely to result in a benefits evaluation procedure and a method of justification for gauging stations. It is unlikely that other hydrometric data (including groundwater data) will be covered at this stage. However, the results for the gauging stations may prove a useful addition to this project. Therefore, it is considered that the R&D shall not constrain this project but will be complimentary.

The Environment Agency maintains an asset register of all capital items, of which monitoring boreholes forms a subset. The asset survey may be cross referenced against the asset register so as to review the quality of data within the register.

There are no known national initiatives for data archiving which will have a direct influence on this project.

4 Business Case

4.1 Objectives and Criteria

The objectives of this project have been fully defined in Section 3.3. The main impetus for this project is the need for the Agency to better carry out its statutory duties under the Environment Act (1996). In particular are the general provisions with respect to water where the Agency is duty bound to conserve, redistribute or otherwise augment water resources and to secure its proper use - Section 6(2). This provision underpins many other aspects of water resource legislation, in particular abstraction licence determination.

4.2 Options

In assessing the options there are three main projects, namely:-

- 1) customer requirements survey;
- 2) asset survey; and,
- 3) groundwater level monitoring review.

Although these projects combined are considered to be key for the proposed monitoring review, they are separate and definable projects and would benefit from individual appraisal.

For the customer requirements survey project there are only two options identified, namely:-

4.2.1 Option 1.1: No Customer Requirements Survey

This option would result in assumptions of customer requirements for a monitoring network.

4.2.2 Option 1.2: Customer Requirements Survey

This option would establish the customer requirements for a monitoring network and where to strategically target any further development of the network, whether in data collection/archive or in location of monitoring sites.

For the asset survey project there are only two options identified, namely:-

4.2.3 Option 2.1: No Asset Survey

This option would continue with the current knowledge and detail of the established groundwater level monitoring sites.

4.2.4 Option 2.2: Asset Survey

This option would undertake a full review of each monitoring site and to detail as much information about that site. There will also be an associated programme to determine information which is currently unknown.

For the groundwater level monitoring review project there are four principle options identified, namely:-

4.2.5 Option 3.1: No Groundwater Level Monitoring Network Review

This option would continue with the current groundwater level monitoring network and would not commission/decommission any boreholes. It would assume that the current network is efficient and effective without a detailed appraisal and review.

4.2.6 Option 3.2: Groundwater Level Monitoring Network Review

This option would undertake a detailed review of the groundwater level network with consideration to both aquifer and catchment needs

4.2.7 Option 3.3: Develop a new Groundwater Level Monitoring Network

This option would decommission all currently monitored boreholes and would commission new boreholes based on a new network.

4.2.8 Option 3.4: Total Cessation of Monitoring

This option would decommission all currently monitored boreholes and would not continue any further monitoring.

4.3 Appraisal of Options

4.3.1 Option 1.1: No Customer Requirements Survey

The consequence of not establishing the customer requirements would be a network which would satisfy the needs of the Water Resource Section but would not, in all probability, satisfy the needs of internal and external customers. This could result in the monitoring network having to be reviewed in the future to satisfy the latent needs of customers.

The cost of not undertaking a customer requirements survey is difficult to quantify as the costs relate to consequential effects and not costs directly attributable to this option.

There are no perceived benefits from ignoring customer requirements.

4.3.2 Option 1.2: Customer Requirements Survey

Customers of groundwater level data will be surveyed to determine their requirements of a groundwater level monitoring network and where they consider future development should be targeted. In this context, future development will refer to all aspects of a monitoring network from borehole site location to data processing and archiving.

The cost of undertaking a customer requirements survey would be less than £5k - of which all would be internal Agency staff costs. There would be no other direct costs attributable to this option. There will be intangible cost savings in avoiding any consequential effects.

The principle benefit in undertaking a customer requirements survey is that the Agency will focus the monitoring network on the customer and will be able to provide a monitoring network which is effective. In inviting comments from customers on the effectiveness of the network the survey would enhance public perception and confidence in the Agency.

4.3.3 Option 2.1: No Asset Survey

The Environment Agency should have already a full documentation of each monitoring site. However, due to the way in which the current monitoring network has evolved, significant data has been lost or not recorded.

The consequences of not undertaking a survey impacts directly on the groundwater level monitoring network review. An inadequate knowledge of the monitoring sites would severely curtail the extent and detail of any monitoring review to such an extent as to render the review useless.

The cost of not undertaking an asset survey is difficult to quantify as the costs relate to consequential effects and not costs directly attributable to this option.

There are no perceived benefits from ignoring customer requirements.

4.3.4 Option 2.2: Asset Survey

A full asset survey of the monitoring sites will have direct benefit for two processes. The first process is the asset register which requires the location and basic financial information for generating depreciation costs of all existing assets. Therefore, it is important that the asset cost is known as well as the current status of the site (whether existing or not). The asset survey could be cross-referenced with the fixed asset register so as to review the quality of data within the register.

Secondly, it is inevitable that any formal review of the monitoring network will require detailed knowledge of each site. Only with this baseline of information will a considered monitoring network be unequivocally established.

The cost of the asset survey will depend on the amount of data needed to be gathered. There are various aspects of an asset survey which need to be established, including lease agreements, borehole geology, borehole construction and the quality of record. In particular, to borehole geology and borehole construction data which is missing from the archive records may require geophysical logging to properly establish. Similarly, to re-establish lapsed lease arrangements may result in protracted legal agreements. The full extent of the asset survey is uncertain and as such cannot be sensibly estimated at this stage. However, for budgeting purposes it is estimated that the cost of the asset survey could be in the order of £150,000.

The asset survey must be done not only for this project but also to complete the asset register. To minimise the risk of over-expenditure it is proposed to stagger the asset survey into sub-projects. This will enable proper financial monitoring and the possibility of staging the asset survey over several financial years. Although there will be no direct beneficial income derived by the asset survey there will be indirect benefits to the Agency which must not be overlooked.

4.3.5 Option 3.1: No Groundwater Level Monitoring Network Review

The consequences of doing nothing would be that the Agency continues with the current potentially inefficient and ineffective groundwater level monitoring network. The Agency would not be in a position to unequivocally state whether the current network targets all current and future needs, and whether the current network is cost effective. Not undertaking a review could result in:-

- failure to reasonably manage water resources;
- failure to adequately plan for future demands;
- failure to have installed an adequate drilling and expenditure programme;
- inefficient and ineffective groundwater level monitoring network;
- failure to recognise groundwater requirements to maintain riverflow objectives;

- lack of public credibility in not having a proven baseline from which to support core Agency functions.

If the Agency were to continue to base core and statutory decisions on the current network then this could result in environmental damage. If these decisions need to be reversed in the future then the Agency would be liable for compensation to abstractors. Such compensation could run in the order of £0.5m to £1m per cmd for PWS relocation. An abstraction licence can add up to £3000/ha to agricultural land prices. For a typical farm of 400 ha this could have an overall effect of £1.2m in land prices alone. This figure does not take into account the cost of infrastructure changes needed in converting from irrigated land to dry land farming.

There is a definite risk that the current monitoring network will reduce in the long term due to natural wastage. This would not be acceptable and could undermine the credibility of the Agency.

4.3.6 Option 3.2: Groundwater Level Monitoring Network Review

This option would consider both long term and short terms needs of groundwater level monitoring and will be sufficiently flexible for both aquifer and catchment issues. It is an integrated approach bringing together many facets of Agency data provision (including water quality, surface water hydrometry and abstraction licences) and will result in a comprehensive three tier network as proposed by BGS.

This overall monitoring network review project is considered to be large and could be difficult to manage, both in terms of financial and resource management, as one project. It is proposed that the project could be staged so that each aquifer may be reviewed initially and hence establish the reference monitoring sites and part regional monitoring sites. Catchment issues may be reviewed later as part of the CMP/LEAP programme, thereby completing the regional monitoring sites and establishing the local monitoring sites.

Although a three tier classification scheme has been recommended, the BGS report did not propose an effective methodology to determine the monitoring sites to be included in each tier. Therefore, a scoping study will be initiated at the start of this project which will highlight the most appropriate methodology for network review. The study will address the various review methods (methods may include a broad based density assumption, detailed statistical methods, GIS) and will determine the strategy of review and the way of apportioning boreholes to reference, regional and local networks. The scoping study will also address the assessment of optimisation and how such concepts can be realistically quantified.

To minimise the risk that the methodology may be unworkable, a pilot study is proposed to complement the scoping study. These two catchments of the Lt Ouse and the Waveney are considered ideal for testing potential methods as they are adjoining but have contrasting conditions.

The cost of this option is difficult estimate due to the uncertainties of the unknown review methodology. The cost of the methodology to design an optimum network will be dependent on the outcome of the scoping study. However for budgeting purposes it is estimated that the cost the monitoring review could be in the order of £100,000.

The groundwater level monitoring network must be completed so that unequivocal decisions for both core and statutory functions of the Agency can be firmly supported by a proven and tested baseline. To minimise the risk of over-expenditure it is proposed to stagger the monitoring review into sub-projects. This will enable proper financial monitoring and the possibility of staging the groundwater level monitoring network review over several financial years. Although there will be no direct beneficial income derived by the monitoring review there will be indirect benefits to the Agency which must not be overlooked.

4.3.7 Option 3.3: Develop a new Groundwater Level Monitoring Network

This is not a viable option as it is considered to be very expensive and totally impracticable. If a new network had to be built from scratch then the following disadvantages are perceived:-

- There would be no continuity of hydrometric record;
- The benefit of long term monitoring would be lost;
- The cost of replacing the current network if based on 1400 boreholes at £5000 per borehole would be in the order of £7m.

4.3.8 Option 3.4: Total Cessation of Monitoring

This option implies that the Agency does not need or require groundwater level monitoring to support its core and statutory duties and responsibilities. This premise is discussed by World Meteorological Organisation (Bachamat Y. 1989, "Management of Groundwater Observation Programmes" Operational Hydrology Report No.31) and which subsequently stressed the importance of data information in the decision making process and the overall management of the groundwater aquifer system.

Therefore, this is not a viable option.

4.4 Identification of Preferred Option

The preferred option is a composite. The Agency must undertake groundwater level monitoring network review to support and maintain its statutory duties and requirements. However, to satisfactorily complete this review both a customer requirements survey and an asset survey must be completed. Any other combinations of the identified options would not be satisfactory as they could severely curtail the extent of this project and could also reduce the Agency's effectiveness in supporting its statutory duties and responsibilities.

The preferred composite of options is beneficial as it provides a better understanding and appreciation of the current network and will assist in developing a network for current and future needs. It will help to improve customer focus by having consideration of customer needs when reviewing the groundwater level monitoring network.

The cost of the preferred approach could be in the order of £260,000. There is little in the way of beneficial income which could be directly attributable to the preferred approach. The main benefits are intangible benefits relating to certain statutory duties and responsibilities and are difficult to quantify. However, the consequential impact of not undertaking the review could cost abstraction licence holders, as an example, greater than a million pounds loss in derived revenue.

4.4.1 Do Nothing

The Do Nothing option assumes that the status quo is maintained and equates to no customer survey, no asset survey and no groundwater level monitoring network review. The Agency, through its predecessors, has built a network either around ad hoc and arbitrary design rules or the result of special projects. The reduced available resources during the drought periods of the 1990's and the future demand increases for public water supplies has re-affirmed to water resource managers the need to have a reliable calculation of the long term yield. The groundwater level monitoring database is an important keystone in determining the long term yield and hence the strategic development and management of an aquifer. In essence, if the monitoring network is inadequate then the calculation of resource availability may be equivocal.

Therefore, the Do Nothing option is not acceptable.

4.5 Risk Assessment

There are risks associated with the preferred approach. However, on balance this approach is still considered viable and must be undertaken. The risks identified are as follows:-

- The review methodology recommendation may be difficult to effect and may result in an unwieldy network design procedure. To mitigate this risk it is proposed that a scoping study with a two catchment pilot be initiated to test and assess the effectiveness of the proposed methodology. Given a satisfactory completion to the scoping study a staged programme of sub-projects will be generated.
- The asset survey may require a lot of investigation to complete satisfactorily and the cost may go over budget. To mitigate this risk it is proposed to complete an asset survey for the two catchment pilot area so that the cost and resource implications can be assessed. Given a satisfactory conclusion to the asset survey of the of the pilot area the asset survey will be divided into Area based sub-projects.
- Our customers may have nothing to say about their requirements. The Agency already has a good concept of what it needs from a monitoring network. It is considered that this will not vary significantly from our customers with the exception of minor issues.
- The cost of a capital works programme may be relatively expensive. This is not a direct risk to the project but highlights that the recommendations from this review will be moderated by budgetary constraints. However, this review will detail a prioritised works programme which will provide a framework for future expenditure programmes.
- The methodology may not be compatible for all aquifers due to innate characteristics. To mitigate this risk it is proposed that the review should be staged so that the aquifer monitoring is completed prior to catchment monitoring.
- Inadequate data correlation between new and decommissioned boreholes may lead to data loss. This is typical when a site needs to be replaced by an adjacent borehole. To mitigate this risk a minimum overlapping period of 3 years monitoring from both boreholes will be completed before decommissioning the old borehole.

Unfortunately, most risks identified may not be recognised for a minimum of 5-10 years. This places greater emphasis on getting the methodology and review procedure correct from the start.

4.6 Summary

It is clear that a formal review of the groundwater level monitoring network is required. Currently the Agency does not have a good understanding of the purpose and functionality of either the existing individual monitoring sites or the current monitoring network.

It is strongly recommended that the Agency undertake a formal review of the groundwater level monitoring network and this should be completed following a formal customer requirements survey and an asset survey.

The cost of the overall project is within the order of £260,000. Although there is no direct beneficial income from the project, the cost of the project should be compared to the benefits to the Agency maintaining its statutory duties and responsibilities as well as the consequential effects to the public (e.g abstraction licence holders).

5 Project Plan

The overall review will be divided into main projects which in turn will be divided into sub-projects. The main reason for this approach is to minimise the risk to the Agency of any problems due to project management or financial monitoring.

Each project and sub-project will be costed in more detail when formal approvals will be sought. As presented in section 5 the costs given are estimates only and may vary considerably. The detail of each project is deliberately "broad-brush" so as to show the context only in which the projects and sub-projects (which make up the overall review process) shall be structured and programmed. All approvals for individual project expenditure, commencement and detail will be sought and justified separately.

It will be the remit of the Project Board and Project Team to maintain the strategic direction of the overall review as well as identifying the detail and most effective composition of each project/sub-project.

The actual staff time has not been determined due to the uncertainties and complexities of each project. Therefore, to give an overall estimate of programme time in calendar months to complete the project, as opposed to staff resource time, has been used instead. There is no differentiation between Agency or Consultancy time.

The approach to be adopted is as follows:-

Customer Requirements Survey

This project will require internal and external consultation and liaison with groundwater hydrometric customers. A questionnaire will be developed and circulated to each customer. A follow up meeting will be arranged to discuss their comments and requirements further. It is intended that external customers will include water companies, consultants, universities and government departments. Internal liaison will be concentrated on functions within the Anglian Region including engineering, conservation and water quality.

It is estimated that this project will cost less than £5,000 and will be completed within 3 calendar months.

Asset survey

This project will be divided into 4 separate sub-projects as follows:-

- Sub-project 1 - Asset Survey of the pilot area
- Sub-project 2 - Asset Survey of Central Area
- Sub-project 3 - Asset Survey of Eastern Area
- Sub-project 4 - Asset Survey of Northern Area

The intention is that the asset survey of the pilot area will be completed prior to the Area asset surveys. This will allow a full appreciation of the scale of the asset review in terms of cost and resources and will also determine the same implication for the subsequent Area asset surveys. It will also allow the Area asset surveys to be scheduled at different times to allow for provisions for Area staff time and budget restrictions.

As part of the asset survey will be the need to establish and understand the geology and borehole construction at each site. This information should have been collated following drilling, however, for various reasons this data may not be available. To overcome this shortfall it may be possible to utilise the BGS borehole log archives to derive and interpolate data. In order to confirm the derived strata and construction of a monitoring borehole the use of geophysical logging which, if correlated properly, could give a reasonable understanding. It is intended to release a term contract for geophysical logging which will not only serve the needs of all 4 sub-projects but also any other logging required by the Agency.

The tasks identified within each sub-project are:-

- Setup database of all open monitoring boreholes (used/disused)
- Collect/Collate data based on standard proforma
 - Estates for ownership/lease/payment
 - Data prep contract for well archive sheets on digital format
 - Field visit for basic data
 - Depth of borehole
 - Casing type/material/diameter at surface
 - Photograph of setting
- Determine missing data
 - Rank missing data against:-
 - Quality of record
 - Length of record
 - Requirement/need of record
- Infill missing technical data on order of priority sites
 - Actual and derived information from National well log archives
 - Geophysical logging contract
- Complete asset survey

It is estimated that this project will cost in the order of £150,000 and will be completed within:-

Sub-project 1	6 calendar months
Sub-project 2	12 calendar months
Sub-project 3	12 calendar months
Sub-project 4	12 calendar months

Groundwater Level Monitoring Review

This project will be divided into 4 sub-projects as follows:-

- Sub-project 1 - Scoping study with two catchment pilot
- Sub-project 2 - Monitoring review based on aquifer requirements
- Sub-project 3 - Monitoring review based on catchment issues
- Sub-project 4 - Financial appraisal of monitoring review

The intention is that the scoping will be completed prior to the other sub-projects. This will allow a full appreciation of the scale of the monitoring review methodology in terms of cost and resources and will also determine the same implication for the subsequent monitoring review sub-projects. In this regard, such an approach will allow for strategic staging of the monitoring review.

Each sub-project listed will have a detailed series of tasks to be completed and may have inextricable links with the other sub-projects. The formal approach to be adopted for the aquifer and catchment monitoring reviews and the structure of the sub-projects will depend significantly on the outcome of the scoping study.

It is estimated that this project will cost in the order of £100,000 and will be completed within:-

Sub-project 1	6 calendar months
Sub-project 2	14 calendar months (all aquifers)
Sub-project 3	14 calendar months (all catchments)
Sub-project 4	12 calendar months

Summary

The outline programme is represented in the attached Gantt chart. It will be noted that each project is to be completed by a series of sub-projects, which in turn will be completed by a series of tasks. The tasks have not been identified at this stage due to the uncertainties of the project. It is the intention that dividing the project into definable sub-projects and tasks will provide positive project management and will allow for the overall project to be deferred at any stage should problems occur. The programme is considered generous and sub-projects/tasks, especially for the groundwater level monitoring review, may be brought forward by strategic management of the asset survey.

5.1 Definition of Projects and Timing of Approvals

For clarity, this section shall refer to the aggregation of similar projects as tasks. From the programme it is likely that the review may be covered by 5 distinct tasks, namely:-

- Customer requirements survey
- Asset survey - Pilot area study
- Asset survey - Three areas
- Groundwater level monitoring review - scoping study
- Groundwater level monitoring review - Aquifer/catchment/financial appraisal

The tasks will be treated as separate entities and each will require approvals prior to the commencement of each task. It is recommended that Form A approval limit should be based on the main project and not the cost of either the overall review or the individual task. This would result in three Form A's; one each to cover the customer requirements survey, asset survey and the groundwater level monitoring review. In regards to the asset survey and the groundwater level monitoring review projects the pilot area study and the scoping study will be set up as interim Form A's for their respective project. Where interim Form A's are submitted then the final Form A estimate will evolve from the results and recommendations of the customer requirements survey, asset survey (pilot area study) and the groundwater level monitoring review (scoping study).

To detail the Agency's commitment to expenditure an attachment will be provided with each approval to show the overall review costs itemised down to each project/task.

The Gantt chart has been annotated to show the timing of approvals.

5.2 EC Procurement

Following discussions with the Regional Procurement Manager it was agreed that the customer requirements survey, asset survey and monitoring review are sufficiently different from each other as to require different consultants to undertake the work. Therefore, the aspect of aggregation of consultancy cost will be based on the grouping of related (sub)projects and not on the overall review.

Whenever possible, the Agency is to obtain the select tender list from the Consultants database (which was created following an OJEC advertisement and subsequently review of proposals). However, where this is not possible then the following two conditions apply:-

- if the aggregated sum of consultancy costs for a group of related sub-projects is greater than £147k then EC procurement procedures must be invoked;
- otherwise non EC procurement procedure may be relaxed.

The Project Team will be responsible to determine if full EC procurement is required as well as to obtain the best option for the Agency in regard to the use of consultancy verses Agency staff. However, it is likely the customer requirements survey, asset study (pilot area study) and the groundwater level monitoring review (scoping study) will be undertaken by consultancies as three separate entities.

The remainder of the asset survey will be aggregated and it is likely that a consultant will undertake the majority of the work. The Project Team (in particular the Area contact staff) will determine the level and detail of work which can be covered by the Agency (as a whole) and what work will need to be completed by the consultant. Similar approach will be adopted for the remainder of the groundwater level monitoring review.

5.3 Impacts on other Projects

It is not the intention that this review should curtail other projects. However, it is inevitable that certain projects, especially those involving a drilling programme, will be referred to this review as part of the justification and need statement. The Agency should continue with work which is needed and justified either before or after this review. Before the recommendations of this review are established the following borehole drilling programmes should be considered on their own merits and separate to this study:-

- a programme for the maintenance of the current network;
- special development projects;
- development of an existing groundwater level and well archive database;

- interim development to the current network with the network design based on national targets (via BGS recommendations).

This review should establish a framework for future development of the network. Following this review, however, the above exceptions should be justified on their own merits together with a cross-reference to the recommendations of this review.

5.4 Quality

This is a complex project in which the general need and direction is known, however, the tools, methodology and products are uncertain. It is considered that the broad quality criteria will be based upon meeting the functional objectives which will be established following the customer requirements survey.

The Project Board, Project Team and Quality Review Panel also form an integral part of maintaining a high quality result. All Areas are represented as well as Water Quality and Water Resources (Hydrometry). The network review methodology and results as well as competent linkages with other monitoring networks will have to be agreed and approved by key personnel before the project may be signed off.

5.5 Post Project Monitoring and Review

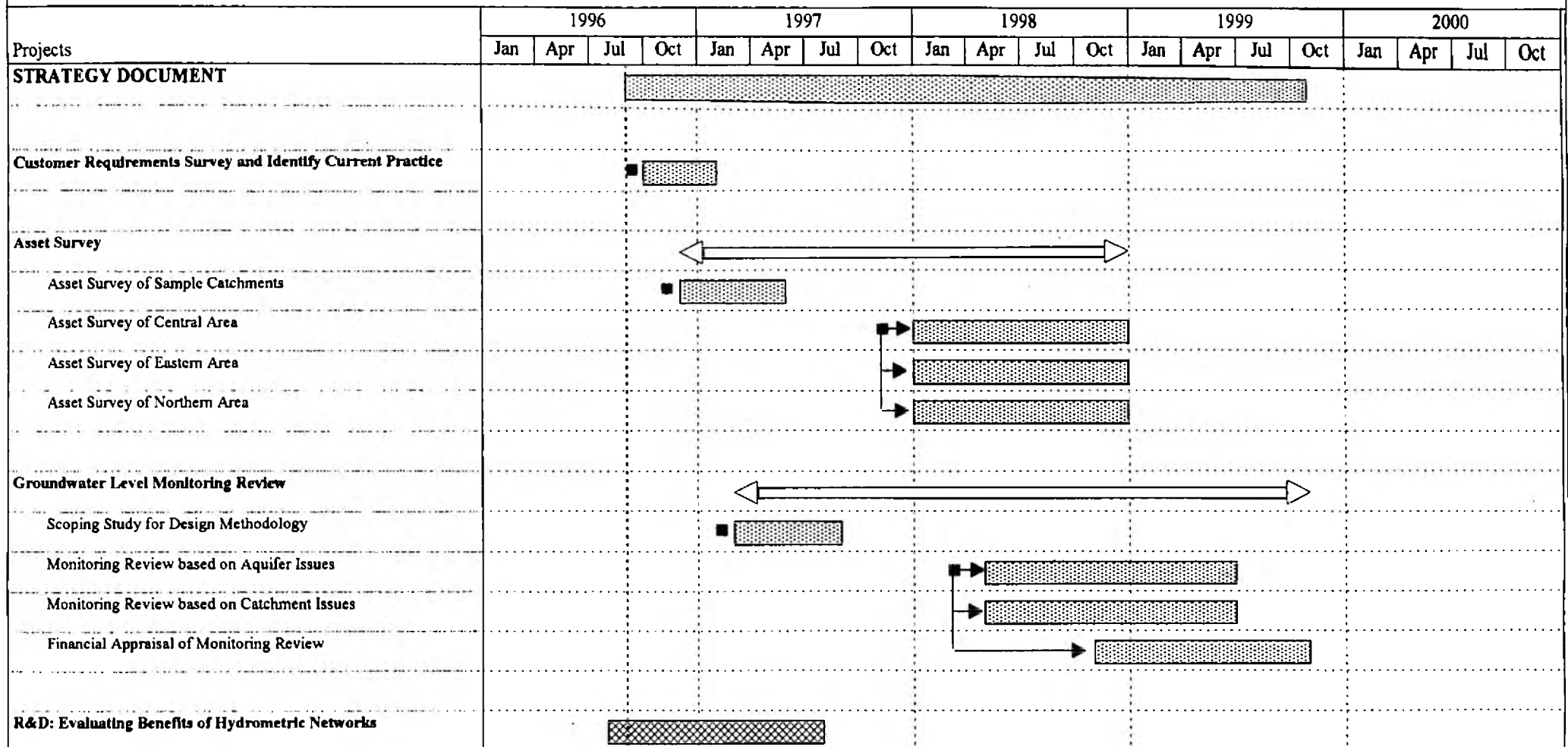
Routine hydrometric monitoring will continue throughout the project and will assist in assessing the effectiveness of the monitoring network. If a new monitoring site is proposed to replace another site then a minimum overlap period of 3 years monitoring from boreholes will be completed before decommissioning the old borehole.

New boreholes will be monitored for a period of 5 years before any formal review of their effectiveness. This will allow for a reasonable period of aquifer and climatic conditions to influence the hydrometric response and hence the effectiveness of the borehole.

A 10 year rolling review programme needs to be established to take into account the changing needs of customers, as well as the impact of previous reviews.

6 Project Programme

Regional Groundwater Level Monitoring Review

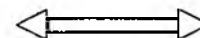


Date: 26/09/96

Task



Summary



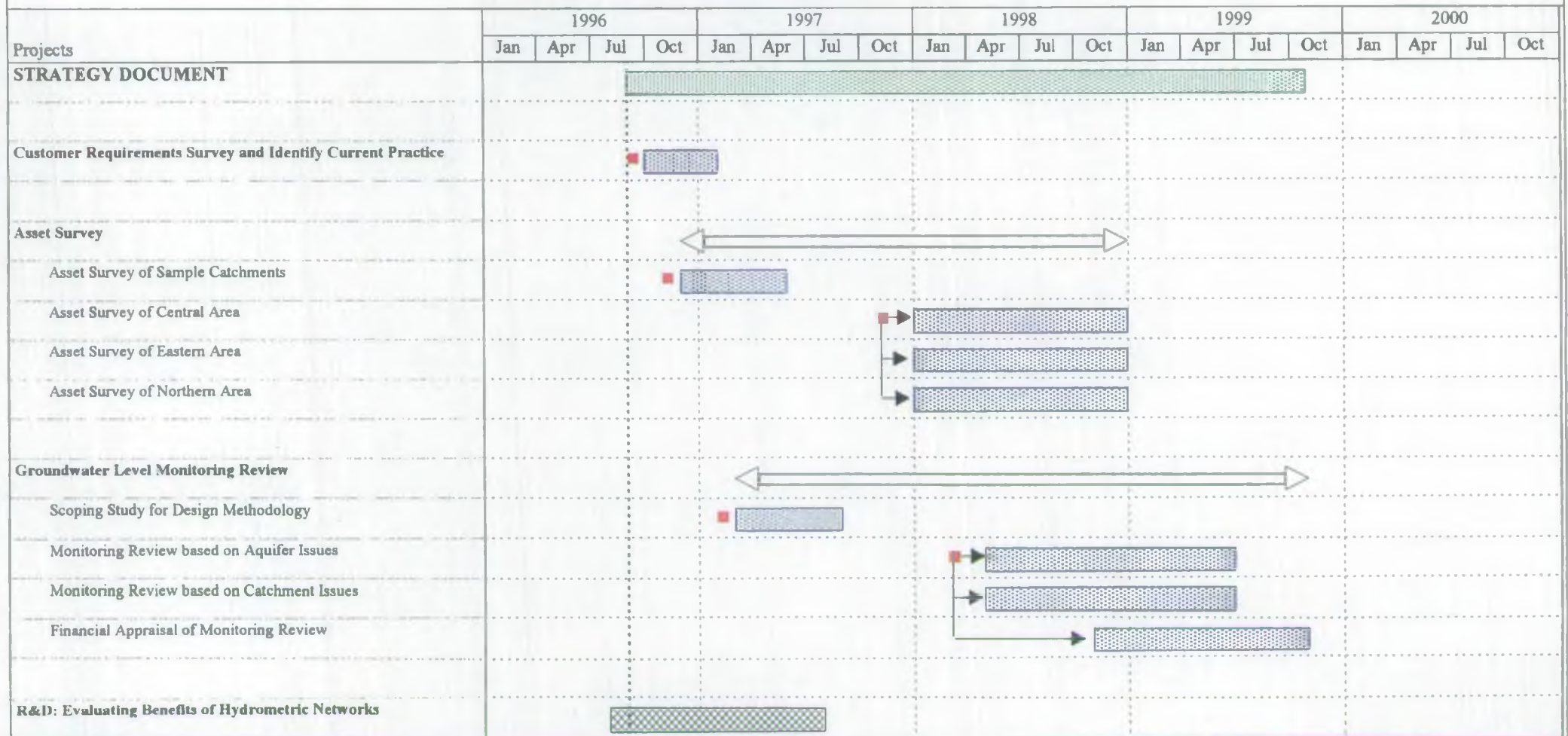
PAB Approval



Linked Approvals



Regional Groundwater Level Monitoring Review



Date: 26/09/96

Task



Summary



PAB Approval



Linked Approvals



MANAGEMENT AND CONTACTS:

The Environment Agency delivers a service to its customers, with the emphasis on authority and accountability at the most local level possible. It aims to be cost-effective and efficient and to offer the best service and value for money.

Head Office is responsible for overall policy and relationships with national bodies including government.

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