



RICARDO-AEA

DWI: Drinking Water Quality and Health Final Report

Evaluation of the drinking water quality and health evidence programme

Report for DWI

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Executive Summary

The DWI currently manages the Defra funded Drinking Water Quality and Health (DWQH) evidence programme. This publicly-funded research is intended to provide evidence for policy development by Government (both directly and via the EU) and to ensure that Ministers can discharge their obligations (in this case to ensure that drinking water is safe to drink and aesthetically pleasing to consumers).

The DWQH evidence programme is governed by the Drinking Water Quality and Health Evidence Plan agreed in 2013¹ which updated the previous ROAME (Rationale, Objectives, Appraisal, Monitoring, Evaluation) Statement². The research funded under the evidence programme is intended to meet the objectives of the Evidence Plan by guiding the execution and delivery of drinking water policy (in particular by the DWI) and addressing the issues on which Ministers may need to take decisions in future (e.g. issues concerning new and emerging risks to health, new technology and new processes).

The overall objective of this study was to carry out an assessment of the research completed under the DWQH evidence programme between 2005 and 2013 and report on the following seven objectives:

1. Whether the objectives of the DWQH evidence programme have been appropriate, given the responsibilities and policy objectives of the DWI and Defra;
2. The scientific quality of research outputs and where appropriate, performance of contractors;
3. Whether the content and objectives of the evidence programme were appropriate, taking into account the role and responsibilities of other organisations both national and international that have interests in drinking water research;
4. Whether outputs from the DWQH evidence programme have been effectively disseminated to customers and the scientific community in general (e.g. success of newsletter approach); (awareness of the programme of activities in the water industry, related stakeholders and elsewhere)
5. Whether value for money has been achieved, including consideration of whether advantage has been taken of opportunities for collaborative or complementary activities at the national and international level (success in attracting EU funding to research new areas of interest);
6. Wider technical or policy implications that warrant consideration in future evidence programmes;
7. The future scale and development of the DWQH evidence programme

The approach taken by the review team, which consisted of experts and researchers from Ricardo-AEA, CREH (the Centre for Research into Environment and Health) and Icaro Consulting, consisted of three aspects: a preliminary desk study, in-depth reviews, and interviews with key stakeholders.

During the preliminary desk study, our review team provided scores from 1 (poor) to 5 (excellent) for each objective (and subcategories within objectives) for each of the 74 projects completed during the review period. Ten projects, selected by a random sampler methodology, were then subjected to an in-depth review. Interviews were carried out with key stakeholders, including Defra, other government departments and agencies, the water industry and contractors, to provide an alternative perspective on the programme and its future development.

The assessment of research delivered under the DWQH evidence programme between 2005 and 2013 against the seven objectives has demonstrated that the programme is generally of a very high standard and the research undertaken is policy-relevant and addresses current and future public health issues. The findings of this research can be summarised as follows:

Policy Relevance

- The preliminary desk study scores for this objective were good (an average of 3.9 across all projects). 66% of total projects scored a 4 or above.

¹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221072/pb13914-evidenceplan-drinking-water-quality.pdf

² <http://webarchive.nationalarchives.gov.uk/20101110035533/http://www.dwi.gov.uk/research/research-programme/Roame%20DWI.pdf>

- Performance against the ROAME statement policy objectives was good, with some projects meeting more than one criteria. The vast majority of research areas mentioned specifically in the ROAME statement were covered by at least one research project.
- Stakeholders were able to provide examples of where research under the DWQH evidence programme has led to changes in policy and legislation on drinking water, therefore demonstrating the relevance of the research.
- Stakeholders also provided examples of where research had been useful in other contexts, including responding to the press regarding potential health issues, and issuing health advice.
- Collaboration with the World Health Organisation (WHO) gives the DWI an insight into issues that may be arising in other developed and developing countries and thus ensures that the DWI can contribute and respond to the international evidence base.

Scientific Quality

- Generally the scientific quality of the projects reviewed was considered to be of a high standard with nearly two thirds achieving scores of 4 (“very good”) and above.
- Appropriateness of methodology was found to be variable across research projects. In most cases methodologies chosen were considered to be sound and sufficient to meet the project objectives. However, in a few cases, the project assessment team considered the methodology proposed, or used, was problematic.
- Quality and availability of data reviewed within projects had an impact on the strength of confidence in the findings.

Performance of Contractors

- 89% of total projects scored a 4 or above for this objective in the preliminary desk study. However, the scoring at this stage was based on a series of assumptions. The detail found during the in-depth reviews and interviews provided are more reliable means of assessment.
- Contractor performance was generally considered to be good. However, the in-depth reviews revealed that in some cases, the DWI project officers had to work closely with the contractor to rectify difficulties and ensure that research projects were delivered to time and specification.
- Some contractors went above what was required of them. However, in other instances there were discrepancies between the specification and the work delivered, including methodology changes, which impacted on the reliability and value of the work.

Fit with role/remit

- 85% of total projects scores a 4 or above for this objective.
- It was felt that in some cases projects carried out and funded under the DWQH evidence programme were of particular significance to water company operations, planners or environmental and economic regulators. This suggests that funding should have been provided from other sources.
- Collaboration was utilised in some cases to support the remit of the work, but the expert team felt that frequency of collaboration could be increased.

Effectiveness of dissemination

- 70% of total projects scored a 4 or above for this objective.
- Reports were generally considered to be accessible to those who needed to see it, although stakeholders made several suggestions for how dissemination could be improved.
- 78% of total projects were included within the DWI newsletter, introduced in 2008 to raise awareness of research carried out under the DWQH evidence programme. However, a number of stakeholders were unaware of the newsletter, suggesting that the promotion and dissemination of the newsletter could be improved.

Value for money

- 76% of projects scored a 4 or above for this objective.
- There were good examples of collaborative funding of projects, particularly with the World Health Organisation (WHO), the Water Research Foundation (WRF), and UK Water Industry Research (UKWIR).

- However In some instances it was difficult to determine the total costs and the costs to individual contributors of collaborative projects, as access to this information was not always provided.
- The expert team found that research projects that enhanced understanding, created legislation, or provided outputs such as handbooks or spreadsheet tools were especially good value for money.

Future evidence programme

The findings indicate there is a close match between the research carried out and the criteria set out in the ROAME statement and its 2013 successor. There were however some gaps identified in the research topics and it is recommended that the DWI consider the following when selecting further research:

- Any issues identified from the Drinking Water Quality and Health Evidence Plan without publications during 2005 – 2013 programme, and which would benefit from further research going forward, should be considered for the evidence programme.
- The DWI review the recommendations provided by projects at the annual research ideas meeting, which determines whether sufficient research has been completed in relation to that topic. The outcomes of the review should be clearly and consistently communicated to relevant stakeholders and relevant, high priority recommendations should be taken forward in a future evidence programme.
- There was widespread agreement from stakeholders that the programme would benefit from additional and wider stakeholder engagement with respect to how the research projects are decided and how the findings are disseminated back to the stakeholders. This two way communication will assist in the identification of emerging issues

In view of the DWI's responsibilities being limited to England and Wales the scale of research is usually limited accordingly. Where research is relevant to other devolved administrations DWI should engage with them at each stage of the project going forwards. The ease of this has reduced in recent years due to the formation of national Governments and Assemblies in Scotland, Wales and Northern Ireland. Stakeholder engagement needs to ensure that a full representation is included when developing the evidence programme going forward.

Recommendations

There are some aspects of the programme which could be improved and this report makes the following key recommendations for the ongoing DWQH evidence programme:

1. It is recommended that DWI should develop a communication plan to communicate to relevant stakeholders the outcomes of the research review meeting to determine whether sufficient research has been completed in relation to the issues set out in the Drinking Water Quality and Health Evidence Plan 2013.
2. The formation of an expert working group would assist in identification of potential new research areas and also with dissemination of existing research from the programme.
3. It is recommended that DWI should take steps to raise stakeholder awareness of the value of the DWI newsletter. Stakeholders may not appreciate that the newsletter is primarily a means of disseminating valuable research information.
4. Increase the use of workshops or seminars to disseminate research delivered under the DWQH evidence program.
5. To ensure the scientific quality and calibre of proposals submitted during the tendering process it is recommended that the tender period is extended from four to six or eight weeks.

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1 Background

1.1 Policy and Research Context

1.1.1 Governance of the Drinking Water Quality and Health Evidence Programme

Regulations on drinking water quality are enforced in England and Wales by the Drinking Water Inspectorate (DWI). The DWI works to protect public health by assessing whether water companies are complying with their duty to supply wholesome drinking water as defined in the Water Supply (Water Quality) Regulations which implement the EU Drinking Water Directive and additional national standards. The DWI also provides guidance, including to local authorities who are responsible for regulating private water supplies

Publicly-funded research is intended to provide evidence for policy development by Government (both directly and via the EU) and to ensure that Ministers can discharge their obligations (in this case to ensure that drinking water is safe to drink and aesthetically pleasing to consumers). Defra presently funds research under the Drinking Water Quality and Health (DWQH) evidence programme to enable it to meet these obligations. The DWQH programme is currently managed by the DWI.

The programme is governed by the Drinking Water Quality and Health Evidence Plan agreed in 2013³. This updated the previous ROAME (Rationale, Objectives, Appraisal, Monitoring, Evaluation) Statement⁴. The ROAME Statement made it clear that the programme was intended to fund only the research needed to guide the execution and delivery of drinking water policy (in particular by the DWI) and to address issues on which Ministers may need to take decisions in future (e.g. issues concerning new and emerging risks to health, new technology and new processes). Seven key policy objectives were identified:

- (1) to implement properly EU and national legislation and advise on future legislation` (n.b. the Commission consulted on a possible revision of the Drinking Water Directive in 2008 but subsequently decided not to proceed at that time) ;
- (2) to ensure new risks drinking water quality are identified and assessed and where appropriate to develop national standards or guidance to protect drinking water quality and consequently public health;
- (3) to keep abreast of, and influence, international developments in drinking water safety and regulation, such as the WHO Water Safety Plan approach (there was an understanding that as part of the evidence programme the DWI would work with the World Health Organisation (WHO) and act as a collaborating centre to commission research to support the development of the water safety plan approach to drinking water quality.
- (4) to ensure the legislation is implemented and enforced based on sound science;
- (5) to support the periodic review of prices;
- (6) to support water suppliers in developing an effective response to security threats to drinking water quality issues;
- (7) to support the regulatory approval process for products in contact with drinking water.

1.1.2 The current DWQH evidence programme

The DWQH evidence programme for the period 2005 -2013 consisted of 76 research projects for which project reports had been published (see Appendix 1). The research topics covered were classified by the DWI under the subject categories as detailed in Table 1.

³ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221072/pb13914-evidenceplan-drinking-water-quality.pdf

⁴ <http://webarchive.nationalarchives.gov.uk/20101110035533/http://www.dwi.gov.uk/research/research-programme/Roame%20DWI.pdf>

Table 1: Breakdown of research projects by subject matter

Subject Matter	Number of research projects
Chemical Risk	22
Chemical Monitoring	12
Consumer research / behaviour	8
Microbiological risk assessment	8
Regulation 31 (materials in contact with water)	6
Cryptosporidium / Giardia	5
Analytical methods	3
Distribution	2
Premise Risk	2
Other	8
Total	76⁵

For information, the previous evaluation of the Drinking Water Quality and Health evidence programme carried out in 2006⁶ evaluated 71 projects over the period 1996 -2004. These projects may have influenced the current topic selection based on any recommendations for further evidence to support and verify findings. The previous evaluation covered the following topics:

- Chemical content: 27
- Economic content: 7
- Microbiological content: 39
- Cryptosporidium: 19

⁵ This total of 76 research projects includes the two projects discussed in footnote 7

⁶ Watts C, Fawell J, Sartory D, Leaman J and Tuffin A (2006) Evaluation of the Drinking Water Quality and Health (DWQH) Research Programme (1996-2004) for Defra, Defra Project Code: DWI 70/2/188

2 Objectives of this study

The overall objective of this study was to carry out an assessment of the DWQH research completed between 2005 and 2013 and report on the following seven criteria:

- Whether the objectives of the DWQH programme have been appropriate, given the responsibilities and policy objectives of the DWI and Defra;
- The scientific quality of research outputs and where appropriate, performance of contractors;
- Whether the content and objectives of the evidence programme were appropriate, taking into account the role and responsibilities of other organisations both national and international that have interests in drinking water research;
- Whether outputs from the DWQH programme have been effectively disseminated to customers and the scientific community in general (e.g. success of newsletter approach); (awareness of the programme of activities in the water industry, related stakeholders and elsewhere)
- Whether value for money has been achieved, including consideration of whether advantage has been taken of opportunities for collaborative or complementary activities at the national and international level (success in attracting EU funding to research new areas of interest);
- Wider technical or policy implications that warrant consideration in future evidence programmes;
- The future scale and development of the DWQH programme

The 2013 Evidence Plan document sets out the expectation that the strategic positioning of the evidence programme, in relation to the overall national programme of research on issues relevant to the responsibilities and activities of Defra drinking water policy, this will be an important consideration in the evaluation review.

3 Approach & Methodology

There were three principal stages of this project. Firstly Ricardo-AEA and its project partners Centre for Research into Environment and Health (CREH) and Icaro Consulting carried out a preliminary desk study to evaluate the 74⁷ research projects that were carried out under the Drinking Water Quality and Health evidence programme between 2005 and 2013, as listed in Appendix 1. The projects were assessed for policy relevance, scientific quality, contractor performance, fit with role/remit, effectiveness of dissemination and value for money. The projects were scored according to the methodology outlined in Appendix 2: Further information on methodologies, and the results are summarised in section 4 of this report.

Ten projects were then selected to be taken through for in-depth review using a random sampler methodology. The methodology used and findings of these more detailed reviews is also found in Appendix 2: Further information on methodologies.

To gain further insight into the DWQH evidence programme and how it is perceived, interviews were conducted with a range of stakeholder groups. The findings from the interviews were used to evaluate the programme against the review objectives. The stakeholders interviewed included representatives from the DWI, Defra, other government departments and agencies, water industry, contractors and other regulators.

3.1 Preliminary Desk Study

We identified the appropriate technical experts to lead each of the project reviews, ensuring they were able to draw upon a wider pool of resources within Ricardo-AEA and the project partner organisations as necessary. In order to ensure impartiality each project was scored by two reviewers independently: the lead technical expert for the subject matter and a researcher based in Ricardo-AEA. For consistency, the same researcher was used for the second review across all projects.

Impartiality and consistency was also ensured by the use of a scoring template shared and agreed with Defra at project inception. This provided for each project to be scored on a scale of 1 (poor) to 5 (excellent) for five objectives as set out below. Scores were provided for the constituent elements of each objective, and the scoring template also provided the facility for reviewers to make additional comments used to assist with the evaluation process.

- Policy relevance (objective 1), i.e. fit with the objectives set out in the ROAME Statement and Evidence Plan:
 - The development and implementation of national and European legislation
 - The assessment of emerging risks to public health
 - Contributing to and influencing the international evidence base.
 - Ensuring evidence-based support to the operation and development of the UK water industry
- Scientific quality (objective 2a)
 - Taking into account the methodology used
 - How it advances knowledge
 - The number of citations the project has received
- Performance of contractors (objective 2b)
 - Did the contractor deliver to time?
 - Did the contractor deliver to cost?
 - Did the contractor deliver to specifications?
 - Note: this objective may be best assessed via the in-depth studies
- Fit with role/remit (objective 3)
 - Taking into account the responsibilities of others e.g. the water industry, other Government Departments, the European Commission

⁷ The total number of projects carried out in this time period was 76. WT1268 refers was the workshop component of WT1215: there is only a page workshop summary provided. This project has not therefore been included as a separate entity. WT1217 was an extension of WT02049 and these two projects both have the same file reference of 70/2/210. The extension project has therefore not been reviewed as a separate entity.

- Effectiveness of dissemination (objective 4)
 - Is the report available to those who need to see it?
 - Is it covered in the electronic newsletter on the DWI website?
 - Is it clear what happens next?
- Value for money (objective 5)
 - Were opportunities for collaboration/complementarity taken?
 - What is the assessment of the cost for the work delivered (the costs to Defra range from a few thousand pounds to six-figure sums, with 14 contract values exceeding £100,000).

A set of user notes was provided to the technical experts and second reviewers alongside the template to give further guidance on how the scores should be determined. These user notes also set out a structure for scoring some of the quantitative subsections of objectives as shown in Appendix 2: Further information on methodologies).

It is important to note that the overall score for each objective was not an average of the scores for the subsections, but was intended to reflect an overall judgement of the relevant objective. This approach was adopted so as not to discriminate against those projects intended to fully meet one or more particular objective(s), but not all of them (particularly relevant for objective 1).

On completion of the project evaluations, the scores from the expert and second reviewer were combined to produce one set of scores for each project. The scores from the two reviewers were largely consistent. Where the scores differed by more than two points on the scale, we explored the reasons for these differences and reached an agreement based on the technical points raised by each reviewer. It should be noted that this approach will have softened extreme scores in some instances.

In most cases, the DWI provided access to reports for which only an Executive Summary was freely available on the projects database. However, for two reports, the associated documents were not provided and therefore the scoring was limited to the summary only: these were WT1282, a project with only a five page summary, and WT1257 for which there was a two page summary (the accompanying excel spreadsheet was not provided).

3.2 Interviews

To ensure that the views of those involved in commissioning, managing, delivering and using the research projects are taken into account during the review of the DWQH evidence programme, 15 interviews of selected stakeholders were undertaken. The representative sample was agreed with the DWI to provide sufficient coverage across a range of stakeholder organisations which had involvement with the programme. These were selected to represent those involved in delivering the programme both from a project management and a contractor basis. The interviews aimed to collate the views of representative users of the programme outputs including government departments and related agencies and also water industry groups.

The interviews supported the review process by assessing the appropriateness of the content of the programme and its effective dissemination to customers and the wider scientific community.

3.3 In-depth reviews

The ten studies were selected for in-depth review using a random sampler methodology (see Appendix 2: Further information on methodologies). Table 2 details the ten studies that were selected for in-depth review.

Table 2: The ten projects selected for in-depth review

Publication Year	Report Title	Project ID & File Ref		Lead Contractor
2013	Understanding the changes in pesticide usage to inform water company risk assessments	WT1264	70/2/274	ADAS
2012	Monitoring of Nitrogenated DBPs in drinking water	WT1256	70/2/268	Imperial College
2011	Investigation of instances of low or negative pressures in UK drinking water systems	WT1243	70/2/245	WRc
2010	Investigation of the taxonomy and biology of the <i>Cryptosporidium</i> rabbit genotype	WT1226	70/2/241	National Public Health Service, Wales
2010	Contaminant Candidate List Viruses: Evaluation of Disinfection Efficacy	WT02039	70/2/187	AWWA Research Foundation
2009	Calcium and magnesium in drinking-water Public health significance	WT02053	70/2/196	WHO
2009	Perchlorate - risks to UK drinking water sources	WT1206	70/2/218	WRc
2008	A review of different national approaches to the regulation of THMs in drinking water	WT1212	70/2/216	WRc
2008	National Tap Water Consumption Survey	WT1214	70/2/217	Accent Marketing & Research Ltd
2008	A review of research on pressure fluctuations in drinking water distribution systems and consideration and identification of potential risks of such events occurring in UK distribution systems	WT1205	70/2/220	WRc

Following selection, all information available for the ten projects was collated. The following information was collected in person from the DWI:

- The proposal
- The number of expressions of interests submitted for the project, and the number of those invited to tender
- Evidence of scoring for qualification to the tender
- Any information on collaboration
- Any information on the breakdown of funding split with partners
- Evidence of project communication – emails etc.
- Evidence that showed changes to timeframes or costs and the reasons behind these.

This information was provided to the relevant experts who reviewed the projects in the preliminary desk study. Due to confidentiality issues we were unable to view expressions of interests or bids submitted.

4 Evaluation

4.1 Overall evaluation

Table 3 below shows an overall average score for each of the policy objectives (see section 3.1 above) from the preliminary desk study. The following sections break down the scores by subsections of the five objectives and by project topic.

Table 3: Average score for each objective across all projects (rounded to 2 significant figures)

Project objective		Average Score
Objective 1	Policy relevance	3.9
Objective 2a	Scientific quality	3.8
Objective 2b	Performance of Contractor	4.2
Objective 3	Fit with role/remit	4.4
Objective 4	Effectiveness of dissemination	4.1
Objective 5	Value for money	4.2

To provide context to the evaluation process, Table 4 provides the basis for the qualitative scoring of each objective.

Table 4: Qualitative scoring definition

Quantitative Score	Qualitative Score
1	Very Poor
2	Poor
3	Good
4	Very Good
5	Excellent

Objective 2a (scientific quality) produced the lowest overall average score at 3.8. Objective 1 (policy relevance) followed with an overall average score of 3.9, and objectives 2b to 5 ranged from 4.1 to 4.4, with objective 3 (performance of contractor) producing the highest overall average score.

No individual project received less than 2 for a particular objective, although the tables in Appendix 3 show that some projects were given lower scores for some constituent elements.

4.2 Policy Relevance

For the preliminary desk study, the policy relevance objective was broken down into four scoring criteria:

- The development and implementation of National and European legislation
- The assessment of emerging risks to public health
- Contributing to and influencing the international evidence base.
- Ensuring evidence-based support to the operation and development of the UK water industry

An overall score was provided to reflect how each of the projects fit to the policy relevance objective. All project categories scored relatively highly for this objective, with the 'Chemical Monitoring' category receiving the highest overall average score of 4.6 (further details at Appendix 3, Table 7). However, this was also the only objective where individual projects were scored below 3 on individual criteria. These were the two projects on distribution, where the scorers felt the projects were not clearly linked to domestic or international policy. Looking at the overall score for this objective, all projects scored a 2 or above, with 66% of total projects scoring a 4 or above (equating to 49 projects), and only four projects (5.4% of total projects) received a score of 2 or 2.5.

Performance against the ROAME statement policy objectives was generally good, with some projects meeting more than one criteria. For example one scorer described a project as follows:

'The project meets the policy objectives set out in the ROAME Statement by providing (or in this case, collecting) evidence to underpin both the assessment of the emerging risks to public health (given advances in treatment) and ensuring evidence-based support to the operation and development of the UK water industry (e.g. water softening).'

Examples of relevance to policy include the amount of research on the levels of contaminants and agents in drinking water the water, and the resulting risks to health. This helps to provide an excellent evidence base for developing policy standards, formulating briefing material for dealing with policy based questions and providing guidance to industry. One particular example identified by an interviewee was where a project on Chromium VI helped develop a water treatment plan, thus driving a change in the industry.

Results from a number of projects in the DWI's evidence programme confirmed that there is little or no risk to the public from particular contaminants. These findings are particularly useful when responding to the press and issuing public health advice.

In interviews some stakeholders felt their recommendations for research had not been taken forward. Most agreed that the emphasis of the programme should have a focus on the practical and operational side of drinking water quality to complement the research based or academic topics. However, it was recognised that some of the DWI research is helpful in to guide water companies and provide assurance that certain risks to both water utilities and the public are very small. *'The DWI are always concerned about emerging contaminants that could enter the drinking supply and are tapping into European concerns in this area.'*

Many projects were linked to previous DWI projects; this demonstrates a joined up approach in the evidence programme and provides evidence that follow up activities are carried out in areas of importance.

4.2.1 The development and implementation of National and European legislation

The DWI attend regular meetings with European drinking regulators and are well positioned to know about emerging areas that might benefit from UK research. One stakeholder said that *'the DWI are good at being aware of future areas of drinking water that may be a problem and planning research in advance of the problem occurring'*.

The DWI also have an informal network of European regulators to help them understand what is being discussed in terms of drinking water quality at the European level and stay up to date within this arena. This means new issues causing concern in Europe can be looked at in the UK context before they become matters of public concern. During the review period of 2005 - 2013 a revision of the EU Drinking water Directive was expected but did not occur.

The following reasoning was provided by an expert reviewer as justification as to why one particular project scored highly for this criterion:

'The project demonstrates policy relevance as it discusses the impacts of different regulations and policy scenarios and their potential impacts on pesticide usage. The results of this research have the potential to influence pesticide regulations but also provides evidence to support the operation and development of policies for the UK water industry.'

In interviews, some stakeholders gave examples of where research under the DWQH evidence programme had clearly led to changes in policy and legislation. For example, Public Health England (PHE) found the research on manganese useful and has considered its advice on manganese in drinking water. PHE now provide more precautionary advice regarding certain potentially susceptible groups (e.g. bottle-fed infants, young children and pregnant mothers).

4.2.2 The assessment of emerging risks to public health

The vast majority of areas mentioned specifically in the ROAME statement and its successor as emerging risks to public health were covered by at least one research project (see Table 5). Altogether, 46 projects out of the 74 were considered to be related to this objective. This includes research projects on disinfection by-products, pharmaceutical residues, pesticides, veterinary medicines, metals, and pathogens, amongst others.

Throughout the preliminary desk review, the in-depth reviews and the interviews, positive comments were made regarding the relevance of the DWI research to public health issues. One interviewee highlighted the usefulness of the research on lead, which is demonstrated by its use by the Welsh Government in amendments made to its water strategy. As another example, during the in-depth reviews, an expert reviewer commented on a project looking at release into water of nickel from kettle elements as follows:

'It's a very good example of a scientific study that was designed to address a particular health concern in terms of drinking water quality.'

4.2.3 Contributing to and influencing the international evidence base.

The DWI maintain communication with the World Health Organisation (WHO) and are thus aware of issues that may be arising in other developed and developing countries and can contribute to and learn from the international evidence base. The WHO and the DWI often collaborate on projects; unsurprisingly these projects generally scored very highly for this objective.

Some projects however received a low score for this objective where the data principally related to the UK, for example where:

'The project focussed primarily on UK sample sites, with limited information or comparison outside of the UK.'

Projects awarded a higher score for this criteria often pulled together research completed in other countries and discussed some of the similarities and differences between them. A project that did this received a score of 4 for international evidence compared to the former example which received a score of 2. A project which scored a 5 for contributing to the international evidence based provided information to inform documentation relating to future WHO water safety plan documentation.

Some collaborative projects predominantly related to the US situation and did not always convert the relevance of international research to a UK context. These kinds of projects scored relatively highly for this objective subsection, but in some cases received a lower score for 'ensuring evidence-based support to the operation and development of the UK water industry'.

4.2.4 Ensuring evidence-based support to the operation and development of the UK water industry

Nineteen projects were identified as contributing to the objective of ensuring evidence based support to the operation and development of the UK water industry by the reviewers (see Table 5). These covered the issues as stated in the ROAME statement, including catchment management, phosphate dosing, emergency events, water pressure, desalination, consumer perceptions and monitoring, amongst others. Some interviewees expressed concerns regarding funding research that could legitimately be funded by water companies to show due diligence and managing their risks properly. However other stakeholders encourage the DWI and DWQH programme to have closer co-ordination with the water industry to enable the successful implementation of this objective.

Examples of projects that scored highly were those that provided a set of ready-made templates, or that showed evidence of having been developed by a robust a level of research and testing. One example of a project that scored lower was where a conclusion was reached that '*there is evidence that perchlorate arises naturally*'; the reviewer concluded that this does not give a helpful impression of potential source significance for the UK.

The importance of having UK wide scientific evidence available so that Northern Ireland, England and Wales can draw their policy conclusions from a common evidence base was raised during the interviews.

4.3 Scientific Quality

For the preliminary desk study, the scientific quality objective was broken down into four scoring criteria:

- Methodology used
- How it advances knowledge
- Evidence of citations
- Strength of confidence in the findings

An overall score was provided to reflect how each of the projects fit to the scientific quality objective. Forty seven projects (63% of total projects) scored a 4 or above as an overall score for this objective. Twenty seven projects (36%) scored a 3 or 3.5. No projects scored below a 3.

Higher scores were attributed to reports that were well organised and had a sound structure and methodology.

4.3.1 Methodology used

Appropriateness of methodology was an interesting point within the reviews. In most cases the methodologies chosen were considered by the expert review team to be sound and sufficient to meet project objectives.

However, one expert noted that the methodology proposed for a particular project was problematic, in that the use of passive samples (the method of choice) would not be suitable to measure the target compounds. Another project used a method that was inappropriate for measuring longer-term effects. Additionally, it was highlighted that on occasions some possible assessment methods were not fully considered; for example one project described six possible methods but only properly considered one of these.

Issues relating to method execution were also identified. These are discussed further in 4.4 Performance of Contractors.

4.3.2 How it advances knowledge

In terms of advancing knowledge, some projects were considered beneficial for underpinning other work and analyses rather than being important in their own right. Some projects seemed to simply repeat information from other studies. Although this meant they didn't add any new knowledge or analysis, they did serve to provide a collated and consolidated document and acted as a springboard for new research by setting out clear recommendations on what should follow.

For some projects it was difficult to understand who the intended end user or audience would be and therefore it was hard to determine the appropriateness of how the output was framed. The use of an executive summary was seen by the review team as particularly useful in projects where the main report was tailored to a more informed audience.

4.3.3 Evidence of citations

As indicated by Table 8 (see Appendix 3), the citations scores were highest for projects in the categories 'Cryptosporidium / Giardia' and 'Premise Risk'. The number of times a project had been cited may have been impacted by the date the project was published; more recent projects would have had less exposure time in which to build up citations.

As well as gaining a high score for being cited many times, a journal paper related to project 'Contaminant Candidate List Viruses' was seen to be the highest cited journal in its field as found by one of the expert reviewers during the in-depth reviews .

It is important to note the differentiation between citations of project reports and citations of any journal papers that may have been published as a result of the work under the DWQH evidence programme. The number of citations can vary significantly, with some project reports not receiving any citations, but a journal paper related to that project being cited more than 50 times. Some research projects may have had several journal articles published that are associated with the work. In other cases the project report itself may have high number of citations, and there may not be any related scientific journal publications.

Some interviewees felt that research should be published in academic papers in order to make the data more robust. Others however put forward the counter argument that the DWI is not an academic institution and the aim of the research is rather to produce usable results. Published papers could make the research less accessible to some stakeholders because of the cost of subscribing to or purchasing scientific journals or the unfamiliarity of individual publications. Reviewers considered that, where contractors had gone to the additional steps required to publish peer-reviewed papers, this provided added independent verification of the quality of work carried out. The peer-reviewed publications had value in validating the research findings, even if practitioners would normally consult the project report documentation.

4.3.4 Strength of confidence in the findings

Generally the review team scored strength of confidence in the findings of the projects highly, reflecting the soundness of the chosen methodologies and analysis.

It was however noted that the data available for use in some projects was not of the highest quality and in many cases data available was limited or not available, impacting on confidence in the findings and their ability to advance knowledge. Confidence was also compromised in a small number of projects because of a lack of available information about the substances in question.

4.4 Performance of Contractors

For the preliminary desk study, the 'performance of contractors' objective was broken down into three scoring criteria:

- Delivering to time
- Delivering to cost
- Delivering to specifications

An overall score was provided to reflect the fit of each of the projects against the objective. The scores captured for this objective are shown in Table 9 (see Appendix 3). The overall scores for this objective were high with 89% of total projects (66 projects) scoring a 4 or above. The lowest overall score for this objective was a 3, with eight projects (11%) scoring a 3 or a 3.5.

The expert team considered contractor performance to be generally good. However both the in-depth reviews and the stakeholder interviews revealed that some issues relating to the performance of contractors may have been obscured by the lack of information available at preliminary review, and that some projects were in danger of not being delivered to the high standard expected by the DWI. In these cases the DWI would work with the contractor to rectify any issues (this was noted as a strength of the DWI). The style of DWI project management includes milestone meetings between project managers

and contractors which are important for refocusing a project if it has gone off scope. It was also noted that there is high quality control before publishing a report to ensure that the DWI were happy with it.

Other points raised by interviewees included the following:

- Research produced since 2005 has been of very good quality and offers good value for money.
- High quality scientists and expert research groups were used to ensure high quality outcomes.
- Reports, were well written, clear, and provide a sufficient level of scientific detail to inform policy whilst at the same time being presented in a usable format, making them accessible to all stakeholders.
- One organisation felt they never feel that they need to duplicate any of the research undertaken under the DWI evidence programme, as the quality of research is sufficiently high.

4.4.1 Delivering to time

As shown in Appendix 2: Further information on methodologies, we used a basic scoring method based on the amount of time between end of project and publication date to produce a score for this criterion. Within the information accessible during the preliminary review, there was no evidence of any problems relating to the contractor delivering to time. The average score across all projects for delivering to time was 3.5 (see Table 9 in Appendix 3).

The additional information available for the in-depth reviews showed however that whilst many projects were completed to the timeframes initially stated, some were published before the proposed project end date and some had extensions given.

Delays in delivery that were identified during the review were due to:

- Draft reports being provided late and multiple rounds of comments between DWI and the contractor, in one instance an extension had to be provided, at no cost, to finalise the project. This extension was agreed in the January with the work anticipated to be finished by the December (the original end date was the July of the previous year).
- Limited data being available was another reason for time extensions; a small data gathering exercise needed to be conducted to fill a data gap in one project.
- Project delays being out of the control of the contractor, for example the impact of “purdah” in the run up to elections.
- Project start dates being delayed (however the delivery timeframe often managed to keep within the requirements set out).
- Short delays associated with particular tasks were also identified, although again this often did not have any adverse consequences on the timing of the overall project delivery.

One research project undertaken raised the difficulties found with regards to time within the project report: *‘It required considerable effort and negotiation with water companies to identify suitable sites and this led to a substantial delay in progressing the project’.*

4.4.2 Delivering to cost

The DWI indicated that they had no specific concerns with the performance of contractors for any of the projects. For this reason, all projects were scored a 5 for cost. However, one of the technical experts pointed out that the methodology for project WT02042 results in *‘an impact on delivery to time, cost and specifications – with most information being archived and difficult to locate this delayed the programme and increased costs’.*

Two projects out of the ten taken through to in-depth review had an approved increase in project costs. The reason for one of these cost extensions was because the project team had some unexpected findings and needed to undertake additional experiments to verify these and ensure that the results reached statistical significance. A third project file had evidence of a variation order being submitted to

increase the budget. However it was not clear whether this was accepted from the project files provided for this evaluation.

4.4.3 Delivering to specifications

Two was the lowest score for the 'delivering to specifications' subsection of this objective (two projects, 3%, scored a 2 or 2.5). Eight projects (11%) scored a 3 or 3.5 but the majority (64 projects, 86%) scored a 4 or above. The findings of the in-depth reviews suggested that most projects fully met the project objectives.

In a couple of instances the contractor went above the specified requirements, one example added an additional virus for assessment which was not specified in the original request.

Some contractors presented the reports very clearly, with discrete sections laid out and a structured conclusion. However, some projects lacked an easy to understand conclusion or summary. This was particularly the case for projects within the 'analysis' topic area. During the interviews a number of stakeholders emphasised the importance of having the research in an easy to read format. Generally it was felt that most of the research strikes the right balance between robust results and an accessible presentation. While most reports were clear and well-written, poor editing of reports was also seen in a few cases.

On occasions there were discrepancies between the objectives and the work delivered. In one instance this was stated to be because of *'unpredicted additional work and costs associated with the method development phrase'*. This led to less monitoring being carried out and the collection of only half of the data that was originally anticipated. Some of the other objectives in this particular project were also not completed. Additionally, some contractors failed to comment on, or provide explanation for data which varied widely from those found in literature or that was expected.

Regarding methodologies, the project team identified occasional inconsistencies between what was referred to within the report and the appendices; questionnaires for example. Methods were also sometimes altered as projects progressed. However the decision maker (contractor or DWI), could not be determined from the preliminary desk study.

The in-depth reviews revealed that some methodology changes made by contractors resulted in disappointment on the part of the DWI because of the expected decrease on the reliability and value of the work. In one particular instance a change in sampling approach altered the scope of the project. in a way that surprised the DWI. However, the development could not be rectified by the time it had become apparent. In this case the fault did appear to rest squarely with the contractor as there was no reason given as to why or how the approach changed. Consequently, a secondary piece of work had to be commissioned in order to fill the data gap because of the unforeseen methodology alteration. However, aside from this issue, this particular report did deliver against the original brief.

Other issues identified relating to methodologies included:

- A protocol defining sampling collection, extraction, analysis and turn-around times was agreed during the inception meeting for one project. However, those times were not met for all sampling rounds due to analytical problems with instruments and samples not being collected or sent when due.
- Execution of the research for another project did not adhere to the maximum storage times for samples as recommended by the US Environmental Protection Agency (US EPA).
- Another project was unable to report data for some compounds as 'they failed to meet analytical quality control standards on precision and recovery'.
- One report mentioned the possibility of contamination from the equipment used. This could have been avoided if it had been sufficiently accounted for in the risk assessment for the project.

The in-depth studies revealed that the DWI often took steps to improve the performance of contractors: some required much more correspondence and pushing from the DWI than others. This was needed to ensure that complex analytical issues were taken into account and that the final report would be of

the quality expected. This is likely to have applied more widely to other research projects which were not subject to in-depth review.

4.5 Fit with role/remit

For the preliminary desk study, this objective had one specified scoring criteria:

- Taking into account the role of others

An overall score was provided to reflect how each of the projects addressed this objective. The scores given were generally high, as indicated by Table 10 (see Appendix 3). Sixty three projects (85%) scored above a 4, ten projects (14%) scored a 3 or 3.5, and only one project scored a 2 (the lowest score for this objective).

Collaboration on projects seemed appropriate and there was no evidence of serious or systemic mismatch with remit, but a small number of projects were only partially about drinking water so would be relevant to other government departments and organisations.

The reviewers perceived that the contractor selected had a background in the topic and was a good fit for the work and sort information and collaboration where the project scope extended into areas where others were better placed to be involved.

For some projects, large amounts of data were sourced from other organisations. The expert reviewers felt that in some cases this might imply that the organisation supplying the data should have been a collaborator in the project. There was a general feeling that more collaboration could have been undertaken.

On the other hand, many projects involved contacting lots of relevant industry associations to gather information and also speaking to water companies which was seen as a positive thing and attracted a higher score. A project also scored highly for this subsection if the project involved stakeholders from different countries.

Projects also could have scored higher for this criteria if the contractor had carried out previous work in the subject area, or if those who carried out previous work were consulted.

It was noted on a few occasions that the work carried out was of significance to water utilities themselves, planners or environmental and economic regulators. As such, some of the funding for this work could have been provided by these different bodies.

4.6 Effectiveness of dissemination

For the preliminary desk study, the effectiveness of dissemination objective was broken down into three scoring criteria:

- Is the report available to those who need to see it?
- Was it covered by the DWI newsletter?
- Is it clear what happens next?

An overall score was provided to reflect how each of the projects fit to the effectiveness of dissemination objective. The overall scores for this objective as determined by the preliminary desk study showed that 52 projects scored a 4 or above (70%), 18 projects scored a 3 or 3.5 (24%), and four projects (5%) scored a 2 or 2.5 (the lowest score for this objective) See Table 11 in Appendix 3 for the full table of scores.

In the DWI project specifications it is stated that:

'It is Defra policy to publish all final project reports and the report from this project will be made available on both the Defra and DWI websites. Defra encourage bidders to publish findings in scientific journals but will always reserve the right to determine if and how results should be published'.

The interviews highlighted the importance that stakeholders attach to effectively feeding back the results of DWI research to a wide audience including water companies, local authorities and other relevant stakeholders, particularly given that DWI research supports public health. However, it was accepted that most members of the public will not necessarily have an interest in technical research and as such dissemination needs to be focussed. Identifying and improving the communication and dissemination channels with specific stakeholders such as the Environment Agency could improve the effectiveness of dissemination.

Stakeholders felt there were some ways in which the DWI research should not be disseminated, and some instances in which additional care should be taken. For example social media may not necessarily be an appropriate channel for highlighting DWI research as some of it can be sensitive. A balance needs to be struck between drawing attention to the results for informed stakeholders and not encouraging unfounded media speculation. The important thing is that the information is in the public domain and easily accessible by stakeholders:

'The most important thing is to get the research off the bookshelf and get it into the hands of those who can use it'.

It was however acknowledged that some reports may have restricted access due to their sensitive contents. In such circumstances it was considered important to ensure careful liaison with relevant organisations before publication.

The DWI does hold dissemination workshops. The attendance at these varies according to the focus of the research and the participants invited (for example some are held with local authorities, others with water companies and Water UK. Stakeholders considered workshops held after the annual report to be particularly useful as they provided an opportunity to be informed by the content of the report. The DWI also present research results in advisory meetings, such as the scientific committee meeting open to the public. Liaison with water companies is carried out every 3-6 months to make industry aware of any research and where to find it. Another stakeholder interviewee stated that:

'It would be more effective if the research or results of projects could be presented to its stakeholders to help them understand the implications of the research'.

One interviewee noted that *'some projects have involved the DWI producing information letters to the industry as a way of rolling out the research findings'*. On occasions, guidance has been provided to industry based on DWI research outcomes, indicating how industry should approach certain issues. This has included information letters sent regarding research on nitrosamines in water treatments, coagulants and drinking water, and pharmaceuticals in raw and treated waters.

Significant improvements have been seen with regards to dissemination, for example the introduction of the newsletter (discussed further in section 4.6.2). Some stakeholders nonetheless felt that there is scope for improving how the DWI makes its research available and for the DWI to be more proactive in the dissemination of research. This is highlighted by the fact that the DWI is sometimes approached by water companies who are not aware of research that has been carried out.

Some stakeholders underlined the importance of engaging with research managers at water companies, adding that such individuals should be added to the mailing list and possibly also involved in the external stakeholder meeting. Some recommended that a mechanism could be developed with Water UK to promote and disseminate research through their network. One suggestion for improvement was that DWI could present their research results at more conferences to reach out more to the wider scientific community.

It was stated in the interviews that previously there have been workshops held, with industry present, where contractors gave feedback to DWI on the project carried out. Some stakeholders recommended that, where possible, this should be made standard practice for contractors when procuring the research contract.

A handbook for assessing the impact of a radiological incident on levels of radioactivity in drinking water and risks to operatives at water treatment works was produced by the Health Protection Agency for one project; this was seen as particularly good dissemination. Another report (Water safety plan manual: Step-by-step risk management for drinking-water suppliers) by the World Health Organisation was published in six different languages (English, Arabic, Chinese, French, Russian, Spanish), making this resource accessible to a much wider audience.

4.6.1 Is the report available to those who need to see it?

The accessibility of the reports varied. Some are freely available on the DWI website and some are held on external websites. Most of those held on external collaborator websites can be downloaded free of charge, but sometimes only for quite a substantial fee (ranging from £100 to £500). For two of the 76 project reports, it seemed that the final document was unable to be downloaded even at cost. These different stages of accessibility were taken into account by the scoring methodology for this section (see Appendix 2: Further information on methodologies).

The following sentence was found in some reports: 'RESTRICTION: This report has the following limited distribution'. This may have limited the dissemination potential of some projects. It is acknowledged by stakeholders that this may be necessary in some instances due to political and commercial sensitivities or to reduce the risk of uncontrolled release resulting in unfounded speculation within the public domain.

Some stakeholders felt that the DWI website can be cluttered and it is sometimes difficult to find particular research. Other stakeholders felt that, given the ground-breaking nature of some of the research carried out under the DWQH evidence programme, the results should be given wider circulation than just the DWI website. The website itself was not particularly well known, especially outside of the UK. One interviewee, for example, stated that whilst his contacts in the USA considered the DWQH research to be very good, they would never have come across it without being told about it. The DWI should use their contacts and networks around Europe and the world to disseminate research. However there may be difficulties in justifying the investment of time to do this.

4.6.2 Was it covered by DWI newsletter?

The scoring in this section in the preliminary study was somewhat binary. Where a project was covered by the DWI newsletter, it was awarded a score of 5 and where it wasn't it was given a score of 1. Therefore the closer the score is to 5 for 'was it covered by the DWI newsletter' in Table 11 (see Appendix 3), the higher the number of projects within the topic area that were featured in the newsletter. Likewise a score closer to 1 indicates that a larger proportion of projects within this topic area did not appear in the DWI newsletter.

The DWI newsletter was introduced in 2008 to raise awareness of the research being carried out. The newsletter can be found on the DWI website and is also circulated to an email address list. This list began as the main stakeholders who were invited to meetings to discuss research ideas, but it has since grown to include anyone who has requested to be notified when the newsletter is published. A notification email is also sent to an identified contact in all the water companies when a newsletter is published to allow them to disseminate as appropriate.

Several of the stakeholders interviewed were not aware of the DWI newsletter. This is disappointing and indicates that more needs to be done to promote this resource.

Of the projects reviewed, a total of 59 (80%) were covered by the DWI newsletter, with 15 projects (20%) not covered. The majority of these pre-dated the newsletter and covered the following issues:

- 3 = Chemical Risk
- 1 = Consumer
- 4 = Cryptosporidium / Giardia
- 1 = Microbiological Risk
- 2 = Other
- 1 = Premise Risk
- 2 = Reg 31 materials

This explains the particularly low score for the Cryptosporidium / Giardia typology as four of the five projects within this section were published prior to the introduction of the newsletter.

The one project report not currently published, WT1275 'National assessment of the risks to water supplies posed by low taste and odour threshold compounds' is due to appear in a forthcoming edition of the newsletter. .

Whilst many of the reports score highly on this subsection of objective 4, it has been noted that some of the links to the project reports in the DWI newsletter do not work; two examples of this are WT1209 and WT1252. Links from the DWI website have also been flagged as not working in a couple of instances. We recommended that checks are carried out to ensure the functionality of these prior to publishing.

The in-depth reviews indicated that the format and wording of the project summaries in the DWI newsletter makes the research more accessible and appropriate for wider public dissemination. Most stakeholders felt that the newsletter is a useful tool, some noting that other government departments also circulate it to stakeholders. However, it was felt that while those who are aware of the newsletter will go to it to find out information, there are many who would find the information useful who are unaware of its existence.

Private water suppliers are thought to find the DWI newsletter particularly useful because they will gain information on specific substances that they encounter when sampling.

It is recommended that more frequent and more easily digestible email communications might be more effective in encouraging recipients to read the communications. These could be sent around to the relevant professionals as the research is published (with the final report attached).

4.6.3 Is it clear what happens next?

Thirty nine projects (53%) scored a 4 or above for this objective in the preliminary study. Twenty projects (27%) scored a 3 or 3.5, nine projects (12%) scored a 2 or 2.5, and six projects (8%) scored a 1 or 1.5.

Examples of what would have received a high score for this criteria include:

- DWI writing to water companies asking them to obtain more data as a result of a project
- The project including clear suggestions for future research with plenty of detail on how this could be carried out.

However it is sometimes not apparent as to whether such suggestions for further work were taken forward. For example, one project advised that seminars should be hosted each year.

4.7 Value for money

For the preliminary desk study, the value for money objective was broken down into two scoring criteria:

- Were opportunities for collaboration taken?
- What is our assessment of the cost for the work delivered?

An overall score was provided to reflect how each of the projects addressed the value for money objective (see Table 12 in Appendix 3). Three projects (4%) scored a 2 or 2.5 as an overall score. Fifteen projects (20%) scored a 3 or 3.5, and 56 projects (75%) scored a 4 or above. During the preliminary review our assessors scored projects as representing good value for money if for example they provided conclusions that would enhance understanding or lead to legislative/policy change or the creation of a useful tool. Outputs found to be particularly good value for money were handbooks presented in several languages to support the multicultural community in the UK and a spreadsheet tool which allowed water companies to vary parameters and produce business cases for different options

We found it difficult to draw conclusions on value for money. However stakeholders generally felt the programme appeared to offer good value for money.

4.7.1 Were opportunities for collaboration taken?

Of the 74 research projects examined, 23 had formal collaboration. Two examples of wide collaboration include projects WT1259 and WT1223. The former was led by WRc, with collaborators including Defra, Environment Agency, Natural England, Scottish Environmental Protection Agency, The Water Services Regulation Authority (Ofwat), and the Water Research Foundation (WRF). The latter also had a range of collaborators, including the Consumer Council for Water (CC Water), Environment Agency, WaterUK, Defra, Natural England and Welsh Assembly Government. The lead contractor for this project was Ofwat.

Smaller groups of collaborators were also seen, e.g. between NSF international and WRc, between Imperial College and the University of Reading, between UKWIR, Atkins Limited and the University of Abertay, and between the WHO and the International Water Association (IWA).

The DWI collaborated on three projects for which WHO were the lead contractor, five projects for which UKWIR were the lead contractor, and eight projects for which WRF were the lead contractor. Projects led by these organisations are likely to be good value for money as they bring together expertise from different organisations, often including experts from different countries as well. The DWI also collaboratively funds research with these three organisations. It was not possible to identify any collaborative opportunities that may have arisen from partnership arrangements in alternative tender proposals from the information provided in the project files.

4.7.2 What is our assessment of the cost for the work delivered?

During the preliminary desk study some project reviewers felt that a small number of projects seemed to offer such good value for money that they queried whether the costs of the project was fully divulged. Some collaborative projects in particular came into this category (e.g. jointly commissioned research), given the number of report outputs, collaborators involved or the volume of data handled or analysed. But from the information available it was not possible to judge how much of the funding had been provided by the collaborating organisation(s). One expert note that in collaborative projects with the WHO or UKWIR it was often not clear who had contributed to the work. Collaborative projects with the American Water Works Association Research Foundation (now more commonly known as Water Research Foundation, WRF) were generally clearer on this.

4.8 Other Findings

A number of other issues arose during the stakeholder interviews and in-depth reviews. These are discussed below.

4.8.1 Selection of research topics for the DWQH programme

The selection of research projects to be included in the DWQH programme are scored against the objectives in the ROAME statement and now the Drinking Water Quality and Health Evidence Plan by a selection panel led by the DWI. The research provides a good basis for bringing forward ideas and information related to water quality.

The DWI liaise with UKWIR to co-ordinate projects; it was suggested that earlier involvement would further reduce the chances of overlap. Most stakeholders interviewed considered that there was little or no overlap with research conducted by other organisations. However one stakeholder referred to instances of duplication of effort, some of which had been nipped in the bud by subsequent tailoring of project scope so that work was ultimately complementary. Such complementarity worked particularly well in some instances, e.g. where phase 1 was carried out by DWI and then UKWIR undertook sampling on behalf of the industry in phase 2. Another stakeholder referred to some overlap with university research within the interviews, but this was viewed as a positive, commenting '*broadens the basis of British Science*'; and '*compliments university research as it takes a different approach/focus*'.

The following comments from interviewees demonstrated support for the current selection of research topics:

- *'Recent research topics have been chosen that are topical and useful to the DWI, government and other stakeholders now and in the near future. Most recent and relevant topics have included work on pharmaceuticals in water and toxins from bracken in water'.*
- *'DWI have been very good at looking at areas that may become issues in the future and planning projects accordingly'.* This has been particularly useful for Defra as DWI's research has been concluded just at the time that Defra needs the information for its own projects.
- *'DWI have covered quite extensively all the areas that need to be covered'.*
- *'DWI are excellent at spotting potential topics, particularly from outside the UK experiences'.*
- *'DWI do very well to fill any knowledge gaps. They often spot areas that have been an issue in Europe and look into it before it becomes an issue in the UK'.*
- *'DWI research is the first point of call when looking for research on a particular area of drinking water'.*

However, water industry representatives suggested in their interviews that the DWI could be better at exchanging views between the DWI and UKWIR at an earlier stage, i.e. before the project topics have been decided on.

There are certain topics associated with water quality where it is not clear to stakeholders as to the limits of the DWI's remit and responsibility, e.g. on what happens within buildings and issues associated with fittings, plumbing and health and safety. This is also the case with some Environment Agency issues. It is therefore recommended that efforts are made to define and communicate these roles and remits.

4.8.2 Outcomes of the DWQH evidence programme

Under the ROAME Statement the DWQH evidence programme is expected to inform policy or technical decisions within the water industry.

One stakeholder noted the following:

'The DWQH has informed policy or technical decisions, an example from the water industry would be the disinfection by-products research by DWI. This research has triggered a large piece of research at UKWIR including:

- *A PhD studentship at Cranfield; and,*
- *Water companies to look at widening the scope of what is included in their sampling programmes.*

In this instance, from the DWI research UKWIR saw a gap in knowledge and continued the research. The DWI research results outlined what the scope of the problem might be but didn't quantify it; this highlighted it to UKWIR who went on to do further research.

Another stakeholder welcomed the research carried out on lead which was done in parallel with UKWIR and which had influenced the development of the Welsh Government Water Strategy. However this had only been picked up indirectly. Whilst the DWI invites key stakeholders to research ideas meetings, this suggests there is room for further improvement on communications and engagement.

Other stakeholders commented that:

- *'DWI research has been used when there is a query on water quality and through using the research it has proven there is not a problem which is just as useful'.*
- *'DWI research has supplied the background evidence to regulatory issues'.*
- *'From DWI / WRc research they produced standards on PSOS and PSOA. Similarity NDMA research produced tiered standards'.*
- *'Perhaps at a first glance it may not be immediately apparent what the research is trying to achieve...However, when set in context, the value of the research becomes apparent and the programme as a whole is seen as effective'.*

4.8.3 Stakeholder Engagement

DWI representatives interviewed indicated that there can be difficulties in the process of identifying areas of research that fit within the DWQH programme. The current approach seeks to identify research topics through both internal and external engagement. Internal annual workshops are held for the DWI staff, with interactive sessions. These are opportunities for all staff to get together and generate ideas, for example from the issues that have faced inspectors during the year.

Annual meetings are then held with a range of stakeholders, including EA, FSA, and PHE, and also other departments within Defra. This meeting is similar to the internal one; presentations are given and feedback is provided on areas where research should be carried out. One challenge is that external stakeholders tend to focus, understandably, on areas relevant to their interests and remit, which may not always fit the remit of the DWQH evidence programme. This can include operational issues for water companies which the companies themselves could fund, such as optimisation of treatment processes. The DWI is reluctant to invite consultants and academics to these meetings given their vested interest.

The DWI also have regular meetings with stakeholders such as the Welsh Government, UKWIR and WaterUK. Some interviewees indicated that whilst there was communication with Local Authorities through the Institute of Environmental Health, representation tended to be very South East focused and there needed to be engagement with representatives from other regions who have to travel further.

The DWI have informal meetings with other stakeholders, including contractors (eg WRc) but an interviewee recommended that it could be beneficial to make this a formal regular event including other organisations and other technical experts / scientists.

Stakeholders generally perceived their relationships with the DWI to be strong and generally felt that their views and ideas were represented in the evidence programme. They felt that this level of stakeholder involvement should be at least maintained, and preferably increased. In particular some felt that there were opportunities for further interaction with the water industry.

4.8.4 Role of the DWI in the DWQH evidence programme

A small number of projects threw up significant issues. However, the documents provided show that DWI handled these well, clearly recording and documenting all correspondence. When responding to contractors' draft research reports and project questions, the DWI team invited comments from relevant colleagues in different parts of Defra and collated these so that they could give feedback to contractors in a single document. The internal communication within the DWI and more widely between the DWI and Defra was felt by both to be excellent. Communication with contractors was seen to be extensive and well documented; and was an asset to the projects.

The in-depth reviews provided positive appraisal of the DWI project officers. The review team considered them very experienced with the subject matter and they were generally actively involved in all stages of the project. This involvement meant that in many cases the project officers were able to address issues as they arose and in most cases mitigate any future problems. A typical view from an expert reviewer was that *'the project manager identified those issues and worked with the contractor to find acceptable solutions'*.

Project officers also made a valuable contribution to final reports, providing comments and suggestions for improvements. However, one contractor did state that there is some variation in project management depending on the work load of the officers and their area of expertise and interest; more senior staff often have less time to dedicate to project management. The DWI have recently put effort into ensuring consistency between project managers to increase the quality of project management across the DWI; an approach recommended by some contractors interviewed. A further suggestion for improvement by stakeholders was to ensure the same project manager from the planning stage right the way through to the end of the project. This would allow for more ownership and care for the project and would help to ensure high quality, consistent standards.

One contractor interviewed particularly welcomed the DWI's project management style, under which they felt they were provided with enough freedom to progress with the research and were only required to report back as and when required, rather than at set periods.

4.8.4.1 Tender process

Regarding the tendering process, expert reviewers questioned whether inviting a low number of contractors to tender (for example three from ten expressions of interest) would limit the ultimate selection options, should only one or two of the invited contractors submit a full tender. Some stakeholders also referred to the bureaucracy inherent in the tendering system, which often created delays in getting projects up and running. Getting funding in place could also be a slow process. Improving the speed of the tendering process was suggested as a mechanism to help the programme run more effectively.

However, others felt the tendering process used was very effective with the quality of bids submitted being extremely high and the process used to evaluate them sufficiently rigorous and appropriate. One interviewee stated that:

'Research was awarded to specialists and academic experts in their fields who were very competent and ensured quality for research was high'.

All tenders are independently scored and critiqued by three different people, ranked, and then considered against cost. However, this evaluation method is not always clear to contractors. Some stakeholders also felt that the tendering and evaluation process seems to change regularly which can be quite confusing to potential contractors. The fact that contractors are able to ask the DWI questions during the tendering process was however seen to be very helpful.

One project that was taken through to in-depth review was a single tender action. The DWI explained that the use of an STA was considered necessary in this case because of the specialist knowledge and quick response to an outbreak required.

Stakeholder consultation indicated that challenges have occurred as a result of the devolution of powers within the UK. The DWQH programme needs to consider the implications carefully and consult fully when making future decisions associated with the content and direction of the DWQH.

The review process identified some projects where funding was increased to extend the scope of the work. Some contractors felt that there could be scope for improving the bid guidance, in particular clarification around the possibility of any additional funding and how bids should be structured to reflect this. This would allow the proposal to provide an indication of the cost and additional tasks which could be included to assist the project in meeting objectives. From the information available for this review it was not possible to ascertain as to whether successful bids included options of further work in their proposals.

5 Future evidence programme

As part of the review process, consideration has been given to the direction and future of the DWQH evidence programme addressing the following objectives:

- Wider technical or policy implications that warrant consideration in future evidence programmes;
- The future scale and development of the DWQH evidence programme

5.1 Technical or policy implications

The Drinking Water Quality and Health Evidence Plan 2013⁸ document sets out the expectation that the strategic positioning of the evidence programme “*will be an important consideration during this current review period, particularly in relation to the overall national programme of research on issues relevant to the drinking water policy.*”

Government reform and the devolution of powers to individual countries of the UK may also influence the future objectives of the DWQH evidence programme. The previous government, under the overall priority of “helping to enhance the environment and biodiversity to improve quality of life” had sub-priorities to “Improving human health and well-being” and “achieving a more sustainable balance between demand for and availability of water, with improving water quality” this manifests itself in the Defra policy priorities of “maintaining high standards of drinking water” and “improving water quality”. These priorities may be subject to change under the current Government.

The proposed review of the EU Drinking Water Directive is also likely to further direct the remit and priority topics for the future DWQH evidence programme.

An interviewee from the DWI raised the point that *‘it is more difficult to have a longer term plan for the research and take a more strategic approach because drinking water is much safer nowadays than in the past.’* It was stated that *‘nowadays the focus of research is about responding to drinking water issues as and when they arise.’*

5.1.1 Research Gaps

As discussed previously in section 3, the evidence programme during the review period covered 76 projects across 10 broad topic areas ranging from chemical and microbiological risks to distribution and consumer behaviour. The selection of research and evidence projects for the previous review period may have influenced the topic selection, taking into account recommendations for further evidence to support and verify findings from the 2006⁹ review which evaluated 71 projects, classified under the following topics:

- Chemical content: 27
- Economic content: 7
- Microbiological content: 39
- Cryptosporidium: 19

The review team undertook a brief analysis of the research topics covered in 2005-13 against the research criteria and the specific issues mentioned in both the ROAME statement and the Drinking Water Quality and Health Evidence Plan 2013 the results are detailed in Table 5.

⁸ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221072/pb13914-evidenceplan-drinking-water-quality.pdf

⁹ Watts C, Fawell J, Sartory D, Leaman J and Tuffin A (2006) Evaluation of the Drinking Water Quality and Health (DWQH) Research Programme (1996-2004) for Defra, Defra Project Code: DWI 70/2/188

Table 5: Assessment of possible research gaps.

ROAME Criterion	Issue (as mentioned in ROAME statement and 2013 revision)	Example	Research projects 2005-13	No. of projects
1. Development and implementation of national and European legislation	Radon, tritium etc		WT02050	1
	Annex 1 – Parametric values			0
	Annex 2 - Monitoring		WT1207	1
	Annex 3 – Specification for analysis of parameters		EAS GCMS report (unnumbered)	1
	Other		WT1257	1
Total				4
2. Assessment of the emerging risks to public health	Perfluorinated chemicals		WT02044	1
	Other chemicals e.g. NDMA, BFRs		WT02049/WT1217, WT1206, WT1208, WT1261	4
	Disinfection by products	Haloacetic acids	WT02051, WT1237, WT1236	3
		Nitrosamines	WT1238, WT1219, WT1256	3
		THMs	WT1212, WT1220	2
		Other	WT02030, WT1224, WT1228, WT1204	4
	Pharmaceutical residues		WT02046, WT1222	2
	Pesticides		WT1221, WT1264	2
	Endocrine disruptors		WT1253	1
	Veterinary medicines		WT1218, WT1274	2
	Nanoparticles		WT1239	1
	Chromium VI			0
	Lead intake		WT1277	1
	Manganese		WT1266	1

ROAME Criterion	Issue (as mentioned in ROAME statement and 2013 revision)	Example	Research projects 2005-13	No. of projects
	Other metals, e.g. nickel, molybdenum		WT02047, WT02062	2
	Pathogens	Viruses	WT02039, WT1227	2
		Cryptosporidium	WT02031, WT02035, WT02055, WT02056, WT1226	5
		E coli 0157	WT02059	1
		Other	WT02037, WT1215/WT1268	2
	Toxins		WT02058, WT1209, WT1235, WT1249	4
	Effects of tap water on skin function		WT1248	1
	Water hardness		WT02040	1
	Effect of UV on chemical composition			0
	Microbial growth testing		WT1252	1
	Private supplies			0
Total				46
3. Contributing to and influencing the international evidence base (WHO)	Water Safety Plan approach		WT02043, WT1213	2
	Other WHO issues		WT02053	1
	Other public health		WT02028, WT1263	2
Total				5
4. Ensuring evidence-based support to the operation and development of UK water industry	Price review		WT02064, WT1210, WT1223	3
	Security threats			
	Monitoring, methods of analysis		WT1282	1
	Contact materials		WT02042, WT02063	2
	Consumer perceptions		WT02060, WT1214, WT1216,	6

ROAME Criterion	Issue (as mentioned in ROAME statement and 2013 revision)	Example	Research projects 2005-13	No. of projects
			WT1233, WT1255, WT1275	
	Desalination		WT02061	1
	Water pressure		WT1205, WT1246	2
	Emergency events		WT1260	1
	Other		WT1211	1
	Phosphate dosing		WT1250	1
	Catchment management		WT1259	1
	Total			19
	Overall Total			74

The findings indicate there is a close match between the research carried out and the ROAME statement and its 2013 successor. The only significant gaps relate to Chromium VI, the effect of UV on chemical composition (which may be an extension of the disinfection by-product issue, which is well covered) private water supplies and security threats. It was noted however, that it may not be appropriate for all papers on security issues to be in the public domain, for example if the term security related to terrorist threats rather than security of supply through improved water efficiency.

It is recommended that the DWI consider firstly whether any of the issues without publications during 2005 – 2013 programme would benefit from further research going forward. Secondly, it is recommended that the DWI should review recommendations from each project report to determine whether sufficient research has been completed in relation to the issues listed in Table 5. Relevant and high priority recommendations should be taken forward in a future evidence programme.

5.1.2 Emerging and ongoing issues

Through the review process and from feedback received from the stakeholders interviewed, a number of topics were suggested for consideration for inclusion in the DWQH evidence programme. The topics were identified either because they are an emerging issue which may threaten the quality of drinking water, or because of the need for ongoing monitoring to maintain the knowledge base associated with the risk to water. The influence of evidence and new technologies from overseas research and the WHO may also drive future research topics. Finally there is also a need to consider the interaction of implementation advice across different topic areas to ensure sustainable and robust management guidelines and policies taking account of synergies as well as potential policy conflicts or contradictions. Table 6 provides examples of possible future topics which were identified as part of the review.

Table 6: Recommendations for future topics for the DWQH evidence programme

Topic area	Issue
Emerging Issues	Personal care products
	Biocides
	Shale gas extraction (fracking) and the risks posed by the use of chemicals in hydraulic fracturing fluids; safe treatment and re-use/disposal of waste water; risks posed by surface transportation, handling and storage of fluids; potential impacts of shale gas on water resource management.
	Hydrocarbons
	Climate change impacts on biological and chemical water quality and water availability
	Chemical mixing (Most research looks at the toxicity of a specific chemical when found alone but in reality chemicals are mixed with other chemicals which might have an influence on their properties / safe levels. How chemicals interact with and influence other chemicals found in drinking water requires more detailed investigation.
	An investigation of the significance of internal lead plumbing and whether it is potentially a problem now or in the future.
	Are there alternative treatments to treating lead with phosphate and what would the environmental and economic impacts of alternative treatments be?
	Disinfectant by-products
	Water safety plans
Ongoing monitoring and risk assessment	Impacts of naturally occurring geological chemicals Impact of natural geology on chemicals in water. Some areas of the country e.g. Cornwall have naturally high levels which can be a problem.
	Monitoring of arsenic and fluoride in private supply
	Water infrastructure investment and maintenance and the impacts on water quality. (Economic cost: benefit study which considers the conflict of interest between investment and maintaining of water quality in relation to meeting EU legislation.)
	Radioactivity survey for private water supplies
	Evidence to support the regulation of the bottling of drinking water to avoid contamination and public health risks
	Microbial and chemical risk assessment for example: The usefulness of clostridium as an indicative parameter
	Review
Intelligent water systems e.g. smart metering, real time sensors, and real time data so that the system works more efficiently.	
Achieving 100% compliance on health based standards - is this feasible, financially viable and the best use of resources?	
Potential effect of UV treatment on the taste of water	

Topic area	Issue
<p>Interactions between different risks and the regulation and advice provided</p>	<p>Simultaneous compliance - This could include investigating the range of regulations that Defra puts in place and understanding the trade-offs between e.g. bacteria control and disinfectant by-product formation.</p> <p>Sustainability in water treatment and operation - For example the trade-offs between more stringent water treatment and the impacts that this has on energy consumption and carbon emissions. Wither ever more stringent regulations comes the responsibility to look at trade-offs in the sustainability of processes that are necessary to achieve compliance.</p> <p>Water supply challenges / water resource diversification - Water quantity is becoming an ever more pressing issues for water companies. This is an international issue but also seen in water stressed area of the UK such as the South East of England. Research could focus on non-traditional water sources (e.g. grey water reuse, desalination, and reuse of municipal waste water) and how water companies could use this and whether policies would support or prove a barrier to alternative water sources.</p>

5.2 Future scale and development

The evidence programme received positive feedback from both stakeholders and the expert review team as part of this project. The programme is well managed and in general delivers appropriate quality science in support of the DWI’s objectives.

In recent years the interaction and involvement between the DWI and private water supplies has increased which is considered a positive development and should continue in future programmes. One stakeholder recommended a focus on ‘*Research that supports a more proactive framework in which regulators and water companies can work collaboratively to optimise water provision*’. Stakeholders also indicated that developing the programme from a more strategic perspective would add value. For example: the development of health-based regulation and adopting a UK position on this ahead of any EU revisions to the drinking water directive would be of benefit in planning appropriate evidence review.

The potential research areas identified in section 5.1 are extensive and cover a wide range of the programme objectives. It was suggested during the interview process that prioritisation and a clearly defined strategy for identifying new areas would improve the process. There are challenges in getting new areas to fit with the remit and avoid repetition of work, and a clearly defined strategy may help to address these. Section 5.1 provides suggestions for areas of focus of this strategy. As part of this strategy engaging with a wider range of stakeholders would provide additional insight into relevant topics (for example, Public Health England and its counterparts in Devolved Administrations).

In view of the DWI’s responsibilities, future research needs to be relevant across the UK. The ease of this has reduced in recent years due to the formation of national Governments and Assemblies in Scotland, Wales and Northern Ireland. It may be appropriate to review the stakeholder engagement to ensure that a full representation is included when developing the evidence programme going forward.

The introduction of the DWI newsletter has been a valuable mechanism to improve and increase the dissemination of the programme reports. Further improvements could be made by the introduction of workshops and events to present research findings, and by taking steps to raise stakeholder awareness of the DWI newsletter. Increasing networking and communication channels to raise awareness of the DWQH evidence programme and the type of evidence and research it covers would also be valuable.

6 Conclusions and Recommendations

6.1 Conclusions

The review of the DWQH evidence programme for the period 2005 and 2013 confirms that it meets the objectives as set out in the ROAME statement and the Drinking Water Quality and Health Evidence Plan 2013.

The evidence programme is a significant support mechanism to the development and implementation of policies and water regulations in the UK. The programme provides particular emphasis on the protection of public health through maintaining water quality, with 46 out of the 76 projects in the review period related to this topic area in some form. As the DWI acts as a collaboration centre for the WHO, the evidence programme is well placed to integrate research to support and enhance the knowledge base on a global scale as well as at a UK and European level.

The research carried out has in almost all respects been of good quality with only minor issues identified from the review process. Many of the research projects met several of the policy objectives, but those which only met single elements were not necessarily of poor quality because the nature of the topic was standalone and warranted research and analysis in its own right. For example many of the projects within the chemical risk category met all policy objectives, whereas the projects within the distribution category tended to focus on providing support to the UK water industry.

The scientific quality of the projects reviewed was considered to be of a high standard with nearly two thirds achieving scores of 4 and above. Some weaknesses in this area were associated with the development and delivery of methods and the strength of confidence in the findings. However some of the latter can be attributed to limit data availability.

With the introduction of the DWI newsletter and some focused workshops, the dissemination and awareness of published research has increased. A wider range of bodies are informed about the evidence programme, in addition to the key stakeholders involved with the programme. Stakeholders however did indicate that there was further room for improvement to raise awareness of research, ensuring that it reached specific and appropriate audiences through proactive engagement with additional stakeholders.

On the whole projects appeared to deliver to time and cost and were perceived to be good value for money. However, the information available did not always make the costs of the work transparent, especially where collaboration was involved as the funding sources were not necessarily clear.

6.2 Recommendations

There are some aspects of the programme which could be improved and this report makes the following recommendations for the ongoing DWQH evidence programme:

1. To mitigate against the risk of poor method design and implementation, the DWI should ensure it has processes in place to review the method proposed and ensure that it is adhered to or that discussions take place if issues arise.
2. The DWI should review the communication plan for the DWQH evidence programme to ensure that the most appropriate people are invited to stakeholder engagement meetings and receive information about and are consulted on the programme.
3. The DWI should develop a framework for reviewing the recommendations of previous research. The aim of this review would be to determine whether sufficient research has been completed in relation to the issues set out in the Drinking Water Quality and Health Evidence Plan 2013 or whether additional research is needed.
4. The DWI should consider the recommendations for future research topics identified as part of this evaluation process and set out in Section 5.1.2.
5. Whilst the DWI currently has mechanisms in place to identify international evidence programmes, this could be strengthened to improve the identification of research opportunities and new information from other experts worldwide.

6. The DWI should establish an expert Steering Group to assist with identification of potential new research areas and also with dissemination of existing research from the programme.
7. The DWI should provide a supporting summary document or resume covering the aims, objectives and outputs for all projects. This could be drafted by the contractor and could help improve knowledge of work being undertaken, as well as providing the basis for the text to go into the DWI newsletter.
8. The DWI should take steps to raise stakeholder awareness of the DWI newsletter. Stakeholders may not appreciate that the newsletter is primarily a means of disseminating research information. One option could be to rename or rebrand the newsletter as “research highlights,” or a similar name, to make its scope and purpose clearer.
9. The DWI should ensure that appropriate use is made of social media to raise awareness of new research publications while minimising the risk of project headline findings being taken out of context and misinterpreted.
10. The DWI should make feeding back the research findings to stakeholders a deliverable for all projects where possible (some already include a workshop or seminar in addition to the report, delivered by the contractor). Dissemination of research becomes a lower priority after it has been completed. Ensuring it happens within the project cycle and by the contractor will ensure it is fed back in a more proactive way.
11. The DWI should formalise the consultation and communication processes with stakeholders on tender selection, where there appears to be some confusion and uncertainty at present
12. To ensure the scientific quality and calibre of proposals submitted during the tendering process it is recommended that the tender period is extended from four to six or eight weeks.

Appendix 1: Full list of projects carried out under the DWQH evidence programme between 2005-2013

Publication Year	Report Title	Project ID & File Ref		Lead Contractor
2014	National assessment of the risks to water supplies posed by low taste and odour threshold compounds	WT1275	70/2/281	Cranfield University
2014	Speciation of manganese in drinking water	WT1266	70/2/276	WRc
2013	Assessing the likelihood of selected veterinary medicines reaching drinking water	WT1274	70/2/286	ADAS
2013	An analysis of water company raw water monitoring data for 2009-2011	WT1282	70/2/284	ESI Ltd
2013	Potential Contaminants in Drinking Water Treatment Chemicals	WT1261	70/2/272	WRc
2013	Brass fittings – a source of lead in drinking water?	WT1277	70/2/287	UKWIR
2013	Understanding the changes in pesticide usage to inform water company risk assessments	WT1264	70/2/274	ADAS
2013	Viruses in raw and partially treated water: targeted monitoring using the latest methods	WT1227	70/2/234	Hyder
2012	Monitoring of Nitrogenated DBPs in drinking water	WT1256	70/2/268	Imperial College
2012	Health-Based Targets for Drinking-Water Safety and Regulation	WT1257	70/2/264	Univ of North Carolina - Chapel Hill
2012	Probabilistic modelling for assessment of exposure via drinking water	WT1263	70/2/273	Cranfield University
2012	Validating the cause of coliform failures in drinking water	WT1268	70/2/279	UKWIR
2012	Quantifying the benefits of water quality catchment management initiatives	WT1259	70/2/269	UKWIR
2012	Tap water drinking behaviour: a study of children aged 0-15	WT1255	70/2/251	Ipsos-Mori
2012	A review of latest endocrine disrupting chemicals research implications for drinking water	WT1253	70/2/266	Cranfield University

2012	investigation into the potential formation and removal of nitrosamines in drinking water treatment	WT1219	70/2/239	WRc
2012	Health impacts from extreme events water shortages	WT1260	70/2/263	Health Protection Agency
2012	Potential Optimisation and Improvement of the Mean Dissolved Oxygen Difference (MDOD) Test to Assess the Ability of Non-Metallic Materials of Construction to Enhance Microbial Growth	WT1252	70/2/259	WRc
2011	Alternatives to phosphate for plumbosolvency control	WT1250	70/2/260	UKWIR
2011	An Investigation of Leaching from Flexible Rising Mains Leading from Borehole Pumps	WT1211	70/2/225	WRc
2011	Desk-based study of current knowledge on veterinary medicines in drinking water and estimation of potential levels	WT1218	70/2/235	Food & Environment Research Agency
2011	Investigation of Instances of Low or Negative Pressures in UK Drinking Water Systems	WT1243	70/2/245	WRc
2011	A review of fungi in drinking water and the implications for human health	WT1249	70/2/255	Bio Intelligence Service
2011	A Review of Skin Irritation and Tap Water Quality	WT1248	70/2/257	WRc
2011	Review of the risks posed to drinking water by man-made nanoparticles	WT1239	70/2/246	Food & Environment Research Agency
2011	Evaluation of Haloacetic Acid Concentrations in Treated Drinking Water	WT1237	70/2/253	WRc
2011	Targeted monitoring for human pharmaceuticals in vulnerable source and final waters	WT1222	70/2/231	Food & Environment Research Agency
2011	Analytical Methods for Predicted DBPs of Probable Toxicological Significance	WT1204	70/2/224	Water Research Foundation (ex AWWARF)
2011	Improving communication on Cryptosporidium and 'Boil Water' notices: Lessons from Pitsford	WT1233	70/2/244	King's College, London
2011	Water safety in buildings	WT02043	70/2/189	WHO

2010	Review of the current toxicological and occurrence information available on nitrogen-containing disinfection by-products	WT1238	70/2/243	Imperial College
2010	Ptaquiloside & other bracken toxins: A preliminary risk assessment	WT1235	70/2/237	Food & Environment Research Agency
2010	Investigation of the taxonomy and biology of the <i>Cryptosporidium</i> rabbit genotype.	WT1226	70/2/241	National Public Health Service, Wales
2010	Chlorine taste & odour contacts and chlorine levels or variability	WT1228	70/2/238	WRc
2010	A Desk Study on Pesticide Metabolites, Degradation and Reaction Products to Inform the Inspectorate's Position on Monitoring Requirements	WT1221	70/2/232	Food & Environment Research Agency
2010	A review of the current knowledge on dermal and inhalation toxicity of regulated THMs	WT1220	70/2/230	WRc
2010	Significance of Methods and Sample Volumes for E.coli and Total Coliform Measurements	WT02059	70/2/206	AWWA Research Foundation
2010	Contaminant Risk Management Communication Strategy and Tools	WT02060	70/2/207	AWWA Research Foundation
2010	Contaminant Candidate List Viruses: Evaluation of Disinfection Efficacy	WT02039	70/2/187	AWWA Research Foundation
2010	Methods for Measuring Toxins in Finished Water	WT02058	70/2/205	AWWA Research Foundation
2010	Impacts of Lining Materials on Water Quality	WT02063	70/2/209	AWWA Research Foundation
2009	Evaluation of Haloacetic Acids Concentrations in Treated Drinking Waters	WT1236	70/2/242	Cranfield University
2009	The formation and occurrence of Haloacetic Acids in drinking water	WT02051	70/2/194	Imperial College
2009	Review of the current toxicological and occurrence information available on iodinated disinfection by-products	WT1224	70/2/233	WRc
2009	Critical Assessment of Implementing Desalination Technology	WT02061	70/2/208	AWWA Research Foundation

2009	Perchlorate – risks to UK drinking water sources	WT1206	70/2/218	WRc
2009	Brominated flame retardants - risks to UK drinking water sources	WT1208	70/2/219	Building Research Establishment
2009	Good Practice for Communicating about Drinking Water Quality	WT1216	70/2/221	Risk Solutions
2009	Understanding customers' views PR09 Quantitative Research into Customers' Priorities	WT1223	70/2/227	Ofwat
2009	Validating the cause of coliforms in drinking water	WT1215	70/2/229	UKWIR
2009	Calcium and magnesium in drinking-water Public health significance	WT02053	70/2/196	WHO
2009	Water safety plan manual (WSP manual) Step-by-step risk management for drinking-water suppliers	WT1213	70/2/228	WHO
2008	National Tap Water Consumption Study	WT1214	70/2/217	Accent Marketing & Research Ltd
2008	A review of research on pressure fluctuations in drinking water distribution systems and consideration and identification of potential risks of such events occurring in UK distribution systems	WT1205	70/2/220	WRc
2008	A review of different national approaches to the regulation of THMs in drinking water	WT1212	70/2/216	WRc
2008	Molybdenum in British drinking water: a review of sources and occurrence and a reconnaissance survey of concentrations	WT02062	70/2/211	British Geological Survey
2008	NDMA - Concentrations in drinking water and factors affecting its formation	WT1217	70/2/210	WRc
2008	Handbook for Assessing the Impact of a Radiological Incident on Levels of Radioactivity in Drinking Water and Risks to Operatives at Water Treatment Works	WT02050	70/2/192	Health Protection Agency
2008	Deliberative Research concerning Consumers' Priorities for PR09 for the Water Industry Stakeholder Steering Group	WT1210	70/2/227	Ofwat
2008	NDMA - concentrations in drinking water and factors affecting its formation	WT02049	70/2/210	WRc
2008	Review of England and Wales Monitoring Data for Which a National or International Standard Has Been Set	WT1207	70/2/215	Watts & Crane

2008	Risk assessment of BMAA	WT1209	70/2/226	WRc
2008	Survey of the prevalence of Perfluorooctane Sulphonate (PFOS), Perfluorooctanoic Acid (PFOA) and related compounds in drinking water and their sources	WT02044	70/2/212	WRc
2008	Characterisation of waterborne <i>Aeromonas</i> species for their virulence potential	WT02037	70/2/165	AWWA Research Foundation
2007	Desk based review of current knowledge on pharmaceuticals in drinking water and estimation of potential levels	WT02046	70/2/213	Watts & Crane
2007	A study into the possible association between step changes in water hardness and incidence of cardiovascular disease in the community	WT02040	70/2/203	UEA
2007	Further study on the potential for the release of nickel from kettle elements – final report	WT02047	70/2/214	Scottish Executive Env & Rural Affairs Dept
2007	Investigation of genetic variation within <i>Cryptosporidium hominis</i> for epidemiological purposes	WT02056	70/2/199	National Public Health Service, Wales
2007	The Long Term Migration of Substances from In-situ Applied Epoxy Resin Coatings	WT02042	70/2/91	WRc
2007	Chlorination Disinfection By-products and Risk of Congenital Anomalies in England and Wales	WT02030	70/2/161	Imperial College
2006	Cryptosporidiosis: A report on the surveillance and epidemiology of <i>Cryptosporidium</i> infection in England and Wales	WT02055	70/2/201	Health Protection Agency
2005	European Acceptance Scheme - UK Performance Testing of EAS GCMS General Survey Test		70/2/172	WRc
2005	Assessment of the costs and benefits arising from Government and water industry participation in the development of European standards	WT02064	70/2/182	Atkins Environment
2005	A Case Control Study Investigating Drinking Water & Dairy Products in the Aetiology of Crohn's Disease - A Possible Role for <i>Mycobacterium avium paratuberculosis</i> – The CMAW Study	WT02028	70/2/156	UEA

2005	Investigation of <i>Cryptosporidium</i> clinical isolates and analysis with epidemiological data	WT02031	70/2/125	Scottish Centre for Infection & Env Health
2005	Establishing the relationship between farm re-stocking and <i>cryptosporidia</i> : the Caldeu catchment study	WT02035		Centre for Research into Env & Health, Aberystwyth

Appendix 2: Further information on methodologies

Preliminary desk study

Structure for scoring some of the quantitative subsections of objectives:

Objective 2a, subsection 3 'the number of citations the project has received' were categorised in the following manner:

- 1: no citations
- 2: 1-10 citations
- 3: 11-30 citations
- 4: 31-50 citations
- 5: >50 citations

In order to capture any peer-reviewed papers that may have been published in relation to the project, a search on key terms and authors was undertaken in Google Scholar.

Objective 2b, subsection 1 'did the contractor deliver to time' was categorised in the following manner:

- 1: more than two years
- 2: between one and two years
- 3: seven months to one year
- 4: three to six months
- 5: less than two months

Objective 4, subsection 1 'is the report available to those who need to see it?' followed the basic scoring set out below:

- 1: no access to the full report (i.e. just a summary available)
- 2: full report available but at a cost
- 3: full report available to subscribers only, but at no cost
- 4: summary available on DWI website and full report elsewhere at no cost (e.g. WRF)
- 5: full report available on DWI website at no cost

Objective 4, subsection 2 'is it covered in the electronic newsletter on the DWI website?' was scored as follows:

- 5: project covered by DWI newsletter
- 1: project not covered by DWI newsletter

In-depth reviews

Random Sampler methodology

The random sampler iteratively generates a list of projects by doing the following for each iteration:

1. Assigning a 'score' to each of the projects based on how different they are from the most recent project selected
 - For the first selection all projects are given a score of 1
 - The projects gained an additional 1 to its score for each characteristic which it had a different ID number from the most recently selected project.
 - All projects were given ID numbers for the following characteristics: cost bracket, subject area, contractor, project officer, and whether it was a collaboration or not. For example a project with a cost of over £250,000 was assigned an ID of 6, whereas a project with a cost of less than £10,000 was assigned an ID of 0.
2. This score is added to a running total of scores
3. A random number between 0 and the sum of the scores is generated which decides which project is selected next

This process means that the selected random sample is biased towards having diverse characteristics.

Questions for in-depth reviews

1. Performance of contractor
 - Process documentation - tenders received of a high quality
 - Way they addressed topic
 - Did they address the complexity of the project
 - Was the project budget increased – if yes, why?
 - Were conclusions and recommendations clear and appropriate?
 - Timeliness of delivery – did it start finish on time any need to extend the project
 - Were there any issues identified in project files
2. Performance of DWI project officer – review project file notes
 - What is the DWI's project officers experience with the subject matter
 - Project management documentation - did everything run smoothly or were there any issues in managing the research contract, what programme / project procedures were followed.
3. Performance of project against project aims and objectives (policy relevance)
 - Was the project specification clear and concise?
 - Did the project fulfil the objectives of filling specific gaps in the evidence base?
 - Performance of project against ROAME statement
 - Was any independent peer review carried out? If yes, what were the findings?
 - Did the project tender process restrict the outcomes?
 - E.g. competitive tendering may affect the quality of research
 - Were high quality tenders received and properly evaluated, has this been properly documented?
4. Collaboration
 - What information is in the project file
 - What is the level of stakeholder involvement in the project?
 - What was the role of the collaborator - best fit?

- Has there been collaboration between government departments for the design/ outcomes of the project
5. Availability of report?
- Where is it available
 - Did the contractor specify in the proposal the report would be published
 - Who's responsibility was the associated publishing costs
 - Were the research findings easy to understand and effectively disseminated to users?
 - Has the research been used to develop policy/practice/ scientific thinking (citations etc.)

Interviews

Interviewees

Company	Name	Job Title
Defra	Poala Cassenelli	Secretariat to the Hazardous Substances Advisory Committee
Defra	Donna McInnes	Senior policy advisor for drinking water quality at Defra
DOE Northern Ireland	David O'Neil	Senior drinking water inspector
DWI	Claire Pollard	Deputy Chief Inspector
DWI	Keith Smith	Principal Inspector
DWI	Peter Marsden	Principal Inspector & manager of DWQH evidence programme
FERA	Carmel Ramwell	Research Scientist
Public Health England	Stephen Robjohns	Senior Toxicologist for the General Toxicology Group, Centre for Radiation, and Chemical and Environmental Hazards
UKWIR	Hans Jensen	Chief Executive of UKWIR
UKWIR/ Yorkshire Water	John Haley	Water Quality Strategy Manager at Yorkshire Water and UKWIR Drinking Water Client Manager
WaterUK	Dr Jim Marshal	Policy and Business Adviser for WaterUK
Welsh Government	Liz Franks	Water Industry Management and Regulation Programme Manager at Welsh Government
Welsh Government	Cat Osborne	Policy Lead at Welsh Government
WRc	Paul Rumsby	Principal Toxicologist
WRF	Chris Rayburn	Director of Research

Interview Script

Name of interviewee:

Job title:

Organisation:

Date:

1. Identifying Research Opportunities and the Tendering process

- a) What has your role / involvement been in the DWQH evidence programme?
- b) Please state the projects that you have been involved with and your role or relationship to the projects.

2. Identifying Research Opportunities and the Tendering process

- a) Have you been involved in the research and tendering process for the DWQH and if so then in what capacity?

If not go to question 3

- b) Considering the DWQH evidence programme, how effective do you feel the process of identifying appropriate research has been and why? Do you think this process could be improved and how?
- c) Is there overlap/duplication with research conducted by other organisations? Is that a good or a bad thing? Why is that?
- d) How could the DWI better identify necessary / appropriate research opportunities?
- e) Thinking about the tendering process, is the system used by DWI effective? Do you feel the tendering process could be improved and if so how?

3. Research Topics and Outputs

- a) Do you have any views on the topics of research and do you think they are the most relevant / useful topics? Are there any topics that you feel are not covered by the DWQH evidence programme and should be?
- b) What do you think about the quality of the research produced since 2005 and its value to the UK public?
- c) Do you feel that the research conducted since 2005 provided a great deal of scientific support for the DWI? Why is that? Can you think how it could be made more effective?
- d) In your opinion has the research informed policy or technical decisions? Please explain your decision.
- e) Are you aware of any emerging or future areas that you think would benefit from being included in future DWQH?

4. DWI Project Management

- a) Have you been involved in or had experience of the DWI's project management of the DWQH and if yes then in what capacity?

If no go to Q 5

- b) Based on your experiences, how well have the projects that you're aware of been managed by the DWI and its project managers? Are there any areas that could be improved upon in the future?
- c) Have you had any experience of jointly funded projects between the DWI and other organisations? If so who was involved and how would you evaluate the management of the project(s)? Where there any areas that you felt could be improved?

5. Dissemination of research

- a) How important do you feel it is that the DWI feeds back its research to a wide audience?

- b) Which stakeholders do you think benefit the most from DWI research?
- c) With regards to the dissemination of research outcomes, how effective has the DWI been at this and do you feel there is room for improvement (please explain)?
- d) The DWI newsletter provides an insight into research undertaken and is a source of dissemination for many papers. Are you aware of the newsletter and do you find it a useful source?
- e) Do you feel that there are any important stakeholders that could benefit but that DWI research currently reach? If so, can you think of the best way to engage with these stakeholders?

6. Summary

- a) In summary and taking all factors into account how effective do you feel the DWI evidence programme was overall between 2005 and 2014?
- b) What are the main things you would like to see changed about the DWI evidence programme in the future?
- c) Are there any particular projects that you're aware of that you feel need to be reviewed?
- d) Do you have any suggestions in terms of administration changes that would help the programme run more effectively?
- e) Is there anything else we have not covered that you would like to add?

Thank you for your time

Appendix 3: Tables showing scoring from the Preliminary Desk Study

Table 7: Average scores for objective 1: 'Policy Relevance' across all 74 projects, including the breakdown of average scores for each of the subsections of this objective

Project classification	Analysis	Chemical Risk	Consumer	CryptoGiardia	Distribution	Mbiol Risk	Monitoring - chem	Other	Premise Risk	Reg 31 - materials	Average
Overall score for objective 1	4.0	4.0	3.9	4.0	2.8	3.8	4.6	4.3	4.0	3.7	3.9
National and European legislation	3.3	3.8	3.1	3.5	1.5	3.6	4.3	3.0	3.0	3.7	3.3
Emerging risks to public health	3.2	3.9	2.4	4.2	2.5	3.5	3.7	2.8	3.8	2.8	3.3
International evidence base	4.0	3.1	1.4	3.6	1.8	3.6	3.8	3.8	4.0	2.3	3.2
UK water industry	3.3	3.6	3.5	3.9	3.8	2.6	4.4	4.4	3.8	3.9	3.8

Table 8: Average scores for objective 2a: 'Scientific Quality' across all 74 projects, including the breakdown of average scores for each of the subsections of this objective

Project classification	Analysis	Chemical Risk	Consumer	CryptoGiardia	Distribution	Mbiol Risk	Monitoring - chem	Other	Premise Risk	Reg 31 - materials	Average
Overall score for objective 2a	4.0	4.0	4.1	4.6	3.3	3.5	3.9	3.8	4.3	3.7	3.8
Methodology used	4.5	4.2	4.6	4.4	3.3	3.5	4.1	4.2	4.5	3.9	4.0
How it advances knowledge	4.3	3.9	4.3	4.6	3.3	3.6	4.4	4.0	4.0	3.7	3.9
Evidence of citations	2.0	2.0	2.3	4.3	2.0	2.3	2.5	2.1	3.5	1.3	2.3
Strength of confidence in the findings	4.3	4.0	4.3	4.8	4.0	3.9	4.0	3.6	4.0	3.9	4.0

Table 9: Average scores for objective 2b: 'Performance of contractors' across all 74 projects, including the breakdown of average scores for each of the subsections of this objective

Project classification	Analysis	Chemical Risk	Consumer	CryptoGiardia	Distribution	Mbiol Risk	Monitoring - chem	Other	Premise Risk	Reg 31 - materials	Average
Average score for objective 2b	4.2	4.6	4.6	4.7	3.8	4.0	4.5	4.2	4.0	3.9	4.2
Delivering to time	2.5	4.3	4.3	4.2	3.8	3.2	4.3	3.6	2.8	3.2	3.5
Delivering to cost	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Delivering to specifications	4.7	4.6	4.8	4.6	4.3	3.9	4.4	4.3	4.3	4.0	4.3

Table 10: Average scores for objective 3: ‘Fit with role/remit’ across all 74 projects, including the breakdown of average scores for each of the subsections of this objective

Project classification	Analysis	Chemical Risk	Consumer	CryptoGiardia	Distribution	Mbiol Risk	Monitoring - chem	Other	Premise Risk	Reg 31 - materials	Average
Average score for objective 3	4.7	4.2	3.6	4.8	4.0	4.4	4.6	4.3	4.5	3.9	4.4
Taking into account the role of others	4.7	4.2	3.6	4.8	3.8	4.4	4.6	4.3	4.5	3.9	4.3

Table 11: Average scores for objective 4: ‘Effectiveness of dissemination’ across all 74 projects, including the breakdown of average scores for each of the subsections of this objective

Project classification	Analysis	Chemical Risk	Consumer	CryptoGiardia	Distribution	Mbiol Risk	Monitoring - chem	Other	Premise Risk	Reg 31 - materials	Average
Average score for objective 4	4.0	4.5	3.6	4.3	3.8	3.5	4.5	4.2	4.0	4.1	4.1
Is the report available to those who need to see it?	3.3	4.8	4.8	4.4	5.0	3.2	4.9	3.8	3.3	4.7	4.2
Was it covered by DWI newsletter?	5.0	4.5	4.5	1.8	5.0	4.4	4.6	4.0	3.0	3.7	4.1
Is it clear what happens next?	3.3	3.9	2.4	4.6	3.5	3.4	3.7	4.4	3.5	3.6	3.7

Table 12: Average scores for objective 5: ‘Value for money’ across all 74 projects, including the breakdown of average scores for each of the subsections of this objective

Project classification	Analysis	Chemical Risk	Consumer	CryptoGiardia	Distribution	Mbiol Risk	Monitoring - chem	Other	Premise Risk	Reg 31 - materials	Average
Average score for objective 5	4.5	4.3	4.6	4.6	3.5	3.9	4.2	3.9	4.8	4.0	4.2
Were opportunities for collaboration taken?	4.5	4.2	4.0	3.5	N/A	3.9	5.0	4.3	4.5	5.0	4.3
What is our assessment of the cost for the work delivered?	4.8	4.2	4.6	4.6	3.8	3.8	4.3	3.9	5.0	4.0	4.3

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