Scottish Government / DWQR

Cost Benefit Analysis of the Private Water Supplies (Scotland) Regulations 2006

Detailed Case Study

Final Report

20th May, 2010

SISTech

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Executive Summary

The purpose of this study is to assess the costs and benefits relating to the Private Water Supplies (Scotland) Regulations 2006 by reviewing and improving the assessment made in previous studies conducted in 2002 and 2004. The study is based on a case study of one Scottish Local Authority, the Scottish Borders Council.

A standard Cost Benefit Analysis (CBA) framework was used to assess the economic efficiency of the regulations. The boundaries of this CBA were agreed with a project Steering Group.

The principal costs considered in the CBA were as follows: costs to Relevant Persons in upgrading and maintaining Private Water Supplies (PWS); SBC staff and administration costs; and cost to Scottish Government / DWQR in terms of administration of the scheme. These costs were quantified through use of data obtained from SBC and Scottish Government/DWQR.

The benefits from introduction of the Regulations were assessed in terms of the avoided cost of illness from drinking water from PWS. This was quantified by analysing the total number of supplies improved to date and making projections of the number of supplies that would be improved over an extended period. Health Protection Scotland (HPS) was consulted to obtain the best available epidemiological data to inform this assessment. However, difficulties were still encountered in obtaining robust figures for the number of people falling ill each year as a result of PWS.

The total projected costs over the 15 year period starting from 2005 are £4.6 million. The majority of these costs (54%) fall on the PWS owners. The total projected reduction in health costs over the same period is £5.7 million. From this, £3.7 million arises from improvement of Type A supplies. The 2006 Regulations therefore have a net benefit to society in SBC area of £1.16M.

Although there is a net benefit, analysis of data from the SBC has shown there has been very low uptake of the grant scheme amongst Type B supplies. One possible reason for this is the difference between the cost of upgrading supplies and the level of grant provided. This issue is explored further in the report.

It was concluded that the study has enabled the actual impact of the Regulations, in terms of number of supplies improved, to be assessed for the case study area. However, it highlights a number of deficiencies in some datasets, in particular health data. A number of recommendations have been put forward for how these deficiencies could be addressed in future studies.

Abbreviations and Acronyms

2002 Report	Economic Assessment of Possible Regulations for Private Water Supplies and Public Buildings in Scotland (2002)
2004 Report	Economic Assessment in Support of the Partial Regulatory Impact Assessment for Possible Regulations for Private Water Supplies and Public Buildings in Scotland (2004)
2006 Regulations	Private Water Supplies (Scotland) Regulations 2006
CBA	Cost Benefit Assessment
DWQR	Drinking Water Quality Regulator
EHO	Environmental Health Officer
GI	gastro-intestinal (illness)
LA	Local Authority
PCV	Prescribed Concentration or Value
PWS	Private Water Supply
REHIS	Royal Environmental Health Institute of Scotland
SBC	Scottish Borders Council
SG	Scottish Government

1 Introduction

Private Water Supplies (PWS) in Scotland are regulated by local authorities using the Private Water Supply (Scotland) Regulations 2006 and the Water (Scotland) Act 1980.

The 2006 Regulations were introduced to implement the EC Directive (98/83/EC) on the quality of water intended for human consumption. The main changes as a result of the implementation of the 2006 Regulations were as follows:

- Introduction of a new system of categorising PWS into Type A or B supply depending on volume supplied and whether the water is used for commercial purposes.
- Requirement for some additional water quality determinants to be analysed for and a reduction in the maximum prescribed concentrations for certain existing determinants.
- Introduction of a grant scheme to assist in Relevant Persons upgrading their supplies to meet the requirements of the 2006 Regulations.
- Introduction of the requirement for Local authorities to undertake risk assessments of the potential health risks associated with private water supplies

Prior to the introduction of the 2006 regulations SISTech and Envirocentre undertook a Cost Benefit Assessment (CBA) of the predicted impact of the new regulations. This assessment focussed on economic costs and benefits to Local Authorities and to the owners and users of PWS. MWH and SISTech were commissioned by the Drinking Water Quality Regulator (DWQR) in 2010 to review and improve this assessment in the light of three years' experience of the regulations being in place in Scotland.

2 Project Purpose and Objectives

The purpose of this study is to assess the costs and benefits relating to the Private Water Supplies (Scotland) Regulations 2006 by reviewing and improving the assessment made in previous studies conducted in 2002 and 2004 by SISTech and the Envirocentre[1]. The study is based on a 'case study' of one Scottish Local Authority, the Scottish Borders Council.

The project objectives were to

1. Review the costs to the local authority, the Scottish Government and DWQR, owners and users of private water supplies, and other stakeholders, based on experience since the implementation of the regulations.
2. Assessment of the health benefits (i.e. avoided health costs) realised through the use of risk assessments and grant scheme.
3. Perform a cost-benefit analysis of the regulations, based on the above costs and benefits.

A Project Steering Group, including representatives of the Scottish Government and DWQR, Health Protection Scotland, the European Commission Directorate-General Environment, and Scottish Borders Council, met in the early stages of the work, to agree a methodology for the analysis.

This report sets out the methodologies used for the overall analysis and for the evaluation of the costs and benefits of the implementation of the regulations, and presents recommendations for the continuing improvement of water quality from PWS.

3 Summary of Previous Study

In 2004, an economic assessment of the possible impact of the (then draft) 2006 Regulations was published by EnviroCentre and SISTech for the Scottish Executive Central Research Unit[1] above. This study estimated the cost and benefits of the new regulations to the whole of Scotland and included scoping for a grant scheme to support the implementation of the regulations.

The report concluded that the costs for implementing the new regulations ranged between £6 - £46M over 15 years and would result in a health benefit saving ranging between £40 - £111M (with base values of £14.3M for Type A supplies and a further £47.2M for Type B supplies). These figures resulted in a favourable cost benefit ratio across most of scenarios considered and formed the economic evidence used in the Regulatory Impact Assessment conducted by the Scottish Government to justify the decision to proceed with the provision of the 2006 Regulations and the supporting grant scheme.

The large range of values and large number of scenarios considered in the 2004 Report were due to the high number of uncertainties which had to be considered in this analysis.

4 Selection of case study area

The present CBA has studied the impact of the 2006 regulations on one local authority - Scottish Borders Council (SBC). SBC extends from the southern fringes of greater Edinburgh in the north to the national boundary with Cumbria and Northumberland in the south east and South Lanarkshire and Dumfries & Galloway in the south west. SBC covers an area of approximately 4,700 km^2 with a population of 106,800 (in 2001[2]). Although there are some larger settlements, such as Hawick (14,000 people) and Galashiels (12,400), the area is characterised by rural communities.

According to the DWQR's annual report[3] there are a total of 1,414 registered PWS, including 128 Type A supplies, in SBC's area; only three local authorities have more PWSs in Scotland. The annual report states that risk assessments have been completed for 113 Type A supplies and number of Type B supplies. SBC agreed to provide the project team with access to records of risk assessment undertaken and the available details of subsequent upgrades.

Given that this project was intended as a pilot for potential future studies it was also judged appropriate to undertake a case study of a local authority geographically close to the project team. This would ensure best use of available resources.

The Scottish Borders Council is coterminous with the NHS Borders, the local Health Board, which offered potential advantages to the study.

5 Cost Benefit Methodology

5.1 Overview

A standard cost-benefit analysis framework was used to assess the economic efficiency of the regulations. The boundaries of the study were confined to the following parameters, which were agreed with the project Steering Group on 29th January 2010:

- Private Water Supplies (PWS): The study covers both Type A and Type B PWS.
- Geographic: The area of the Scottish Borders Council Local Authority is considered.
- Population: Residents and commercial organisations within the area of the Scottish Borders Council are included. Non-residents who enter the Scottish Borders and use PWS for a limited time within the area are also considered in the study.
- Time scales: The study projects likely cost and benefit scenarios 15 years into the future.

The steering group also agreed the set of costs and benefits to be considered. These include the costs arising from implementation of the Private Water Supplies (Scotland) Regulations 2006 to the various stakeholders (the Scottish Government and DWQR, the Local Authority, PWS owners), including any new costs that may have arisen as a result of the regulations. Each of the costs and benefits was physically quantified and then monetarily evaluated, using primary data where possible. Each cost and benefit is discussed in more detail below. The standard Treasury discounting formula, using a discount rate of 3.5%, was applied and a present valuation of the costs and benefits made. Finally, a sensitivity analysis of the results

was carried out, to estimate their robustness and identify the impact of key assumptions and uncertainties.

Care was taken to avoid any double counting of costs or benefits, and to treat transfer payments correctly[i].

5.2 Cost and benefits to be considered

Table 1 and Table 2 below show the costs and benefits considered within this study.

The benefits from the regulations are actually the 'avoided costs' of illness arising from PWS. In agreement with Steering Group, the study focuses on only health impacts related to microbiological contaminants only. These means that the health benefits considered are due only to reduced incidences of gastro-intestinal disease.

The 2004 SISTech and Envirocentre study included predictions of the costs to local authorities of implementing the regulations, including staff costs, expenses and materials, and taking into account fees charged for carrying out risk assessments. The aim of this study is to either replace these predictions with actual data or at very least improve the estimates made (see section 5.3 for more information on data utilised)

It should be noted that the term 'Relevant Person' in Table 1 refers to the person responsible for paying costs of improvement, maintenance, and sampling.

[i] Transfer payments occur when money is redistributed within a system rather than the use or creation of a resource.

Table 1: Summary of costs of the Private Water Supplies (Scotland) 2006 Regulations in the Scottish Borders

Cost	Who incurs cost?	Methodology	Data used
Carrying out risk assessments	SBC	Costs provided by SBC	SBC staff time and overhead costs
Collecting and analysing samples	Relevant Person / SBC	Costs provided by SBC; estimate laboratory costs.	SBC staff time and overhead costs; lab costs
Upgrading supplies (for Type A / B supplies)	Relevant Person / SBC	Costs of any upgrading of supplies after implementation of the regulations will be analysed using primary data	SBC risk assessments and associated case files
Ongoing maintenance costs to PWS	Relevant Person/ PWS Owner and users	Model costs based on expected maintenance needs	Cost and frequency of maintenance, typical requirements of PWS
Taking enforcement action against failing supplies	Relevant Person / SBC	Costs provided by SBC	SBC staff time and overhead costs
Providing education and advice to owners and users of supplies	SBC	Costs provided by SBC	SBC staff time and overhead costs
Updating and maintaining registers	SBC	Costs provided by SBC	SBC staff time and overhead costs
Providing more detailed returns to the SG	SBC and the Scottish Government	Costs provided by SBC and SG	SBC staff time and overhead costs; SG staff time and overhead costs
Grant provision	Scottish Government	Use of primary data and projections of future uptake of grants	SBC register of grants issued
Grant provision administration	SBC and Scottish Government	Costs provided by SBC and SG	SBC staff time and overhead costs; SG staff time and overhead costs
Costs to the Scottish Government and Drinking Water Quality Regulator	Scottish Government and DWQR	Costs provided by SG	SG/DWQR staff time and overhead costs

Table 2: Summary of Benefits of the Private Water Supplies (Scotland) 2006 Regulations in the Scottish Borders

Benefit	Who incurs benefit?	Methodology summary	Data used
Health benefits from reduced gastro-intestinal (GI) illness due to fewer high risk PWS	PWS owners and users	The number of people expected to contract a gastro-intestinal disease from drinking from a high risk PWS in any year is modelled as depending upon • the probability of a source failing a sampling test (from SBC sample data) • the probability of getting ill from drinking from a high risk source • the number of people exposed • the number of days each is exposed (estimated) Review health benefit model used in 2004 to determine if narrower / improved ranges can be utilised for key parameters Use epidemiological data where available.	SBC numbers of samples failing micro-biological testing; Health Protection Scotland data on levels of key GI diseases; SBC data about each PWS; DWQR Annual Return data Various epidemiological studies (referenced in relevant sections)

5.3 Data Sources on PWS in the SBC area

Table 3 provides details of the primary datasets utilised to assess the PWS in the SBC area.

Table 3: PWS datasets used in Study

Data Source	Use in
SBC Grant Registration Details:	Register of risk assessments undertaken and grants issued.
SBC Risk Assessment Case Files	Details of the results of risk assessments (including reasons for a supply being identified as high risk) Water Quality analysis from samples taken at time of risk assessment Details and improvements required as a result of risk assessment process and in a number of cases the actual costs incurred by the Relevant Persons
DWQR Annual Return Data	Data received by DWQR for 2008. Includes data fields for: Supply Type (A or B); population served; whether an risk assessment has been carried out; source type; type of treatment system in place; grant award dates; grant purpose; sample results.

To develop a full picture of PWS in the SBC area these various datasets have been used in combination. In particular, details from the SBC records have been used to augment that available from the DWQR. In the main, this process updated the DWQR data fields concerning risk assessments, award of grants and sample results

5.4 Costs to stakeholders

The costs are divided between the stakeholders listed below:

- The Scottish Borders Council (SBC)
- The Scottish Government, including the Drinking Water Quality Regulator (DWQR)
- The Private Water Supply (PWS) owners in the Scottish Borders

The costs to each stakeholder will be considered in turn along with an explanation of the sources of data. Although CBA is primarily concerned with the total cost, whichever stakeholder it falls to, it was judged that the division of costs amongst stakeholders would be of interest to the client. It is also comparatively easy to split the data into stakeholder groups because of the nature of the data gathering process in this study.

5.4.1 Scottish Borders Council

Costs to SBC include:

- Collection and analysis of samples and undertaking risk assessments
- Taking enforcement action (this cost is zero since no enforcement action has been taken to date)
- Providing education and advice to PWS owners and users
- Updating and maintaining registers (including set up costs)
- Ensuring that test results are properly displayed
- Providing detailed returns to the Scottish Government
- Grant administration

The costs to the SBC are folded into the staff time, admin and travel costs for the members of staff connected with PWS. These include an Environmental Health Manager, four EHOs and

a technical assistant as well as admin staff. Data given by Ken Jones (Environmental Health Manager, SBC) on staff salaries and time spent on PWS has been used to estimate SBC costs (see Appendix 1).

Local Authorities are also obliged to pay PWS owners the sum of the grant once work is completed (along with the £125 charge for sampling and analysis costs). However, the LA claims this amount back from the Scottish Government annually, meaning that the true cost lies with the SG and any extra costs lie with the PWS owner or user themselves.

5.4.2 The Scottish Government

Costs to the Scottish Government include:

- Grant administration and amount
- DWQR costs (staff time, admin, set up and running costs)

The Scottish Government incurs the cost of the grant scheme, as well as minor additional admin costs to the financial department of processing this scheme. The DWQR incurs costs such as staff time in processing the data on PWS sent to them from each LA in Scotland, the creation of education and advice for PWS owners and users including a website. These costs are folded into staff time, admin and travel costs. Data given by David Gryzbowski on staff salaries and times has been used to estimate costs to the Scottish Government regarding grants and their administration as well as DWQR costs.

5.4.3 Relevant Persons

Costs to the relevant persons responsible for a PWS includes:

- Capital costs associated with improving supply post risk assessment (above £800 grant per property)
- Maintaining the treatment at an acceptable level
- Ongoing sampling and analysis costs as stipulated in the 2006 Regulations (Type A only)

Costs associated with Improving Supplies

SBC hold records of improvement costs incurred by the relevant person for a number of the supplies improved since 2006. For Type A supplies, records were available for all supplies improved 2006 to 2009. For Type B, 41 out of 50 were available.

Each property has been allocated to a size band – measured in population served – and the maximum, minimum and average costs were calculated for each band. Table 4 and shows the cost ranges for Type A supplies. Table 5 shows the cost ranges for Type B supplies.

Table 4: Improvement Cost ranges for Type A Supplies.

Population Band	Cost per person benefiting		
	Max	Min	Average
1 to 9	£2,950	£125	£1,009
10-19	£1,223	£80	£535
20-49	£500	£115	£288
50-99	£483	£19	£196
100-199	£95	£69	£82
200-499	£151	£27	£89
500-2000[1]	£20	£20	£20

[1] NB There was only one property for which data was available in this population band

Table 5: Improvement cost ranges for Type B Supplies

Population Band	Cost per person		
	Max	Min	Average
1 to 4	£12,048	£251	£2,680
5 to 9	£1,883	£159	£780
10 to 19	£1,520	£64	£551
20+	£664	£62	£228

There are wide differences in maximum and minimum vales of improvement work for both Type A and Type B supplies. The cost of improvement works can be very site specific, dependant on factors such as site access, distance to source, and ground conditions. In addition, some supplies may already have in place reasonably robust supply system.

Despite the potential issues with using these costs they have been used as a basis for estimating future improvement costs. A detailed study of improvements costs, e.g. by producing standard cost curves, was outside of the scope of this project.

These cost bandings were used to estimate costs for those supplies which had already been improved but for which actual cost data was not available and also for those supplies projected to be improved in the future. For Type A, based on what infrastructure was already in place the maximum, average, or minimum costs were then applied to the supply i.e. it is likely the improvement costs will be lower where a treatment system already exists. For Type B supplies the improvement cost was calculated based on average cost per person.

Maintenance Costs

To continue to meet Prescribed Concentration and Values set out in Schedule 1 of the Regulations Relevant Persons will need to undertake ongoing maintenance of their supply systems. Although there is no ongoing sampling of Type B supplies it is assumed these supplies will be maintained to a point whereby they could meet relevant PCV standards in Table D, Schedule 1 of the 2006 Regulations.

For the purposes of this study maintenance costs are made-up of: replacement of cartridge filters; replacement of UV lamps; and borehole scaling/cleaning with compressed air. This assumes that UV is the only disinfection system utilised by private water supplies**.** Other maintenance activities will be required, such as cleaning of UV lamps and storage tanks. However, as these will typically be carried out by the property occupier/owner, they have not been included in the CBA.

A number of commercial or large supplies (now classified as Type A supplies under the 2006 Regulations) would have installed treatment systems prior to the introduction of the 2006 regulations. From records held by SBC and SG it was estimated that a total of 96 supplies already had filtration and UV. A consequence of introduction of the regulations is that these existing systems will need ongoing maintenance. Therefore, the cost of maintaining these supplies has been included in the CBA from 2006 onwards. For all other supplies the annual maintenance cost of any new treatment systems will included in the CBA from the year in which the supply is defined

Typical costs for maintenance activities have been obtained from suppliers of small scale treatment systems and maintenance contractors. More detail can be found in Appendix 2.

Sampling and Analysis Costs

As part of the risk assessment process a sample will be taken as part of the risk assessment (Type A & B). SBC will invoice the Relevant Person a fee of £125 for the analysis and administration costs associated with this sample. If a grant is subsequent approved for the supply this costs can be claimed back by the Relevant Person in addition to the £800 per property.

Type A supplies will be subject to periodic sampling by SBC (in most cases only once a year). The costs associated with this sampling (£125 per sample) will be fully borne by the Relevant Person, owners, or users of the supply. It should be noted that in the case where more than one property is shared from the same supply the Local Authority has discretionary powers to take one sample and share the costs across the Relevant Person/owners/users.

5.5 Benefits from avoided Health Costs

This section explains how the benefits considered in the CBA were calculated.

As previously stated this analysis is assessing the impact on health from microbiological contamination of supplies. Health Protection Scotland (HPS) report that the following pathogens were most relevant to PWS: E. Coli O157, Cryptosporidium, Campylobacter, Giardia. Schedule 1 of the regulations sets PCVs for: Enterococci; and the indicator organisms E.coli; and Coliform Bacteria. For the purposes of this study it has been assumed that where a supply is deemed capable of meeting the Schedule 1 requirements it will also be free of the pathogens considered relevant by HPS. However, it should be noted that neither Cryptosporidium or Giardia are implicitly tested for. This means that even if a supply is low risk and a sampling test indicates no microbiological presence in the PWS system, Cryptosporidium and Giardia pathogens could still be present and lead to illness in anyone who comes into contact with that water. Since the Regulations do not allow for this possibility, this potential scenario has not been taken into account in this study.

Salmonella was also initially considered. However, it was subsequently removed from the analysis due to a lack of data. HPS advised that although Salmonella can be caught from water supplies, it is much more likely to be caught from food, and so should be the least important of the diseases considered in this study. Disease caused by viruses was not considered.

In order to calculate the benefits of the 2006 Regulations two factors were calculated:

- The number of people who contract a gastro-intestinal disease from drinking from a high risk PWS
- The cost of contracting a disease from a high risk PWS

5.6 Number of people contracting gastro-intestinal disease

To calculate this, the equation to estimate the expected number of people who contract a GI disease from a high risk PWS, created in the previous 2004 study, was modified to include the empirical data collected since the last study, to give a more accurate estimate. The original equation was:

$E = (1-(1-pq)^{n}) \times N$ **[Equation 1]**

Where:
E = Expected number of people getting ill due to a high risk PWS to achieve required standards
p = the probability of any supply failing a sampling test on a given day
q = the probability of someone getting ill if they drink water that does not meet required standards

N = the total number of people exposed to high risk PWS
n = the number of days they are exposed for

The value 'q' is effectively a constant, whereas the other parameters should reduce as the Regulations take effect. In the 2004 CBA, none of these parameters was known with any accuracy, and a model was constructed to allow a range of values of each to be used and varied.

The data collected on PWS in the SBC area and data provided by HPS has allowed for improved estimates to be made of values for 'E', 'N', 'n', and 'p'. For a baseline year this allows for a figure for 'q' to be determined. This value of 'q' was then used to predict the future values of E (the number of cases of illness due to PWS) for the years beyond 2009.

It should be noted that this provides a 'guideline' figure for 'q' and not absolute figure.

The Expected Number of People getting Ill in the Scottish Borders due to a high risk PWS (E)

Data on the number of cases over the last 10 years for each of the four gastro-intestinal diseases considered in this study was supplied by Health Protection Scotland[4]. For *E. Coli* O157, the most thoroughly investigated disease of those considered, the percentage of cases in Scotland relating to PWS is known: 14% of *E.Coli* O157 outbreaks (121 cases) between 1996-2006 were due to PWS (HPS, 2010), and it is estimated that 8% of the cases were attributable to PWS[5]. This information was used to estimate the number of *E. Coli O157* infections due to PWS for each year from 1999-2009.

For the other diseases, the rates of disease from PWS were estimated using data on the relative rates of each disease to *E. Coli* O157 for water borne cases [6] The numbers of cases of Cryptosporidium, Campylobacter and Giardia due to PWS in Scotland for 1999-2009 were then estimated using the rates for E. coli O157 and the relative ratios of E. coli O157 cases to each disease. HPS provided similar data for outbreaks which occurred only in the Scottish Borders. However, the dataset was too small to apply robust statistical testing so the national dataset was used instead.

To estimate how many of these PWS cases occurred in the Scottish Borders, these numbers were then divided by the proportion of PWS in the Borders, relative to the whole of Scotland (7.5%). These numbers were then taken as estimates of the expected number of cases of people getting ill due to each disease considered in the Borders from a high risk PWS.

Number of people exposed to PWS (N) and number of days exposed (n)

For all the PWS in the Borders, the size of the residents and transient populations served were determined for both Type A and Type B supplies based on DWQR Annual Return data.

For each Type A supply the maximum population that could be served was estimated for the following categories:

1. Domestic population (residents on Type A PWS)
2. Overnight Guest population in Type A supplies
3. Day visitors to Type A PWS

Values of 'N' and 'n' (see Equation 1) were then calculated as set out below.

Overnight Guest Population:

- The average length of stay for Tourist Accommodation in SBC is 3.5 days[7]
- The average occupancy rate for Tourist Accommodation in SBC is 50%[7]

- N has therefore been calculated as:

(Maximum capacity of accommodation x Occupancy Rate x Number of days open per year)/Length of stay

- n (number of days exposed) is taken to be the average length of stay

Type A Domestic Population

- It is assumed that the average number of people per property is 2.5
- 'n' is assumed to be 365 e.g. the total number of people living at the property is present for 365 days per year

Day Visitors to Type A PWS

- It has been assumed that average number of people exposed per day is 40% of the maximum visitor population per day e.g. on average a visitor centre is only 40% full
- 'n' for visitor attractions has been assumed to be 1 i.e. a different population of people visit each day

For Type B supplies the population associated ('N') with each supply was based on data in the DWQR Annual return. It is assumed that this population is present for 365 days a year (n) Second home ownership is relatively low in the SBC area (<5% of total housing stock) and the impacts if this transient population has not been taken into account[8].

Table 6 summarises the results of this analysis

Table 6 Number of people exposed to a high risk private water supply and number of days exposed for each type of person served by the supply

Type of person exposed to a high risk PWS	Number of days exposed per year (n)	Number of people exposed in 2005 (N)
Type B	365	8,030 [1]
Type A – Domestic Population	365	1,768[1]
Type A – Day visitor	1	600,624
Type A – Overnight Guest	3.5	134,607 x Occupancy rate (50%)

It was assumed that occupancy rates stayed constant over the whole year. Staff have not been explicitly considered. However, in many cases they will form part of the domestic population associated with a Type A supply.

For the purposes of the CBA is necessary to determine the year in which a supply has been improved. This study has assumed that, once a high risk PWS, has been improved the probability of a sample containing microbiological containments is reduced to zero. In reality, although the risk will be minimised, a risk of contamination will always remain, even with public water supplies. However, for the purpose of this study, a zero risk was deemed an acceptable approximation to the greatly reduced possibility of contamination once a supply has been fully improved as per the Risk Assessment.

This assumption requires the following two conditions to be true:

1. That the Relevant Person, owner, or user undertakes sufficient maintenance to ensure the supply remains capable of supplying water of a quality which meets the required standards
2. The supply is resilient to environment factors e.g. severe weather

A Type A supply is defined as being 'improved' once a grant payment has been paid. For those supplies already improved the date of improvement has been sourced from SBC data. However, the average length of time between a risk assessment and the works being satisfactorily completed and grant made is 18 months. Therefore, there are some supplies for which a grant has not yet been made. For these supplies the following logic has been utilised:

- If the date of the risk assessment is after June 2009 then the improvement date is assumed to be 18 months after the risk assessment date
- If the date of the risk assessment is before June 2009 then it is assumed that a Risk Assessment will need to be repeated in 2010. Any improvements will then be required in 2012

It should be noted that the Local Authority is required periodically to review and update its risk assessments.

As a result, all Type A supplies requiring improvement will be completed by 2012. The CBA model assumes no new supplies will then be categorised as Type A during the assessment period.

As for the Type A supplies, a Type B supply is defined as being 'improved' once a grant payment has been paid. For the period 2010 – 2021 a projection has had to be made on the number of supplies that will be improved each year.

Between 2007 and 2009 an average of 16 Type B supplies had been 'improved' each year. Therefore, the baseline scenario for the CBA is that the number of supplies improved will remain at a constant 16 between 2007 and 2009. A sensitivity analysis has been carried out on this by increasing or decreasing the number of supplies each year.

Type B supplies in SBC range is size between 1 and 43 people served. Between 2006 and 2009 the range of supplies improved reflects the overall size profile (in terms of population served) found across all the Type B's. A similar profile has been adopted for those supplies projected to be improved 2010 – 2021.

The Probability of a Source Failing a Sampling Test (p)

The CBA requires calculation of the probability of a supply failing to achieve on any given day the Prescribed Concentration and Value (PCV) for one of the microbiological parameters set out in Table 1 of the 2006 regulations. This is a value of 'p' shown in Equation 1. The 2004 study utilised an overall failure rate of 19% across Type A and Type B supplies. An objective of this study was to review this failure rate and determine if an improved estimate can be used.

In this study the value of probability of a supplying failing on any one has been calculated by the equation below

P = Number of supplies which have been identified as high risk
Number of supplies which have been identified as high risk and exceeded a microbiological PCV

This equation assumes that only supplies which have been identified in the risk assessment process as being high risk will fail a microbiological sample.

Water quality data for this calculation is based on the sample taken by SBC at the time of the risk assessment. From this data the probability of a source failing to meet PCV has been calculated as:

Type A: 0.28
Type B: 0.67

These values represent an estimate of the chance that a person drinking from a PWS that has been identified as high risk will be drinking microbiologically contaminated water (a p-value of 0 represents no chance of drinking contaminated water, whereas a probability of 1 means a source is guaranteed to contain microbiological contaminants).

It should be noted that the probability values used in this CBA should still be viewed as an estimate. To develop a more robust estimate of the probability of a supply failing would require a programme of regular periodic sampling from a number of supplies.

Probability of getting ill from drinking from a high risk PWS (q)

This factor is built on the concept of the 'incident rate' or the number of cases of a disease over a specific period in a given area (put simply, q is the incident rate relating only to PWS). Very little data was available to calculate the present value of q. Since (E) – the expected number of people becoming ill due to a PWS was known for the past ten years (see section 5.6), the equation above was rearranged (see below) and solved for q. This figure was then used to calculate future values of E.
Rearranged equation:

$$q = [1-(1-E/N)^{(1/n)}]/p$$

5.6.1 The Cost of Contracting a disease from a high risk PWS

The cost of a particular GI disease from a high risk PWS will depend on many factors including:

- The severity and duration of symptoms
- Treatment given (including the economic loss factor and any loss of income to the patient and their carers)
- Morbidity and mortality factor

For each of the diseases considered in this project, costs will vary – some diseases will take longer to recover from and require more expensive treatments in a higher proportion of cases. In order to make the methodology concise, each factor which contributed to the overall cost of contracting a disease was estimated separately then averaged (weighted by the relative frequency of the disease in cases due to PWS) to give one figure for costs per person who gets ill. The method of estimating each of these costs is discussed below:

The severity and duration of symptoms

Cases were divided into community cases and treated cases. Community cases are people who show symptoms but are not recorded in the National Surveillance system by Health Protection Scotland because, although they may visit a GP, they never have a sample taken as their case is not judged to be severe by their GP, meaning their disease is not identified and included in national statistics. However, there is a cost associated with their illness which must be included in the CBA analysis. Therefore the number of community cases to treated cases and the cost of both community cases and treated cases were necessary parameters to estimate for this project. Community cases were estimated using a study of community cases to reported cases of GI diseases in England[9].

An average duration of the diseases was estimated across these groups using data on duration of diseases gathered from discussions with HPS[10].

Treatment given

For treated cases, medical costs (including costs to the NHS, society and the cases and carers for prescriptions etc.) were estimated from Roberts et al. (2000)[11] for E.Coli cases and from Roberts et al. (2003)[12] for other diseases. For Community cases, medical costs were

estimated from Roberts et al. (2003) (E. Coli O157 symptoms are so severe there are no community cases for this disease).

Costs due to loss of productivity were also considered. These costs consisted of loss of income to cases and carers due to days off sick and an economic cost to society due to the loss of the work which would have otherwise been conducted by the ill people. Loss of income costs per case were based on the average daily wage for Scotland in 2007[13]. Economic loss was taken from the figure used in the 2004 Report which calculated economic loss to be 30% above the daily wage.

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Morbidity and mortality factor

As with the 2004 CBA study, a standard cost of £50 per case was included to account for morbidity due to illness.

An average cost of illness for community cases and treated cases was calculated using an average of all costs for all diseases weighted by the prevalence of each disease in cases due to PWS in the Scottish Borders. All costs were calculated in 2010 prices and discounted by 3.5% using economic data from the HM Treasury[14]. These figures were then combined with the estimates of the number of people falling ill due to PWS in the Scottish Borders for the time period considered by the project to give a monetary value of the benefits of implementing the 2006 Regulations.

Although this project has considered the reduction in number of cases of illness due to PWS as a benefit, it can more accurately be considered as a reduced cost, as costs still occur but fewer people will become ill. In order to estimate whether the implementation of the 2006 Regulations has been a cost saving exercise or not, the cost of implementation and the reduced cost due to implementation must be compared with the costs if no regulations had been introduced. If the 2006 Regulations had not been transcribed into Scottish Law then illness rates due to PWS would remain as high as they had been pre-regulations. Therefore, the results of this project were compared with the cost of illness due to PWS in the Scottish Borders in 2005 and over the next 15 years.

6 Results of Study

6.1 Key results from SBC case study

Type A

- A total of 118 risk assessments were completed for Type A supplies between 2006 and 2009[2]. The majority of these risk assessments identified that there was a risk of microbiological contamination to the supply.
- A total number of 29 supplies have been improved as a result of these risks assessments (up to March 2010). The maximum population served by these supplies in any one day is estimated to be 3234.

Type B

- A total of 105 risk assessments were completed for Type B supplies between 2006 and 2009. All of these risk assessments identified that there was a risk of microbiological contamination to the supply.
- A total 50 supplies have been improved as a result of these risk assessments. It is estimated that 417 people would benefit from these improvements.
- It is estimated that the total population in SBC area served by Type B supplies is 8030.

6.2 Summary of CBA

Table 7 shows the projected (discounted) costs over the 15 year period of implementing the 2006 Regulations and provided in 2010 prices. The costs are shown for each stakeholder.

Table 8 shows the projected (discounted) benefits over the same period. These are shown for Type A and Type B supplies. Table 9 summarises the overall CBA results

Table 7 Projected Costs over a 15 year period starting from 2005 (discounted and in 2010 prices)

Stakeholder	Projected Costs due to the implementation of the 2006 Regulations
Scottish Borders Council	849,422
Scottish Government (total) - Staff and Admin costs - Grant scheme	1,217,368 62,140 1,155,228
PWS Relevant Persons (Type A and Type B)	2,451,929
Total	**4,518,719**

[2] This figure is less than the 128 quoted in the DWQR Annual Report 2008. However, the project team have excluded 10 supplies which appear to be either Type B supplies or which were established to be a double count of a supply already included in the analysis

Table 8 Projected Benefits over a 15 year period starting from 2005 (discounted and in 2010 prices)

	Reduction in health costs due to the implementation of the 2006 Regulations	Hypothetical health costs of PWS if the 2006 Regulations were not brought in
Type A	3,706,385	7,684,457
Type B	2,069,210	30,837,967
Total	5,775,596	38,522,424

Table 9 Cost Benefit Analysis of the PWS (Scotland) 2006 Regulations over a 15 year period from 2005 (discounted and in 2010 prices)

Costs of implementing Regulations over 15 years	Reduction in health costs due to the implementation of the 2006 Regulations	Net CBA Net Cost (-) or Benefit (+)	CBA Ratio (Benefits / Costs)
4,518,719	5,775,596	1,256,877	1.3

6.3 CBA Sensitivity Analysis

A sensitivity analysis was carried out on following variable factors within the CBA:

- Disease reporting rate (number of Community cases per Treated case reported via the National Surveillance System (Table 10)
- Duration of illness (Table 10)
- Rate of improvement in Type B supplies 2010 onwards (Table 12)

Table 10 – Impact of reporting rate on reduction in health costs (discounted and in 2010 prices)

Reporting Rate	Hypothetical costs of PWS if the 2006 Regulations were not brought in	Reduction in Costs due to the implementation of the 2006 Regulations	Costs due to the implementation of the 2006 Regulations	CBA Ratio
6.36 (Figure used in report)	38,522,424	5,775,596	4,518,719	1.3
12.7 (High)	71,430,870	10,783,724	4,518,719	2.4
3.18 (Low)	22,068,667	3,297,539	4,518,719	0.7

Table 11 – Impact of duration of illness on reduction in health costs (discounted and in 2010 prices)

Duration of illness (days)	Hypothetical costs of PWS if the 2006 Regulations were not brought in	Reduction in Costs due to the implementation of the 2006 Regulations	Costs due to the implementation of the 2006 Regulations	CBA Ratio
6.5 (Figure used in report)	38,522,424	5,775,596	4,518,719	1.3
13 (High)	142,028,751	21,294,109	4,518,719	4.7
3.25 (Low)	11,304,331	1,694,838	4,518,719	0.4

Table 12 – Impact of the rate of Type B improvement on the CBA (discounted and in 2010 prices)

Number and rate of Type B improvement over the 15 years of the project (Number of people benefiting)	Hypothetical costs of PWS if the 2006 Regulations were not brought in	Reduction in Costs due to the implementation of the 2006 Regulations	Costs of implementing Regulations	CBA Ratio
1593 (Figure used in report)	38,522,424	5,775,596	4,518,719	1.3
2367 (High)[1]	38,522,424	9,471,616	7,588,181	1.2
979 (Low)[2]	38,522,424	5,489,190	4,105,001	1.3

[1] Number of Type B's improved doubles from the baseline rate after 2013 (due to a hypothetical doubling of the grant amount in 2011 and assuming a year for the changes to filter through to PWS owner level).

[2] After 2013 the number of Type B improvements is reduced until no improvements occur by 2017 (reflecting a scenario where everyone who wants the grant has upgraded their supplies by 2017 and all other PWS owners do not upgrade their supplies).

7 Discussion of Results

7.1 Key results from SBC case study

- The number of Type B supplies which apply for risk assessment is relatively low in comparison to the total number in SBC.
- Only about 50% of Type B supplies where a required improvement is identified are actually upgraded.
- Risk assessments frequently identify a microbiological contamination risk to a PWS.

7.2 CBA

- The total projected costs over the 15 year period starting from 2005 are £4.6 million. The majority of these costs (54%) fall on the PWS owners.
- The total projected reduction in health costs over the same period is £5.7 million. From this, £3.7 million arises from improvement of Type A supplies. Although there are fewer Type A supplies they serve a larger number of people due to their commercial activities.
- The 2006 Regulations have a net benefit to society in the SBC area of £1.16M and the ratio of benefits to costs is 1.2. This CBA ratio is similar to that presented in the Partial Regulatory Impact Assessment published in 2004[15].
- The sensitivity analysis shows the results of the model are highly dependent on the reporting rate and duration of illness parameters. Halving the reporting rate would reduce the CBA ratio to 0.69. Halving the Duration of Illness would reduce the CBA ratio to 0.34.
- The low rate of Type B improvements since 2006 indicates that less than half the people served by Type B supplies (the majority of which are currently assigned as being as risk of microbiological contamination in their Risk Assessment) will be improved by 2020. The sensitivity analysis indicates that the number of Type B supplies does not have a great effect on the overall reduced costs of the 2006 Regulations. If the number of Type B supplies per year doubles to after 2013 then the cost benefit ratio would only increase to 1.39.

7.3 Comments efficacy of Grant Scheme

The 2009 study into the level of engagement with the 2006 Regulations highlighted that there was often a perception amongst owners and users that supply improvement costs were considerably more expensive than the grant scheme[16].

Grants are offered to 'relevant persons' of up to £800 per property. After the risk assessment SBC EHOs will provide home owners with a 'Schedule of Works setting out improvements required. To claim the grant relevant persons will be required to demonstrate that all these works have been completed.

For a certain number of sources in the SBC area records are available of the total improvement cost incurred by the supply owner. Table 13 summarises the differences between these costs and the grant awarded.

Table 13 Summary of difference between improvement costs and grant costs

	Supply Category	
	Type A	**Type B**
Number of supplies for which improvement cost data was available	**30**	**41**
Number of supplies for which improvement costs are greater than 20% more expensive than available grant[1]	**16**	**31**
Average difference between grant and estimated costs	**£4167**	**£4,374**
Maximum difference between grant and estimated costs	**£32,800**	**£17,014**

[1] In the situation where more than one property is served from a supply a grant of £800 is available for each property. The results in this table assume that all properties served by a supply take-up the maximum grant available

The above analysis is across a relative small sub-set of supplies. However, it indicates that in the majority of cases the improvement cost is significantly greater than the grant available. Improvement costs will be sensitive to the nature of the supply system already in place and local site conditions such as access, distance to source, and ground conditions. To illustrate the variance in costs and work required two short case studies of supplies in SBC are included below. The first of these required ground works and installation of a new point of entry filter and UV treatment system. The second replacement of raw water pipework and upgrades to the treatment system.

Short Case Study 1 – Type B Farmhouse supply

Works were completed on a farmhouse water supply which had a spring source located in a fenced area on the verge of a farm road. The works included:

- Cleaning of the collection tank.
- Lowering of the ground level around the tank.
- Digging a Ditch around the tank, line with a membrane and fill with gravel.
- Installation of new Point of Entry UV and sediment filter.

Photo 1: New Point of Entry UV and Sediment Filter

The estimated total of all the works was £6000. The supply fed one property, and a grant of £800 was awarded in September 2008, resulting in a cost of £5,200 for the homeowner.

Short Case Study 2 – Type B Borehole Supply
Works were completed on an existing borehole water supply with grant assistance. The borehole supply failed the Microbiological Risk Assessment and the Microbiological sample. The required works done included:

- Replacement of UV filtration system
- Replacement of pipework liable to fracture.
- Relocation of pre-sediment filter downstream of pumps.

The estimated total cost of the works was £2,486 broken down into:

- £1,348 on the new UV systems.
- £668 on new pipework
- £470 on pre-sediment filter for well pump line.

The Borehole supply serves three properties, but only two took part in the grant scheme. A grant of £1600 was awarded in December 2008, resulting in a cost of £886 for the homeowners.

The grant scheme is intended to be a contribution towards the costs of upgrades. Due to the regulation of Type A supplies it is likely that in most cases these properties will claim the full grant to which they are entitled. Type B sources, on the other hand, may decide not to accept grant on the grounds of the total cost being to expensive. It is possible that these supplies may undertake some lesser improvement works. For example, they may install a filter & UV system without improving the integrity of raw storage and conveyance.

From the data available it is not possible to definitively calculate what number of Type B supplies decide not proceed with the grant. However, discussions with SBC EHOs during the data collection process indicates that this is a fairly common occurrence.

8 Principal limitations to the study

- Although epidemiological studies have been used to improve estimates of the number of people falling ill as a result of PWS there is still uncertainty around the factors used in this report. It is likely that this would only be improved by changing the manner in which GI diseases are reported in Scotland. It is understood that the type of GI data which is reported to HPS varies across different Health Boards.
- Long-term health impacts of non-microbiological contamination (e.g. from reduced lead and copper levels in PWS) have not been included in the CBA. Health impacts which may or may not occur in the distant future were considered to be too uncertain to include in the study.
- The determination of the probability of a sampling failure ‘p’ for Type B supplies is based only on one sample per supply. As there is no requirement in the Regulations for ongoing maintenance of these supplies it is difficult to see how the estimate of this probability could be improved unless a specific sampling programme is commissioned.
- The probability of a sampling failure for Type A supplies is based on only few years of data. However, due to the periodic sampling of Type A supplies, this estimate will be improved over time.

9 Recommendations for further work

Replication for carrying out assessment in other areas
This project was viewed as pilot for carrying out similar work in other Local Authorities where PWS were prevalent. Although this study has improved the robustness of the CBA presented in 2004 it is recommended that consideration be given to the following points before proceeding with further studies.

Firstly, the manner in which GI disease data is collected in the relevant health board(s). This will greatly determine whether accurate estimates can be made of the health impacts. Secondly, the method by which the local authority collates and stores their risk assessment data. This will obviously impact on the resources required to carry out the study.

Improvement in the collation of GI disease data
It is recommended that further discussion be held with HPS as to how changes could be made to the manner in which GI disease data is collected which would assist in determining impacts of PWS. Any changes put forward could possibly be piloted in selected area with a high number of PWS.

Correlation of Peak PWS contamination risk and Tourism Season
The current model assumes that risk of microbiological contamination of a PWS and number of people served by a Type A supply are both constant throughout the year. However, there is a seasonal trend in contamination risk levels and tourism numbers which means that the two events peak at a similar time of year. This may mean that the current study underestimates the number of people exposed, for one of the most vulnerable groups of people studied in this project. Future work could account for this using seasonal data.

Age and Resident related Vulnerability
Discussions with HPS and the literature review suggest that certain groups of people are more vulnerable to catching a disease from a contaminated PWS than others. Both young and old people are more at risk of developing severe symptoms once a GI disease develops (increasing the costs of treatment). Additionally young people and tourists do not have as much resistance to these diseases, meaning they are more likely to catch the diseases from high risk supplies and more likely to develop severe symptoms. Recent evidence from a study conducted on Cryptosporidium cases surrounding Loch Lomond[17], suggested that improvements to PWS could actually increase the vulnerability of residents. This was due to residents developing a partial resistance to the disease due to frequent low exposure. By improving the supply, this resistance was lost. Future work may be able to account for some of these anomalies.

Increases costs to the Rural Tourism Industry
The 2009 Aberdeen Report which investigated ways to increase engagement of PWS owners and users in implementing the 2006 Regulations found that there were persist concerns amongst Type A owners about the effect of the Regulations on rural tourism by dissuading visitors to custom an establishment served by a PWS, which, due to the 2006 Regulations must display a notice informing their guests and visitors that they may be exposed to a PWS. A survey of visitors to rural regions of Scotland could be used to assess whether these concerns are justifiable. If so, these costs should be included in the CBA.

10 Conclusions

- This report details the methodology and results of a CBA undertaken for the implementation of the Private Water Supply (Scotland) Regulations 2006 in the Scottish Borders Council area.

- Over a period of 15 years it is projected that the introductions of Regulations in the Scottish Borders will result in a net benefit of £1.1 million.

- An earlier study into the level of engagement with the 2006 Regulations highlighted that there was often a perception amongst owners and users that supply improvement costs were considerably more expensive than the grant scheme. Analysis of data from SBC on has shown that in the majority of cases the cost of improving a PWS is significantly greater than the grant available. This may be the cause of the low uptake of the grant scheme amongst Type B supplies.

- This work builds on a previous pan Scotland study undertaken in 2004 pre-introduction of the regulations. This study has enabled the actual impact of the regulations to be assessed in terms of number of PWS improved. However, it highlights a number of deficiencies in some datasets, in particular health data. A number of recommendations have been put forward for how these deficiencies could be addressed in future studies.

Appendix 1 – SBC staff costs

The staff costs for SBC in administration of the scheme were determined through discussion with Ken Jones of SBC (Environmental Health Manager)

The following staff members spend a proportion on there time on PWS: four EHOs; one technical assistant; and Environmental Health Manager. Salary costs for these staff member have been estimated with an on-cost (25%) to cover admin and management time. The total annual costs have been estimated as £64,645. SBC have indicated that these costs are indicative of the yearly costs from 2006 to date. Unless there were to be a step change in the number of Type B supplies coming forward for risk assessment these costs would not vary significantly over the timeframe of the CBA.

Appendix 2 – Details of PWS Maintenance Costs

For the purposes of the CBA the maintenance activities shown in the table below have been costed. Estimates for each activity have been obtained from suppliers of small scale treatment systems and maintenance contractors. All estimates are based on 2010 prices.

Maintenance costs used in the CBA

Activity	Frequency	Annual Cost per property size (number of people served)		
		1 - 3	4 – 10	10 +
Replacement of cartridge filters	Once every 3 months	42	82	82
Replacement of UV lamps	Once every 9 months	29	39	59
Borehole scaling /cleaning with compressed air	Once every 5 years	£200		

The following assumptions have been made in developing the above unit costs:

- UV is the only disinfection system utilised by private water supplies (occasionally a different system, such as Chloride disinfectant is used but this possibility was excluded from the model).
- Other maintenance activities will be required, such as cleaning of UV lamps and storage tanks. However, as these will often be carried out by the property occupier/owner, they have not been included in the CBA.
- A number of Type A supplies will have been equipped with treatment systems prior to the introduction of the 2006 regulations. From records held by SBC and SG it was estimated that a total of96 supplies already had filtration and UV. A consequence of introduction of the regulations is that these existing systems will need ongoing maintenance. Therefore, the cost of maintaining these supplies has been included in the CBA. No such allowance has been made for Type B properties.
- The annual maintenance cost of any new treatment systems (Type A or Type B) has been included in the CBA from the year in which the supply is improved.
- The CBA includes no allowance for end-of-life replacement of PWS assets or upgrade in the event of an amendment to the 2006 regulations.

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