Outbreak of cryptosporidiosis in North West Wales, 2005

Report of the Outbreak Control Team

(Anglesey County Council, Anglesey Local Health Board, Centre for Research into Environment and Health, Dwr Cymru, Environment Agency Wales, Gwynedd County Council, Gwynedd Local Health Board, National Public Health Service for Wales)
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Summary

The outbreak

An outbreak of cryptosporidiosis occurred in North West Wales in the last quarter of 2005. The number of confirmed cases associated with the outbreak was 231.

Cryptosporidiosis is a diarrhoeal illness caused by a parasite called cryptosporidium. Symptoms may not appear until five to ten days after becoming infected.

Several lines of investigation produced evidence that the outbreak was waterborne and linked to the mains water supply from Llyn Cwellyn:

- A high proportion of cases were resident in the area supplied with water from Llyn Cwellyn;
- A significant number of people falling ill were adults indicating that the cause of the outbreak was a common, low level, community source (the contamination was an unusual event);
- The dates on which people developed symptoms of illness pointed to the cause being a continuing, low level, common source, not a single point source in time;
- People with cryptosporidiosis were more likely than people who were not ill to have drunk unboiled mains tap water; the more mains tap water drunk, the greater the probability of being infected;
- Microbiological investigations demonstrated the same strain of Cryptosporidium hominis in pre- and post-treatment water samples as had been identified in cases;

No other plausible hypotheses have been identified that would explain the findings.

Environmental investigations, confirmed by microbiological testing, identified several routes by which Cryptosporidium hominis from sewage treatment systems in the Cwellyn catchment could have entered the reservoir. Sewage effluent, even after standard treatment, cannot be guaranteed to be free from cryptosporidium.

It would seem likely that one or more people in the catchment area of Llyn Cwellyn had cryptosporidiosis before the main outbreak. Although they would have been ill with diarrhoea, they would probably not have known that this was due to Cryptosporidium hominis. There are no recorded cases of cryptosporidiosis in the area at the time so either people did not submit samples to the laboratory or they may have been visitors to the area.

Cryptosporidium hominis entered Llyn Cwellyn through one or more of the routes identified from sewage treatment systems in the catchment area. There were no effective barriers to prevent it then reaching the mains water supply.

The Cwellyn water treatment works appears to have been operated by Dwr Cymru in compliance with regulatory requirements and its risk assessment. However, the water treatment process in place at Llyn Cwellyn at the time was not designed to remove or kill
cryptosporidium. The risk assessment had assumed that sewage effluent would be diluted significantly in the lake, but this may not be the case under certain conditions.

Examination of water quality data and operational details have failed to identify any problems previously known to be associated with waterborne outbreaks. Although there had been heavy rain prior to the outbreak and heavy rain has been associated with some other outbreaks, this is not unusual in the area.

By early November – after a period of time in which Cryptosporidium was transmitted into the water supply and then incubated in people drinking it - the first indications of a possible outbreak became apparent. An incident management team, involving representatives of all the relevant agencies was established immediately. It would not have been possible to identify the start of the outbreak any earlier.

The cause of the outbreak was not clear at first. The incident management team set in place a series of investigations into the people with cryptosporidiosis, the way it was spreading, the microbiology of the illness and all possible causes. By 29th November, the evidence demonstrated that waterborne infection was the most likely cause of the increase in cases. At this point, an outbreak was declared and people in the area were advised to boil their mains tap water before drinking it.

Investigations continued. Although these strengthened the evidence supporting mains tap water as the probable source, they did not identify a water treatment fault which could be rectified. The only option was to install additional treatment.

On this basis Dwr Cymru installed new ultra-violet (UV) treatment, which kills Cryptosporidium. Once installed and shown to be working effectively, the advice to people to boil their mains tap water was lifted.

It is difficult to see how the outbreak could have been prevented, or its impact reduced, given what was known before the outbreak started and what became apparent as the outbreak developed.

It is possible to say that such an outbreak should not occur again given the proper functioning of the ultra-violet treatment at Llyn Cwellyn.

One hundred and fifteen people worked on the outbreak investigation over a five month period. This was the largest, and only the second recorded, waterborne outbreak of cryptosporidiosis in Wales.

**Observations and lessons learned**

**Water treatment**

1. Continuous monitoring was used, from 2nd November, at Llyn Cwellyn for operational water treatment (non-regulatory) purposes (i.e. to obtain data). The data collected showed very low levels of oocysts which were well below the regulatory treatment standard specified for sites identified as at significant risk (average of less than one oocyst per 10 litres in a continuous sample at 40 litres/hr/ ~24hrs). The 1999 Statutory Instrument (subsequently incorporated into Statutory Instrument 2001, paragraphs 27-29) says by way of explanation that it is intended to ensure that water supplied for human consumption is
not contaminated with cryptosporidium, a parasite which can be detrimental to public health. This level does not, however, guarantee freedom from risk of waterborne cryptosporidiosis.

2. It is important to take notice of even low numbers of oocysts in treated drinking water since they may constitute a threat to public health.

3. Conventional sewage treatment systems alone, when located in the catchment area of reservoirs, cannot be relied upon to prevent the water supply from being contaminated by cryptosporidium that may be found in human faeces.

4. The existing widespread practice of relying on dilution is unreliable as a general policy.

5. The infectious dose may be as low as a single oocyst of Cryptosporidium hominis.

Water Supply

6. A Water Supply Zone is not usually co-terminus with a single local authority boundary and more than one Water Supply Zone can exist within a geographically large unitary authority re- emphasising the need for collaboration between different organisations.

7. Consumers use mains water that may be derived from more than one original source and water companies can occasionally switch sources for operational reasons. The majority of calls to the helplines related to the fact that people do not know the source or sources of their water supply.

8. The automatic identification of households and other premises for the purpose of issuing an individual Boil Water Notice to each property is complicated by the need to maintain flexibility in the boundaries of water supply zones for operational purposes.

Outbreak occurrence

9. The natural history of Cryptosporidium hominis infection, the rarity of outbreaks in small communities in rural catchments and the likely impact of heavy rainfall provide a plausible explanation of the rarity and unpredictability of waterborne outbreaks caused by Cryptosporidium hominis.

10. With current knowledge it cannot be guaranteed that there will be no further outbreaks.

Boil Water Notice

11. Some public health experts have questioned the value of a Boil Water Notice (BWN), primarily due to evidence of poor compliance (O’Donnell et al, 2000; Hunter 2000). Where an alternative water supply (e.g. through re-zoning) is not an option, and where there is evidence of a continuing risk, then it is essential to ensure that the notice is issued as quickly and as effectively as possible. It is important to recognise the right of individuals to make an informed choice whether to boil or not. Even with poor compliance fewer people will be exposed to infection. This issue needs to be reviewed by the Group of Experts or equivalent body.

12. Time limiting a Boil Water Notice to a specific date may reduce flexibility in managing an incident.
13. It may sometimes be necessary to issue a Boil Water Notice without a precisely defined exit strategy, contrary to the existing advice outlined in the Report of the Group of Experts (Anon).

Guidance

14. The advice issued by the Chief Medical Officer on the need for immunocompromised patients to boil all their drinking water could usefully be reviewed. The need for the advice to be issued to appropriate patients needs to be re-emphasised to clinicians.

15. Questionnaires routinely administered by environmental health professionals to cases should record the place (postcode) of work/day care/education (i.e. anywhere else where water may be consumed) in addition to the place of residence, and should record the volume of unboiled tap water drunk.


Microbiology

17. Routine laboratory examination for cryptosporidium in faecal samples from people reporting diarrhoea, and reference tests for Cryptosporidium species/genotype identification in clinical specimens are essential for effective incident/outbreak investigation and control. (Casemore in Anon 1998, pp137-142; Casemore & Roberts 1993).

18. Core funding is not currently provided for widespread routine reference tests for Cryptosporidium species/genotypes in England and Wales.

19. Cryptosporidium species/genotype identification of environmental samples, including raw and final waters, improves information provided from oocyst numbers alone by indicating potential sources and infectivity for humans.

Recommendations

1. The Chief Medical Officer should consider the lessons learned (above) and the need for updated expert advice on cryptosporidiosis and the water supply especially the risk associated with small numbers of oocysts.

2. The Chief Inspector of Drinking Water should consider the lessons learned (above) and the need for updated expert advice on cryptosporidiosis and the water supply especially the risk associated with small numbers of oocysts.
Glossary of terms and abbreviations

A1 source  Surface waters that meet the criteria for an A1 source as set out in The Surface Waters (Abstraction for Drinking Water) (Classification) Regulations 1996.

AM  Assembly Member (of the National Assembly for Wales).

Allele  One of the variant forms of a gene at a particular location.

Analytical epidemiological  A study in which groups are compared to identify and quantify causes of disease by testing a theory as to what the cause may be. A case-control study is an example of an analytical epidemiological study.

Attack rate  The proportion of a well defined population that develops a disease over a limited period of time, such as during an outbreak.

BWN  Boil Water Notice.

Backwash  Cleaning filters by reversing the flow of water.

Bacteria  A group of microorganisms which lack a distinct nuclear membrane and have a cell wall of unique composition. They may be harmless or may cause disease. Generally, they range in size from 0.5 to 5µm.

Bathymetric  The measurement and mapping of the depth of water in a lake.

Biodisc package plant  A package sewage treatment plant is delivered and installed as a prefabricated package, with its interconnected chambers or treatment method configured in a compact unit.

Bolus  Not dispersed in place and time.

CC  County Council.

CDSC  Communicable Disease Surveillance Centre. It is based in the National Public Health Service for Wales.

CI  Confidence Interval – see description below.

COWP gene  Cryptosporidium Oocyst Wall Protein gene: one of the genetic targets for the characterisation of Cryptosporidium spp.

CREH  Centre for Research into Environment & Health.

CRU  Cryptosporidium Reference Unit for the UK. It is based in the National Public Health Service for Wales.

Case  A person with the disease or condition under investigation e.g. cryptosporidium infection.
Case Control Study  
An analytical epidemiological study. It involves comparing people with a disease (cases) to a similar group of people free from that disease (controls) and looking back to see whether they were exposed to a risk factor of interest e.g. drinking unboiled tap water. Different rates of exposure between cases and controls may point to the cause of the disease.

Chi square  
A statistical test that estimates the probability that an observed difference between the proportion of individuals exposed to a risk factor in two groups could have occurred by chance. The test produces a p value (see definition below). A p=0.05 indicates a 5% probability, or a 1 in 20 chance that the difference could have occurred as the result of random variation.

Clostridium perfringens  
A spore-forming bacterium present in the gut of warm-blooded animals, and used as an indicator of historic faecal contamination of water. Its presence in drinking water requires investigation: the standard is 0 per 100ml treated water.

Clostridia spores  
A form of clostridium species (including Clostridium perfringens) that is exceptionally resistant to unfavourable conditions in both the natural environment and disinfection processes.

Coagulation  
A water treatment process to reduce turbidity. It involves the addition of chemicals to bring about the aggregation (floculation) of fine particles. They can be removed by appropriate separation processes such as sedimentation or filtration.

Coliform  
A group of bacteria present in the gut of warm-blooded animals, widely distributed in the environment and sometimes found growing on plant matter. Their presence in drinking water indicates a need to investigate the integrity of the water supply system. The standard is 0 per 100ml treated water.

Confidence interval  
A way of expressing, statistically, the certainty about the precision of the findings from a study. The 95% confidence interval represents the range of measurements, calculated from a study, within which people can be 95% certain that the true value lies.

Confirmed case  
A person who submitted a stool sample in which Cryptosporidium spp. was identified.

Control  
In a case control study (see above), a person without the disease or condition under investigation.

Cryptosporidium  
A microscopic protozoan parasite of man and other vertebrates. It is Greek for ‘hidden spores.’

C. hominis  
Cryptosporidium hominis – a species of Cryptosporidium whose principal host is man.
C. parvum  Cryptosporidium parvum – a species of Cryptosporidium whose host range includes man, cattle, sheep and other mammals.

Cryptosporidiosis  The disease caused by Cryptosporidium.

DETR  Department of the Environment, Transport and the Regions.

DNA  Deoxyribonucleic acid: the genetic material which controls heredity and is located in the cell nucleus.

DWI  Drinking Water Inspectorate.

Dwr Cymru  Dwr Cymru/Welsh Water – the company supplying the public water supply and sewage treatment service in North West Wales.

Dirt loadings  The suspended solids contained in the raw water that would be deposited on the pressure filters.

Descriptive epidemiology  Describing the characteristics of cases, i.e. date of onset of illness, place of residence, age or sex.

Dose response relationship  The relationship between the amount of exposure to the risk factor of interest (as opposed to simply being exposed or not exposed) and the risk of developing the disease under investigation. If the risk of individuals developing a disease is found to increase as the levels of exposure increase e.g. as the number of glasses of unboiled tap water drunk increase, this provides further evidence to suggest that the exposure caused the disease.

Drainage field  Soakaway.

EA  Environment Agency.

EHO  Environmental health officer.

E. coli  Escherichia coli. Bacteria present in the gut of warm-blooded animals. Their presence in drinking water indicates faecal contamination and should be investigated immediately. The standard is 0 per 100ml treated water.

Epidemic curve  Graph showing the growth and decline of new cases with time.

Epidemiology  The scientific study of the patterns, causes, and control of disease in groups of people.

Epilimnion  Upper layer of warmed water in a lake. The situation in which there are layers showing different temperatures is known as a thermocline. Such layers (thermal stratification) are normally seasonal and may reduce the dilution capacity of a lake when present.
Exposure Individuals are exposed if they have experienced the risk factor of interest e.g. they have drunk unboiled tap water.

Flocculation See coagulation.

GP General medical practitioner.

GP60 gene Encodes a precursor protein that yields the cell surface glycoproteins gp45 and gp15, hence GP60. It is one of the genetic targets for the characterisation of Cryptosporidium spp.

Grab sample A water sample taken using a fixed volume container (commonly 10 litres). The results are indicative only and not directly comparable with continuous monitoring samples.

Group of Experts A joint Department of Health/DETR multidisciplinary committee set up to study and report on the problem of cryptosporidium in water supplies and to provide relevant advice to the Department of Health, DETR, the water industry and others.

HPA Health Protection Agency.

HPT Health protection team. Health protection teams in Wales are part of the National Public Health Service for Wales.

Homology Similarity of form.

Hydrodynamics Study of the movement of water.

Hydrogeology The branch of geology dealing with ground water.

Hydrology The study of water resources.

ID The number (dose) of a parasite or other organism needed to infect a person or other susceptible host.

ID50 The dose of a parasite or other organism found to infect 50% of an exposed population.

Indicator organism An organism such as E.coli that is tested for in water samples (as a parameter or limit set by water quality regulations), which is not normally pathogenic itself but indicates possible faecal contamination and the need for further investigation.

LHB Local health board.

MP Member of Parliament.

Microbiology The science of microorganisms.

Morphology The visual characteristics, including size and shape, that define a particular species of parasite or other organism.
Morphometry  The measurement of organisms.

NPHS  National Public Health Service for Wales.

NTU  Nephelometric Turbidity Unit – the measurement used to indicate the amount of turbidity, mainly due to particulates, in water (a parameter under water quality regulations. The limit is 1NTU as an indicator and 4NTU as a mandatory requirement).

OCT  Outbreak control team.

OfWAT  Office of Water Services.

OR  Odds ratio – see below.

Odds  Odds refers to the ratio of the number of individuals being exposed to a risk factor to the number not being exposed to that risk factor. If among 10 cases of cryptosporidium infection 7 had drunk unboiled tap water and 3 had not the odds would be 7/3.

Odds ratio  The odds of exposure of cases to a risk factor divided by the odds of exposure of controls. Used to measure statistical association in case control studies. An odds ratio of 1.0 means that there is no association between the illness and the exposure. A value greater than 1.0 means there is a positive association i.e. disease more likely in the exposed. A value less than 1.0 means there is a negative association.

Onset  The point in time when the initial symptoms of a disease become apparent e.g. the date that a patient first develops diarrhoea or other symptoms of cryptosporidium infection.

Oocyst  The environmentally resistant transmissible life cycle stage of cryptosporidium, shed in the faeces of an infected host.

Outbreak  Two definitions are used to detect an outbreak. Either there is an increase in the number of people with an illness or disease that is above what would normally be expected in the population at that particular time; or, two or more linked cases with the same illness.

P value  P-values are calculated by statistical tests to estimate how likely it is that the associations observed between an exposure e.g. drinking unboiled tap water and an outcome e.g. cryptosporidium infection, could have been due to chance alone. A p-value of 0.05 means, therefore, that there is a 1 in 20 probability that the different levels of illness between an exposed and an unexposed group occurred by chance alone (and hence a 19 in 20 chance that there is some other “real” explanation). The smaller the p-value the more likely the difference between the two groups is real.

PCR-RFLP  Polymerase Chain Reaction – Restriction Fragment Length Polymorphism. A sensitive technique used to characterise...
Cryptosporidium spp. at targeted gene loci e.g. the COWP or ssu rRNA genes.

pH Hydrogen ion concentration - indicative of acidity/alkalinity.

PPU Public protection unit – of the local authority.

Package sewage treatment plant A package sewage treatment plant is delivered and installed as a prefabricated package, with its interconnected chambers or treatment method configured in a compact unit.

Parameter Organisms, substances, etc, which must be tested for in drinking water under the water quality regulations. Limits are defined by the regulations on the number or concentration which may be present.

Pathogen A microorganism capable of causing disease.

Plumbosolvency control The chemical adjustment of water to reduce the amount of lead which can get into water from lead pipes.

Post backwash The period immediately after backwashing when water is returned to its normal direction of flow.

Primary infection The first individual within a group or family to acquire the infection directly from the source of the infection e.g. drinking infected tap water. There may be several primary cases in a household or group if they are exposed to the same source around the same time.

Propagated outbreak In propagated outbreaks cases continue to occur and each new case may infect some more and keep the outbreak going.

Protozoan parasite A single-celled microorganism, with at least one well-defined nucleus, which lives in a host from which it obtains its nutrition, to the detriment of the host.

RA Risk assessment.

RNA Ribonucleic acid: an organic acid concerned with the synthesis of proteins.

Rainfall event A significant increase in rainfall which may increase the challenge to water treatment.

ssu rRNA gene Small subunit ribosomal RNA gene: one of the genetic targets for the characterisation of Cryptosporidium spp.

Secondary infection A second or subsequent individual within a group or family to develop a disease who has acquired the infection from a primary case e.g. by person to person spread within a household, rather than directly from the original source of the infection e.g. drinking unboiled tap water.
Seroprevalence  The frequency of occurrence of antibody (present in the blood, etc, in response to infection) in a given population.

Stratification  See epilimnion.

Supernatant  The remaining liquid after a mixture is centrifuged.

T-test  A statistical test used to determine whether the mean of a particular measurement in each of two groups is statistically different from the other. For example, to determine if the average age of individuals with cryptosporidium infection (cases) is higher or lower than the average age of individuals without infection (controls).

Thermocline  See epilimnion.

Turbidity  Particulates and other substances which reduce the clarity of water; measured in NTUs.

Turbidity spikes  Defined increases in NTU from normal background levels. They may reflect a rainfall event or indicate other sources of contamination, or result from sediment moved by water turbulence.

UKWIR  UK Water Industry Research. An organisational framework for the procurement of a common research programme for UK water operators “one voice” issues.

UV  Ultra violet.

Univariate analysis  Univariate analysis explores one risk factor at a time in an epidemiological study. The association between each risk factor and the disease is investigated separately.

Unripened filters  Filters in the immediate post-backwash period which have not yet returned to their optimum operating condition.

VLA  Veterinary Laboratories Agency.

WTW  Water treatment works.

Wash water volumes  The volume of water used to backwash filters and which must be dealt with in an approved manner after backwashing.

Waterborne  Any route of transmission via water.
1. Background

Cryptosporidiosis is a diarrhoeal disease of humans and animals, caused by a microscopic protozoan parasite called cryptosporidium. The organism is widespread among mammals, including farm and domestic animals, particularly young stock, and is passed on through their manure. It is present in the environment at low levels all the time, but higher levels are common in springtime, particularly when heavy rain washes the parasite into the ground and into rivers and lakes. It can also be passed on through human faecal contamination.

Cryptosporidium is transferred to humans by a variety of routes. Person-to-person spread is an important source of infection if care is not taken with personal hygiene. Contact with farm animals (and sick pets) can put people at risk of infection. Water supplies may be vulnerable to contamination with cryptosporidium and the infection can be spread via drinking water.

There is no routinely available effective treatment for cryptosporidiosis. This is why people with immune problems in particular are advised to avoid contracting the infection in the first place if at all possible. The infection will usually clear up by itself in a healthy person. Taking antibiotics is not normally advised. It is generally good advice for someone to increase fluid intake when they have diarrhoea.

Two species of Cryptosporidium predominate in human disease in the UK. Cryptosporidium hominis is largely restricted to humans. Cryptosporidium parvum is hosted by both humans and other animals.

Cryptosporidium is detected by identification of oocysts – the environmentally resistant transmissible life cycle stage which is shed in the faeces of the person or animal with the infection.

Cryptosporidiosis cannot be diagnosed by a person’s symptoms. A stool sample is needed for laboratory diagnosis.

Approximately 300 cases of cryptosporidiosis are reported annually to Wales surveillance (about 4,500 in England and Wales). The average annual incidence is 8.7 cases per 100,000 population in England and Wales (HPA and NPHS data). It is likely that this under-represents the actual number of cases. For every case of cryptosporidiosis identified from visits to the GP there may be up to six in the community (Wheeler et al., 1999).

Laboratory test sensitivity and reporting may also contribute to an underestimation of the number of cases.

Cryptosporidium is routinely identified in fewer than 1% of sporadic cases of diarrhoea.

The majority of cases of cryptosporidiosis appear to occur sporadically. Less than 10% of cases in England and Wales are linked to recognised outbreaks.

Risk factors observed in sporadic disease include:

- Person-to-person transmission especially through contact with young children;
- Travel outside the UK;
• Contact with farm animals;
• Drinking mains water and private water supplies;
• Contact with a contaminated environment; and
• Consumption of contaminated food such as raw sausage, raw milk, etc.

Specific risk factors associated with Cryptosporidium hominis in analytical epidemiological studies are changing nappies, contact with another person with diarrhoea, travel abroad and using a toddler pool (Hunter et al., 2004).

Outbreaks in the UK have been associated with:

• Swimming in swimming pools;
• Open/educational farm visits;
• Drinking mains water;
• Drinking private water supplies;
• Using interactive water features (fountains and water parks);
• Environmental/surface water contact
• Institutions including nurseries; and
• Consumption of raw (unpasteurised) milk; a food borne outbreak involving mistakes in the pasteurisation of milk.

The number of outbreaks of cryptosporidiosis linked to drinking water from public supplies in England and Wales has declined in recent years. There were four reported in the five years from 2000 to 2004 compared with 16 in the previous five years (Nichols et al., 2006).

In 2005, there was a further outbreak in England linked to drinking water (Surveillance of waterborne disease in England and Wales: summary of 2005 CDR 13 July 2006).

In Wales, there has been just one previous reported outbreak associated with mains water, involving 30 cases due to a cracked service reservoir on the private distribution system at St Athan in 1995 (Meirion Evans, then CCDC South Glamorgan, pers. comm.)

The general reduction in outbreaks linked to drinking mains water is due in part to improvements in water treatment with respect to cryptosporidium driven by The Water Supply (Water Quality) (Amendment) Regulations 1999 and The Water Supply (Water Quality) Regulations 2000 (2001 in Wales).

Risk assessments on all water treatment works were undertaken nationally in 1999 by water companies. These took account of the source water, catchment characteristics and treatment provided, to identify works deemed to be at significant risk. In this way, treatment could be
optimised and additional appropriate treatment, or continuous monitoring, installed; or regulatory monitoring could be undertaken.

For works assessed by the water company to be at significant risk, there is a treatment standard. Any breach of the standard is required to be notified to the Drinking Water Inspectorate and appropriate action taken.

The same equipment, sampling and test protocols are also used for water treatment at sites not deemed to be at significant risk. They may be used for untreated and treated water. This is done, for example, to obtain data to be used in assessing a source or for managing water treatment processes. In such cases the term regulatory water treatment standard is not used. However, the limit set by the regulation is used by the water company to assess the possible significance of oocyst numbers. Any significant increase in oocyst numbers, especially above the treatment standard (as set for water treatment works designated as at significant risk), could well indicate an increased potential risk to public health; and could be expected to lead to appropriate action.

In addition, water companies may choose to take so-called grab samples, usually of 10 litres, rather than using a continuous sampling method. There is no regulatory limit on oocysts in such samples but the results may assist in water treatment decisions. The results of grab samples are indicative but cannot be compared directly with results from continuous sampling.
2. Chronology of the outbreak and public health response

2.1 Background

To inform public health interventions (for the prevention of case to case spread and control of outbreaks) laboratory identifications of cryptosporidium in Wales are reported to the National Public Health Service for Wales local health protection team. This is done normally by a semi-automated electronic reporting system. The identifications are then relayed to the relevant local authority for investigation. This normally results in a local authority officer contacting the case or, where minors are involved, a parent or guardian of the case. They then go through a standard questionnaire to seek out possible risk factors and sources of infection.

Notification rates for cryptosporidiosis in the Anglesey and Gwynedd local authority areas are between 15 and 25 cases per 100,000 population per year. As elsewhere in Wales cases tend to be clustered in distinct spring and autumn peaks.

During 2004, a total of 36 laboratory confirmed cases of cryptosporidiosis resident in Anglesey or Gwynedd were notified to the NPHS North Wales health protection team (a rate of 19 per 100,000).

2.2 Early cases

From the second week in September until the end of October 2005, laboratory notifications of cryptosporidiosis rose to an average of 2.6 cases per week, a rate compatible with the normal seasonal increase. This was largely matched by increases elsewhere in Wales. By the first week of November, however, the cumulative total of notifications (21 cases since the beginning of September), together with a marked increase in the number notified in the week commencing 31st October 2005 (11 during that week), led the lead NPHS consultant in communicable disease control (CCDC) to review the situation.

The rate for Anglesey and Gwynedd had doubled compared with the same period the previous year. Although the residential addresses of initial cases were distributed widely in Anglesey and Gwynedd, there appeared to be some concentration along either side of the Menai Straits.

Half of the cases were in the 15-44 year age group. Seventy per cent were female.

Of the first 21 cases notified by 2nd November 19 were Cryptosporidium hominis, one was Cryptosporidium parvum and one was untypable.

2.3 Establishment of incident management team

On 2nd and 3rd November 2005 the consultant in communicable disease control discussed her findings with:

- Environmental health practitioners acting in their capacity as Lead Officers;
- The director of the microbiology laboratory at Bangor;
- The regional epidemiologist at the NPHS Communicable Disease Surveillance Centre;
• The head of the UK Cryptosporidium Reference Unit; and

• The area and regional scientists for Dwr Cymru, the water company supplying North West Wales.

It was agreed that an incident management team should be established for a formal review of the evidence available and to further investigate possible causes. Meanwhile, to get a more accurate picture of the number of cases in the community, on 4th November the consultant in communicable disease control contacted all general practitioners in Anglesey and Gwynedd by fax. She informed them of the recent increase in cases and asked them to consider laboratory investigation of any cases of acute diarrhoeal illness.

The first meeting of the incident management team, on 7th November, drew together observations and advice from the health protection team, Dwr Cymru, the Communicable Disease Surveillance Centre Wales, Anglesey County Council, Gwynedd County Council, NPHS laboratories and the UK Cryptosporidium Reference Unit.

It was noted that Cryptosporidium hominis indicated a human origin for the infection and, that while Cryptosporidium parvum was typically responsible for the spring peak, Cryptosporidium hominis was typically responsible for the normal autumn peak in cases.

Interviews of cases by environmental health officers had shown no clear risk factors. However, it was observed that three of the cases had reported drinking relatively large quantities of tap water.

Most of the Menai Straits area was served by two water supply zones, one fed by water from the Cwellyn water treatment works, and the other by a blend of water from Mynydd Llandegai water treatment works and Cwellyn water treatment works. The water company was not aware of any local water treatment failures or operational changes in the water supply. Cases reported to date – mapped by post code - had been supplied by a variety of different water supplies. Moreover, it was reported that there had been several recent samples of the Cwellyn supply tested for Cryptosporidium. The counts of these samples were consistently well within the water treatment standard that would have applied had the site been designated as at significant risk.

The Mynydd Llandegai/Cwellyn blend was the largest supply zone in North West Wales, supplying approximately 40,000 people in Bangor and South Anglesey.

A cause of the increased number of cases could not be worked out from the evidence available. It was agreed, therefore, that the cases should be investigated in more detail, by means of a case control study. Further water tests and environmental investigations were also agreed. The NPHS agreed to lead on any necessary communications to ensure that clear and consistent information was available to professionals and the public.

2.4 Incident management team meeting, 18th November

The second incident management team meeting reviewed:

• The available microbiological results;

• The number and temporal pattern of new notifications;
• A preliminary analysis of the case control study;
• A preliminary analysis of the attack rate by supply zone (the place of residence of the cases);
• The initial results of environmental investigations; and
• The conditions at the Cwellyn water treatment works.

Dwr Cymru reported that oocyst levels in the Cwellyn supply remained well within the water treatment standard that would have applied had the site been designated as at significant risk. All continuous monitoring results indicated less than 1 oocyst in 100 litres. The treatment standard for water supplies designated as at significant risk is less than 1 oocyst per 10 litres. As mentioned in the Background section, these results are indicative and used for operational purposes, for which the regulatory treatment standard does not apply.

Preliminary results from the case control study showed that cases were more likely than controls to have drunk tap water in the preceding two weeks. This statistical association did not, on its own, allow an inference of causation.

Moreover, calculation of attack rates in the 12 different supply zones in North West Wales showed high rates in several zones. There were no zones without cases.

Early results from raw water samples taken, on 7th November, from the Llyn Cwellyn catchment and from final water at Llanwnda suggested that Cryptosporidium hominis might be present, but further work was required to confirm this.

Cryptosporidiosis incidence rates were following a similar, though steeper, course to the rest of the UK.

The position at this stage, therefore, was that there was no clear indication of the likely cause of the increase in cases. The current likelihood of illness in an individual member of the population as a whole was considered low.

Taking all the evidence together, the incident management team concluded that, while it was possible that drinking water might be the vehicle of infection, the evidence was equivocal. It was agreed that a decision to issue advice to the public to boil their drinking water could not be based on such equivocal evidence. Such a decision itself poses risks as well as considerable inconvenience to the public.

However, the incident management team observed that the risk to those individuals who had severely impaired immune systems was no less than at any other time. It was therefore agreed that it would be prudent to remind them to continue their normal practice of boiling their water for drinking and food preparation.

The Third Report of the Group of Experts on Cryptosporidium in water recommended that all water, from whatever source, which might be consumed by immunocompromised people, should be brought to the boil and allowed to cool before use (Anon, 1998).

Initial advice to the immunocompromised, issued by the Chief Medical Officer, stated that those who may be immunocompromised include people with:
• Impaired immunity as a result of HIV infection;
• Various haematological or genetic disorders;
• Malignancy; or
• As a result of therapy with immunosuppressive or cytotoxic drugs (CMO, 1999a).

This advice was subsequently changed and the immunocompromised restricted to:

• People with HIV infection who are immunosuppressed;
• Children with severe combined immunodeficiency; and
• Those with specific T-cell deficiencies, such as CD40 ligand deficiency, also known as Hyper IgM Syndrome (CMO, 1999b).

The incident management team considered if its advice on the use of boiled water should be issued to the wider group of immunocompromised people identified in the original Chief Medical Officer communication or the narrower group to whom the recommendation was subsequently limited.

A decision was taken to issue the advice in line with the latest direction from the Chief Medical Officer (1999b).

In addition to this decision, the following measures were agreed:

• Checking of the integrity of the water distribution system;
• Establishment of a central incident log and case ascertainment;
• Briefing of the media and provision of question and answer information sheets;
• Liaison with Environment Agency Wales and Gwynedd and Anglesey local health boards. Thereafter these organisations also joined the incident management team;
• The Drinking Water Inspectorate should be updated on a regular basis and invited to join the incident management team as an observer;
• The National Public Health Service health protection team in North Wales would be the main point for public contact.

2.5 Progress of outbreak, 18th November – 29th November

On Monday 21st November the Director of the Infection and Communicable Disease Service of the National Public Health Service met with senior colleagues. They put arrangements in place to support the incident management team’s effective management of the incident and communications with the public.

More detailed analysis of the case control study strengthened the association between drinking water and illness. Re-analysis of the attack rates by drinking water supply was undertaken to test the hypothesis that residence in an area supplied with water from Llyn Cwellyn was linked to the illness. Grouping the area supplied by Cwellyn with that supplied by a blend of Cwellyn and Mynydd Llandegai, and comparing the attack rate in those areas (92 per 100,000) with the attack rate for all the other areas combined (12 per 100,000), produced
statistical support for the strategy of focusing the environmental investigation on the Cwellyn supply.

During this period environmental investigations intensified. The Environment Agency Wales was contacted to provide assistance. These investigations are described in detail in section 4.

A report of a collaborative investigation led by Gwynedd environmental health officers was circulated to the incident management team on 23rd November. This identified numerous possible sources for cryptosporidium that included a consented direct discharge to Afon Gwyrfai from the Rhyd Ddu sewage treatment works. The sewage treatment works serves a community of about 20 residential properties, two commercial properties and a public toilet. Also identified were three additional individual domestic properties, two served by their own package treatment plant and a property served by a septic tank where there was a failure of its soakaway system.

No cases of diarrhoeal illness had been reported in residents of households within the Llyn Cwellyn catchment served by public and private systems.

On 23rd November a press statement was released. Letters were also sent to all general practitioners and others involved in the care of patients with severely impaired immune systems. Further details of communications are set out in section 5.

2.6 Outbreak declared, 29th November

The third incident management team meeting was held on 29th November.

The number of microbiologically confirmed cases since 1st October had risen to 87.

The team was in a position to examine the case numbers by date of onset rather than by date of notification. (At the time of notification, the date of onset is not usually known, but is often two weeks or more earlier. See fig 1 for cases by date of notification). A graph showing numbers of cases by date of onset - the epidemic curve - was a valuable pointer to the likelihood of sustained and ongoing exposure.

Results of the epidemiological investigations independently supported the conclusion that waterborne infection was the most likely explanation for the increase in incidence of cryptosporidiosis. Food borne illness, swimming pools and person to person spread were considered and excluded as alternative hypotheses (see section 3).

Cryptosporidium positivity rates had also risen for the increased number of stool samples being received by the local National Public Health Service laboratory between 7th and 29th November. This suggested a true rise in the number of community cases, rather than simply an increase in case ascertainment.

The epidemiological, environmental and microbiological evidence satisfied the team that the incident represented a major outbreak and that mains water sourced from Cwellyn was the most likely cause. An outbreak was declared and the team was renamed the outbreak control team (OCT).

Public health measures to contain both primary and potential secondary infection were instituted the same day. Dwr Cymru was advised by the outbreak control team to issue a boil
water notice (BWN) to all customers in areas supplied with mains water from Cwellyn. The notice was to be effective until 9th January 2006. The time limit was set so that, if a correctable defect could not be identified in the supply, there was an alternative rationale for changing advice to the public.

Dwr Cymru sent letters to 37,000 customers over the following three days. These included advice to use boiled, then cooled, water for drinking, food preparation, baby feeds, teeth brushing and ice-making. The NHS Direct helpline, information sheets and website information were updated to reflect this development, as were the NPHS and Dwr Cymru websites and the Dwr Cymru helpline. A press statement, listing the affected local towns and villages was also released. Hygiene advice was reinforced, in particular relating to hand washing and use of swimming pools. Thereafter, bilingual press updates were issued nearly every day throughout the outbreak. All assembly members and members of parliament representing the affected area were updated in writing. The Minister for Health and Social Services was briefed ahead of a statement he made to the National Assembly for Wales on 29th November.

The outbreak control team agreed further investigation measures. These included:

- Ongoing environmental sampling;
- Continued monitoring for cryptosporidium at Cwellyn and Afon Gwyrfai;
- Interviewing of new cases by environmental health officers;
- Investigations of water flow at Llyn Cwellyn;

On 5th December Gwynedd County Council served a statutory notice on the owner/occupier of one of the properties with a private septic tank. This required remedial works to be carried out to the defective private sewage treatment system.

A second phase of environmental investigations was agreed after a site meeting held at Rhyd Ddu on 7th December. The aim was to identify specific defects and systematic problems within the catchment area to assess ongoing risk. One hundred and sixty three cases had now been confirmed. Five possible sources of human faecal contamination had been identified based on effluent discharges, septic tank and sewage failure and microbiological sampling.

The new sampling plan included provision for:

- Routine, twice weekly sampling of surface waters at high risk;
- Targeted sampling after peak flow events; and
- One-off sampling of the identified defective areas.

Three other potential routes of investigating contamination were discussed:

- Animal sampling, to exclude the unlikely possibility of an animal source;
- Tracer studies to assess possible streaming across the lake;
• Sewage travel via the periglacial scree.

(Logistical difficulties, lack of robust information on animal movement, changes in animal populations, the catchment and the very low number of cases of Cryptosporidium parvum isolated from cases resulted in prioritisation of other investigative routes). This work continued until the end of the outbreak.

Although waterborne illness remained the likely cause of the outbreak, the outbreak control team continued to assess risk factors in each new case and to address proactively alternative hypotheses.

On 8th December the chair of the team contacted the director of development at Gwynedd County Council to assess possible alternative community outbreak theories. There were anecdotes, recently heard, about school absenteeism predating the outbreak.

Over this period approximately 10 new cases of cryptosporidiosis were being confirmed each day in Anglesey and Gwynedd.

On 9th December Dwr Cymru lifted the Boil Water Notice for 9,000 of its customers. The majority of these were now receiving water from sources other than Cwellyn after some re-zoning by the company. The others had initially received the Boil Water Notice despite never being supplied from Cwellyn. They had received letters because Dwr Cymru had decided both to take a precautionary approach and to act without undue delay. There had been limitations to the company’s ability to mail automatically all customers of the specified supply.

Remaining customers were reminded of the need to boil water and prevent person to person spread.

Letters were also sent by Dwr Cymru to all customers who had been advised to boil their water from 13th December onwards. They were advised they would receive ex-gratia payments.

This coincided with advice issued to all water companies by the Drinking Water Inspectorate (reference IL17 2005 - Appendix F). It noted the higher autumn peak in cryptosporidiosis reported across England and Wales and instructed water companies to review their risk assessment and operational risk management arrangements for surface water derived water supplies. (When a company assesses a supply as being at significant risk, additional treatment and/or continuous monitoring is required).

By 14th December the number of reported cases exceeded 200.

On 15th December the Drinking Water Inspectorate wrote to Dwr Cymru requiring the company to review its risk assessment for Cwellyn and to resubmit it by 31st December.

2.7 Decline and end of outbreak, 15th December 2005 – 30th January 2006

At the outbreak control team meeting on Thursday 15th December epidemiological and environmental evidence was reviewed.
Further analysis of the case control study continued to support a waterborne outbreak and no other hypotheses (see section 3).

It was agreed to re-interview adult cases from outside the area served by Cwellyn to assess whether they had consumed water from Cwellyn when away from home. A questionnaire review and assessment of children who lived outside the Cwellyn service area was also agreed. This was part of a continued investigation into the hypothesis of an outbreak of diarrhoeal illness in the community preceding the one being managed from November.

There was biological support for the existing epidemiological findings. At least five potential sources of sewage run-off existed in the Cwellyn catchment area. Cryptosporidium hominis had been isolated in water entering and leaving Llyn Cwellyn, both before and after treatment. Species/genotype identification was being confirmed by DNA sequence analysis.

The outbreak control team considered current environmental findings and their associated risk, in particular:

- The designation of Cwellyn as a low risk upland water source;
- The consented discharge of Rhyd Ddu sewage treatment plant into a river that enters a lake used as a source of mains drinking water;
- The number of oocysts in the water remained low, within the treatment standard that would have applied if the water treatment works had been designated as at significant risk, although low levels do not indicate freedom from a potential risk to public health.

Monitoring of extended sampling of the distribution system at new sites (Bangor and Llanfairpwllgwyngyll) and old sites since the last meeting showed low oocyst counts at all.

A Dwr Cymru hydrodynamic survey at Cwellyn had started. Microbiological analysis of environmental samples was ongoing.

The outbreak control team reviewed the ongoing risk to public health and the potential to lift the Boil Water Notice. Even though it was recognised that compliance with the notice may not be comprehensive, withdrawal of the advice was rejected because:

- Evidence for a sustained reduction in cases was not found - there was a persistence of a high proportion of adult cases and the return to normal proportions of sample positivity had not yet occurred;
- Although remedial action had taken place where possible, no barriers currently existed to prevent the risk associated with potential human contamination of Llyn Cwellyn;
- The size of Llyn Cwellyn meant a large volume of potentially contaminated water still existed.

It was agreed that mains water supplied from Llyn Cwellyn was the ‘probable’ source of the outbreak.

Plans to maintain continuity of communications and case follow-up over the Christmas/New Year holidays were made.
The rate of reporting of primary illness began to slow from 16\textsuperscript{th} December, just over two weeks from the introduction of the Boil Water Notice.

Helpline hours were reduced by one hour at weekends from 17\textsuperscript{th} December as the number of calls dropped.

By 21\textsuperscript{st} December 22\% of notifications were secondary cases and the positivity rate of samples was declining.

This expected downward trend in cases following the issuing of the Boil Water Notice was discussed at the third outbreak control team meeting on 29\textsuperscript{th} December. The number of confirmed cases was 224.

Follow up of cases, both adult and child, had shown most living out of the area had had work or social contact within the Cwellyn supply zone. This supported the waterborne hypothesis.

Members of the outbreak control team again reviewed the existing risk to public health:

- Further water sampling within the distribution system had continued to show cryptosporidium levels well within the treatment standards that would have applied at water treatment works designated as at significant risk;
- Oocyst numbers detected in samples of treated water since mid November had decreased with an average of 0.02 oocysts per 10 litres in each sample;
- The holiday period may have influenced the lowered reporting rates of illness – people are less likely to visit their GP over the Christmas period - and there was no definitive evidence that the outbreak had ended;
- No single point source was likely to be detected although mains water was the probable route of transmission of the outbreak;
- Multiple sources of Cryptosporidium hominis remained in the catchment with no effective barriers between source and lake;
- Summer stratification may have reduced dilution within the body of the reservoir; wind speed and direction enhance streaming in the upper epilimnion during summer and autumn;
- Dwr Cymru was currently installing new ultra violet (UV) treatment, which would kill any cryptosporidium oocysts present.

The team’s opinion was that a risk to the public remained until the UV treatment was fully operational. It was agreed that the Boil Water Notice should be reissued in January to allow time for full commissioning and operational checks on the new equipment to be completed.

On Tuesday 3\textsuperscript{rd} January, members of the outbreak control team met with the Health Minister, Dr Brian Gibbons, to brief him on progress on the outbreak.

The decision to reissue the Boil Water Notice was communicated by letter to Dwr Cymru customers (28,000 households) timed to arrive on 5\textsuperscript{th} January. The NPHS, NHS Direct and Dwr Cymru web sites were updated. There were coordinated outbreak control team and Dwr Cymru press statements. Bilingual communications were sent specifically to general
practitioners, schools, nurseries, businesses serving food, dentists, swimming pool managers and managers of residential and nursing homes. These communications also provided advice on preventing secondary spread and information on access to additional help.

On the same day the Drinking Water Inspectorate provided a written response to the Welsh Assembly Government’s questions on the difficulties of confirming the water supply as the source of an outbreak (see Appendix F)

The last new case associated with the outbreak was notified to the outbreak control team on Wednesday 11\textsuperscript{th} January. The total number of cases since 1\textsuperscript{st} October in Anglesey and Gwynedd areas was 231.

The Dwr Cymru UV unit was commissioned on Friday 6\textsuperscript{th} January and had been in full operation at Cwellyn since 7\textsuperscript{th} January.

On 13\textsuperscript{th} January the Drinking Water Inspectorate inspected the monitoring equipment to ensure that it had been installed and was operating in accordance with regulatory requirements. It concluded that the continuous monitoring equipment had been installed correctly.

Final completion of the UV system, involving connection to an emergency generator, was completed on Tuesday 17\textsuperscript{th} January and tested over the following fortnight. Regulatory monitoring of cryptosporidium at Cwellyn commenced on 19\textsuperscript{th} January.

A further outbreak control team meeting took place on 18\textsuperscript{th} January. The risks to public health were again reviewed:

- Oocyst counts on treated water had fallen to an average 0.0136 oocysts/10 litres despite recent heavy rainfall;
- No further environmental sampling was considered necessary to control the outbreak;
- Dwr Cymru had implemented bathymetric and hydrological studies;
- The total number of cases notified had been static at 231 for the last week.

Allowing time to ensure all Cwellyn water not treated by UV was flushed from the distribution system, it was agreed the Boil Water Notice should be lifted on 30\textsuperscript{th} January. A combined communication strategy was planned with Dwr Cymru.

On 30\textsuperscript{th} January letters to residents, coordinated with agreed press statements from the outbreak control team and Dwr Cymru, announced the end of the outbreak and the lifting of the Boil Water Notice. Bilingual written communications were distributed to general practitioners, schools, nurseries, residential and nursing homes, food businesses, swimming pool managers, dental practices and all affected Dwr Cymru customers. Question and Answer sheets were updated to reflect this new advice - that it was safe to use tap water again for those with normal immune systems. The Helpline was updated and remained operational until 10\textsuperscript{th} February. The public were advised an outbreak report would be completed and made available in both English and Welsh.
2.8 Aftermath

The outbreak control team met to discuss the report on 28th March 2006.

The chief inspector of Drinking Water for Wales undertook to commission the Health Protection Agency to prepare an updated report on human cryptosporidiosis (Nichols et al 2006). She also undertook to assess what further actions might be required in light of the Drinking Water Inspectorate’s formal investigation. The chief inspector is the statutory technical advisor to the National Assembly for Wales on these matters. She confirmed that she would carefully consider the outbreak control team report findings when the report was formally submitted to her (Anon.,1998).

The outbreak control team met again on 27th September to finalise and agree its report.

Figure 1: dates of notification for confirmed cases Cryptosporidium hominis
3. Microbiology and epidemiology

3.1 Microbiology

Two hundred and thirty one cases of cryptosporidiosis in residents of Gwynedd and Anglesey were notified between 1st October 2005 and 31st January 2006. 218 of these were confirmed as Cryptosporidium hominis infection by the UK Cryptosporidium Reference Unit (CRU). Four cases were identified as Cryptosporidium parvum infection, one was not typable and three were not confirmed as cryptosporidial infection. Specimens from the remaining five possible cases were not available for confirmation and species/genotype identification at the CRU.

3.2 Descriptive epidemiology based on the first 218 confirmed cases

Characteristics of confirmed cases of Cryptosporidium hominis infection

56% (122/218) of cases were female and 44% (96/218) male. The difference is significant (chi squared, p=0.02). The majority of cases were under 40 years of age (figure 2). Female cases (mean 28 years, median 23 years) were significantly older (t-test, p<0.0001) than male cases (mean 16 years, median 12 years).

Figure 2: age distribution of confirmed cases Cryptosporidium hominis

Dates of onset of confirmed cases of Cryptosporidium hominis infection

Onset dates are known for 195 of the 218 confirmed cases of Cryptosporidium hominis infection (figure 3).
Source of drinking water for households of confirmed cases *Cryptosporidium hominis* infection

Water from Llyn Cwellyn was supplied to the homes of 79% (168/214) of the cases. The attack rate was significantly higher in the population whose household was supplied with water from Cwellyn (table 1). The relative risk of *Cryptosporidium hominis* infection in the population supplied by Cwellyn was 4.5 (95% CI, 3.2 – 6.2, p<0.0001).

<table>
<thead>
<tr>
<th>Source</th>
<th>Cases</th>
<th>Population supplied</th>
<th>Attack Rate per 100,000 population</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cwellyn*</td>
<td>168</td>
<td>60,656</td>
<td>277</td>
<td>237 - 322</td>
</tr>
<tr>
<td>Other</td>
<td>46</td>
<td>74,402</td>
<td>62</td>
<td>45 - 82</td>
</tr>
<tr>
<td>Total</td>
<td>214</td>
<td>135,058</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Water either solely from Cwellyn or as a blend of Cwellyn and Myndd Llandegai*
No difference was observed in the proportion of female (80%, 97/122) and male (77%, 74/96) cases whose households were supplied by Cwellyn (chi squared, p=0.66).

### 3.3 Case control study

**Method**

A case was defined as a resident of Gwynedd or Anglesey aged 16 years or older with diarrhoea (three or more loose stools in 24 hours) with an onset after 1\textsuperscript{st} September 2005; and *Cryptosporidium hominis* as the only isolate from a faecal specimen. Cases were excluded if, during the two weeks before onset, they had a history of travel outside the UK; or a household contact with new onset of diarrhoea.

One hundred potential controls were identified by selecting random telephone numbers from the directory. An individual was eligible to be a control if they were a resident of Gwynedd or Anglesey aged 16 years or older; and did not have a history of travel outside the UK in the two weeks prior to 5\textsuperscript{th} November 2005, or a household contact with new onset of diarrhoea since 1\textsuperscript{st} September 2005.

Controls were interviewed by telephone during the week beginning 14\textsuperscript{th} November using a structured questionnaire (Appendix D). Potential cases reported by the laboratory between 3\textsuperscript{rd} October and 20\textsuperscript{th} November were interviewed using a similar questionnaire. Controls were asked about exposures in the two weeks before 5\textsuperscript{th} November. Cases were asked about exposures in the two weeks before the onset of symptoms.

**Results**

Forty five of the 69 potential cases met the study case definition. Forty of the potential controls were contactable and agreed to be interviewed, 37 of whom met the study control definition.

There was no gender difference between cases and controls: 76% of cases and 75% of controls were female. However, controls were significantly older than cases. The mean was 63 years for controls compared to 39 years for cases (p<0.001).

Drinking unboiled tap water was significantly associated with disease, odds ratio 6.1, p=0.002 (table 2). No other significant risk factors were found on univariate analysis, although contact with a farm appeared to be protective.

Stratified analysis by age found a statistically significant association between drinking unboiled tap water at home and disease in the 16-44 and 45-64 age groups (table 3). A dose response relationship was found with an increasing risk of disease with higher consumption of unboiled tap water (table 4).
Table 2: univariate analysis of risk factors

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Cases n=45</th>
<th>Controls n=37</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed</td>
<td>Non exposed</td>
<td>Exposed</td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drink bottled water</td>
<td>14</td>
<td>27</td>
<td>17</td>
</tr>
<tr>
<td>Private water supply home</td>
<td>0</td>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>Swimming</td>
<td>5</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>Drink unboiled tap water*</td>
<td>40</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>Wash fruit or salad</td>
<td>14</td>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boating</td>
<td>1</td>
<td>44</td>
<td>1</td>
</tr>
<tr>
<td>Been on a farm</td>
<td>0</td>
<td>45</td>
<td>9</td>
</tr>
<tr>
<td>Contact with pets</td>
<td>24</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>Fruit juice drink</td>
<td>29</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Shellfish eating</td>
<td>1</td>
<td>42</td>
<td>5</td>
</tr>
<tr>
<td>Attended social events</td>
<td>11</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>Travel within UK</td>
<td>11</td>
<td>33</td>
<td>3</td>
</tr>
<tr>
<td>Contact with a child &lt;5 y</td>
<td>6</td>
<td>35</td>
<td>4</td>
</tr>
</tbody>
</table>

* any source of mains tap water (none of the cases in this study were on private water supply)
Table 3: stratified analysis of drinking unboiled tap water at home by age group

<table>
<thead>
<tr>
<th>Age group</th>
<th>Exposed</th>
<th>Non exposed</th>
<th>Exposed</th>
<th>Non exposed</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 to 44 years</td>
<td>26</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>26 (2-336)</td>
</tr>
<tr>
<td>45 to 64 years</td>
<td>6</td>
<td>0</td>
<td>5</td>
<td>6</td>
<td>∞ (1.43-∞)</td>
</tr>
<tr>
<td>&gt;64 years</td>
<td>6</td>
<td>2</td>
<td>14</td>
<td>7</td>
<td>1.5 (0.2-9.4)</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>5</td>
<td>20</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: dose response number of glasses of unboiled tap water at home

<table>
<thead>
<tr>
<th>Number of glasses of unboiled tap water</th>
<th>Cases</th>
<th>Controls</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=45</td>
<td>N=37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No glass</td>
<td>5</td>
<td>16</td>
<td>Ref.</td>
</tr>
<tr>
<td>1 to 4</td>
<td>23</td>
<td>17</td>
<td>4.3 (1.3-14.1)</td>
</tr>
<tr>
<td>5 to 8</td>
<td>11</td>
<td>3</td>
<td>11.7 (2.3-59.5)</td>
</tr>
<tr>
<td>More than 8</td>
<td>6</td>
<td>1</td>
<td>19.2 (1.8-199.9)</td>
</tr>
</tbody>
</table>
3.4 Discussion of epidemiological studies

Description of epidemiology

The epidemic curve is not compatible with a single point source in time (figure 3). This pattern could arise from either a propagated outbreak (infection arising from a single point source in time with subsequent case to case spread), or a continuing common source. The onset dates of the 61 cases of suspected secondary infection (cases in households that had had another case in the previous two weeks) suggests that the outbreak was caused by a continuing common source.

It should be noted that, because information on the date of onset was not available at the time of notification, the epidemic curve describing onset could be defined only after the case had been interviewed. In the 195 cases of confirmed Cryptosporidium hominis infection with a known onset date, the mean time between onset and notification was 12 days, median 9 days and range 1 to 59 days. Most of this interval reflects the delay between onset of symptoms and seeking medical advice, with additional time required for the collection, transport and investigation of the specimen. Longer delays probably reflected the fact that some cases sought medical advice and investigation only after the outbreak was publicised.

The epidemic curve of primary cases of Cryptosporidium hominis infection suggests that exposure to the primary source of infection was most likely to have occurred between 17th September and 3rd December 2005.

Case control study

The case control study demonstrated a statistically significant association between the consumption of unboiled tap water and Cryptosporidium hominis infection.

The size of the risk makes it unlikely that it could be explained by any bias arising from the age difference between cases and controls. Although drinking water consumption surveys undertaken by MORI have shown that older people drink less water, this difference would not give rise to an association of the magnitude observed. Age stratification was used as a statistical technique to control for potential confounding from age in the analysis of the study. Statistically significant associations were found between consumption of unboiled tap water and infection in the 16-44 and 45-64 age strata. An increase in immunity to cryptosporidium infection with age would explain the absence of an association in the over sixty fives.

The inclusion of individuals who are immune in the control group - who could not develop disease if exposed to the source of infection - will reduce the size of any association between exposure and disease. Overall the effect of an older control group probably reduced the size of the observed association between the consumption of unboiled tap water and Cryptosporidium hominis infection.

Recall bias can occur in case control studies if there are differences in the way exposure information is remembered or reported by cases, who have experienced an undesirable health outcome, and by controls who have not. Recall bias is unlikely to have been particularly important in this study because it was undertaken before any publicity about the outbreak.
There were 12 cases whose water at home was not supplied from Cwellyn. Eight of them had visited or worked in the area serviced by Cwellyn during the incubation period. The other four cases could either be explained by the background epidemiology of the disease or other factors that have not been identified.

### 3.5 Conclusion

The descriptive epidemiology and the analysis of the case control study both support the conclusion that this was a waterborne outbreak, with some secondary spread within households. The evidence does not support any alternative hypothesis based on other known methods of transmission of *Cryptosporidium hominis*. 

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**Author: Chris Lines, NPHS Wales**  
**Page: 37 of 184**
4. The water supply

4.1 History of Cwellyn water treatment works

Prior to 1995

The water treatment works prior to 1995 had a relatively basic level of treatment. The raw water was abstracted from the Afon Gwyrfai at the Nant Mills intake below the Cwellyn dam. At the water treatment works, the water passed through a coarse metal strainer (microstrainer) and was then treated with chlorine and lime before supplying distribution via a treated water tank. The water treatment works did not have any filters.

4.2 Development of the water treatment works

The water treatment works had a major upgrade in 1995 as part of an overall investment strategy to provide filtration to upland sources for the first time. This included the construction of an additional building housing four pressure filters and ancillary equipment and a chlorine contact tank.

The installation of pressure filters was in response to a failure to meet the standard for manganese in the Water Supply (Water Quality) Regulations 1989. The company put forward a programme of works to deal with the non-compliance. The Drinking Water Inspectorate signed off the works as dealing with the non-compliance in December 1995.

The raw water is classified as ‘A1’ as defined by EC directive 75/440/EC and receives treatment specified for such a classification.

Additional chemical treatment such as carbon dioxide (pH correction) and orthophosphoric acid dosing (plumbo-solvency control) was also installed.

The intake was extended up to the Cwellyn dam itself (a distance of 1km) with the Nant Mills intake no longer used.

An additional 8 megalitre treated water storage was also constructed.

At the time of the outbreak the treatment process at the water works comprised:

(a) A coarse strainer at the dam;
(b) A dedicated raw water main to the water treatment works;
(c) Pre filtration dosing of the water with chlorine and lime to assist in the removal of natural manganese on the filter media;
(d) Filtration through 16/30 sand with 20% manganese dioxide in 4 pressure vessels arranged in parallel;
(e) Post filtration dosing of the water with chlorine, lime, carbon dioxide, and orthophosphoric acid before a chlorine contact tank. The water then receives further chlorine contact time in an on-site, treated water reservoir.
The water treatment works is monitored constantly for a range of parameters such as chlorine, pH and turbidity. Alarms are monitored at a central control centre. Data on parameters is archived to a database allowing performance trends to be analysed. The water treatment works will shut down automatically if specific high or low level alarms are generated for key parameters e.g. chlorine.

Process studies concluded that backwash rates on the filters were appropriate, wash water volumes were normal and the filter media was very clean. The filters reduce turbidity values by approximately 50%. Slow start reduces turbidity spikes immediately after returning a filter to service. Filtration rates are within the normal range for manganese removal filters. Dirt loadings associated with the typical raw water turbidity are well within acceptable design values.

Pressure filters alone, without the use of a coagulant, are relatively inefficient at removing bacteriological organisms such as Clostridium perfringens or Cryptosporidium from the water (Anon, 1990). The treatment works is not designed specifically to remove organisms of this type but to remove or reduce the amount of larger particles, manganese (a defined parameter) naturally present in the water, and to chlorinate the water. Cryptosporidial oocysts and clostridial spores are resistant to chlorination. Process studies in the autumn of 2005 indicated that there is approximately a 30% reduction in clostridia spores across the filters with low numbers detected in the final water on a recurring basis. Clostridia are an indicator parameter in the drinking water regulations. In the absence of other faecal indicators, they are not regarded as a risk to health but require further investigation.

4.3 Turbidity event 2004

Following an exceptional rainfall event on 3rd February 2004, the turbidity increased dramatically for water leaving the Llyn Cwellyn treatment works. This resulted in the final turbidity remaining above the 1 NTU indicator limit for several weeks. The highest final water turbidity recorded in laboratory samples was 8.8 NTU on 4th February 2004 at 07:16. The last time the limit was exceeded in association with this event was on 21st March 2004 with a result of 1.06 NTU.

The elevated turbidity in the reservoir was believed to be due to wash-off from the steep slopes to the west of the reservoir. This was the first major flood in the area since a significant proportion of the forestry plantation had been felled.

The event was fully reported by the water company to the Drinking Water Inspectorate in accordance with the Water Undertakers (Information) Direction 2004. It was also reported to Gwynedd County Council’s Environmental Health Department, North Wales Health Authority, Ofwat and the National Assembly in accordance with the Water Supply (Water Quality) Regulation 35(8).

Operational sampling for cryptosporidium, using continuous monitoring, was carried out during the 2004 incident. Low numbers of oocysts were detected but all samples showed levels well within the treatment standard that would have applied at water treatment works designated as at significant risk. Disinfection was not compromised and coliform compliance remained satisfactory throughout.
Subsequent to this, further heavy rainfall events have caused relatively short periods of elevated turbidity. For example, a severe storm on 14\textsuperscript{th}-15\textsuperscript{th} February 2006 caused the raw water turbidity to exceed 1 NTU (with a maximum of 5.78 NTU) between 01:45 and 09:00 on 15\textsuperscript{th} February. Continuous cryptosporidium monitoring was in place at this time and the sampling filter which was changed at 14:05 on 15\textsuperscript{th} February had a result of 1 oocyst in 1167.9 litres (0.0086 oocysts / 10 litres).

### 4.4 Cwellyn regulatory improvement programme

The treated water at the Cwellyn water treatment works is monitored daily for bacteriological parameters such as total coliforms and \textit{E. coli}.

There were two failures against the total coliform parameter in 2004. This group of bacteria are not regarded as a risk to health, but are used as an indicator of water quality. Detailed process investigations of the works indicated that these failures were attributable to the structural condition of the on-site treated water tank. The tank had never had a bypass, which meant that it could not be removed from service for capital improvements or operational maintenance.

Any transient contamination by total coliform bacteria is quickly eliminated by the significant level of free chlorine in the water. No associated failures in the distribution system were detected.

The regulatory programme of work was agreed between Dwr Cymru and the Drinking Water Inspectorate on this issue. In order for the treated water tank to be taken out of service to allow appropriate remedial work to be undertaken, a large diameter bypass capable of carrying the 20 megalitres per day of water that the works can produce was installed before the end of March 2006.

### 4.5 Drinking Water Inspectorate audit, September 2005

The Drinking Water Inspectorate visited Cwellyn water treatment works on 27\textsuperscript{th} September 2005. The works featured as a high priority site for inspection during 2005 following the turbidity event during 2004. The focus of the site inspection was to witness the implementation of the enhanced turbidity plan in action and to monitor the progress of the steps required in the regulatory improvement programme. However a general audit of site operation was undertaken.

### 4.6 Cryptosporidium monitoring at Cwellyn water treatment works

It is a regulatory requirement under the Water Supply (Water Quality) Regulations 2001 that, for every water treatment works in Wales, an individual cryptosporidium risk assessment has to be carried out by the relevant water company and submitted to the Drinking Water Inspectorate who receive it on behalf of the National Assembly of Wales. The Drinking Water Inspectorate confirms that the risk assessment methodology has been carried out satisfactorily and notifies the water company.

Each water treatment works needs to be put into one of two categories; “significant risk” or “not significant risk”. “Significant Risk from cryptosporidium” is defined in the 2001 Regulations as “there is a significant risk that the average number of Cryptosporidium oocysts
per 10 litres of water supplied from the works for regulation 4(1) purposes, if sampled and analysed in accordance with regulations 29(5) to (15), would not at any time be one or more”.

The water company’s risk assessment, undertaken in November 1999 and in place at the time of the outbreak, had concluded that the Cwellyn water treatment works was not at a “significant risk from cryptosporidium”.

All raw water sampling from 1996 to 2002 had failed to detect cryptosporidium in any of the samples taken.

The continuous monitoring during the elevated turbidity event in February 2004 indicated that, even during exceptional flood conditions, the level of cryptosporidium in the final water was low.

As part of the Llyn Cwellyn regulatory improvement programme, sampling for cryptosporidium had commenced on the raw water during October 2005. Ten litre grab samples were taken from the raw water on 6th October, 11th October, 19th October, 27th October and 2nd November 2005. Cryptosporidium oocysts were not detected in these samples.

Continuous investigational monitoring at Cwellyn started on 2nd November 2005, again as part of the coliform regulatory programme. This confirmed that cryptosporidium levels were indeed very low in the final water. The average level of cryptosporidium in 118 continuous filter cartridges collected between 3rd November 2005 – 27th February 2006 was 0.0137 oocysts / 10 litres with a maximum of 0.0764.

The Drinking Water Inspectorate required water companies (DWI Information Letter 17/05, issued on 13th December 2005) to review existing risk assessments for surface water derived supplies and to resubmit them to the DWI by 30th April 2006. In addition, the Drinking Water Inspectorate required Dwr Cymru to review the Cwellyn risk assessment by 31st December 2005

The Cwellyn risk assessment was resubmitted by the company as required by the Drinking Water Inspectorate in January 2006. No additional risk factors were identified apart from the possible association between the Cwellyn water treatment works and the cryptosporidial outbreak. The guidance issued in 1999 said that all sites, where “past history of an outbreak of cryptosporidiosis associated with the water supply where the reason is unexplained and no specific steps have been taken to prevent a recurrence”, should be considered as of significant risk. Therefore, from this point, Llyn Cwellyn was designated as a significant risk.

As a result of the company changing its risk assessment, Dwr Cymru was required to install continuous regulatory monitoring for cryptosporidium. The cryptosporidium monitoring equipment was tagged (security sealed in compliance with the regulations) and inspected by the DWI on 13th January 2006. Regulatory monitoring started on 19th January 2006.

During the cryptosporidium incident, as well as the continuous monitoring for cryptosporidium carried out on Cwellyn final water, additional continuous filters (Filta-Max™ samples) were set up at various points on the distribution system. These showed very low numbers of oocysts. Samples were also taken from the final water at Mynydd Llandegai water treatment works which blends with Cwellyn water at a storage tank at Pentir before going on to supply Bangor and South Anglesey (see table 5).
Table 5: summary of the continuous monitoring results from the Filta-Max™ sampling

<table>
<thead>
<tr>
<th>Location:</th>
<th>Cwellyn WTW final water</th>
<th>Cwellyn WTW raw water</th>
<th>Llanwnda distribution</th>
<th>Upper Bangor distribution</th>
<th>Mynydd Llandegai WTW final water</th>
<th>Llanfair PG distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Final water at water treatment works</td>
<td>Raw water prior to filtration</td>
<td>Customers on direct supply from Cwellyn</td>
<td>Customers on blend of Cwellyn and Mynydd Llandegai</td>
<td>Final water at water treatment works</td>
<td>Customers in South Anglesey on blend of Cwellyn and Mynydd Llandegai</td>
</tr>
<tr>
<td>Date range of samples</td>
<td>03/11/05 – 28/02/06</td>
<td>05/11/05 – 27/02/06</td>
<td>05/11/05 – 06/01/06</td>
<td>05/11/05 – 02/01/06</td>
<td>05/11/05 – 27/02/06</td>
<td>28/11/05 – 03/01/06</td>
</tr>
<tr>
<td>Number of samples</td>
<td>118</td>
<td>31</td>
<td>23</td>
<td>18</td>
<td>33</td>
<td>18</td>
</tr>
<tr>
<td>Average oocyst number / 10 litres</td>
<td>0.0137</td>
<td>0.0296</td>
<td>0.0101</td>
<td>0.0068</td>
<td>0.0076</td>
<td>0.0095</td>
</tr>
<tr>
<td>Maximum oocyst number / 10 litres</td>
<td>0.0764</td>
<td>0.1372</td>
<td>0.0378</td>
<td>0.0294</td>
<td>0.0647</td>
<td>0.0178</td>
</tr>
</tbody>
</table>

Molecular tests undertaken by the UK Cryptosporidium Reference Unit on water testing microscopy slides confirmed *Cryptosporidium hominis* by PCR-RFLP at the ssu rRNA gene (Xiao *et al*., 2001) and COWP gene (Spano *et al*., 1997) and by bi-directional DNA sequence analysis, initially of 447 base pairs of the ssu rRNA gene in the sample from Llanwnda final water in distribution taken on 7th November 2005.

This finding was further substantiated by investigation of 795 bp which showed 100% homology with *Cryptosporidium hominis*. The results of further molecular testing are provided in the results of environmental sampling.

### 4.7 Installation of UV plant

An ultraviolet light (UV) disinfection system was fitted onto the works and commissioned on 6th January 2006.

UV disinfection was chosen because it provided the only viable short term solution to the outbreak control team’s need for reassurance that the water from Cwellyn water treatment works could be eliminated as a possible cause of future cases of cryptosporidiosis. This would therefore allow for the lifting of the Boil Water Notice.
In the United States, UV is being increasingly used to reduce the risk of waterborne cryptosporidiosis. The US Environment Protection Agency (EPA) have developed a very detailed protocol for the use of UV in this role. As there is no equivalent UK guidance, the US EPA protocol has been employed to install, commission and operate the UV disinfection at Cwellyn water treatment works.

Two independent UV units were fitted. Each one is of a size to disinfect the full flow of the water treatment works adequately. This enables continuous dosing even during maintenance work. The water treatment works has been programmed to shut down automatically if the UV units fail. This ensures continuous treatment.

### 4.8 Topographical description of catchment

The approximate centre of Llyn Cwellyn is at grid reference OS 256000 355000.

The hydrological features of the lake are under investigation by Dwr Cymru. Superficially, it is approximately 2km long and 0.75km wide and orientated north west (NW) – south east (SE) at approximately 142 metres above sea level.

Afon Gwyrfai flows into the lake at the south eastern end. It flows out of the lake, over a weir at the north western end. The raw water abstraction point for Cwellyn water treatment works is at the outflow weir.

Historical data show that the lake is likely to be stratified with a distinct thermocline developing during the summer period and a likely turnover in the autumn.

The dominant wind direction in the area is south to north west. The wind can funnel from inlet to outlet along the lake main axis through this mountain valley. It is possible that this, together with the summer stratification, provides the potential for rapid streaming of surface water along the lake. These features are currently under investigation by Dwr Cymru.

The adjacent land rises steeply on both sides of the lake. On the south western side, land rises very steeply to Mynydd Mawr (698 m). Much is forested or recently de-forested as part of the Beddgelert forest plantation. Above and below the lake the valley exhibits a classical ‘U’ cross profile typical of previously glaciated areas such as the Snowdon massif. In the south, adjacent to the principal lake input Afon Gwyrfai, drainage from the Snowdon massif (summit 1085m) crosses the valley floor before entering the lake in a number of tributary streams. On the north eastern side, drainage is received from steep terrain draining from Foel Goch (605m), Foel Gron (629m) and Moel Eilo (726m).

### 4.9 Hydrogeology

The solid geology of the area adjacent to the lake comprises Ordovician slates. Intrusive igneous rocks (dolerite, rhyolite, bedded pyroclastic rocks, etc.) are dominant on the higher ground around the Snowdon summit (Smith and George, 1961).

The relief of the area is extremely steep and with extensive landforms characteristic of glaciation and subsequent periglacial activity. The characteristically glacial ‘U’ shaped valleys are bounded by steep valley sides often covered by scree deposits. Soils in this high rainfall area largely comprise:
- Rankers (thin, well-drained, immature soils) of the Bangor association – on the steepest and highest slopes, notably on the flanks of Mynydd Mawr and Snowdon;

- Brown podzols (somewhat deeper, well-drained soils) of the Manod association – on steep slopes of moderate altitude, notably on the mid and lower slopes to the north west of the lake;

- Groundwater gleys (soils subject to water logging as result of a high water table) of the Laployd association – on more poorly drained hill slopes and foot slopes; and


The high rainfall, extreme ‘relief’, soil characteristics and glacial/periglacial deposits of this area suggest that the potential exists for rapid near-surface through-flow of water within natural soil pipes and/or coarse grained deposits of scree and fluvioglacial gravels.

4.10 Hydrodynamic survey

Investigations are underway to determine the pattern of water movement in Llyn Cwellyn and to identify the conditions under which “short-circuiting” or rapid flow across the surface of the lake can occur. A bathymetric survey has been undertaken to determine the topography of the lake bed and the total volume of the lake. Two hydrodynamic surveys have been undertaken to measure water circulation under different wind conditions.

The data from these surveys is being used to calibrate a computer generated model of the lake. Results obtained to date show that the overall circulation is dominated by the wind direction and strength. Chemical and physical data collected during the surveys indicates, as expected, that there is no thermal stratification during the winter months and that the lake is completely mixed.

Further surveys and investigations are planned for later in the year when the natural thermocline is well established.

Subject to further discussions with Environment Agency Wales, investigations will be undertaken to confirm whether or not any discharge from the sewage reception arrangements at a remote commercial property can drain into Llyn Cwellyn.

4.11 Land use in the catchment

The Llyn Cwellyn catchment is a sparsely populated rural area, with single dwellings, a small village, Rhyd Ddu, and a transient but year round tourist population.

In agricultural terms, the holdings in the catchment are upland/hill, predominantly sheep farms. Cattle farming of small suckler herds on the hills and fattening on improved land is practised. Registered fields, common land and Forestry Commission land make up 98% of the total area.
Data collected during the Welsh Agricultural Census 2004 for Small Area 22 (provided by the Welsh Assembly Government), which encompasses the Cwellyn Catchment, provide broad land use and stock numbers for holdings within the area. However, it must be noted that there is a large proportion of common land for which the stock numbers are not readily available. Additionally, Small Area 22 includes land to the west of the lake that is outwith the surface hydrological drainage basin. The ‘area’ data are therefore an over estimate although the proportional land use should be more representative of the Llyn Cwellyn drainage basin.

Figures (provided by, and used with the permission of, the Welsh Assembly Government) from June 2004 show the Small Area containing around 42,000 sheep, 2,600 cattle (nearly all beef rather than dairy animals) and small numbers of poultry and horses. In Area 22, permanent pasture accounts for 3,158 hectares, rough grazing for 3,196 hectares and new grassland 136 hectares.

Numbers of animals recorded for the purposes of the Single Farm Payment 2005 Scheme (provided by the Welsh Assembly Government) for Betws Garmon Parish are available on a holdings basis. However, of the 30 holdings where the main address is within the Parish, some will have land elsewhere. Other holdings with an address outside the Parish will have land within it. Common land is not included. However, approximately two-thirds of Betws Garmon Parish is downstream of Llyn Cwellyn or otherwise outside the hydrological catchment.

Single farm payment figures show around 6,000 sheep, 363 cattle and very small numbers of poultry and horses.

Broadly speaking, sheep are grazed on high ground and the in-lamb ewes brought to lower pasture in February/March prior to lambing in April. Where possible, in-lamb ewes are put on better pasture. Some farmers rent land on Anglesey for their sheep over the winter. Ewes and lambs return to higher pasture until June when the lambs are brought to fatten on better pasture. Sheep numbers are much reduced over winter from early November. Cattle, on the whole, are housed from late October/early November. Much of the husbandry of the sheep and cattle will conform to agri-environment schemes such as Tir Gofal and Tir Cymmal being run in the Snowdonia National Park. These determine in-housing and artificial feeding of livestock during winter months. The location and number of sheep and cattle grazing in the catchment change substantially at the end of October/beginning of November.

The Veterinary Laboratories Agency (VLA) diagnosed 30 incidents of cryptosporidiosis in cattle and 5 in sheep in Gwynedd in 2005 (VLA data) (an incident in veterinary data can refer to any number of animals in a herd/flock). The monthly incidence is much as would be expected from lambing and calving patterns in the area, with most reported during April and May. There were only single incidents in cattle and none in sheep in the months from June onwards. Prior data from the UK Cryptosporidium Reference Unit, where 385 positive routine diagnostic faeces from calves and lambs from four VLA regional laboratories (including those serving Wales) were tested by PCR-RFLP COWP gene, showed all confirmed isolates were *Cryptosporidium parvum*.

4.12 Climatic conditions

The Environment Agency has rain gauges relevant to the catchment situated at Hafod Wydr (grid reference OS 257536 349826) and Betws Garmon (grid reference OS 253773 357297).
The Betws Garmon data was not used as it could not be related to river flows and potential flooding due to a damaged weir at a river flow gauging station on the Afon Gwyfai at Bont Newydd. The Hafod Wydr rainfall recorder, although more distant from the lake outflow was probably more characteristic of the contributing catchment area. So, data from this gauge are used in this report. (The data supplied by Dwr Cymru came from Environment Agency Wales gauges at Betws Garmon and Hafod Wydr.)

The two data sets show that there were significant rainfall events (>30mm precipitation in 24 hours) on 23rd August 2005, 11th October 2005, 18th October 2005, 23rd October 2005, 5th November 2005 and 8th November 2005.

A peak reservoir level at Llyn Cwellyn in 2005 of 0.8m above the spillway level occurred on 11th October. This level is not unusual - levels have been higher - and would be expected around every two years. Similarly average flows for the October/November 2005 period measured at Nant Mills gauging station (grid reference SH546563) were not unusual for that time of year.

During a site visit in November it was stated by Dwr Cymru that the camp site at the head of the lake had been inundated to a level higher than the top of the package sewage treatment unit although there was no visual evidence of leakage.

4.13 Sewage treatment

The majority of properties in the UK are connected to a main sewer and the sewage is treated at works where the resulting effluent is disposed to a river or surface water course under consent issued by the Environment Agency. However, in many parts of rural Gwynedd it is not practical or economical for properties to be connected to a main sewer.

In these circumstances alternative methods of sewage disposal are used. One solution is prefabricated package plants, which allow settlement of solids and the biological decomposition of sewage to a similar level attained by a full scale sewage treatment works. The resulting effluent can be disposed in the same way as effluent from mains sewage treatment and may require consent issued from the Environment Agency.

A septic tank system is another alternative solution. These can be prefabricated in fibreglass or can be brick built. They consist, basically, of 1-3 chambers where the raw sewage undergoes settlement and anaerobic digestion. The treatment in these tanks allows the break down of the organic component of sewage. The effluent leaves the tank by gravity (or by pumping) and is disposed by soakage into the ground by sub surface irrigation pipes known as a soak away. The efficiency of the soak away system is much dependent on the subsurface geology, and on such factors as soil type, pore size, saturation capacity, and the dilution and dispersion according to the characteristic of the local drainage pattern generally.
Although the potential harm of sewage is much reduced by treatment, whether at a main sewage treatment plant, a packaged plant or by a septic tank, large numbers of pathogens including cryptosporidium oocysts could still potentially be discharged. For this reason additional treatment may be required to ensure that water abstracted in such catchments is fit for human consumption.

4.14 Investigation of potential sewage treatment failure

A visual inspection of the catchment for potential inputs of human sewage surface was conducted by the Environment Agency and local authority on 22nd November 2005 and 23rd November 2005. It was used to target cryptosporidium sampling sites. It must be noted that this approach may not be effective in the identification of all pathogen sources since some sources of faecal contamination may be non-visual.

The visual inspection of the catchment revealed:

(a) Package plants and septic tanks serving residential and commercial properties with consented discharges to land and to surface waters, all with a potential hydrological link to Llyn Cwellyn;

(b) One septic tank serving a residential property had a defective soakaway evident by surface breakout of effluent;

(c) A blocked public sewer serving the busy public toilets at Snowdonia National Park’s car park (grid reference OS 257078 352590). This is at the starting point of one of the most popular paths leading to the summit of Snowdon. It is also near a disembarkation point of the newly reopened narrow gauge railway. It was identified that the blockage of the public sewer at grid reference OS 57064 52612 had the potential to pollute a small water course which flows into the Afon Gwyrfai at grid reference OS 256838 352544);

(d) A small sewage treatment plant (STP) (grid reference OS 257120 353160) operated by Dwr Cymru, serving the population of Rhyd Ddu;

The sewage treatment plant discharges a secondary treated effluent to the Afon Gwyrfai upstream of Llyn Cwellyn at grid reference OS 257050 353080. The discharge is compliant with the conditions of the discharge consent issued by the Environment Agency (see Appendix G).

The works was constructed in 1950 to serve a population of up to 100 people. It has not undergone any major refurbishment since that time. The treatment process comprises primary settlement, percolating filter and final settlement. There is no storm separation at the plant. Due to its small size, sewage flows are not continually measured. During sustained periods of heavy rainfall it is possible that the sewage plant would not have treated the village sewage to the normal standards although remaining compliant with its consent. It should be noted that microbiological parameters are not generally part of consent conditions at UK sewage treatment works. Treatment systems are not designed primarily to produce reductions in faecal indicator bacteria or protozoan parasites such as cryptosporidium.

In addition to sampling undertaken by Dwr Cymru from 2nd November 2005, environmental sampling was undertaken in two phases:
• Phase 1 sampling (25\textsuperscript{th} – 28\textsuperscript{th} November 2005) was designed to inform the outbreak control team whether contamination remained in the catchment and if cryptosporidium was still entering the raw water source;

• Phase 2 (from 2\textsuperscript{nd} December 2005) was designed to provide continuing microbiological information on the specific defects / systematic problems identified by visual inspection within the catchment, to inform decision making regarding the lifting of the Boil Water Notice.

During the sampling period, there were no rainfall or peak flow events, so all results are representative of base flow conditions when peak concentrations of microbiological contamination in surface waters is unlikely.

### 4.15 Results of environmental sampling

Environmental samples taken by Environment Agency Wales and Gwynedd County Council were tested for the presence of cryptosporidium oocysts by CREH. The full details of the results are shown in tables 6 and 7.

#### Table 6: cryptosporidium oocysts detected at frequently sampled sites

<table>
<thead>
<tr>
<th>Location (grid reference)</th>
<th>Date range of samples</th>
<th>No. of samples</th>
<th>Mean no. oocysts in 10 litres (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Llyn Cwellyn Lake outlet at dam (OS 255200 355595)</td>
<td>02/12/2005 - 28/12/2005</td>
<td>6</td>
<td>0.7 (0 to 2.9)</td>
</tr>
<tr>
<td>Afon Gwyrfai Inflow to Llyn Cwellyn (OS 257200 353607)</td>
<td>25/11/2005-28/12/2005</td>
<td>7</td>
<td>2.49 (0.2 to 7.9)</td>
</tr>
<tr>
<td>250m downstream of Rhyd Ddu sewage treatment plant (STP) (OS 257200 353607)</td>
<td>19/11/2005 - 28/12/2005</td>
<td>7</td>
<td>8.04 (0.8 to 29)</td>
</tr>
<tr>
<td>Upstream of both Rhyd Ddu STP and the tributary from the direction of the public toilets (OS 257070 353050)</td>
<td>23/11/2005 - 28/12/2005</td>
<td>7</td>
<td>1.3 (0-5)</td>
</tr>
<tr>
<td>Rhyd Ddu sewage treatment plant Final effluent (OS 257070 353050)</td>
<td>19/11/2005 - 28/12/2005</td>
<td>8</td>
<td>&gt;900 (30 to uncountable) Incl. 2 samples too many to count.</td>
</tr>
<tr>
<td>Influent (OS 257060 353020)</td>
<td>14/12/2005 - 28/12/2005</td>
<td>5</td>
<td>237 (15 to 480)</td>
</tr>
</tbody>
</table>
Table 7: Cryptosporidium oocysts detected at occasionally sampled sites

<table>
<thead>
<tr>
<th>Location:</th>
<th>Description</th>
<th>Date of sample</th>
<th>No. of oocysts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property 5</td>
<td>Biodisc package plant</td>
<td>28/11/2005</td>
<td>300/l</td>
</tr>
<tr>
<td></td>
<td>Package plant effluent</td>
<td></td>
<td>Not detected</td>
</tr>
<tr>
<td>Property 7</td>
<td>Stream below property</td>
<td>28/11/2005</td>
<td>0.02/l</td>
</tr>
<tr>
<td>Property 7</td>
<td>Stream beside property</td>
<td>28/11/2005</td>
<td>0.03/l</td>
</tr>
<tr>
<td>Property 12</td>
<td>Ditch water</td>
<td>25/11/2005</td>
<td>0.04/l</td>
</tr>
<tr>
<td>Property 13</td>
<td>Septic tank</td>
<td>25/11/2005</td>
<td>3,800,000/l</td>
</tr>
<tr>
<td></td>
<td>Soakaway breakout</td>
<td></td>
<td>560,000/l</td>
</tr>
<tr>
<td></td>
<td>Culvert to stream</td>
<td></td>
<td>0.26/l</td>
</tr>
<tr>
<td></td>
<td>Stream below property</td>
<td></td>
<td>1.38/l</td>
</tr>
<tr>
<td></td>
<td>Septic tank</td>
<td>02/12/2005</td>
<td>7,730/l</td>
</tr>
<tr>
<td>Blocked sewer below toilets at</td>
<td>Sewage</td>
<td>08/12/2005</td>
<td>3/g</td>
</tr>
<tr>
<td>car park, Rhyd Ddu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property 12</td>
<td>Biodisc plant</td>
<td>14/12/2005</td>
<td>Not detected</td>
</tr>
<tr>
<td>Property 1</td>
<td>Septic tank</td>
<td>21/12/2005</td>
<td>4/l</td>
</tr>
<tr>
<td>Remote commercial property</td>
<td>Septic tank 2</td>
<td>31/01/2006</td>
<td>180/l</td>
</tr>
<tr>
<td></td>
<td>Septic tank 3</td>
<td></td>
<td>175/l</td>
</tr>
</tbody>
</table>

Cryptosporidium hominis was confirmed by a DNA analytical technique known as polymerase chain reaction restriction fragment length polymorphism (PCR-RFLP) at a minimum of one gene locus, usually two, and by DNA sequence analysis of the ssu rRNA gene (in samples marked §) in samples from a number of sites. The DNA sequence of part of the GP60 gene, including a region of variable number tandem repeats, identified the same allele and subtype as that in the human cases, IbA10G2, in eight of these environmental isolates (table 8).
### Table 8: samples in which *Cryptosporidium hominis* was detected

<table>
<thead>
<tr>
<th>Location (grid reference)</th>
<th>Date</th>
<th>PCR-RFLP for <em>C. hominis</em> ssu rRNA sequence analysis</th>
<th>GP60 DNA sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Llanwnda</td>
<td>07/11/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td>Llyn Cwellyn Outlet at dam (OS 255200 355595)</td>
<td>02/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>14/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td>Afon Gwyrfai Inflow to Llyn Cwellyn (OS 257200 353607)</td>
<td>25/11/2005</td>
<td>+</td>
<td>§ IbA10G2</td>
</tr>
<tr>
<td></td>
<td>02/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>14/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>16/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>250m downstream of Rhyd Ddu STP (OS 257200 353607)</td>
<td>14/12/2005</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>19/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>21/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>28/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td>Rhyd Ddu sewage treatment works Final effluent (OS 257070 353050)</td>
<td>19/11/2005</td>
<td>+</td>
<td>§ IbA10G2</td>
</tr>
<tr>
<td></td>
<td>23/11/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>25/11/2005</td>
<td>+</td>
<td>§ IbA10G2</td>
</tr>
<tr>
<td></td>
<td>14/12/2005</td>
<td>+</td>
<td>§ IbA10G2</td>
</tr>
<tr>
<td></td>
<td>16/12/2005</td>
<td>+</td>
<td>§ IbA10G2</td>
</tr>
<tr>
<td></td>
<td>19/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>21/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>28/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>Influent (OS 257060 353020)</td>
<td>14/12/2005</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>16/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>19/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>21/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td></td>
<td>28/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
<tr>
<td>Property 13 septic tank</td>
<td>25/11/2005</td>
<td>+</td>
<td>§ IbA10G2</td>
</tr>
<tr>
<td>Soakaway break out</td>
<td>25/11/2005</td>
<td>+</td>
<td>§ IbA10G2</td>
</tr>
<tr>
<td>Remote commercial property Septic tank</td>
<td>31/12/2005</td>
<td>+</td>
<td>§</td>
</tr>
</tbody>
</table>

*Cryptosporidium hominis* was found only at sample sites under the influence of human sewage. Other *Cryptosporidium* species and genotypes were also detected, some of which may have come from humans or animals and some of which are restricted to animals.
4.16 Conclusions of environmental sampling

- There are no effective barriers to prevent contamination of Llyn Cwellyn from human and other sources of cryptosporidium via private and public sewage facilities or run-off of surface water from land.

- *Cryptosporidium hominis* has been detected at several sites within the catchment of Llyn Cwellyn, the reservoir itself, and in the treated water supply.

- The same genotype of *Cryptosporidium hominis* found in human cases with this outbreak, GP60 allele IbA10G2, has been identified in eight of the environmental samples.
5. Communications

Communication was a standard agenda item for the outbreak control team’s meetings. It was a key priority for the team and was discussed at every meeting. It was agreed at the first meeting of the incident management team on 7th November that, given the number of organisations involved, the National Public Health Service for Wales should take the lead on communications.

Following the meeting of the incident management team on 18th November, when it seemed likely that there was a problem affecting both Gwynedd and Anglesey, and when the results of preliminary investigations suggested that the problem was possibly connected to the water supply, a pro-active communications plan was developed and agreed.

The team always sought to contact cases, their families, residents and those most affected by the outbreak directly. However, events were fast-moving and the outbreak affected tens of thousands of people across a wide and dispersed geographical area. So, there were times, such as the announcement of the Boil Water Notice, where it was judged to be more effective to use the media to communicate information to a wide audience quickly.

5.1 Communications with cases, their families and the public

The following means of communication were used by the outbreak control team:

Direct personal contact

Environmental health officers sought to contact every case and their immediate family by telephone or in person with advice and information on the cryptosporidiosis infection and how to control its spread. Questionnaires were completed. This verbal contact was backed up with information in writing and contact numbers should families have wanted further advice or information.

Letters to consumers

Independent of, but after liaison with the outbreak control team, Dwr Cymru wrote to all customers receiving water from Llyn Cwellyn on four occasions:

30th November 2005 – to issue the Boil Water Notice and to give advice;

13th December 2005 – to provide an update and to give advice;

5th January 2006 – to re-issue the Boil Water Notice and to give advice;

30th January 2006 – to lift the Boil Water Notice and to give advice.

On 8th December 2005 Dwr Cymru wrote to 9,000 customers to lift the Boil Water Notice following rezoning.
Each letter promoted the help line set up by the outbreak control team and the Dwr Cymru call centre. The web sites of the National Public Health Service for Wales and Dwr Cymru were also promoted as a source of additional information.

On three occasions – the issuing of the Boil Water Notice, the re-issuing of the Notice and its lifting – advice letters specific to each of the following affected groups were sent:

- Managers of public swimming pools (21 in Gwynedd, 15 in Anglesey)
- Businesses serving and processing food (618 in Gwynedd, 252 in Anglesey)
- Other businesses

Head teachers of schools and managers of nursing and residential homes were sent specific letters on the re-issue and lifting of the Boil Water Notice. When the Boil Water Notice was issued, they were circulated with a copy of the press release.

Letters (45 in Gwynedd and 32 in Anglesey) were sent to children’s nursery operators to remind them of the importance of hygiene and to reduce the chance of person-to-person spread of the disease.

All letters were sent bilingually.

Dwr Cymru hand delivered copies of the Boil Water Notice, a list of the areas affected and other information to:

- Dentists
- Bangor University Students’ Union
- Post Offices
- Leisure Centres
- Swimming Pools
- Pharmacies
- Supermarkets and other shops
- Garage food outlets
- Nursing Homes

**NHS Direct Help line**

NHS Direct Wales was commissioned by the National Public Health Service for Wales to handle calls from the public in Welsh and English enquiring about cryptosporidium. Briefing notes and a series of questions and answers were provided. The main NHS Direct help line was briefed that calls could be received nonetheless.

The help line was available from 24th November 2005, as soon as it was announced that the Boil Water Notice for those at particular risk e.g. children with severe combined immunodeficiency, was to be initiated. It was closed on 10th February 2006.
The help line staff gave initial information to all callers based on the briefing notes, questions and answers (Appendix D) and regular updates provided by the National Public Health Service for Wales. Any calls that could not be answered by the help line were directed to specialist National Public Health Service for Wales staff.

The help line was set up on 24th November with one number. As a result of increasing demand, a second was established on 2nd December. The hours of operation were extended to 9am - 6pm for weekdays and 9am - 4pm for weekends, including the Christmas and New Year period.

Approximately 1,500 calls were answered by the help line during its 11 weeks of operation. Figure 4 shows the number of calls answered on a daily basis during this period.

**Figure 4: calls answered by the Helpline**

![Calls Answered by Helpline](image)

**Dwr Cymru call centre**

The Dwr Cymru call centre number was promoted in letters and press releases as a source of information for customers. In particular it was for those customers who needed confirmation of whether they lived in an area affected by the Boil Water Notice. Call centre staff were able to give customers information based on briefing notes. Any technical or more detailed questions that could not be readily dealt with were passed to technical or operational staff. Customers who raised specific medical or health queries were referred to the NHS helpline. The call centre was open 24 hours a day, seven days a week and dealt with around 10,000 contacts from customers.
Web sites

The National Public Health Service for Wales posted information on its web site about cryptosporidium including advice to the public and some frequently asked questions and answers at the time that at-risk patients were first contacted.

The web site was updated on a near daily basis during the course of the outbreak. Material was included in both the English and Welsh languages.

The Dwr Cymru web site also carried details of affected areas, frequently asked questions and answers, copies of boil water notices and letters to customers and press releases on cryptosporidium.

NHS Direct Wales also carried frequently asked questions and answers and copies of press statements on its web site.

Advertising

To supplement the letters sent directly to customers, Dwr Cymru placed advertisements in local newspapers which contained details of the Boil Water Notice, affected areas and, subsequently, the lifting of the Notice.

Media

The outbreak control team adopted the strategy of proactively using the media during the outbreak and of being open in its approach. Notwithstanding the legitimate public and news interest of the outbreak, it was agreed that the media was an essential vehicle for promoting public health messages to such a large number of affected people at high speed.

It was agreed that media communications should be managed so that there was ‘one voice’ for the team. This would be more likely to deliver clear and consistent messages.

In line with the decision that the National Public Health Service for Wales should lead on communications in the outbreak, it was agreed that all press enquiries would be channelled through its communication office. National Public Health Service spokespeople were nominated to conduct media interviews in the English and Welsh languages.

When the decision was taken to ask clinicians to contact specified patients at risk to issue or reinforce national advice on boiling water before use, it was agreed that there should be a briefing organised for the media on Thursday 24th November to explain the actions being taken.

Before all clinicians had been able to contact their patients, and before the briefing had been announced, on Wednesday 23rd November, the National Public Health Service received an enquiry from the Daily Post about the increased number of cryptosporidium cases in North Wales.

As a result, the press release was issued that afternoon with notice of the briefing on the following day.
A further media briefing was held on Thursday 29th November following the outbreak control team’s decision to issue a Boil Water Notice.

From that day until Friday 13th January 2006, a press release giving an update on the outbreak was issued nearly every day to the media. After that, occasional updates were issued if there were developments to report.

There was daily liaison between members of the outbreak control team in confirming information and messages for the press release. A bar graph was used occasionally to explain the timeline for the actions taken.

The communications offices and agencies of the team’s members liaised on many individual media enquiries and requests for filming and interviews.

Independent of, but after liaison with the outbreak control team, Dwr Cymru issued press releases as follows:

30th November 2005 – on the issuing of the Boil Water Notice
8th December 2005 – on lifting the Boil Water Notice for 9,000 customers
13th December 2005 – on the intention to make ex-gratia payments to affected customers
5th January 2006 – on the re-issuing of the Boil Water Notice
30th January 2006 – on the lifting of the Boil Water Notice

Media interest in the outbreak was significant and ongoing for many weeks. The outbreak was frequently the lead item on the Welsh print, on line and broadcast news. It was covered by current affairs and news programmes and, on a number of occasions, in the UK media.

During the course of the outbreak, the team received more than 350 separate enquiries from the media. More than 70 broadcast interviews were given. Only a small handful of interview requests were not accepted – usually because of time pressures and unavailability.

Most of the media coverage was helpful in explaining the actions of the outbreak control team, an understanding of cryptosporidium and in promoting the help line and web sites for further information. There was some coverage, however, early on which exaggerated the risks to the public.

### 5.2 Communications to health professionals

On 4th November the National Public Health Service for Wales wrote to general practitioners in Anglesey and Gwynedd to advise them to be alert to cases of cryptosporidiosis and to report cases if identified.

On 23rd November the National Public Health Service for Wales wrote to general practitioners in Anglesey and Gwynedd as well as the medical directors of the two LHBs and North West Wales NHS Trust and the paediatricians, haematologists, renal physicians, oncologists and some other specialists at the Trust. The letter asked them to contact specified patients at risk
to issue or reinforce national advice on boiling water before use. A draft letter was included for the purpose.

General practitioners were written to again when the Boil Water Notice was issued, when it was re-issued and when it was lifted. Dentists were also sent letters at the same times with specific and relevant advice.

The North West Wales NHS Trust was also given advice on precautionary action to take in the provision of its services.

5.3 Communications to Government, politicians and public officials

The outbreak control team anticipated that there would be much government and political interest in the outbreak. The public would get some of their information from their political leaders so the team considered it important that such public debate should be well informed.

The Office of the Chief Medical Officer for Wales was notified on 21st November of the increased incidence of cryptosporidiosis. The Office was then updated on an occasional basis until the outbreak was declared. After that, updates were given on a near daily basis during the course of the outbreak.

The Minister was briefed directly by officers of the National Public Health Service for Wales. Lines of communication were also opened with his private office.

When people at risk from cryptosporidiosis were first contacted, opposition political party health and environment spokespeople and Assembly Members (AMs) and Members of Parliament (MPs) representing the affected areas and those adjacent, were sent a briefing and an offer of a meeting. They were written to again when the Boil Water Notice was issued.

The same AMs, MPs and other interested parties, such as Community Health Councils, were sent near daily updates during the course of the outbreak.

Officers of the local authorities involved took responsibility for briefing within their respective organisations.

Dwr Cymru also kept its stakeholders informed throughout.
6. General Discussion

6.1 Introduction

Outbreaks of waterborne cryptosporidiosis usually result from a chain or sequence of adverse circumstances or factors (figure 5). This chain often includes an identifiable problem with water treatment processes or an unexpected challenge e.g. exceptional rainfall, described as plant under strain (Anon, 1990, 1995, 1998; Meinhardt et al., 1997).

In this outbreak, in North West Wales, there was no evidence of such a problem or challenge. The water treatment works appeared to have been working normally according to its agreed parameters.

In an attempt to understand what might underlie or explain the outbreak, a set of assumptions was developed to support a working hypothesis that water from Llyn Cwellyn was the source of the outbreak. This was hypothesis was developed, based on site observation and other evidence available (see Casemore 1994, 1995; Meinhardt et al., 1997; Casemore 2006). This was informed by:

- Experience of other outbreaks of cryptosporidiosis;
- Knowledge of water supplies and treatment processes;

Some critical events preceded recognition of the outbreak and cannot be confirmed. Definitive proof of the hypothesis is therefore not possible. However, the hypothesis describes a complex set of circumstances which, taken together, identified a plausible mechanism by which transmission of the infection may have occurred. This mechanism is biologically and epidemiologically consistent with the evidence.

It was apparent during the investigation that, if the hypothesis was correct, it would not be possible to guarantee the future safety of the water without enhanced treatment. Nor would it have been possible to remove the Boil Water Notice with confidence. The installation of UV treatment provided this enhanced treatment.

The following description is based on the hypothesis because it provides the most likely explanation for the outbreak, it is supported by the evidence found, and no plausible alternative explanation has been found.

6.2 The catchment

Llyn Cwellyn is a natural lake in Snowdonia with a controlled outflow, situated in a hilly, rocky catchment. Afon Gwyrfai flows from the western flank of Mount Snowdon and feeds directly into the south east end of the lake. Numerous other streams also flow from the surrounding hills into the lake.

The hydrological catchment area is typically ‘flashy’ with steep slopes and thin upland soils with peri-glacial scree beds in some areas that permit rapid transit of rainwater. The typically high rainfall within the catchment therefore produces rapid and excessive conditions in

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streams and ditches feeding into the lake. This results in the potential for the rapid transfer of pollutants if present.

It was believed that this potential could be ameliorated by the retention, settlement and dilution of the pollutants in the lake water. However, lakes such as Cwellyn are likely to experience summer stratification which may reduce the dilution of inflowing water. Other factors, such as wind, may also enhance surface streaming (short-circuiting), as described below.

About one mile south east of the lake, there is a small village, Rhyd Ddu, with a public house and visitors’ toilets in the Snowdonia National Park car park. These public toilets are likely to be used by visitors in large numbers all year round. The narrow gauge railway line had reopened as a tourist attraction and will have added to visitor numbers. The area is popular with walkers and campers. These visitors may defecate elsewhere in Cwellyn’s catchment.

Sewage from the settlement and public toilets goes to a small treatment plant just below the village. The plant discharges treated effluent into the Afon Gwyrfai. Solids are taken away by tanker as required.

There are a few habitations around the lake, including guest accommodation. Most have septic tanks discharging to drainage fields. A youth hostel has a modern treatment system which is believed to be well managed. There is a camp site at the south eastern end of the lake with a modern package sewage treatment plant, the top of which is only a few feet above the water level of the lake. There was some visual evidence of pollution at some sites.

Instances of significant rainfall occurred in the autumn months, causing local flooding of low-lying areas, including the camp site.

There is pasture for sheep and beef cattle along one side of the lake and adjacent hillsides. This produces potential for lake contamination with Cryptosporidium parvum, and possibly other species, especially in spring when lambs, which are a recognised source of Cryptosporidium parvum, are present. Although not relevant to this outbreak as a source of oocysts, this is important in terms of local residents’ exposure to infection and hence their immunity. A source of Cryptosporidium parvum adds to the potential risk from the Cwellyn source.

6.3 Likely impact of sewage effluents on the lake

Sewage inputs to Llyn Cwellyn from human sources have been assessed and at least five have been identified, one or more of which appear to have been faulty. Some were found to have a direct connection, while others may have had an indirect route especially in periods of heavy rainfall, a common event in this catchment. Several of these were found to contain Cryptosporidium hominis oocysts.

The potential for contamination from the sources was considered when the 1999 risk assessment for Llyn Cwellyn was compiled. Based on the risk assessment, the site was considered a low risk supply. The water company concluded there was no significant risk and therefore did not have to install upgraded treatment or to undertake regulatory or operational monitoring for cryptosporidium.

Operational monitoring set up in early November 2005 provided valuable data.
Another factor of potential relevance is the location of the abstraction point intakes, which are close to the surface of the lake outlet at the dam at the north west end.

Data on lake hydro-dynamics, including streaming and stratification, were not available during the investigation. However, it seems likely that these factors could have a potential impact on the quality of abstracted water during periods of summer stratification and autumnal thermocline overturn. This is because of the lake morphology and depth, and the nature of the surrounding terrain.

Wind, particularly from a southerly direction, may also result in surface streaming.

These factors would be enhanced by the poor settlement of oocysts in water (see below).

The hydrodynamic surveys being undertaken in the lake will enable the construction of a computer model of the circulation of water in the lake. This will be used to simulate the circulation characteristics under different weather conditions including those prevalent prior to the outbreak. The data gathered to date shows that the water movement (streaming) in the lake, that may result in short circuiting, is driven predominantly by the wind speed and direction rather than by flows from the Afon Gwrfai and the rate of abstraction.

It is the view of Dwr Cymru that, because the abstraction is only two metres below the lake surface, any stratification is unlikely, on its own, to reduce the average storage period for water in the lake stated in the risk assessment.

On the other hand, any streaming in Llyn Cwellyn may receive impetus from wind coming from a southerly direction.

Any short circuiting would reduce the dilution of oocysts, which is also impacted by the negligible settlement of oocysts in water.

Treatment at Cwellyn water treatment works consists of pressure filtration through a set of horizontal mixed media, pressure sand filters, pH correction, and chlorination. There is no facility for coagulation/flocculation as the water is of low colour and turbidity. Flocculation can be difficult to achieve in such water. Dwr Cymru has undertaken process studies and trials which have confirmed the difficulty of achieving coagulation/flocculation at this site. This means that the supply might be more difficult to treat effectively in the event of contamination with oocysts. However the risk of this occurring was considered to be low at the time of the risk assessment (see below).

The source was historically, and following the 1999 risk assessment, regarded by the company as not a significant risk. No alternative enhanced treatment was considered necessary by the company. However, filtration of the type used here is known to be ineffective in guaranteeing removal of cryptosporidium oocysts (Anon 1990), resulting in perhaps $\leq 1$-log$_{10}$ (less than 90%) reduction in particles of the size of oocysts (~5µm). Effective filtration would be required to achieve $\geq 3$ logs reduction (99.9%).

In 2003, sampling for Clostridium was started at Cwellyn water treatment works as part of the implementation of the 2001 Water Supply (Water Quality) Regulations. This sampling indicated the presence of clostridial spores in the treated water. The indication is consistent with faecal contamination (animal or human) of the raw water and microbial passage through the treatment system (see Report 71 and UKWIR Report 2000).
This observation confirms the inherent low efficiency of the water treatment system in the low attenuation of chlorine resistant organisms (cryptosporidium oocysts and clostridial spores are markedly resistant). The filtration system would be considered inadequate for treating water classed as a ‘significant risk’. It could be that the contamination found in this outbreak resulted from an unusual exception to the not significant risk assessment. Given a national estimated annual incidence (attack rate of 8.7 per 100,00 population) then an outbreak in a population of about 200 is likely to be a rare event and difficult to predict. The cost (capital and revenue) of providing protection from potentially rare events (cost-benefit ratio) has to be considered when doing a risk assessment.

6.4 General considerations: fate of oocysts in larger bodies of water such as Cwellyn

Infection with Cryptosporidium hominis is generally more prevalent nationally during the late summer and autumn. It is often associated with a history of travel.

It is believed that the North West Wales outbreak resulted from people within the catchment area developing acute diarrhoea due to Cryptosporidium hominis, before the waterborne outbreak. A case occurred in early October but a specimen was not submitted, tested and notified until December. There were people with clinical symptoms consistent with cryptosporidiosis. From the evidence of oocysts in the environment there had been other cases in the area, which may have included visitors. Infection may have occurred in young children in the catchment area who had not yet developed immunity. Adult residents within the catchment are more likely to have acquired cross-immunity from exposure to Cryptosporidium parvum (Casemore 2006; Priest et al., 2006), probably through exposure to livestock or their faeces.

During the initial phase of the illness the stool is usually profuse and fluid, and contains very large numbers of oocysts (=/>10^5/ml; total output over the acute period has been estimated at =/>10^{10} oocysts).

Freshly voided oocysts in cold water would have a high level of viability. The fluid nature of the stool results in rapid dispersal. However, this is not likely to be a uniform dispersion as would be expected with soluble chemical contaminants. Chemicals tend to disperse more homogenously (Tillett & Lightfoot, 1995) because of a concentration gradient effect. Oocysts seen in samples from surface waters and effluents in the lake catchment were noted to look intact and fresh compared with the appearance of oocysts often recovered from environmental sources (J Watkins, pers comm.).

Oocysts are too small to be subject to Stokes’ law. This defines the settling velocity of a particle which varies according to its density and diameter, and the density and viscosity of the suspending fluid. The density and viscosity of water increases as the temperature declines (Anon 1990).

So, settlement of oocysts is minimal, particularly given the relatively low temperature of the lake water, especially for particles smaller than those addressed by Stokes’ law. In addition, their negative surface charge (zeta potential) is such that they naturally form a mono-dispersed suspension i.e. they do not clump together, which would enhance settlement; and are randomly distributed (Anon 1990).
Oocysts are likely to be carried by surface currents or streaming. This may be enhanced if they are in water that differs significantly in physico-chemical nature from the surrounding water e.g. due to temperature differences, different chemical composition, and/or effluent content. They may have entered the water treatment works more easily if water is abstracted from near the surface (as is the case at Cwellyn). As mentioned above, abstraction flow patterns and wind may add to the streaming effect. (It is relevant to note that in order to recover oocysts from faeces/manure for laboratory study the first step is to dilute the sample to allow debris to be removed by settlement, while the oocysts remain in suspension in the supernatant.)

Because of their small size (~5µm) oocysts themselves may not be detectable as, nor contribute significantly to, increased turbidity (measured as NTUs). Therefore, if other sources of associated increased turbidity are absent or not excessive, NTUs at the plant may not be significantly increased when oocyst concentration is elevated. Relatively low levels of turbidity can result in only slightly increased NTUs and yet may still contain large numbers of oocysts.

Small rises in post-filtration NTUs in individual filters are known to indicate a potential window for the passage of oocysts. These may fail to be detected in the combined flow by a rise in NTU values for the finished water. Dilution by blending with treated water from the other filters will not then minimize risk (Anon 1995). However, it should be remembered that, because of the raw water A1 classification at Cwellyn, the filters were not designed to provide significant removal of oocysts.

It is not possible to speculate on the level of contamination prior to the introduction of monitoring. Sampling of raw water in the reservoir since early November has, however, shown low levels of oocysts, which even without coagulation would be expected to produce treated water that was well within the statutory limit (<1/10L =/>24hr mean) had that applied.

The environmental sampling detailed in Section 4 has shown a number of potential sources of Cryptosporidium hominis. Any oocysts would be expected to pass through pressure filtration treatment without significant reduction in numbers (</= 1-log_10 (less than ten fold) reduction). Given the high potential level of infectivity (low infective dose) for this pathogen, the continued presence of oocysts at the raw water abstraction point would have represented a continuing risk of infection.

6.5 Aspects of water treatment at Cwellyn

In addition to oocysts continuing to penetrate the treatment, random variation in oocyst distribution and other mechanisms, including short term contamination events, may result in short term spikes in oocyst numbers. These would not be revealed by the continuous sampling system which produces a mean value for the sample time and volume. This masks possible peaks in concentration within that time and volume (Casemore et al., 2001; Tillett & Lightfoot 1995).

In the case of high risk sites, pressure sand filtration alone is unlikely to be considered adequate for oocyst removal. Enhanced treatment would normally be required, for example with coagulation, membrane filtration, etc.. In the case of this site, as previously mentioned, the water was unsuitable for coagulation as flocculation could not be achieved reliably. This is true of a number of sites, for example with upland water, which have traditionally been
perceived as ‘pristine’. As the site was classed by the company as ‘low risk’, enhanced treatment was not required.

Where sites have been assessed as ‘at significant risk’, regulatory continuous oocyst monitoring is required (Statutory Instrument 1999). However, this is a treatment standard intended to indicate that excess penetration (c.f. background levels) has not occurred, not that the water is safe. Exceeding the standard would indicate the need for operational investigation to ensure that the water treatment e.g. coagulation, filtration, was optimised, and is required to be reported to the Drinking Water Inspectorate.

Had continuous monitoring been in place, it is by no means certain that an excess number of oocysts would have been noted. The distribution of cases by time does not suggest a short-term spike or bolus of contamination, but rather an ongoing low-level source.

Outbreaks have occurred elsewhere in the presence of very low numbers of oocysts that would not have resulted in a failure of the statutory treatment standard where that applied. (CDR Weekly, 2005; Howe et al., 2002; Morgan et al 1995; Neira-Munoz et al., pers comm or in-press; Willocks et al., 1998; CDR Weekly 2002; DWI Annual Report 2002; CDR Weekly 2002; South East Gosport outbreak report 2002; CDR 2006; Assessment Lette DWI 2005/245; DWI Annual Report 2005; CDR 2006; DWI Annual Report 2005).

Although it can be said that a background level of low numbers of oocysts may not be associated with illness, it cannot be said that low numbers do not cause illness. The situation may be further complicated by the fact that areas classed as ‘at significant risk’, and which persistently experience penetration by low numbers of oocysts, may be less likely to experience outbreaks because population immunity levels (seroprevalence) will be increased (Casemore 2006).

Another potential water treatment process factor to be considered is that of dislodgement from filters after backwash. Although there is no hard evidence for this at Cwellyn water treatment works, which was not designed to remove oocysts in the filtration process, turbidities in initial post-backwash water are normally increased. This could also reflect lower particle retention by the unripened filters during initial post-backwash flow. The Badenoch/Bouchier Expert Group reports (Anon 1990, 1995, 1998) and the UKWIR Report (2000), contain several relevant observations. They make recommendations on treatment, including filtration and backwash, and the problems of dislodgement and post-backwash start-up and filter ripening. Significantly, these are aimed primarily at sites assessed as at significant risk. They would not have applied to the Cwellyn water treatment works which was not classified in this way.

The problems of backwash recycling and the importance of the post-backwash so-called ripening period are stressed in the Expert Group reports and UKWIR Report (2000). It was recommended that, for high risk sites, whenever possible, water should be run to waste or recycled to the head of works during the initial post-backwash start-up period (2nd report A.6.31; 3rd Report, 5.3.9, p 44; UKWIR report 2000). Alternatively, where this is not possible, slow start-up is permitted (Anon1990, p 166). This is used at Cwellyn despite it being classed as a low risk site and therefore not the type of works subject to these recommendations.

Nonetheless, the post-backwash period represents a ‘window of opportunity’ for increased oocyst breakthrough. The Third Report of the Group of Experts (Anon 1998) suggests that, if the NTUs for the filtered water are increased by 50%, concern should be triggered. In the case
of Cwellyn, the post-backwash NTUs on individual filters may be increased about threefold during this period. In general terms, when such water is blended with output from the other optimised filters, the final NTU reading of the treated water may well appear to be acceptable. For a chemical parameter where any potential health risk applies only to the final concentration in the blended supply, this may be acceptable. However, for oocysts and other microorganisms this is not a safe assumption (Casemore 1990 in Anon 1990, p113).

This risk is further underlined because, as noted above, oocysts do not cause significant turbidity and are not necessarily associated with sources of significantly raised turbidity. So, whilst patterns of turbidity over time might indicate potential risk, low turbidity cannot be taken as an absolute guarantee of absence of oocysts and, hence, of an absence of such potential risk.

For chemical parameters, it is likely to be acceptable to blend water of lower quality/higher turbidity or chemical concentration with water of an acceptable standard because the critical factor is the concentration of a solute at the tap. However, with microbiological parameters such as cryptosporidium, any oocysts present, although diluted, will remain infectious. The water may therefore still represent a hazard to consumers although fewer may be exposed to an infective dose. With something as widely consumed as water, a low dose may still lead to significant numbers of cases.

The recommendations in the Expert Group’s reports on treatment processes, which are noted above, relate primarily to plant using flocculation plus filtration. However, the risks they seek to mitigate would almost certainly be present or increased with filtration alone, which is less effective in reducing oocyst numbers.

In addition to the continuous, albeit low level, input of oocysts, dislodgment of oocysts during and following backwash may cause the continued contamination of treated water being fed into the supply. This would be through the short-term spikes not revealed by the 24 hour mean sample values. This is one possible explanation for the noticeably ‘spikey’ appearance of the epidemic curve by date of onset. As noted above, Cwellyn water treatment works would not be expected to reduce oocyst numbers significantly in the filtration process. The epidemic curve may also reflect the relatively low level of contamination which may have reduced the number of potential infective exposures (water containing viable oocysts being consumed) on any given day.

Furthermore, biofilm in distribution pipes may harbour and then release oocysts, especially following pressure changes, resulting in intermittent lower-level but additive risk (Howe et al 2002; Percival et al., 2000; also, W. Keevil, pers. comm.).

### 6.6 Oocyst monitoring

The continuous monitoring oocyst limit of <1/10L (average/1000L sampled at a rate of 40 litres per hour for ~ 24hrs (Statutory Instrument 1999; Regulations 2000, 28-29)) is a treatment standard applied to water treatment works designated as at significant risk and was defined by consideration of the following factors:

- The level is not a health-risk based value, which is essentially indefinable (2nd Report, p84, A.10.12; Casemore 2001; Meinhardt et al 1997);
- Virtually all waterborne outbreak investigations have identified faults in the operational management of water treatment works, plant or other treatment failures; or unusual challenges such as unusually heavy rain and/or flooding (plant under unusual strain) (Anon 1990, 1995, 1998);
- It was believed that well optimised water treatment processes using multiple barriers such as coagulation/flocculation plus filtration were capable of minimising, but not eliminating, risk (Anon 1998);
- Oocyst species identification and viability testing are not required as the numbers are purely an indication of the effectiveness of the water treatment process to achieve ongoing particle reduction, including oocysts;
- The level was not intended to indicate the safety or otherwise of water that has less effective treatment i.e. sources classified as not a significant risk, for which continuous monitoring is not required;
- The Statutory Instrument standard is a 24 hour mean and may hide considerable variation within that period - it is accepted that short term spikes may occur within that period;
- A critical factor in the approach was a more structured and detailed risk assessment of each water treatment works and its catchment. That risk assessment, and its reassessment if there are significant changes in the catchment or treatment process, is fundamental and key to the safety of the water supply. The operational application of continuous (non-regulatory) sampling may inform that reassessment.

It is important to note that continuous monitoring for oocysts is likely to underestimate the numbers present as it is unlikely to represent 100% recovery. Recovery can be expected to be in the range 30-80%, but may be less in some cases depending on a number of factors including water quality (Casemore et al 2001). In addition, the value is a 24 hour mean - it may hide short term spikes, as described above - of a small side stream (e.g. with a continuous monitoring sample size approximately 1000-1,500L in this case) out of approximately 20 mega-litres per day total abstraction going into the supply.

It is essential to understand the rationale behind the treatment standard and to separate this from estimating potential public health risk. Generally speaking, water quality and, indirectly, public health risk, is assessed by reference to indicator organisms. Pathogens are not expected to be present (Report 71). The Water Supply (Water Quality) Regulations 2000 state that water should not contain any microorganism or parasite at a concentration or value which would constitute a potential danger to public health.

It is generally difficult to define such a level for cryptosporidium (see Fewtrell et al., 2001), especially given the variability of oocysts in water (source, species, age, viability). In the case of Cryptosporidium hominis it is likely to be very low. The presence of low numbers of oocysts (<1/10L) referred to in the monitoring SI (1999) – a treatment standard - does not imply acceptance of a level of risk. There is no requirement to determine key factors in risk assessment such as species, viability or infectivity.

In outbreaks with other waterborne pathogens e.g. bacteria and viruses, only limited significance is placed on actual numbers of organisms present in the water. The presence of an outbreak organism in the water is usually taken as evidence supporting an association (Tillett et al. 1998).
6.7 Infectivity of Cryptosporidium species

Several studies have attempted to assess the infectivity of Cryptosporidium parvum, including dosing a lamb-adapted strain into water in a large volume water tank. This was then used to make up milk feed for lambs delivered surgically into a sterile environment (Blewett et al., 1993). This showed that very small doses (as few as 1-5) could initiate infection in a fully susceptible host and that cumulative dosing probably occurred.

The 1995 outbreak in the Torbay area (Anon 1998; Harrison et al., 2002; Patel et al., 1998) provides some indirect evidence of relative infectivity in humans. The problem arose because bank-side gravel-derived water (adjacent to the River Dart) with high NTUs was blended with a more satisfactory supply, to give NTUs in finished water which complied with regulation (this underlines the danger of regarding such parameters as indicating freedom from risk of infection). The catchment was largely agricultural with livestock and can be assumed to have contained significant numbers of oocysts of Cryptosporidium parvum and possibly other animal-derived species. In addition, heavy rain was believed to have caused some contamination from storm overflows which included sewage. Despite the mixture of Cryptosporidium species, the majority of patients developed infection with Cryptosporidium hominis. This implies that the latter was more infectious. However, other factors may be involved.

Studies in the USA have used human volunteers (medical students) to estimate infectivity of Cryptosporidium parvum in humans (Okhuysen et al., 1999; Chappell et al. 1996; 1999). These showed that infectivity varies with strain but could be as few as 10 oocysts (Tam strain). The median figure from initial studies often cited was an estimate of 132 oocysts. It is essential to note that these are ID\(_{50}\)s and not minimum IDs.

N.B: ID\(_{50}\) is a measure of infectivity such that 50% of an exposed population would be infected. It is used primarily as a laboratory tool for comparing infectivity of different species or strains. An ID\(_{\text{min}}\) represents the smallest dose (which will vary with the organism species, strain, etc) that can produce infection in any exposed subjects. Thus, a dose representing the ID\(_{50}\) for an organism would potentially result in thousands of cases in a water supply zone. A more realistic measure for such a large population is therefore the ID\(_{\text{min}}\).

Volunteer feeder studies for Cryptosporidium hominis are more problematic for ethical reasons. The same research group has, however, now been able to do such studies. They confirm a very low infective dose size (ID\(_{50} = 10\) oocysts) in otherwise healthy volunteers (C. Chappell et al., in-press). The infected cohort includes a proportion of subjects exposed to less than 10 oocysts, including single oocysts (Chappell, pers. comm.).

The findings in this North West Wales outbreak are consistent with such a low infective dose (high infectivity).

6.8 Other factors in outbreak dynamics

Waterborne outbreaks have complex dynamics (figure 5). It is probable that a number of adverse events and/or conditions must coincide to cause an outbreak (Anon 1998; Casemore, 1994; Meinhardt et al., 1997).

The potential impact of viable oocysts in the water supply depends on:
• The number, viability and inherent infectivity of oocysts;
• Attenuation (weakening) of viability/infectivity by aging and/or adverse environmental conditions;
• The volume and frequency of water consumption;
• The frequency of exposure of the population (from all sources);
• The immune status of the exposed population (Casemore, 2006, figure 5).

Where the local population have not been widely exposed and infected during or since childhood they remain susceptible. The source of infection with Cryptosporidium hominis is likely to be infected humans (occasional instances of infection in animals have been noted). Routes and vehicles of infection include contact with young children (especially children who attend nursery/play group, and changing babies’ nappies), people with cryptosporidial gastroenteritis, swimming and foreign travel.

Incidence is generally increased in the UK during the autumn. This is thought to relate primarily to infection imported by holidaymakers. However, there is an unexplained time lag and this may result from secondary amplification, directly in the community by person to person spread and indirectly via water. In addition, Cryptosporidium parvum infection may be acquired from those same sources and also through exposure to animals, especially lambs and calves directly and indirectly.

Exposure to Cryptosporidium parvum will result in some cross-immunity to Cryptosporidium hominis (Priest et al., 2006).

For individuals in large population groups not exposed to these routes the other most likely route of infection is drinking water. It is for this reason that the first indication of an outbreak of waterborne infection is often a relative increase in adult cases within a water supply distribution area (Casemore 2006; Meinhardt et al 1997). This has been noted repeatedly in well-studied outbreaks. In this outbreak there has been a continuing high level of adult cases.

Food is a much less common source of infection (Casemore 1990; Casemore et al., 1997), and then usually with Cryptosporidium parvum. Cryptosporidium hominis is believed to be less frequently transmitted by the food route. A common epidemiological finding is that frequent consumption of raw vegetables/salad leads to reduced likelihood of infection (negative association or protective effect). The reason for this is not yet clear but may be a direct effect of increased immunity due to low-level contamination, or other confounding (e.g. life-style) factors.

It should be noted that not every case occurring during an outbreak will be attributed to that source. The expected background (sporadic) cases will continue to occur.

In areas where there has been frequent exposure (from any source, including sources of Cryptosporidium parvum), especially in rural areas with livestock exposure and those with a poor quality surface water-derived supply, adult cases will be much less common because of acquired immunity (Casemore 2006). In such areas, following exposure, acute infection may be found among visitors and recent retirees moving to the area, as occurred in the outbreak in the Torbay area in 1995 (Harrison et al 2002).
This does not seem to have been the case in the Cwellyn-derived supply area, suggesting that this outbreak represents an unusual event. As the outbreak progresses, secondary infection increases. This tends to affect children particularly due to their generally poorer hygiene and greater opportunity for exposure. So the age range drops once the source of infection is removed. However, in this outbreak, adults have represented about 50% of cases over a prolonged period. The continuing high proportion of adults suggests low population immunity but also suggests that waterborne transmission has been ongoing during the outbreak period.

Nationally, there have been improvements in public water quality over the last few decades, stemming from the introduction of the Water Supply (Water Quality) Regulations in 1989, cryptosporidium continuous monitoring regulations (Statutory Instrument 1999) and other improvements (Sopwith et al 2005, Casemore 2003). In this case, however, the low population immunity in the supply area, especially in young adults, implied by the high attack rate in that group, may reflect the previous low transmission via the water supply until the cases in the catchment in early October.

The smaller number of cases occurring latterly may reflect either:

- ‘Burnout’ where the majority of susceptible people have been exposed;
- The low level of contamination lowering the opportunity for susceptible people to be exposed;
- The effect of the Boil Water Notice; or
- A combination of these.

It strongly suggests that transmission via this water supply has not been common (although the risk has always been there). Transmission is likely to have resulted from a localised outbreak in the Cwellyn catchment prior to the outbreak in the area supplied by Cwellyn. This is something which, judged by national rates for this infection and the small size of the population within the catchment (a rural population which could be expected to have had pre-existing high levels of immunity due to exposure to Cryptosporidium parvum infection), was probably an unusual event, which could not readily have been predicted.
Oocysts in water are often derived from a variety of sources and host species, which may be of variable infectivity and pathogenicity for humans. Numbers, viability and infectivity decline with dilution, age and environmental attrition, including water treatment processes. These will affect the likelihood of an infective dose being ingested. The risks for target populations vary according to factors including quantities of water consumed and levels of immunity. For a given level of contamination with a pathogenic strain several outcomes are possible:

a) In an area of low seroprevalence the attack rate may be high. Primary cases will tend to include an unusual number of adult cases. Secondary cases occur more frequently in children. So the age-specific rate will decline as the outbreak progresses. Although seroprevalence will be higher following an outbreak, this will decline again unless there is further input of infective oocysts.

b) Where seroprevalence is moderate, outbreaks will tend to be smaller and secondary transmission less frequent. However, seroprevalence may be boosted by immunologically naive individuals with primary infection and sub-clinically infected exposed persons i.e. those who have acquired the infection but do not exhibit obvious symptoms. Such immune exposed subjects, if chosen as controls, will tend to reduce apparent relative risk for water consumption.

c) In areas with high endemicity and seroprevalence, outbreaks will be uncommon but visitors and other at-risk subjects will act as sentinels of high exposure levels. This dynamic, compartmentalised model permits analysis of risk status depending on changes in oocyst input (numbers, viability and infectivity), antibody increase post-exposure and then declining, and recruitment of susceptible people.

Waterborne outbreaks generally reflect a linking of adverse events and/or circumstances involving one or more of the compartments illustrated in the figure.
7. Lessons and recommendations

7.1 Observations and lessons learned

Water treatment

1. Continuous monitoring was used, from 2nd November, at Llyn Cwellyn for operational water treatment (non-regulatory) purposes (i.e. to obtain data). The data collected showed very low levels of oocysts which were well below the regulatory treatment standard specified for sites identified as at significant risk (average of less than one oocyst per 10 litres in a continuous sample at 40 litres/hr/ ~24hrs). The 1999 Statutory Instrument (subsequently incorporated into Statutory Instrument 2001, paragraphs 27-29) says by way of explanation that it is intended to ensure that water supplied for human consumption is not contaminated with cryptosporidium, a parasite which can be detrimental to public health. This level does not, however, guarantee freedom from risk of waterborne cryptosporidiosis.

2. It is important to take notice of even low numbers of oocysts in treated drinking water since they may constitute a threat to public health.

3. Conventional sewage treatment systems alone, when located in the catchment area of reservoirs, cannot be relied upon to prevent the water supply from being contaminated by cryptosporidium that may be found in human faeces.

4. The existing widespread practice of relying on dilution is unreliable as a general policy.

5. The infectious dose may be as low as a single oocyst of *Cryptosporidium hominis*.

Water Supply

6. A Water Supply Zone is not usually co-terminus with a single local authority boundary and more than one Water Supply Zone can exist within a geographically large unitary authority re-emphasising the need for collaboration between different organisations.

7. Consumers use mains water that may be derived from more than one original source and water companies can occasionally switch sources for operational reasons. The majority of calls to the helplines related to the fact that people do not know the source or sources of their water supply.

8. The automatic identification of households and other premises for the purpose of issuing an individual Boil Water Notice to each property is complicated by the need to maintain flexibility in the boundaries of water supply zones for operational purposes.

Outbreak occurrence

9. The natural history of *Cryptosporidium hominis* infection, the rarity of outbreaks in small communities in rural catchments and the likely impact of heavy rainfall provide a plausible explanation of the rarity and unpredictability of waterborne outbreaks caused by *Cryptosporidium hominis*.

10. With current knowledge it cannot be guaranteed that there will be no further outbreaks.
Boil Water Notice

11. Some public health experts have questioned the value of a Boil Water Notice (BWN), primarily due to evidence of poor compliance (O'Donnell et al, 2000; Hunter 2000). Where an alternative water supply (e.g. through re-zoning) is not an option, and where there is evidence of a continuing risk, then it is essential to ensure that the notice is issued as quickly and as effectively as possible. It is important to recognise the right of individuals to make an informed choice whether to boil or not. Even with poor compliance fewer people will be exposed to infection. This issue needs to be reviewed by the Group of Experts or equivalent body.

12. Time limiting a Boil Water Notice to a specific date may reduce flexibility in managing an incident.

13. It may sometimes be necessary to issue a Boil Water Notice without a precisely defined exit strategy, contrary to the existing advice outlined in the Report of the Group of Experts (Anon).

Guidance

14. The advice issued by the Chief Medical Officer on the need for immunocompromised patients to boil all their drinking water could usefully be reviewed. The need for the advice to be issued to appropriate patients needs to be re-emphasised to clinicians.

15. Questionnaires routinely administered by environmental health professionals to cases should record the place (postcode) of work/day care/education (i.e. anywhere else where water may be consumed) in addition to the place of residence, and should record the volume of unboiled tap water drunk.


Microbiology

17. Routine laboratory examination for cryptosporidium in faecal samples from people reporting diarrhoea, and reference tests for Cryptosporidium species/genotype identification in clinical specimens are essential for effective incident/outbreak investigation and control. (Casemore in Anon 1998, pp137-142; Casemore & Roberts 1993).

18. Core funding is not currently provided for widespread routine reference tests for Cryptosporidium species/genotypes in England and Wales.

19. Cryptosporidium species/genotype identification of environmental samples, including raw and final waters, improves information provided from oocyst numbers alone by indicating potential sources and infectivity for humans.
7.2 **Recommendations**

1. The Chief Medical Officer should consider the lessons learned (above) and the need for updated expert advice on cryptosporidiosis and the water supply especially the risk associated with small numbers of oocysts.

2. The Chief Inspector of Drinking Water should consider the lessons learned (above) and the need for updated expert advice on cryptosporidiosis and the water supply especially the risk associated with small numbers of oocysts.
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Appendix A - Membership of Outbreak Control Team

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Dr Dolors Carnicer-Pont, Locum Consultant in Communicable Disease Control (until December 2005)
Dr Rachel Chalmers, Head, United Kingdom Cryptosporidium Reference Unit
Mr Ken Davies, Biomedical Scientist, NPHS Microbiology, Bangor
Mr Drew Donaldson, Biomedical Scientist, NPHS Microbiology, Bangor
Dr Jenny Harries, Specialist Registrar in Public Health.
Dr Tony Howard, Director, Infection and Communicable Disease Service.
Mr Chris Lines, Head of Communications
Dr Marion Lyons, Consultant in Communicable Disease Control
Dr Brendan Mason, Consultant Epidemiologist,
Dr Sandra Payne, Regional Director of Public Health
Dr Mike Poole, Head Scientist, NPHS Microbiology, Bangor
Dr Roland Salmon, Regional Epidemiologist, Communicable Disease Surveillance Centre
Dr A Mark Walker, Consultant Microbiologist/Consultant in Communicable Disease Control (Chairman of Outbreak Control Team)
Dr Chris Whiteside, Consultant in Communicable Disease Control (from February 2006)
Mrs Sue Williams, Health Protection Team Co-ordinator

**Dwr Cymru**

Mr Jon Cannon, Area Scientist
Dr Tim Masters, Head of Quality and Asset Management
Ms Clare Walters, Quality Manager
Mr Mike Withers, Regional Scientist
Mr Tony Andrews, Environmental Manager
Mr Dave Quinn, Operational Manager

**Other organisations**

Dr David Casemore, DPC Centre for Research into Environment and Health, University of Wales (also Consultant Scientist for Welsh Water)

Professor David Kay, Institute of Geography & Earth Sciences, University of Wales, Aberystwyth

Ms Elinor Cordiner, Drinking Water Inspectorate (Observer)
Appendix B – Outbreak Control Team Meeting Minutes

CRYPTOSPORIDIUM INCIDENT MANAGEMENT GROUP

Minutes of the first meeting held on Monday, 7 November 2005

in the Boardroom, Ysbyty Gwynedd, Bangor

Present:  
Dr Dolors Carnicer-Pont, Locum CCDC  
Dr Mark Walker, Consultant Microbiologist/CCDC  
Dr Roland Salmon, Regional Epidemiologist, CDSC Wales  
Dr Rachel Chalmers, Head of Cryptosporidium Reference Unit  
Mr Emyr Searell Jones, Senior Manager Public Protection, Gwynedd Council  
Mrs Ann Rees, Food Safety Officer, Gwynedd Council  
Mr Siôn Wynne, Student EHO, Gwynedd Council  
Mr Tony Burgess, Chief EHO, Anglesey County Council  
Mr Keith Rowlands, Principal EHO, Anglesey County Council  
Mr Mike Poole, Head Scientist, NPHS Microbiology, Bangor  
Mr Drew Donaldson, Bio-medical Scientist, NPHS Microbiology, Bangor  
Mr Jon Cannon, Area Scientist, Dŵr Cymru  
Mr Mike Withens, Regional Scientist, Dŵr Cymru  
Dr Robert Atenstaedt, Specialist Registrar, NPHS  
Mrs Sue Williams, HPT Co-ordinator, NPHS

1. Presentation of cases

Dr Carnicer-Pont reported that an increase in cryptosporidium notifications had been detected last week, with 15 confirmed cases reported from Gwynedd and Anglesey by the end of the week. Between 1 September and 4 November, 36 notifications of cryptosporidium had been received, with CoSurv reports for 32 cases. This was twice the number reported for the same period in previous years. A similar increase was not evident elsewhere in North Wales. The cases were predominantly on either side of the Menai Straits, corresponding to a relatively heavily populated area. Most of the cases were from Gwynedd (66%) and the rest from Anglesey. Half of the cases were in the 15-44 age group and 70% were females. Ten cases
had been interviewed and no clear risk factor could be identified. Another case is a rower, two others had pets at home and one lives on a farm. All but three of the cases is a Cryptosporidium hominis suggesting a human source.

Mrs Rees tabled a list of Gwynedd cases investigated since the beginning of September, and a map showing the distribution of cases. Contact had been made with all but two of the cases. It was noted that the line listing contained confidential patient details that should only be retained for the purposes of investigating the incident. The risk factors relating to these were summarised as follows:

• four cases with illness in household members prior to onset but no specimens were submitted;
• two cases had travelled abroad during the incubation period;
• four cases drank different types of bottled water;
• three cases reported unlinked recreational water activities;
• several cases had animal contact either via pets or farm contact.

Mrs Rees also reported that there was anecdotal evidence of cases drinking large quantities of tap water.

Mr Rowlands reported that fewer cases had been seen on Anglesey and that the geographical distribution was close to the mainland. Nine cases had been investigated but with no obvious links – one was travel associated, three had farm contact, one had recreational water activity and all cases were on mains water supply. The age range of cases was 15 – 85 years.

Dr Walker stated that laboratory staff had been tracking cryptosporidium cases for a few years and that previous years showed a concentration of cases in the more populated areas of Bangor and south Anglesey. There was a predominance of C. parvum in the first eight months of this year, but since September the cases have been mostly C. hominis.

2. Report from Welsh Water

Mr Cannon reported that following receipt of the list of postcodes, he had mapped the water distribution which revealed nine different sources. The two main sources were Cwellyn Water Treatment Works which supplies 70,000 people and Mynydd Llandegai which supplies 35,000. Mynydd Llandegai has a blended supply from two Snowdonian lakes. Mr Cannon tabled briefing notes on these two water treatment works.

Strict regulations were enforced in 2001 which made it compulsory for water companies to reduce cryptosporidium oocysts in water to 1 per 10 litres. There are two WTWs in North Wales that have continuous cryptosporidium monitoring, Bretton in Flintshire and Penybont in Meirionnydd. Filters are checked and analysed daily and very low levels have been recorded. There has been agreement with the Drinking Water Inspectorate to undertake continuous monitoring at Cwellyn since 2 November, and results so far have been well below the agreed limit. It is likely to be two years before there is sufficient data to review. It was noted that the cluster of cases being investigated have an onset date of the end of September or beginning of October, but continuous monitoring did not start until November. During this time, both Cwellyn and Mynydd Llandegai have been working normally with low turbidity levels and the heavy rainfall has not affected these levels.
Dr Walker queried the proximity of Cwellyn to the railway line at Rhyd Ddu and whether faeces deposited on the line could have been washed into the reservoir following recent heavy rainfall. It was considered unlikely that this would cause problems, but Mr Searell Jones agreed to check the distance with the railway company.

*Action: ESJ*

Storage tanks are sampled on a weekly basis for coliforms and E coli with random sampling of clostridia in distribution zones but no positive results have been found.

It was confirmed that it is not possible to test old samples of water for cryptosporidium as large volumes of water are required, but turbidity levels are a good indicator. A brief report on the cryptosporidium monitoring at Cwellyn was requested for the next meeting.

*Action: JC*

Dr Chalmers stated that she would be able to match water samples to cases and Mr Cannon agreed to forward samples to her at the Cryptosporidium Reference Laboratory.

*Action: JC*

It was agreed that no further measures could be taken to improve the water treatment works, and Mr Cannon and Mr Withens were thanked for their detailed report.

### 3. **Source of outbreak**

It was agreed that as there was no obvious source, a case control study would be undertaken by Gwynedd and Anglesey Public Protection departments, working with the NPHS Health Protection Team. Only C. hominis adult cases would be included in the study. Travel-associated and secondary cases would be excluded. It was agreed that the zoonotic questionnaire would be used for the study with additional questions that had been developed when cases in South Wales were being examined. The additional questions would be requested from Dr Gwen Lowe and a copy of the database would be requested from Dr Daniel Thomas in CDSC.

*Action: DCP*

It was agreed that it would be appropriate to obtain the controls from the phone book for Gwynedd and Anglesey.

*Case definition:* a confirmed cryptosporidium case, living in Gwynedd or Anglesey, aged 15 years or over who has not been abroad in the 2 weeks prior to onset of symptoms and who has not been in contact with another case.

*Control definition:* a resident of Gwynedd or Anglesey who has not travelled abroad or been in contact with someone with symptoms of cryptosporidium since 1 October.

It was agreed that despite a predominance of female cases, there was no need to match controls by sex.
It was confirmed that outbreaks involving unpasteurised milk and improperly pasteurised milk were usually C. parvum. The majority of Gwynedd cases obtained milk from a variety of supermarkets rather than doorstep delivery.

4. Communications

Dr Carnicer-Pont has informed Chris Lines, NPHS Head of Communications, of the increased number of cases. It was agreed that the NPHS would take the lead as two Local Authorities were involved. A statement would be drafted by Chris Lines and circulated for comments to Gwynedd and Anglesey Councils, Welsh Water and the relevant Local Health Boards. The statement would only be issued on enquiries.

5. Date of next meeting

12.00 noon Monday, 21 November in the Boardroom, Ysbyty Gwynedd.
Minutes of the second meeting held on Friday, 18\textsuperscript{th} November 2005 in the Meeting Room, Welsh Water, Dinas, Caernarfon.

Present: Dr Dolors Carnicer-Pont, Locum Consultant in Communicable Disease Control, Health Protection Team, National Public Health Service (DCP)  
Dr Mark Walker, Consultant Microbiologist/CCDC, Health Protection Team, NPHS (MW)  
Dr Rachel Chalmers, Head of Cryptosporidium Reference Unit (RC)  
Dr Brendan Mason, Consultant Epidemiologist, Communicable Disease Surveillance Centre, (BM)  
Mrs Ann Rees, Food Safety Officer, Gwynedd Council (AR)  
Mr Sion Wynne, Student Environmental Health Officer, Gwynedd Council (SW)  
Mr Tony Burgess, Chief Environmental Health Officer, Anglesey County Council (TB)  

Cryptosporidium Management Group:  
Mr Keith Rowlands, Principal Environmental Health Officer, Anglesey County Council (KR)  
Ms Eirlys Roberts, Food Safety Assistant, Anglesey County Council (ER).  
Mr Jon Cannon, Area Scientist, Welsh Water (JC)  
Mr Tony Andrews, Environmental Manager, Welsh Water (TA)  
Mr Dave Quinn, Operational Manager, Welsh Water (DQ)  
Dr Rob Atenstaedt, Specialist Registrar, Health Protection Team, NPHS (RA).  

1. Current situation  

Increased cases of cryptosporidium, clustered in North Gwynedd and South Anglesey, are still ongoing, as shown by the recent epidemic curve. Although a letter had been sent to GPs the previous week, making them aware of the incident, the increase in cryptosporidium cases is unlikely to be due solely to raised case ascertainment. MW reported that Bangor laboratory has currently double the workload of stool sampling.  

RC reported that the Cryptosporidium Reference Laboratory had typed approximately 70 cases since 1 September. All had been C. hominis (human form), except for 3 (two were C. parvum and one was not typable). In addition, there had been microbiological sampling at 4 sites; final water at Cwellyn, Cwellyn raw water, Bangor Upper final and Llanwndda. Preliminary findings using recently-developed technology suggested that oocysts isolated from Cwellyn raw and Llanwndda final were C. hominis (results pending for other 2 sites).
However these results (obtained by PCR RFLP) were not conclusive. If confirmed, they would indicate human faecal contamination of the water supply.

JC reported that continuous monitoring by Welsh Water had revealed cryptosporidium oocysts in some of the filters, but the counts were well within the regulatory limit.

2. Further investigations

DCP summarised her report of the incident so far, which included the results of the case-control study undertaken. The study had been undertaken by local authority public protection and NPHS health protection staff. A table of attack rates listed 24 cases in the population served by a blend of Mynydd Llandegai & Cwellyn, giving an attack rate of 7 per 10,000. In the population served by Cwellyn alone, there had been 20 cases, giving a similar attack rate. DCP noted that the high attack rate of 9 per 10,000 in Cilfor was likely to be a chance finding, because it was based on a single case. In addition, a preliminary analysis of risk factors had revealed that the highest odds ratio is for positive response to the question on drinking tap water (OR=9.5). The association between tap water consumption and cryptosporidiosis appeared to be the only significant association in this univariate analysis, providing further evidence that water might be the vehicle for the increased number of cases.

MW noted that there is seasonal variation in cryptosporidium with an increase seen during the autumn. However, he emphasised that the recent increase in North West Wales (which has not occurred in other parts of North Wales) has much greater than expected, possibly by as much as ten times.

TA queried the finding from the case-control study that only 57% of controls had been exposed to tap water. It was noted that the question had asked people how many glasses of unboiled tap water they had drunk on a daily basis. RA mentioned that it was noted that cases had often consumed large volumes of tap water. Further analysis would be required to establish whether the volume consumed correlated with risk.

AR asked about a previous turbidity problem in 2004. JC stated that the rise in turbidity levels in February 2004 may have been linked to forestry work. There had been no recent turbidity problems.

3. Hypotheses

BM reviewed the evidence for an ongoing public health problem and a link with tap water which included:

- the recent increase in cryptosporidium notifications;
- epidemiological evidence from the case-control study linking cases and exposure to tap water;
- the microbiological evidence that suggested that C. hominis species has been isolated both from cases and from Cwellyn water.
BM pointed out that each item of evidence as it stood at present did not, on its own, establish that water was the likely source of the increase in cases. Taken together, however, the evidence suggested that drinking water should be seriously considered as a likely vehicle for infection.

MW noted that the incident may have been the result of some human faecal contamination of water. He hypothesised that this could either be the result of ongoing contamination e.g. through sewage contamination, or a one-off contamination of Cwellyn lake which will take time to correct itself.

Possible sources of contamination were discussed. The lake has a youth hostel on its shore with a new biological septic tank, and a camping site. There is also a tourist railway running nearby. MW’s previous suggestion of contamination from train toilets has been investigated by Welsh Water and the railway has confirmed that there are no toilets on these tourist trains.

The site visit after the meeting may help to clarify these hypotheses.

4. Incident Management

The management of the incident was discussed. MW noted that previous cryptosporidium contamination of drinking water has been managed by changing to alternative water sources or issuing boiling water notices. JC stated that there is no alternative water source to Cwellyn that can be used. In terms of issuing boiling water notices, it was noted that these are of limited effectiveness and can themselves cause harm e.g. people scalding themselves. BM stated that although boil water notices may be of limited effectiveness, if consumers were warned of the risk and advised to boil water, then they could make an informed choice about whether to follow this advice. The importance of a clearly defined endpoint was also discussed when the boiling water notice could be withdrawn. MW suggested that a boil water notice could be issued pending completion of environmental investigation with the notice reviewed when these investigations were complete. DCP suggested that boiling water notices should only be issued at this stage to those who are particularly vulnerable to cryptosporidium infection, particularly immunocompromised patients and this was agreed, pending the result of environmental investigations.

AR asked who would be the point of contact for enquiries from the general public. It was decided that enquiries from the public would be dealt with by the NPHS Health Protection Team. DCP has drafted a reactive press statement which she will discuss with Chris Lines.

TB suggested that other agencies should be involved, and it was decided that the Environmental Agency, Drinking Water Inspectorate and the LHBs should be closely involved in the incident.

It was agreed that a site visit would facilitate the investigation and this would take place after the meeting.
5. **Further action**

- Welsh Water would check the integrity of the water distribution system, especially from Cwellyn downstream, and investigate possible sources of contamination. They will liaise with the Environment Agency about this (*Welsh Water, Environment Agency, Environmental Health Officers*).
- Environmental investigations will include a site visit to Cwellyn (*All parties*).
- A letter will be sent to vulnerable people asking them to boil water (*NPHS Health Protection Team*).
- Public Health will be the point of contact for public enquiries and will modify reactive press statement, in consultation with Chris Lines (*NPHS Health Protection Team*).
- Representatives from the Drinking Water Inspectorate, the Environmental Agency and Gwynedd and Anglesey LHBs should be invited to the next meeting to consider the results of environmental investigations and to discuss any further course of action (*NPHS Health Protection Team/Welsh Water*).

6. **Date of next meeting**

11am Thursday, 24 November 2005 in Welsh Water HQ, Dinas, Caernarfon.
CRYPTOSPORIDIUM OUTBREAK CONTROL GROUP

Minutes of the third meeting held on Tuesday, 29 November 2005

in the Pathology Library, Ysbyty Gwynedd, Bangor

Present:  Dr Mark Walker, Consultant Microbiologist/Consultant in Communicable Disease Control, Health Protection Team, NPHS (AMW) - Chair

Dr Rob Atenstaedt, Specialist Registrar, Health Protection Team, NPHS (RA)

Mr Jon Cannon, Area Scientist, Welsh Water (JC)

Dr Dolors Carnicer-Pont, Locum Consultant in Communicable Disease Control, Health Protection Team, National Public Health Service (DCP)

Dr David Casemore, CREH Consultant for Welsh Water (DC)

Dr Rachel Chalmers, Head, UK Cryptosporidium Reference Unit (RC)

Ms Elinor Cordiner, Inspector, Drinking Water Inspectorate

Mr Ken Davies, NPHS Microbiology, Bangor (KD)

Mr Drew Donaldson, NPHS Microbiology, Bangor (DD)

Ms Ffion Wyn Hewson, Public Protection Manager, Gwynedd Council (FWH)

Dr Tony Howard, Director, Infection and Communicable Disease Service, NPHS (TH)

Mrs Grace Lewis-Parry, Chief Executive, Gwynedd Local Health Board (GLP)

Mr Chris Lines, Head of Communications, National Public Health Service (CL)

Dr Tim Masters, Head of Quality and Asset Management, Welsh Water (TM)

Mr Mark Medway, Environment Officer, Environment Agency (MM)

Mr Tim Owen, Environment Management Team Leader, Environment Agency (TO)

Dr Mike Poole, Head Scientist, NPHS Microbiology, Bangor (MP)

Mrs Ann Rees, Food Safety Officer, Gwynedd Council (AR)

Mr Keith Rowlands, Principal Environmental Health Officer, Anglesey County Council (KR)

Mr Emyr Searell-Jones, Senior Manager, Gwynedd Council (ESJ)

Mr Euron Thomas, Environmental Health Officer, Gwynedd Council (ET)
Ms Jane Waltham, Student Environmental Health Officer, Anglesey County Council (JW)
Ms Clare Walters, Quality Manager, Welsh Water (CW)
Mrs Sue Williams, Health Protection Team Co-ordinator, NPHS (SW)
Mr Mike Withers, Regional Scientist, Welsh Water (MiW)

Apologies: Mr Tony Burgess, Chief Environmental Health Officer, Anglesey County Council
Dr Brendan Mason, Consultant Epidemiologist, Communicable Disease Surveillance Centre
Ms Eirlys Roberts, Food Safety Assistant, Anglesey County Council
Dr Roland Salmon, Director, Communicable Disease Surveillance Centre

Via teleconference in CDSC: Dr Meirion Evans, Regional Epidemiologist
Dr Jenny Harries, Specialist Registrar, NPHS
Dr Robert Smith,

1. Confirmation of previous Minutes
The Minutes of the meetings held on 7 and 18 November were agreed as a true record.

2. Review of epidemiological investigations
DCP tabled a preliminary report on the incident and the case control study undertaken. The epidemic curve by date of onset shows a period of five weeks with a sustained increase in cases, although there was peak in illness in week 45 (week commencing 7 November). (It was noted that the curve by date of onset rises earlier than that by date of notification, owing to the lag between onset and seeking medical advice, submitting a specimen and processing by the laboratory.) A contributory factor may have been heavy rainfall in mid October. There has been an increase in diagnoses of cryptosporidiosis since the end of last week. It was noted that much of this increase was likely to represent a higher level of ascertainment following the recent publicity.

During the period 01 September – 18 November, the attack rate for the population whose place of residence was served by non-Cwellyn sources was 1 per 10,000 population, but the attack rate for the population served by Cwellyn and Blend of Cwellyn and Mynydd Llandegai was 9 per 10,000. The 95% confidence intervals suggested that this was not a
chance finding. JC stated that the population not served by Cwellyn in Table 1 included parts of Conwy and that the total population should be reduced by approximately 80,000.

TM queried whether any other hypotheses had been analysed in as much detail. It was confirmed that the questionnaire used in the case control study included questions on all risk factors.

Six possible secondary cases have been identified with known illness in household contacts prior to onset of symptoms. It was confirmed that these could be co-primary cases, exposed to the same source.

The majority of cases were in the 15 – 44 year age group, with a peak in those aged 15 – 24 years. RC stated that this differs from that of sporadic cases of cryptosporidiosis, for which routine surveillance data shows the highest proportion among those under 5 years of age (mainly in 2 year olds), with very few cases in the elderly. DC stated that previous studies of cryptosporidium outbreaks confirm that an increase in adult cases was an indicator of a water-borne infection. *C. hominis* predominates in cases under 1 year of age.

AMW confirmed that for the period September – November 2005, there had been approximately a 20% increase in samples being tested for cryptosporidium as in the same period for 2004. There was a considerable increase in the number of positive results for this year.

A letter had been sent to GPs during the first week in November to alert them to an increase in cryptosporidium notifications and request faecal samples from patients with diarrhoea.

**Case Control Study**

A case was defined as having symptoms between 1 September and 20 November, aged 15 years and over, with no history of foreign travel and no known illness in household contacts. Cases known to have *C. parvum* were excluded. Controls were Gwynedd and Anglesey residents, unmatched by sex and age and randomly selected from the phone book.

Interviews were undertaken for 82 people, 45 met the criteria for a case and 37 acted as controls. 67% of cases and 11% of controls were in the 16 – 44 age group. 58% of controls were over the age of 64 years which is likely to be due to the fact that interviews were undertaken during office hours when younger people would have been at work. The sex distribution was similar in cases and controls. 95% of cases reported symptoms of diarrhoea.

The analysis of risk factors showed that 89% of cases and 11% of controls drank unboiled tap water in the two weeks before illness, making illness six times more likely in cases. Controls were asked about drinking tap water in the two weeks prior to 5 November. It was also demonstrated that illness was more likely if more glasses of water were consumed. TM questioned the small sample of controls.
It was confirmed that no wider case finding has been undertaken outside Gwynedd and Anglesey. A question was raised about the geographic distribution of controls. DC pointed out that after all cases and potential controls found to have symptoms had been excluded, the remaining population of the at risk area was likely to contain an increased proportion of immune persons. This would tend to reduce the level of association as such persons could consume the water without developing illness.

3. **Review of environmental investigations**

JC confirmed that continuous monitoring has been in place at Cwellyn since 2 November 2005. Very low levels of oocysts (range <0.006 to 0.04; mean 0.016 per 10 litres based on continual monitoring) were seen from 25 samples taken at Cwellyn between 3 and 27 November.

Filter units were set up in other locations. Llanwnda is at the end of the Cwellyn system and that showed similar levels to Cwellyn from huge volumes of water between 5 and 25 November (6 samples range <0.0036 to 0.033 mean 0.011 per 10 litres). Three filters have been running at Mynydd Llandegai where there is no input from human cryptosporidium as it is a very high reservoir with no sewage works. No oocysts were seen and monitoring will continue on an operational basis. Results are pending from Anglesey WTWs. There have been very low levels of oocysts seen in the final water over a 25 day period of continuous monitoring. Turbidity levels in the final water started to rise at the end of October but not to the same levels as in February 2004.

MiW reported that the small sewage treatment works at the eastern end of the reservoir, Rhyd Ddu, serves 20 properties. The public house and public toilets in Rhyd Ddu also discharge into it. There were high levels of oocysts in final water from the sewage plant. Although the stream into which it discharges flows into the reservoir, it does so at a point some miles away from the outflow. RC confirmed that sewage treatment fails to get rid of cryptosporidium oocysts. The number of likely excretors in 20 households is likely to be low.

ET reported on a joint visit to the site on 22 November by Public Protection and the Environment Agency to consider potential sources of contamination, and a report was tabled. There are 13 properties with septic tanks and soakaways situated around the lake. A cryptosporidium sampling strategy had been agreed with RC to be undertaken on 25 and 28 November. Only one soakaway appeared to be failing and the breakaway water from this soakaway was tested. There were no reports of illness from the household. MM confirmed that samples were taken down stream of the sewage treatment works, near the lake Cwellyn, from the sewage works (Rhyd Ddu) and also from further upstream.

4. **Hypotheses**

A water-borne infection associated with Lake Cwellyn was the most likely explanation for the increase in incidence. New cases over the last 24 hours were also from the areas served by Lake Cwellyn.
Alternative hypotheses were considered and excluded, including use of swimming pools (excluded by the case control study and to some extent by the epidemic curve), person to person spread (only one recent case had been in contact with another case) and food-borne.

There were two pieces of epidemiological evidence, which were independent of each other, to support a water-borne infection. The residential population served by Cwellyn were 9 times more likely to become ill, and the case control study indicated consumption of unboiled tap water as a risk factor. Identification of C. hominis as the causative species suggested a human source, and there was evidence from environmental investigations that material of faecal origin could have entered Lake Cwellyn. The epidemic curve indicates continuing exposure, which is also compatible with a water-borne infection.

TM noted that nothing abnormal had occurred at the works and there was no evidence of contamination at the site of the water treatment works, or evidence of flooding at the sewage treatment works. Nevertheless, it was agreed that there was more evidence at this meeting of a water-borne infection (association with tap water consumption persisted after stratification by age, and evidence of a dose-response effect on risk).

JC confirmed that there was no evidence of contamination of the water in distribution

5. Further investigations

- Ongoing environmental sampling.
- Epidemic curve to be amended to match date of onset to age group.
- Results of Environment Agency sampling are awaited.
- Continue the cryptosporidium monitoring at Cwellyn. and Afon Gwrfa
- Continue interviewing of new cases.
- Welsh Water and the Environment Agency to agree arrangements for hydrodynamic survey of Lake Cwellyn.

6. Further public health measures

It was agreed that the public required advice on the use of swimming pools to avoid the spread of infection. It was recommended that people with a diarrhoeal illness should not use swimming pools for at least two weeks after recovery. RC agreed to obtain further sources of information on the subject, including the Pool Water Treatment Advisory Group, and
would assist with the wording on any advice given to the public. RA agreed to forward this advice to the Local Authorities.

It was agreed that this incident amounted to an outbreak of cryptosporidiosis for which the most likely vehicle of infection was mains water derived from Cwellyn. It was agreed to issue a boil water notice to the occupants of properties served by Cwellyn and blend of Cwellyn and Mynydd Llandegai. Welsh Water would contact all householders directly. The boil water notice would remain in force until 9 January 2006, subject to review.

ESJ suggested that lists of towns and villages served by the Cwellyn reservoir should be released as public health information. This was agreed.

Steps had been set in place to minimise the number of customers supplied by the Cwellyn water treatment works.

7. Communications

CL stated that a general communication needed to be issued immediately.

8. Dates of next meetings

11 am Thursday, 15 December 2005

Monday, 9 January 2006
CRYPTOSPORIDIUM OUTBREAK CONTROL GROUP

Minutes of the fourth meeting held in the Boardroom, Llandudno Hospital

11am Thursday, 15 December 2005

Present:

Dr A Mark Walker, Consultant Microbiologist/Consultant in Communicable Disease Control, Health Protection Team, NPHS (AMW) - Chair

Dr Brendan Mason, Consultant Epidemiologist, Communicable Disease Surveillance Centre (BM)

Dr Rob Atenstaedt, Specialist Registrar, Health Protection Team, NPHS (RA)

Dr Dolors Carnicer-Pont, Locum Consultant in Communicable Disease Control, Health Protection Team, National Public Health Service (DCP)

Dr David Casemore, CREH Consultant for Welsh Water (DC)

Dr Rachel Chalmers, Head, UK Cryptosporidium Reference Unit (RC)

Ms Ffion Wyn Hewson, Public Protection Manager, Gwynedd Council (FWH)

Mr Tim Hughes, Gwynedd Council (TH)

Mrs Eirlys Roberts, Food Safety Assistant, Anglesey County Council (ER)

Mrs Grace Lewis-Parry, Chief Executive, Gwynedd Local Health Board (GLP)

Mrs Jo Charles, Associate Director of Public Health, Gwynedd Local Health Board (JC)

Mr Chris Lines, Head of Communications, National Public Health Service (CL)

Dr Tim Masters, Head of Quality and Asset Management, Welsh Water (TM)

Mr Mark Medway, Environment Officer, Environment Agency (MM)

Mr Tim Owen, Environment Management Team Leader, Environment Agency (TO)

Mrs Ann Rees, Food Safety Officer, Gwynedd Council (AR)

Mr Keith Rowlands, Principal Environmental Health Officer, Anglesey County Council (KR)
Mr Emyr Searell-Jones, Senior Manager, Gwynedd Council (ESJ)
Mr Euron Thomas, Environmental Health Officer, Gwynedd Council (ET)
Ms Clare Walters, Quality Manager, Welsh Water (CW)
Mr Mike Withers, Regional Scientist, Welsh Water (MW)

1. **Apologies:** Professor David Kay, Institute of Geography & Earth Sciences, University of Wales, Aberystwyth (DK)
   Mr Jon Cannon, Area Scientist, Welsh Water (JC)
   Ms Elinor Cordiner, Inspector, Drinking Water Inspectorate (EC)

2. **Confirmation of Minutes of meeting held on 29 November**

   The second draft of the minutes were agreed as a true record

3. **Review of epidemiological data**

   BM reviewed the epidemiological evidence. The shape of the epidemic curve indicates a substantial outbreak with a continuous source. Analysis by place of residence shows a high attack rate, especially in the area served by the Cwellyn reservoir, and the case control study gives a statistically significant association between drinking unboiled tap water and disease. One of the concerns raised previously about the case-control study was that the controls were older than the cases. However, this actually tends to hide an association, as older people are more likely to be immune to disease. This is evident in the logistic regression analysis, whereby, when adjusted for age, the odds ratio actually increases from 6 to 12. Therefore, this age difference is unlikely to lead to a spurious association between drinking water and illness. In summary, the epidemiological investigations point towards a waterborne outbreak.

   AMW noted that the case control study had investigated other hypotheses based on other known methods of spread. No alternative hypothesis has come to light that is compatible with both the evidence of an ongoing source and the geographical distribution of cases.

   In terms of extending the case-control study, it was decided that this would not be advantageous because of the potential for recall bias. DC stated that we could exclude food as a likely source of the outbreak. However, it was agreed that it would be useful to investigate further those cases not resident in the Cwellyn treatment area, to see how many of these could be linked back to the outbreak, particularly as regards consumption of tap water at their place of work or education. To minimize recall bias, this investigation would be confined to the adult cases who had been interviewed in the case-
control study, together with those children whose school location was recorded the 
questionnaire. It was agreed that Gwynedd and Anglesey Public Protection Units could 
conduct this exercise, although it was pointed out by ESJ that it would have been 
preferable if the original questionnaire had asked for work-place address. (Some of the 
adult cases had been interviewed twice already; no re-interviewing would be necessary 
where the case was a child).

It was emphasised that interviewing of cases and completion of questionnaires would 
continue as is normal practice for sporadic cases.

4. Review of environmental investigations

General

RC reviewed the progress of environmental investigations. A meeting of the 
environmental investigators had been held at which results from Phase 1 - site survey and 
cryptosporidium sampling - had been reviewed. Groundwork had been carried out by ET 
and MM. Visual inspection had revealed potential sources in: the effluent from both the 
Rhyd Ddu Sewage Treatment Works; a failed septic tank soakaway at Property 13; a 
blocked Public sewer serving the public toilets at Snowdonia National Park car-park in 
Rhyd Ddu with evidence of surface run –off of raw sewage into a tributary of the 
Gwyrfai (since repaired). Other possible sources of potential contamination include 
Property 1 and Property 12 (campsite), which are both under investigation. RC noted as 
well as these potential surface sources, it was also important to consider sewage travel to 
lake via the periglacial scree (non-visual inputs)

Phase 2 of the environmental work had been agreed. This will involve sampling at 
various sites around the lake, both routinely and after periods of high rainfall, for both 
cryptosporidium and bacterial indicators of faecal contamination. It was noted that the 
Severn Trent Laboratory were likely to be able to undertake the bacteriological sampling 
if local laboratories were unable to carry it out (Such work could be arranged by 
Gwynedd Public Protection Unit.)

Another potential source, the toilets at Snowdon café was discussed. It was resolved that 
a one-off sample from the septic tank would be sufficient.

There was discussion around the designation of Cwellyn as a low-risk upland water 
source. ESJ questioned the "upland" designation and pressed for a new risk assessment. 
TH questioned whether it was appropriate to have a basic combined (sewage /surface 
water) Sewage Treatment Works discharging into a water course serving a public 
drinking water supply, especially given the increased loads on the STW from tourism. 
MM pointed out that there are no microbiological standards for inland water. TM 
emphasised that, based on the knowledge at the time, the original risk assessment was 
correct; furthermore, the sewage treatment works is of standard design and consented by 
the Environment Agency. TM drew attention to advice from the Drinking Water 
Inspectorate dated 13 December 2005. This noted there had been recent increase in 
reports of cryptosporidiosis to the Health Protection Agency in England and Wales, and 
recommended that all water companies review their risk assessments and operational risk 
management arrangements for surface water derived water supplies. ESJ welcomed this
letter. In response to a question from RA, TM noted that if a source was designated as high risk, extra treatment or continuous monitoring for cryptosporidium, would be required.

AMW noted that the while the OCG's investigations and conclusions were likely to be of wider relevance, particularly with regard to similar water sources, the OCG's primary task was to bring the current outbreak to an end. GLP agreed with this.

Three possible sources of rainfall data were noted: DK had obtained data (quality assured) from Hafodwyder indicating high rainfall 23rd August (48mm), 11-12 Oct (33mm) and 23/24 Oct (>30mm); TM and TO had data on lake levels and flows.

The question of sampling from farm animals was discussed. RC noted that it would be very difficult accurately assess the possible contribution of animals, for a number of reasons: husbandry patterns changed in the winter, and may well have been in a state of flux in October/November; information on animal numbers and movements specific to the Cwellyn catchment might not be obtainable; and there were logistical issues in collecting samples of animals. It was noted that only 2 Cryptosporidium parvum cases (the zoonotic species) have been reported during the outbreak. Very few reports of the detection of Cryptosporidium hominis in farm animals have been published. In the light of these considerations, together with the observation that there were at least two confirmed sources of C hominis, the OCT concluded that pursuing investigation of possible animal sources of cryptosporidium in this outbreak was less important than the investigations already in progress.

Gwynedd Council

TH discussed the progress of the enforcement notice on Property 13. A notice had been served on the property to remedy defect in their sewage system.

Environment Agency

MM noted that a new soak-away system for Property 13 was unlikely to be adequate and that a package sewage plant was most likely the most effective option (which would discharge directly to the watercourse).

MM stated that EA was not aware of any authorised sewage sludge spreading in the Cwellyn catchment area.

Dwr Cymru

CW stated that a hydrographic survey of Llyn Cwellyn commissioned by Welsh Water had begun. The use of biological tracers was not currently proposed.

Cryptosporidium Reference Laboratory.

RC referred to a spreadsheet previously circulated. Cryptosporidium genotypes were being determined by polymerase chain reaction and restriction fragment length polymorphpism at two loci, and confirmation of species using DNA sequence analysis. C hominis has been confirmed in samples from the following locations: Llanwnda final (customer’s tap), Cwellyn raw water (provisional); Rhyd Ddu sewage treatment works
final effluent and humus tank; Afon Gwyrfai outlet of property 12 and all 3 samples from Property 13. In addition, Afon Gwyrfai at inlet to Cwellyn and outlet both had *C. hominis*.

Summarising the environmental investigations, AMW noted that there are at least 5 potential sources of sewage run-off in the Cwellyn catchment. *C. hominis* has been demonstrated in relation to 2 potential sources (Property 13 and the Sewage treatment plant) and in water entering Llyn Cwellyn and water leaving Llyn Cwellyn, both before and after treatment. This provides biological support for the epidemiological findings.

5. **Cwellyn performance overview**

MW noted that Welsh Water is continuing to monitor Cwellyn raw and final water and presented results to date. He added that sampling of distribution system had been extended (new site in Bangor and in Llanfairpwyllgwyngyll) and all sampling has reflected a low oocyst count.

6. **Further/ongoing investigations required**

- RC to look into logistics of doing faecal indicator sampling.
- AMW to seek evidence of a community outbreak of diarrhoeal illness circulating in young children in the Betws Garmon area. AMW had contacted the Strategic Director Development for Gwynedd Council enquiring whether there had been abnormal level of absenteeism at the beginning of September, but had not yet received a reply. JC mentioned that enquiries might usefully include any illness reported at the Council run Centre at Rhyd Ddu old school.
- Welsh Water – hydrodynamic surveying (ongoing)
- Environment Agency/Gwynedd Council – microbiological sampling programme (ongoing)
- The question of more extensive sampling (of all inputs into the lake) to be agreed outside the formal OCM.
- Gwynedd CC and Anglesey CC – re-interview adult cases who: were the subject of the case-control study; live outside the area served by Cwellyn; and had reported drinking water at work/educational establishment. (To examine the hypothesis that these individuals had consumed water from Cwellyn away from home.)
• Health Protection Team - examine questionnaires for and location of the schools of children living outside the area served by Cwellyn.

• Proposal for more extensive environmental investigations (recommended by DK) to be considered further by RC, and if necessary a detailed proposal to be prepared for consideration by the OCG

7. Hypotheses

AMW stated that investigations to date indicate that consumption of water from Llyn Cwellyn is the probable explanation for the outbreak. TM noted the importance of continuing to review the strength of evidence for this relationship. TM mentioned that levels of oocysts detected had not exceeded statutory levels. However, AMW noted that it is not uncommon to find low levels of oocysts in other water-borne outbreaks. DC added that the statutory level of oocysts is an operational standard, not a standard based on risk to health. Furthermore, there was general agreement is that if oocysts were present in drinking water, there is a risk. RA mentioned that most cases in this outbreak had consumed large volumes of water. RC stated that we have a continuing source of contamination and not a point source; Phase 2 of the environmental examination is directed to locating this source.

The OCT agreed that the new evidence presented at this meeting was consistent with the hypothesis accepted as "the most likely" source at the last meeting.

8. BWN exit strategy

AMW outlined two possible exit strategies. Firstly, a remedial defect might be identified and corrected. Secondly 'natural burnout' might be observed. As no obvious correctable fault had been found, the epidemiological exit strategy was the only one currently available to the OCG

There was some debate around evidence pointing to the outbreak slowing down. DC stated that the 2 key pieces of evidence are the proportion of adults and children (if proportion of adults is high, shows that source is still present) and proportion positive samples tested (which is showing a decline). This decrease could be secondary to the BWN or 'burnout' effect. BM, however, believed that there was no current evidence that the outbreak is self-limiting.

AMW pointed out that the size of the Cwellyn reservoir meant that there is potentially a large volume of contaminated water. In addition, compliance with the boil water notice was unlikely to be universal. GLP queried the compliance for a boil water notice and RA mentioned that evidence had shown it to be about 50%.

The issue of the Boil Water Notice was discussed. This is due to terminate on 9th January. Whether this is renewed or not is determined by the end-point of the outbreak. It was agreed that this should be reviewed at the next meeting on December 29th.
9. Communications

The following statement was agreed: ‘Ongoing investigations have strengthened the evidence that Cwellyn is the probable source of the outbreak. For this reason, we are advising people to continue boiling their water.’

Furthermore, following statement agreed: ‘Microbiological investigations undertaken by laboratory in Swansea have identified human strains of cryptosporidium at low levels in Cwellyn water, both before and after treatment. Environmental investigations have found a number of possible routes for contamination.’

Chris stated that it was important to plan communication for period between Xmas and New Year and the importance of keeping case lists up to date.

10. Any other business

Manpower issues were discussed. It was agreed that sampling would be done by the various bodies contributing to the OCG, with Gwynedd Council Public Protection contributing what resources that had available. It was also resolved that no more information derived from questionnaires would be needed to inform the meeting on 29th December.

ESJ reported that both Council Offices were scheduled to be closed from 23 December to 3 January and so an alternative arrangements would need to be put in place for the continuity of interviewing cases during this period. Anglesey provides an out-of-hours service during this period, but for emergencies e.g. drainage problems. CL noted the importance, particularly for maintaining public confidence, of continued activity over the holiday period. It was agreed that cases notified during this period should be contacted and interviewed without undue delay. Case-lists would be maintained by the Health Protection Team of the NPHS in Mold.

CL stated that he would circulate a memo on the Xmas arrangements.

As this was her last meeting AMW thanked DCP for all the work that she had done in managing the outbreak.

11. Date of next meeting

Thursday 29th December at midday in Board Room, Ysbyty Gwynedd Hospital, Bangor.
CRYPTOSPORIDIUM OUTBREAK CONTROL GROUP

Minutes of the fifth meeting held on Thursday 29th December 2005

in the Board Room, Ysbyty Gwynedd Hospital

**Present:**
Dr Mark Walker, Consultant Microbiologist/Consultant in Communicable Disease Control, Health Protection Team, NPHS (AMW) - Chair

Dr Rob Atenstaedt, Specialist Registrar, Health Protection Team, NPHS (RA)

Mr Jon Cannon, Area Scientist, Welsh Water (JC)

Dr David Casemore, CREH Consultant for Welsh Water (DC)

Dr Rachel Chalmers, Head, UK Cryptosporidium Reference Unit (RC)

Ms Elinor Cordiner, Inspector, Drinking Water Inspectorate (EC)

Mrs Grace Lewis-Parry, Chief Executive, Gwynedd Local Health Board (GLP)

Mr Chris Lines, Head of Communications, National Public Health Service (CL)

Dr Tim Masters, Head of Quality and Asset Management, Welsh Water (TM)

Mr Tim Owen, Environment Management Team Leader, Environment Agency (TO)

Dr Mike Poole, Head Scientist, NPHS Microbiology, Bangor (MP)

Mr Keith Rowlands, Principal Environmental Health Officer, Anglesey County Council (KR)

Mr Emyr Searell-Jones, Senior Manager, Gwynedd Council (ESJ)

Ms Clare Walters, Quality Manager, Welsh Water (CW)

Dr Brendan Mason, Consultant Epidemiologist, Communicable Disease Surveillance Centre (BM)

Mr Mike Withers, Regional Scientist, Welsh Water (MiW)

Mrs Eirlys Roberts, Food Safety Assistant, Anglesey County Council (ER)

Dr Marion Lyons, Consultant in Communicable Disease Control, NPHS (ML).

Dr Sandra Payne, Regional Director, National Public Health Service for Wales (SP)
1. **Apologies:** Mrs Sue Williams, Health Protection Team Co-ordinator, NPHS (SW)
   Mr Mark Medway, Environment Officer, Environment Agency (MM)

2. **Confirmation of previous Minutes**

   The draft of the Minutes of the meeting held on 15 December 2005 were agreed as a true record.

3. **Update on epidemiological data**

   AMW stated that there had been very few cryptosporidium cases in the previous 2 weeks and that the percentage positivity of cases tested had declined by week 51. The percentage of secondary cases had increased, although he noted that the definition of secondary cases used is generous (however, given that the level of exposure is low, it seems unlikely that you would get two co-primaries in the same family). AMW added that the cumulative percentage of secondary cases had risen to 20%

   The epidemiological work around those cases not resident in the Cwellyn area was discussed. Most adult cases interviewed had shown some contact with the Cwellyn area e.g. they had been for nights out in Bangor. In terms of child cases, 18 were living in non-Cwellyn areas; of those interviewed, 2 were secondary cases and 6 had other associations with Cwellyn e.g. overnight stays in the Cwellyn area or attending school in the area.

   AMW discussed the decline in number of cases. The reduction in the previous two and half weeks is greater than the Team would have expected from the impact of the Boil Water Notice. In particular, the number of cases almost halved in the week after the Boil Water Notice was introduced which is unusual. BM stated that the best data to look at is the data using onset dates, which has also seen a downward trend.

4. **Update on environmental investigations**

   RC circulated a working document, drawing the OCT’s attention to the key environmental findings on Page 1: there are multiple point sources of *C. hominis* in catchment; there is the potential for contamination from human and animal sources with other Crypto species; there are no effective natural barriers to the transfer of oocysts between sources and lake Cwellyn; summer stratification might be expected to reduce dilution and enhance streaming within the upper epilimnion during summer and autumn.

   AMW and TM noted however that the OCT has no evidence (confirmed by Welsh
Water) that summer stratification has occurred, although DK stated that we would expect summer stratification to occur in this type of lake.

TM enquired on progress on investigations looking for a particular point source for C. hominis. AMW stated that he had received a reply re: his enquiries of the health of children in Waenfawr Primary School. A report that 4 cases of cryptosporidiosis had occurred in primary school children was noted, but AMW pointed that it was not clear that these cases had been microbiologically confirmed. He noted that lab data showed an early peak in cases in September, corresponding to a general rises in autumn cases. TM queried the geographical location of these cases. AMW noted that the data was compatible with a community outbreak. RC queried whether there were any previous cases in Betws Garmon area.

There was a debate around the infective dose of cryptosporidium. DC noted that he had received permission from colleagues in the US to state that the ID-50 (the infective dose to produce illness in 50% of those exposed) is only 10 oocysts. MW stated that in this case, it was possible that 1 oocyst could produce disease in the relatively small number of those affected in North-West Wales. DC added that evidence from lamb studies showed that there appeared to be cumulative dosing (1-9 oocysts).

JC discussed some of the further sampling which Welsh Water had undertaken and provided the OCT with data on a range of samples, including a customers tap in Bangor, Beaumaris, upstream and downstream of the sewage treatment works, Caernarfon and Anglesey and Mynydd Llandegai. In no cases was the statutory limit of 1 oocyst per 10 litres exceeded (final water samples). In terms of Cwellyn final water, there was an average of 0.02 per 10 litres, with a possible decrease in oocyst readings since Mid-November.

Summarising the environmental information, AMW pointed out that there was no environmental basis for lifting of the BWN.

DC emphasised that the OCT does not have baseline levels of oocysts to compare the current levels with, as Welsh Water was not required to monitor cryptosporidium for regulatory purposes prior to this outbreak. The OCT noted that background levels prior to 2nd November are not available. TM added that routine sampling by water companies are not species typed.

5. **BWN exit strategy**

MW remarked that there were originally two alternative exit strategies – identify a correctable deficiency or observe a natural end to the epidemic. He added that the first is not an option available to the OCT; the second is ruled out because the base attack rate is too low.

AMW noted that it was difficult to lift the BWN using the epidemiological exit strategy. This is because it was expected that the BWN would reduce the number of cases to a level above the baseline; the BWN could then be removed when the level reached the baseline, indicating natural burnout. For example, with 40 cases a week and an on-going risk, we would expect 15 cases a week after the introduction of the BWN; we now do not
have any fall left to measure. ML confirmed this. DC noted that in virtually every other cryptosporidium outbreak, there was a deficiency which could be corrected.

TM stated that although the OCT was of the view that tap water is the probable source of the outbreak, we were not likely to identify a point source and it remained sensible to ask people to boil their water. He proposed that an alternative exit strategy could be provided by Welsh Water. This would be the installation of an extra treatment process, namely ultraviolet light. The aim is to have new UV treatment installed by 6th January. Once this equipment is installed, it would be possible to eliminate the waterborne route as a cause of infection and lift the BWN. However, TM had a couple of concerns. Firstly, he emphasised that the UV treatment was being installed at this plant in these particular circumstances and should not be seen as a treatment stage that should necessarily be provided elsewhere. Secondly, there was a need to identify the mechanism for proving the effectiveness of the UV treatment.

RA enquired about other potential treatment methods e.g. coagulation. TM stated that, although coagulation would be an effective method, it was not possible given the nature of the water at Cwellyn. Membrane treatment would be effective, but would take at least 18 months to commission. Another alternative (both time-consuming and expensive) would be to re-sewer the valley.

RC noted the difficulties of monitoring the effectiveness of the UV treatment in situ. She added that it is very difficult to detect whether oocysts were dead or alive; in the US, they have used coliphages as a marker of effectiveness. DC stated that there is a large body of evidence that the UV treatment is effective. MW agreed that evidence pointed towards it being highly effective. However, it is difficult to monitor. He added that installation of the UV treatment alone is a recognised measure of effectiveness.

TM emphasised that the Water Treatment Works has continued to work normally throughout this process and that low levels of oocysts are not normally associated with illness.

AMW noted that the outbreak is not due to defective water treatment and that there was at yet no definite evidence that the outbreak had come to an end naturally. It was agreed that that a re-issuing of the BWN should be recommended, but that the date of this should be indefinite, pending installation and satisfactory operation of UV treatment.

It was agreed that the OCT should meet again to review the epidemiology of the outbreak, prior to any lifting of the BWN. In addition, SP noted the importance of continued surveillance and the putting together of an outbreak report by the Team. AMW stated that he had told the local AM that a report of the outbreak would be available through the LA within 8 weeks of removal of the BWN. This would be an important piece of work. The OCT would also need to formally sign off any BWN.

There was discussion around what further environmental investigations needed to be done. RC asked the OCT whether more routine sampling of potential sources was necessary. In addition, she was planning to send out the team to do some one-off environmental sampling the next day as heavy rainfall was predicted.
SP stated that environmental investigation and monitoring were not going to be of further help in controlling the outbreak and the questions posed by RC were mainly research questions. TM agreed with this, adding that we are introducing an intervention far more effective than boiling water. ML noted that people should not stop boiling their water until the UV treatment is operational. AMW noted that further environmental investigations were not required for the management and control of the outbreak. ESJ also did not see these environmental questions as the main priority and welcomed the introduction of UV treatment at the plant. The team agreed to suspend further environmental investigations. AMW noted that it was very likely that the cryptosporidium outbreak was caused by a coincidence of 2 or 3 incidents e.g. heavy rainfall coinciding with a community outbreak.

6. Communications

CL noted that he had been working on draft letters re: extension of BWN.

AMW noted that specific letters re: the last BWN were not sent to private nursing homes and that this should be remedied in the next round of mailings.

CL stated that the NHS Direct helpline should be kept going until at least the end of January and preferably early February.

TM noted that his team had done a Q&A on what ultraviolet light treatment is.

7. Any other business.

AMW thanked the OCT so far for their hard work to date.

8. Date of Next meeting

It was decided to cancel the meeting on the 9\textsuperscript{th} January and hold the next meeting on 18\textsuperscript{th} January at midday.
CRYPTOSPORIDIUM OUTBREAK CONTROL GROUP

Minutes of the sixth meeting held on Wednesday 18th January 2006

in the Board Room, Llanfairfechan

Present:  Dr Mark Walker, Consultant Microbiologist/Consultant in Communicable Disease Control, Health Protection Team, NPHS (AMW)  - Chair

Dr Rob Atenstaedt, Specialist Registrar, Health Protection Team, NPHS (RA)

Mr Jon Cannon, Area Scientist, Welsh Water (JC)

Dr David Casemore, CREH Consultant for Welsh Water (DC)

Dr Rachel Chalmers, Head, UK Cryptosporidium Reference Unit (RC)

Ms Elinor Cordiner, Inspector, Drinking Water Inspectorate (EC)

Mr Chris Lines, Head of Communications, National Public Health Service (CL)

Dr Tim Masters, Head of Quality and Asset Management, Welsh Water (TM)

Mr Tim Owen, Environment Management Team Leader, Environment Agency (TO)

Mr Keith Rowlands, Principal Environmental Health Officer, Anglesey County Council (KR)

Mr Emyr Searell-Jones, Senior Manager, Gwynedd Council (ESJ)

Ms Clare Walters, Quality Manager, Welsh Water (CW)

Dr Brendan Mason, Consultant Epidemiologist, Communicable Disease Surveillance Centre (BM)

Mr Mike Withers, Regional Scientist, Welsh Water (MiW)

Mrs Eirlys Roberts, Food Safety Assistant, Anglesey County Council (ER)

Dr Sandra Payne, Regional Director, National Public Health Service for Wales (SP)

Dr Chris Whiteside, CCDC, National Public Health Service for Wales (CWh)

Mr Mark Medway, Environment Agency (MM)

Ms Ffion Hewson, Gwynedd Council (FH)

Mrs Ann Rees, Food Safety Officer, Gwynedd Council (AR)
1. Apologies: Mrs Sue Williams, Health Protection Team Co-ordinator, NPHS (SW)

2. Confirmation of previous Minutes

The Minutes of the meeting held on 29 December 2005 were agreed as a true record.

3. Epidemiology

BM and RA presented epidemiological data and graph. Total of 231 cases to date, no new cases in previous week, increase in secondary cases in latter part of the outbreak.

The Health Protection Team have confirmed that there were clinical cases of cryptosporidium in the catchment area. This information has only come to light since the last meeting. Microbiological confirmation is available for only one of these.

4. Environmental and microbiological investigations

JC noted that WW had continued to sample water in the distribution area, including Bangor, Llanfair, Llanwnda and had seen no oocysts in sampling. WW have continued to sample the Cwellyn raw and final water. Cwellyn final was showing a level of 0.0136 oocysts per 10 litres, which was lower than previously. JC added that cryptosporidium sampling at Cwellyn was now done as a regulatory sampling point. He added that there were zero counts of cryptosporidium from Mynydd Llandegai (where WW continue to do operational sampling).

AMW noted that cryptosporidium counts on treated water had fallen since the last meeting.

TM noted that there had been significant recent rainfall, but that no increase in oocysts had been detected

CW noted that WW had completed bathymetric study and hydrological study, finding that the wind direction was mainly opposite to the lake outflow direction.

RC noted that laboratory analysis was still detecting *C. hominis*. However, the laboratory was also detecting a variety of other species.
5. **Hypothesis**

DC presented a paper written in his capacity as a CREH scientist, outlining an hypothesis for the cryptosporidium outbreak. The hypothesis outlined the possible factors contributing to a waterborne outbreak, and was supportive of the OCT's previous conclusion that drinking water was the most likely cause. This paper was noted by the outbreak control team. Given that it had been circulated only recently, it was agreed that members needed time to read it before any detailed discussion. AMW noted that there would be any opportunity to consider which aspects of it would be appropriate for the outbreak report.

AMW thanked DC for the help that he has provided.

6. **Investigations in progress and options for further studies**

There would be continued monitoring of oocyst counts by WW. Hydrological and bathymetric tests were ongoing.

AMW noted that sufficient environmental investigation had been undertaken for the purposes of controlling the outbreak.

The Cryptosporidium Reference Unit would continue to work on the subtyping of isolates, but would not be undertaking further sampling.

It was noted that RC has drafted proposals for environmental research projects. AMW thanked RC and DK for producing these proposals.

SP stated that recommendations for further research could be brought into the outbreak report which would be put in the public domain.

7. **Timetable for lifting BWN.**

AMW noted that WW was in the process of installing UV. The fully validated functional operation of this plant would represent an additional safeguard against the possibility of further water-associated cases, and could provide a rational criterion on which to base a lifting of the BWN.

TM presented a protocol for operation and validation of UV disinfection system.

CW noted that UV treatment was widely used in the US and that WW had adopted protocols in place for its operation, exceeding precautionary recommendations laid down.

The plant had been running since 7th January. WW need to make sure that it is fully automated, alarmed etc; work had been completed the day before the meeting. WW also want to ensure that all potentially contaminated water has passed through the distribution system before lifting the BWN. From phosphate testing studies, this is likely to be 48...
hours, but WW has assumed 5 days to be cautious. WW are proposing lifting the BWN on Monday 30\textsuperscript{th} January. WW also need to produce letters etc.

CL noted that the date should not be publicised until the OCT was sure of this. AMW agreed, noting that the team agrees that BWN could be lifted as soon as studies on retention time had indicated an appropriate day for providing normal operation.

The OCT agreed that the outbreak should be declared over at the point at which the BWN was lifted. However, the public should still be warned of the risk of secondary transmission.

8. Outbreak report, papers and presentations

The OCT agreed that data could be released for presentations and publications, as long as there was no release of identifiable data about individuals and information that might prejudice the execution of enforcement notices.

The OCT agreed that an outbreak control report would be released within 8 weeks of lifting the BWN (Does not include printing, binding and translation). This would need to be formally signed off by the Team. The translation into Welsh of the final document would be arranged by the NPHS.

CL noted that there should be a planned method of dissemination with advance copies to the public opinion formers etc (not for comment). Great care should be taken to avoid release before agreement by the team.

AMW discussed the outline of the outbreak control report. The draft document should have ‘draft’ in watermark, with individual members of the group leading on particular sections e.g. CL leading on communications section. The final document should be electronic, in portable document format (PDF,) and go on NPHS website. Consideration of whether paper copies should be made available to the public would be the responsibility of Anglesey and Gwynedd County Councils.

9. Other communications

NHS direct helpline would be kept going until 15\textsuperscript{th} February and will be updated.

CC Water are having their first public meeting on Tuesday 31\textsuperscript{st} January in Bangor.

AMW asked WW to more widely circulate their UV treatment document.

RA noted that NHS Direct Helpline was now receiving very few calls and acknowledged the help that they were providing to the OCT.
10. Any other business

The letters lifting the BWN will be going out on Monday 30\textsuperscript{th} January. There will be an embargoed press release on Monday. Letters should go out to various interested groups e.g. dentists on Monday, coordinated by CL. Welsh Water will be telling people that they do not need to wait for a letter before they stop boiling their water.

11. Date of next meeting.

Provisionally arranged for Thursday 16\textsuperscript{th} March at midday. (Subsequently rearranged for Tuesday 28\textsuperscript{th} March at 1300 hours.)
CRYPTOSPORIDIOLOGY OUTBREAK CONTROL GROUP

Minutes of the seventh Outbreak Control Team meeting held on Tuesday, 28 March 2006 in the Dolbadarn Room, Education Centre, Ysbyty Gwynedd, Bangor

Present: Dr Mark Walker, Consultant Microbiologist/Consultant in Communicable Disease Control, Health Protection Team, NPHS (AMW) - Chair

Mr Jon Cannon, Area Scientist, Welsh Water (JC)

Dr David Casemore, CREH Consultant for Welsh Water (DC)

Dr Rachel Chalmers, Head, UK Cryptosporidium Reference Unit (RC)

Ms Elinor Cordiner, Inspector, Drinking Water Inspectorate (EC)

Mr Chris Lines, Head of Communications, National Public Health Service (CL)

Dr Tim Masters, Head of Quality and Asset Management, Welsh Water (TM)

Mr Emyr Searell-Jones, Senior Manager, Gwynedd Council (ESJ)

Ms Clare Walters, Quality Manager, Welsh Water (CW)

Dr Chris Whiteside, CCDC, National Public Health Service for Wales (CWh)

Mr Mark Medway, Environment Agency (MM)

Mrs Sue Williams, HPT Co-ordinator, NPHS (SW)

Apologies: Dr Rob Atenstaedt, Specialist Registrar, Health Protection Team, NPHS

Mr Keith Rowlands, Principal Environmental Health Officer, Anglesey County Council Dr Brendan Mason, Consultant Epidemiologist, CDSC

Mrs Eirlys Roberts, Food Safety Assistant, Anglesey County Council

Dr Sandra Payne, Regional Director, National Public Health Service for Wales

Ms Ffion Hewson, Gwynedd Council

Mrs Ann Rees, Food Safety Officer, Gwynedd Council

Mrs Jo Charles, Associate Director, Gwynedd & Anglesey LHBs

Mr Euron Thomas, Gwynedd Council

Dr Jenny Harries, Specialist Registrar, NPHS

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Author: Chris Lines, NPHS Wales Page: 111 of 184
Dr Marion Lyons, HPT Lead, NPHS

AMW tabled a letter he had received yesterday from Mr Rhodri Morgan, the First Minister for Wales, expressing appreciation of the handling of the outbreak by the Outbreak Control Team.

1. Minutes of previous meetings

AMW recommended that Appendix 2 of the report should include the final version of each set of Minutes. It was agreed that, with the amendments agreed at each meeting incorporated into the approved version, no useful purpose was served in maintaining separate lists of amendments, and that the approved version to be included as an appendix to the OCT's report.

1.1 Minutes of meeting held on 18 January 2006

The Minutes were agreed as a true record.

2. Matters arising

- TM reported satisfactory monitoring of the UV plant at Cwellyn. It was now fully automated with no reported breakdowns to the system. The system is still operating on the first of four power settings, confirming that there has been no deterioration in performance. An operational protocol has been circulated.

- RC confirmed that further typing results would be added to the report.

- The BWN was lifted on 30 January 2006 as agreed.

- New treatment works are in the process of being installed at property 13 and discharge consent has been applied for.

3. Outbreak report

AMW stated that a decision needed to be made at this meeting on how to proceed with the draft report. It was felt that one person should have editorial responsibility, not necessarily with a medical or scientific background. It was agreed that CL should take on this role. It was felt that further consultation was needed amongst colleagues who may not have had an opportunity to read the report. Each section would have a lead who would be responsible for collating and incorporating comments and suggestions. The completed sections would then be forwarded to CL for editing and returned to section leads for final checking. AMW agreed to review the final report before signing off.
CL agreed to circulate a communications plan for the distribution of the report.

TM stated that a letter from Welsh Water previously sent to all customers may have stated that a summary of the report would be issued; this could be placed on their website.

It had been stated previously that the outbreak report would be available within 2 months of the BWN being lifted. DC and RC stated that comments from WAG and DWI indicated that a complete and accurate report was preferable to a hasty one.

DC asked whether a scientific paper would be produced from the report. AMW pointed out that such a paper would need to be considerably shorter than the existing outbreak report before submission for peer review and that the writing of such a paper would need to be led by a medical or scientific professional with detailed knowledge of the outbreak. DC and RC stated that they would be willing to assist with this.

It was noted that there was a lot of interest from various agencies on the results of the outbreak investigation. The target audience for the outbreak report was discussed. It was agreed that it should be addressed to educated lay people (i.e. those with a non-scientific background).

RC requested information on the nature of calls to the helplines which would be useful for future outbreak investigations. RA had produced a summary of helpline calls which would be circulated to all members.

AMW agreed to enquire from the A & E department in Ysbyty Gwynedd whether an increase in scalding injuries had been noted during the period of the BWN. No reports had been highlighted in the media or by various organisations.

4. Outbreak report sections

4.1 Summary (Lead: CL)

Ideally no more than two pages.

4.2 Glossary (Lead: CL)

The glossary should be extended to help the public to understand technical and medical terms.

4.3 Background (Lead: CL)

AMW thanked DC and RC for their contributions to this section. CL suggested that it should be less technical for members of the public. It needs to be useful for policy makers and authorities and should therefore be aimed at professional colleagues. CL would edit with the agreement of the authors.
4.4 Chronology (Lead: CL)

The chronology needs to reflect that all actions taken by the OCT were agreed as the investigation developed. It was agreed that an epidemic curve by notification date would be useful in this section, with an explanation that onset dates would have occurred some time earlier.

It was agreed to add a comment that the decision to time limit the first BWN was based on a desire for an alternative exit strategy for use in the event that a correctable defect could not be identified in the supply.

MM stated that it would be useful to clarify how the various agencies with responsibility for water and environmental health communicate as an outbreak unfolds. There was no suggestion that the relevant agencies had not been involved at appropriate stages in this outbreak. MM agreed to forward comments on behalf of the Environment Agency for inclusion in this section.

4.5 Microbiology and epidemiology (Lead: BM)

Amendments were made to the paragraph following an update on typing from CRU. RC would forward further microbiological information to CL if required after further consultation with colleagues. Outbreak numbers and descriptive epidemiology were based on cases notified between 1 October 2005 and 30 January 2006, although the case-control study included those with onset from 1 September. RC raised the issue of having a more specific questionnaire as a template for use in future outbreaks with a matching database to facilitate data entry. This needs further discussion with BM.

4.6 Water supply (Lead: RC)

RC agreed to draft changes to the chapter and forward to CL for editing.

TM agreed to provide a full listing of the monitoring results summarised in Table 1 for inclusion form as an appendix to the report, and if possible a graphical display. It was agreed that the names of properties should be removed from Table 3 to maintain confidentiality.

4.7 Communications (Lead: CL)

TM will forward a summary of the number and nature of calls to Welsh Water’s helpline to include in this section. ESJ will also forward a list of all communications sent by Gwynedd Council.

4.8 Discussion (Lead: DC)
TM and CW will forward comments to DC who will produce an abbreviated version.

RC agreed to include a comment on developments since the Bouchier Report was published in 1998.

The importance of good communication between the laboratory and the HPT should be moved from “lessons of the outbreak” to the discussion section. (CL)

### 4.9 Lessons (Lead: CL)

Following discussion on the lessons learned from the outbreak, the following amendments were made:

Lesson 1: remains the same.

Lesson 2: this should reflect that the risk of contamination is widely known but that the existing policy of relying on dilution is unsafe. (DC/AMW)

Lesson 3: add information on the natural history of C. hominis infection, rarity of illness in small communities in upland catchments and the likely impact of heavy rainfall to provide a plausible explanation of the rarity and unpredictability of waterborne infections caused by C. hominis. (DC/AMW)

Lesson 4: modify existing lesson 3 to state that routine laboratory examination of human diarrhoeal samples for cryptosporidium and genotyping of infections identified was crucial in establishing the cause of the outbreak. (RC)

Lesson 5: add that identification of households and other premises for the purpose of issuing BWNs is complicated by the need for flexibility in the boundaries of water supply zones in order to maintain a supply in the face of variation in sources. (TM)

Lesson 6: add problems of time-limited BWNs. (TM)

Lesson 7: add necessity to issue a BWN without an exit strategy, contrary to existing advice in the Bouchier Report. (DC)

Lesson 8: as existing lesson 4, the need for a more specific list of patient groups who need to boil water all the time.

### 4.10 Recommendation

The two existing recommendations should be replaced with:

The Chief Medical Officer should consider seeking updated expert advice on cryptosporidiosis and the water supply with particular reference to the lessons of this outbreak.
4.11 Timetable

A list of section leads will be e-mailed to all OCT members. (AMW)

Tuesday, 4 April: deadline for suggested additions and amendments to reach section leads.

Friday, 7 April: deadline for revised submissions by section leads to reach CL for editing and consistency checking.

Friday, 21 April: CL to circulate the completed, edited document to members of the OCT.

Friday, 28 April: deadline for return of responses on the final draft to CL by OCT members.

Early May: report to be forwarded for translation.

Late May: publication of report.
Appendix C – Selection of press briefings

Included in this appendix is a representative selection of press briefings.

1. **23 November 2005 (embargoed until 0001 hours on 24 November)**

   **Statement by Incident Management Group (National Public Health Service for Wales, Gwynedd County Council, Anglesey County Council, Gwynedd Local Health Board, Anglesey Local Health Board, Welsh Water)**

   **Cryptosporidium incidence in North Wales**

   People with severely impaired immune systems in the Gwynedd and Anglesey areas are being asked to boil bottled and tap water before using it.

   The action has been taken following a recent increase in cases of a stomach illness caused by the cryptosporidium parasite. The increase coincides with a higher rate of infection in people in Gwynedd and Anglesey, especially those who are supplied with water from the Cwellyn reservoir.

   The National Public Health Service for Wales has identified 72 cases of cryptosporidiosis in the area since the beginning of October.

   Cryptosporidium is a tiny parasite found in humans and animals and can cause a temporary diarrhoeal illness lasting about two weeks followed by full recovery. The parasite can survive for many months in water and soil.

   It only presents a significant risk for people with severely impaired immune systems.

   Anyone who has been told by their hospital consultant or General Practitioner that they have a severely impaired immune system should only drink tap water or bottled water that has been brought to the boil and allowed to cool before use. This should already be part of the everyday routine for those who have impaired immune systems.

   Anybody who lives in the Gwynedd or Anglesey area who has prolonged diarrhoea that lasts for 3-4 days should either contact NHS Direct on 08458 509 850 or their General Practitioner. However, it is unlikely that they will be suffering from cryptosporidiosis.

   Cryptosporidium multiplies in the gut of infected humans and animals and forms microscopic eggs called oocysts, which are shed in the faeces. These oocysts are very hardy and, if swallowed, can lead to infection.

   Cryptosporidiosis can be transmitted through person to person contact from unwashed fruit and vegetables, contact with animals, swimming pools, and, occasionally, drinking water supplies.

   Although uncommon, outbreaks of cryptosporidiosis caused by oocyst in mains supply drinking water can occur, and it is possible that these recent cases are the result of this.
When it became clear that higher numbers of cryptosporidiosis were being found in North Wales, the National Public Health Service for Wales launched investigations, examining all the likely sources.

Following an incident control meeting organised by the National Public Health Service for Wales with environmental health officers from Gwynedd and Anglesey and officers from the Gwynedd and Anglesey Local Health Boards and from Welsh Water, it was decided to notify people with severely impaired immune systems to make sure they do not use the tap water in the area affected.

Mark Walker, a consultant with the National Public Health Service for Wales, said: “The increase in cases is five times the average levels we normally see at this time of year and it is possible that they are the result of cryptosporidium in the water supply. As a precautionary measure, we are therefore taking action to reduce the risk to people with severely impaired immune systems.”

Welsh Water is checking the Cwellyn water treatment works and conducting environmental investigations. The water works supplies about 70,000 people.

A help line has been set up for people who have questions or concerns. The number is 0845 850 9850. It is open 9am – 5pm, seven days a week.

ENDS

For further information, please contact Chris Lines on xxxxxx

Editors notes:

1. People with severely impaired immune systems include:
   1. HIV infected patients with CD4 counts less than 200
   2. Those taking high dose steroids, equivalent to a dose of prednisolone of 40 mg or more per day, for at least one week in the last 3 months
      (the equivalent dose in children is 2 mg/kg body weight per day for 1 week in the last 3 months, or 1 mg/kg/day for at least month in the last 3 months)
   3. Patients who have had bone marrow, stem cell or organ transplants
   4. Children with severe combined immunodeficiency
   5. Patients with specific T-cell deficiencies, such as CD40 ligand deficiency (Hyper IgM Syndrome). Occasionally patients who are receiving anticancer chemotherapy will have depressed T cell function – cancer specialists are asked to advise on this issue.

2. More information on cryptosporidiosis can be found at:

   www.nhsdirect.nhs.uk

   or

   www.nphs.wales.nhs.uk
2. 29th November 2005

Press statement by the Outbreak Control Team (National Public Health Service for Wales, Gwynedd County Council, Anglesey County Council, Gwynedd Local Health Board, Anglesey Local Health Board, Environment Agency and Welsh Water)

Boil water notice served on users

of Cwellyn reservoir

The 70,000 people who use water from the Cwellyn reservoir are being served with a boil water notice to protect them from cryptosporidiosis.

The action follows a meeting of health and local government officials this morning.

On the basis of new evidence, the meeting decided that the increased number of cryptosporidiosis cases found in the area supplied by the Cwellyn reservoir means that the reservoir is the most likely source of the illness. An outbreak has been declared.

The Outbreak Control Team has served the boil water notice for the period until Monday 9th January. It is hoped that it will be able to withdraw the notice at this point because either a source has been found and eliminated or because the case numbers have fallen substantially.

Dr Mark Walker, speaking on behalf of the Outbreak Control Team, said, “There is now stronger evidence linking cryptosporidiosis with the Cwellyn Reservoir. We cannot say for certain what the cause of the outbreak is but we are taking precautionary action on this basis. We know that bringing water to the boil will kill the cryptosporidium parasite.”

The Boil water notice covers people living in the following towns and villages in the south of Anglesey and north Gwynedd:
• Bangor
• Beaumaris
• Beddgelert
• Bethania
• Bethel
• Betws Garmon
• Bontnewydd
• Caerathro
• Caernarfon
• Carmel
• Cwm-y-glo
• Dinas
• Ffridd Uchaf
• Gaerwen
• Groeslon
• Llandaniel
• Llandegfan
• Llandwrog
• Llandygai
• Llanfaes
• Llanfaglan
• Llanfairpwllgwyngyll
• Llangoed
• Llanrug
• Llanwnda
• Menai Bridge
• Nantmor
• Penyffridd
• Plas Gwynant
• Pont Aberglaslyn
• Pont-Rug
• Rhosgadfan
• Rhostryfan
• Rhy-Ddu
• Seion
• Vaynol Hall
• Waunfawr
• Y Felinheli
Welsh Water are writing directly to every affected customer to inform them of the precautions that need to be taken.

In the affected area, people are being asked to only use water which has been brought to the boil and cooled before drinking, food preparation, baby feeds, brushing teeth and ice making.

Except for those people with severely impaired immunity, bottled water is safe to use.

Incidence of cryptosporidiosis in the rest of Anglesey and Gwynedd is higher than the rest of Wales but much lower than in the area served by Cwellyn. The increased incidence in these areas could be due to people travelling within the counties and using tap water from the Cwellyn area.

Public health officials have warned that cases of cryptosporidiosis will continue to be notified in the next few weeks. The incubation period for disease is typically a week and often people do not report illness immediately to their doctor.

The Outbreak Control Team has carried out two epidemiological studies which demonstrate that people drinking water from the Cwellyn water supply are more likely to have fallen ill with cryptosporidiosis than those who have not, even if their other experiences are similar.

Welsh Water is carrying out further investigative work to be carried out into the Cwellyn water supply and the water treatment works.

From the beginning of October to 4pm on Monday 28th November, 87 cases of cryptosporidiosis have been notified to the National Public Health Service for Wales.

Cryptosporidium is a tiny parasite found in humans and animals and can cause a temporary diarrhoeal illness lasting about two weeks followed by full recovery. The parasite can survive for many months in water and soil.

A helpline is open from 9am – 5pm seven days a week. The number is 0845 8509850.

ENDS

For further information, please contact Chris Lines on xxxx xxx xxx or www.nphs.wales.nhs.uk
3. 14th December 2005

Update by the Outbreak Control Team (National Public Health Service for Wales, Gwynedd County Council, Anglesey County Council, Gwynedd Local Health Board, Anglesey Local Health Board, Environment Agency Wales and Welsh Water)

Cryptosporidium update

Wednesday, 14th December 2005

Cases

The number of confirmed cases of Cryptosporidium in the Anglesey and Gwynedd area since 1st October is 203.

The numbers are expected to rise further. This is because the disease has a long incubation period (up to two weeks), many people seek medical advice after they have had symptoms for several days, and laboratory time is needed to confirm the diagnosis.

Case information

Usually Cryptosporidiosis is found throughout the year. 192 cases were confirmed throughout Wales in 2004 – one case in every 15,000 Welsh residents. Of these, 36 were in Anglesey and Gwynedd residents. Typically there are greater numbers of cases – peaks – seen in spring time and again at the end of the summer. This normal seasonal variation was seen in Wales during 2004.

In 2005 cases have been higher than expected in late summer throughout the whole of the UK, including Wales. More people in Anglesey and Gwynedd contracted the illness than last year, but up to the beginning of November, laboratory reports covering the whole of Wales also showed an overall increase. The C hominis strain of the parasite is more frequently isolated during the autumn peak, and this same strain was found in Gwynedd and Anglesey residents.
Because of the increased illness in the area, Welsh Water began monitoring water supplies daily for Cryptosporidium at the beginning of November and provided mapping of local cases. GPs were also asked to look out for undetected cases of cryptosporidiosis.

An Incident Management Team of public health experts and Welsh Water staff met on 7th November to discuss these findings and to plan more detailed investigations. Results from this work showed background levels of disease were specifically higher for people living in the Cwellyn catchment area. So on the 24th November the Incident Management Team asked doctors to remind their patients with severely impaired immune systems to boil their tap and bottled water before use. This is because this small group of patients may be at higher risk of serious disease, unlike healthy individuals who may suffer an unpleasant, but self-limiting illness. To ensure everyone knew of the advice a press statement was released and dedicated helplines were set up through NHS Direct.

By 29th November, a questionnaire study had shown an association between diarrhoeal illness due to Cryptosporidium and drinking tap water, even though records revealed the water treatment works for Cwellyn reservoir had been operating normally over the past four weeks. Although Cryptosporidium spores have been found in the water at Cwellyn, the concentrations remain well within the recommended guidelines.

During the last week of November a steep rise in infections was confirmed in residents supplied with water from the Cwellyn reservoir – a rise not seen in other areas of Wales. An outbreak was declared and as a precautionary measure the Outbreak Control Team advised Dwr Cymru/Welsh Water to issue a ‘Boil Water Notice’ to residents receiving water from the
Cwellyn reservoir on 29\textsuperscript{th} November. At the same time GPs and local health services were reminded of earlier information which they had received concerning the diagnosis, treatment and prevention of Cryptosporidiosis. NHS Direct helpline hours were extended to cope with any increased demand.

The ‘Boil Water Notice’ will remain in place at least until January 9\textsuperscript{th} while further detailed investigations continue.

**Background**

The largest waterborne outbreak of Cryptosporidium recorded in the UK took place in Torbay, Devon in 1995, involving 575 confirmed cases of illness associated with drinking tap water.

In Wales waterborne outbreaks are rare. All five Cryptosporidium outbreaks reported since 2000 have been strongly associated with farms and farm animals, in particular visiting open farms. The number of people becoming ill on each occasion has ranged from 2 to 36, and the strain of the parasite normally associated with animal faecal contamination, \textit{C parvum}, was isolated in laboratory tests.

The last recorded waterborne outbreak of Cryptosporidium in Wales occurred in 1995. A cracked service reservoir in St Athan was linked to diarrhoeal illness in more than 30 people.

Many cases of Cryptosporidium seen in Wales are contracted overseas, particularly in countries with poor sanitation. People who are associated with farms or participate in water sports also have an increased incidence of illness. Person to person spread following a single infection of illness can cause a local rise in cases. This is particularly common amongst young children. For this reason it is important to maintain good personal hygiene especially after using the toilet or changing nappies, and before preparing food.
Activity

Laboratories are working hard to carry out diagnostic testing during the outbreak. At this time of year the NPHS laboratory at Bangor usually tests around 120 faecal samples per week. Sample numbers in the current outbreak have risen to over 300 in a single week. The Cryptosporidium Reference Unit in Swansea which carries out detailed DNA analysis, has processed more than 210 patient specimens from this outbreak to date, and a further 26 environmental samples. More samples than patients will be recorded during an outbreak. (This is because sometimes duplicate samples are received and others will be awaiting final processing.)

More than 115 people are currently working on the outbreak. These include staff from all the organisations represented on the Outbreak Control Team: National Public Health Service, Gwynedd County Council, Anglesey County Council, Gwynedd Local Health Board, Anglesey Local Health Board, the Environment Agency Wales and Dwr Cymru/Welsh Water.

At peak times dedicated NHS Direct staff have answered 300 calls per day. More than 1300 enquiries have been received since the helplines were opened on 24th November.

Communication

Helplines at NHS Direct remain open for people who have questions or concerns about their health. The Helpline will continue over the Christmas period but weekend availability will reduce by one hour, commencing this weekend.

NHS Direct 0845 850 9859 or 0845 600 6086. Open 9-6 weekdays and 9-4 weekends (change in weekend hours from 17/12/2005).
A Welsh water helpline is open for people who wish to check if they are affected by the ‘Boil Water Notice’: Welsh Water 0800 052 0130 (open 24 hours)

ENDS

For further information, please contact Chris Lines

www.nhsdirect.wales.nhs.uk or www.nphs.wales.nhs.uk
4. 4th January 2006

Update by the Outbreak Control Team (National Public Health Service for Wales, Gwynedd County Council, Anglesey County Council, Gwynedd Local Health Board, Anglesey Local Health Board, Environment Agency Wales and Welsh Water)

Cryptosporidium update

Embargoed until 00.01 Hours

Thursday 5th January 2006

Wednesday, 4th January 2006

Cases

There has been one further case of Cryptosporidium confirmed in the Anglesey and Gwynedd area today, bringing the total to 226 since the beginning of October.

Boil Water Notice reissued

The Outbreak Control Team has reviewed the current status of the outbreak, the findings of current investigations and the ongoing need for a Boil Water Notice.

There has been a welcome slowing in the number of laboratory confirmed cases of cryptosporidium in Anglesey and Gwynedd since the Boil Water Notice took effect. Despite this reduction, new cases of illness are still being diagnosed and we cannot be confident that the risk of infection is no longer present.

It is possible that lifting the Boil Water Notice now, could result in a resurgence of cryptosporidiosis cases.

On this basis, the Outbreak Control Team has advised Welsh Water to reissue the Boil Water Notice when the current Notice runs out on 9th January. We anticipate that we will be able to lift the Notice within a few weeks. To allow for a flexible response, the Notice has been issued, however, for an indefinite period.

These are decisions that are not taken lightly and we are aware of the practical difficulties caused to both individuals and businesses. However public health is our first priority. Members of the Outbreak Control Team are reviewing the issues on a daily basis.

We remain confident that water from the Cwellyn Reservoir is the probable source of the outbreak. The available evidence points to this explanation and there is no alternative explanation.

However, Cwellyn water treatment works has been operating normally throughout the period during which there has been an increase in illness caused by cryptosporidium.
Testing has found only low levels of cryptosporidium in the water supply; well within treatment standards.

As a precaution and to reassure people about their tap water, Welsh Water is introducing additional treatment to water supplies from Llyn Cwellyn. The additional treatment will kill any Cryptosporidium in the water. Once this extra stage of treatment is commissioned the Outbreak Control Team will advise Welsh Water to lift the Boil Water Notice.

**Measures to control the spread of infection**

People who have received written advice to boil their tap water before drinking and food preparation should continue to do so.

Many of the cases seen in the community are arising from secondary person to person spread. People should be especially thorough with their own hand washing. The infection can pass very easily between young children so adults should supervise toileting and hand washing in this age group.

**Communications**

Welsh Water has sent letters to the 28,000 affected households and businesses reaffirming the need to continue to boil water.

Environmental health officers have sent further written advice to managers of food businesses, dental practices and swimming pools reminding them of earlier advice to minimise the risk of illness.

Any lifting of the Boil Water Notice will be accompanied by a letter to all affected individuals. People should continue to boil their water until receiving written advice from Welsh Water to stop.

People with concerns can ring the NHS Direct helpline number: 0845 600 6086 between 9–6 on weekdays and 9–4 at weekends.

ENDS

*For further information, please contact Chris Lines on xxxxx xxxxxx*

www.nhsdirect.wales.nhs.uk or www.nphs.wales.nhs.uk
5. 30th January 2006

Update by the Outbreak Control Team (National Public Health Service for Wales, Gwynedd County Council, Anglesey County Council, Gwynedd Local Health Board, Anglesey Local Health Board, Environment Agency Wales and Welsh Water)

Cryptosporidium update

Embargoed until 00.01 Hours

Monday 30th January 2006

Sunday 29th January, 2006

Outbreak is declared over

The cryptosporidium outbreak is over.

The total number of cases of cryptosporidiosis confirmed in the Gwynedd and Anglesey areas since the beginning of the outbreak is 231. Not all these cases will have been directly linked to the outbreak because a background level of the illness is found all year round.

There have been no new cases in the last two weeks. However we expect a few cases to be diagnosed each month, consistent with background levels normally seen throughout the year. On average three or four cases of cryptosporidiosis are confirmed each month in the Anglesey and Gwynedd areas.

Numbers throughout the UK were high last autumn, but local cases rose rapidly to more than 100 by the end of November, and doubled by mid-December. Because of the incubation period of the infection – up to two weeks - and because people often have symptoms for several days before visiting the doctor, the effectiveness of the Boil Water Notice became apparent from mid December onwards, when the numbers of new cases reported fell sharply.

Boil Water Notice
The Outbreak Control Team has advised Welsh Water to lift the Boil Water Notice to residents in the Cwellyn water catchment area with effect from Monday 30th January. People can now use tap water for drinking and food preparation without first boiling it, unless they are immuno-compromised and have had specific advice from their doctor.
The decision follows the installation and testing of new equipment at the Cwellyn treatment works. The reservoir water is now passed through an ultraviolet treatment plant which will kill any cryptosporidium present.

Investigations

All the available evidence and expert opinion point to Llyn Cwellyn being the probable source of the outbreak. There is no alternative explanation.

The Team’s environmental investigations have now identified six possible routes by which the reservoir could have been contaminated with Cryptosporidium hominis, the type found in the majority of people who have been ill.

The Outbreak Control Team has found that there were clinical cases of cryptosporidiosis in the Cwellyn catchment area in early October. One of these cases has been confirmed in the National Public Health Service for Wales microbiology laboratories.

A duty to protect the confidentiality of individuals means that further detail cannot be provided.

As we have said right from the start, it remains unlikely that the point source or sources of the outbreak will ever be confirmed.

Detailed investigations have been ongoing since the start of the outbreak. As well as finding out more about people who have contracted cryptosporidiosis, studies have investigated the climate, geography, geology, and local land use. Laboratory work on environmental samples is still continuing.

Measures to control the spread of infection

People who receive water from the Cwellyn catchment area no longer need to boil the water they use for drinking, food preparation, ice making or teeth brushing. This advice is immediate and applies to all businesses and residents who have previously received written Boil Water Notice advice. Although all water consumers are being notified in writing, there is no need to await a letter before using the water again.

People with impaired immune systems, for whom illness may be a greater risk, should continue to follow their doctor’s advice. This will normally include boiling all drinking and bottled water, regardless of source. Food premises and other business using machines usually supplied by tap water, such as drinks dispensers, should flush equipment through and change any filters carefully before re-commissioning. Particular care should be taken in the disposal of stagnant water or old filters. Specialist advice should be obtained directly from individual manufacturers where possible.
The risk of person-to-person spread from those who have become infected by the cryptosporidium bug still remains. People should continue to be especially thorough with their own hand washing, particularly after using the toilet or before preparing food. Infection spreads very easily between young children. Adults should therefore supervise toileting and hand washing in this age group whenever possible.

Communications

Welsh Water has written to all affected customers in the Gwynedd and Anglesey areas today, telling them that the Boil Water Notice has been withdrawn.

Environmental Health Departments have also sent letters to managers of food businesses, dental practices, swimming pools, nursing homes and schools informing them that they no longer need to boil tap water and offering further advice on machinery and equipment where relevant. GPs have also been updated.

The NHS Direct helpline remains open for anyone with concerns about their health, 9-6 on weekdays and 9-4 at weekends: 0845 600 6086. The helpline will close on 10th February.

The Dwr Cymru Welsh Water helpline is open 24 hours a day: 0800 052 0130

Outbreak report

The Outbreak Control Team is preparing a full report of the outbreak detailing the action taken and investigations followed. This will include recommendations for any actions the Team considers would help prevent future outbreaks. The report will be available to the public.

Outbreak in numbers

Number of cases: 231
Faecal samples tested in the NPHS Bangor laboratory: 2650
Cryptosporidium isolates tested in the NPHS Cryptosporidium Reference Unit in Swansea: 129
Environmental samples tested in the NPHS Cryptosporidium Reference Unit in Swansea: 56
Staff working on the outbreak: 115
Enquiries received by the NHS Direct helpline: 1500

Background
Cryptosporidiosis usually occurs throughout the year. 192 cases were confirmed throughout Wales in 2004 – one case in every 15,000 Welsh residents. Of these, 36 were in Anglesey and Gwynedd residents. Typically there are greater numbers of cases – peaks – seen in spring time and again at the end of the summer. This normal seasonal variation was seen in Wales during 2004.

In 2005 cases were higher than expected in late summer throughout the whole of the UK, including Wales. More people in Anglesey and Gwynedd contracted the illness than last year, but up to the beginning of November, laboratory reports covering the whole of Wales also showed an overall increase. The C hominis strain of the parasite is more frequently isolated during the autumn peak, and this same strain was found in Gwynedd and Anglesey residents.

Because of the increased illness in the area, Welsh Water began monitoring water supplies daily for Cryptosporidium at the beginning of November and provided mapping of local cases. GPs were also asked to look out for people with symptoms of cryptosporidiosis.

An Incident Management Team of public health experts and Welsh Water staff met on 7th November to discuss these findings and to plan more detailed investigations. Results from this work showed background levels of disease were specifically higher for people living in the Cwellyn catchment area. So on the 24th November the Incident Management Team asked doctors to remind their patients with severely impaired immune systems to boil their tap and bottled water before use. This is because this small group of patients may be at higher risk of serious disease, unlike healthy individuals who may suffer an unpleasant, but self-limiting illness. To ensure everyone knew of the advice a press statement was released and dedicated helplines were set up through NHS Direct.

By 29th November, a questionnaire study had shown an association between diarrhoeal illness due to Cryptosporidium and drinking tap water, even though records revealed the water treatment works for Cwellyn reservoir had been operating normally. Although Cryptosporidium spores were found in the water at Cwellyn, the concentrations remained well within treatment standards.

During the last week of November a steep rise in infections was confirmed in residents supplied with water from the Cwellyn reservoir – a rise not seen in other areas of Wales. An outbreak was declared and as a precautionary measure the Outbreak Control Team advised Dwr Cymru/Welsh Water to issue a ‘Boil Water Notice’ to residents receiving water from the Cwellyn reservoir on 29th November. At the same time GPs and local health services were reminded of earlier information which they had received concerning the diagnosis, treatment and prevention of cryptosporidiosis. NHS Direct helpline hours were extended to cope with any increased demand.

The ‘Boil Water Notice’ was extended on 4th January because a continuing risk could not be ruled out.
The largest waterborne outbreak of cryptosporidium recorded in the UK took place in Torbay, Devon in 1995, involving 575 confirmed cases of illness associated with drinking tap water.

In Wales waterborne outbreaks are rare. All five Cryptosporidium outbreaks reported since 2000 have been strongly associated with farms and farm animals, in particular visiting open farms. The number of people becoming ill on each occasion has ranged from 2 to 36, and the strain of the parasite normally associated with animal faecal contamination, *C parvum*, was isolated in laboratory tests.

The last recorded waterborne outbreak of Cryptosporidium in Wales occurred in 1995. A cracked service reservoir in a private water supply at St Athan was linked to diarrhoeal illness in more than 30 people.

Drinking water is just one of the routes of transmission of cryptosporidiosis. Some cases are acquired during farm visits, or through swimming in contaminated water including swimming pools, and cases often occur in people returning from abroad. Foodborne cryptosporidiosis has occurred but is less common. Person to person spread can cause a local rise in cases, and is particularly common amongst young children.

ENDS

For further information, please contact Chris Lines on xxxxx xxxxxx

www.nhsdirect.wales.nhs.uk or www.nphs.wales.nhs.uk
Appendix D – Model questions and answers

QUESTIONS AND ANSWERS ON CRYPTOSPORIDIOSIS -

BRIEFING FOR THOSE DEALING WITH ENQUIRIES FROM THE PUBLIC

Q What is cryptosporidiosis?
A Cryptosporidiosis is a diarrhoeal disease of humans and animals, caused by a microscopic parasite called Cryptosporidium. The organism is common in farm and domestic animals, and is passed on through their manure. It is present in the environment at low levels all the time, but higher levels are common in springtime, particularly when heavy rain washes the parasite into the ground and into rivers and lakes. It can also be passed on through human faecal contamination.

Q How is cryptosporidiosis spread?
A It can spread to humans by a variety of routes. Person-to-person spread is an important source of infection if care is not taken with personal hygiene. Contact with farm animals (and sick pets) can put people at risk of infection. Water supplies may be vulnerable to contamination with Cryptosporidium, and the infection can be spread via drinking water.

Q What precautions can be taken against cryptosporidiosis?
A Personal hygiene is very important, particularly if there is someone with diarrhoea in the household or if farm animals or sick pets have been handled. Hand washing is important after using the toilet, or as soon as possible after touching potential sources of infection (i.e. farmyard animals or sick pets, manure on the ground, or people with diarrhoea). Good hygiene is particularly important before handling food.

Q In which areas should water be boiled?
A. The Boil water notice covers people living in the following towns and villages in the south of Anglesey and north Gwynedd:

- Bangor
- Beaumaris
- Beddgelert
- Bethania
- Bethel
- Betws Garmon
- Bontnewydd
- Caeartho
- Caernarfon
- Carmel
- Cwm-y-glo
- Dinas
- Ffridd Uchaf
- Gaerwen
- Groeslon
- Llandaniel
- Llandegfan
- Llandwrog
- Llandygai
- Llanfaes
- Llanfaglan
- Llanfairpwllgwyngyll
- Llangodel
- Llanrug
- Llanwda
- Menai Bridge
- Nantmor
- Penyffridd
- Plas Gwynnant
- Pont Aberglaslyn
- Pont-Rug
- Rhosgadfan
- Rhostryfan
- Rhy-Ddu
- Seion
- Vaynol Hall
- Waunfawr
- Y Felinheli

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Welsh Water are writing directly to every affected customer to inform them of the precautions that need to be taken.

Q Why have I been told to boil drinking water? (If appropriate)

A Cryptosporidium is killed by boiling. A boil water notice has been issued because the pattern of illness in the community suggests that water may be a factor in transmission of the disease at present, and the boil water notice has been issued as a precaution.

Q How long do I have to boil water for?

A It is sufficient to bring the water to boil and then allow it to cool. Using an electric kettle is fine.

Q What about bottled water?

A Bottled water does not need to be boiled before drinking, except by those with severely impaired immune systems (which is standard practice).

Q What about brushing teeth, ice cubes, bathing and washing up?

A Braising teeth - use cooled boiled water for brushing teeth. Ice cubes - if you made ice cubes prior to the boil water notice, discard them. Make ice cubes with cooled boiled water or fizzy drinks. Washing and bathing - it is quite safe to wash and take a bath: the route of infection is by swallowing the water. Washing up - dishes should be washed using boiled water if possible, but it is probably sufficient to rinse washed dishes with boiled and cooled water before they are dried. Dishwashers are unaffected if used on a hot wash cycle.

Q Can I use water filters or water purification tablets instead of boiling?

A Domestic filters should not be relied upon unless they are designed for the purpose of removing micro-organisms (i.e. not just designed to improve palatability) and should be absolute 1 µm filters. Please refer to the manufacturer's brochure if in any doubt. Domestic filter cartridges may trap contamination, and particular care is required in hygienic disposal of these. Water purification tablets are not recommended as an alternative to boiling.

Q What are the public health authorities doing about this?

A The National Public Health Service, the environment health officers, Local Health Boards and the water suppliers are working together to ensure that any possible risks to the public are kept to a minimum, and that the need to boil water is removed as quickly as possible.
Q What should I do if I become ill?

A This infection will usually clear up by itself in a healthy person, although this may take several days. You should consult your GP if diarrhoea is unduly prolonged or if you are at all concerned. A GP should also be consulted if the person affected is very young, elderly or frail. It is generally recommended to increase your fluid intake if you have diarrhoea.

Q Is anyone particularly at risk from this infection?

A People who have severely impaired immune systems are more at risk of serious illness or very prolonged illness. These include:

- HIV infected patients with CD4 counts less than 200
- Those taking high dose steroids, equivalent to a dose of prednisolone of 40 mg or more per day, for at least one week in the last 3 months (the equivalent dose in children is 2 mg/kg body weight per day for 1 week in the last 3 months, or 1 mg/kg/day for at least month in the last 3 months)
- Patients who have had bone marrow, stem cell or organ transplants
- Children with severe combined immunodeficiency
- Patients with specific T-cell deficiencies, such as CD40 ligand deficiency (Hyper IgM Syndrome)
- Occasionally patients who are receiving anticancer chemotherapy will have depressed T-cell function – you are advised to check with your GP or consultant about this.

These people should be advised to boil water before consumption at all times, even if bottled water. You should contact your doctor if you think that you might be affected.

Q What treatment is available for cryptosporidiosis?

A There is no effective treatment for cryptosporidiosis, which is why people with immune problems are particularly advised to avoid contracting the infection in the first place if at all possible. The infection will usually clear up by itself in a healthy person, and taking antibiotics is not normally advised. It is generally good advice to increase your fluid intake when you have diarrhoea.

Q Are there special dangers to pregnant women?

A Not specifically related to Cryptosporidium. Pregnant women should follow the boil water advice for drinking water. Pregnant women who develop continuing diarrhoea should seek advice from their GP. Cryptosporidium is not a virus: it is a protozoan parasite which is not transmitted to the fetus.

Q If I am ill with cryptosporidiosis, can I pass it on to someone else?

A Yes, this is probably a common means of passing the infection on. It is important that you and your relatives/carers pay particular attention to hygiene and hand-washing,
particularly before eating. If you are unwell, it is advisable to avoid handling or preparing food for others to eat.

Q Should drinks vending machines be used?

A Use of drinks dispensers is not recommended unless the water is heated to at least 70°C. Ideally, they should be turned off and disconnected from the water supply. When the water supplies are back to normal, the machine should be cleaned out before re-use, and any filters replaced as recommended in the manufacturer's operating manual. Care should be exercised in the handling and disposal of filters in case they are contaminated with *Cryptosporidium*.

Do not use cold drinks from vending machines.

Q I am a dialysis patient. Can you offer advice?

A Cryptosporidiosis is a gut disease and there is no risk of contracting it during dialysis. However, you should boil your drinking water as directed. If you have any other concerns please contact your dialysis administrator.

Q Does the boil water advice have any implications for swimming pool operation?

A The risk of illness from using a swimming pool should be minimal. Closure of swimming pools is not normally considered necessary during a boil water notice period. It is important that people who are symptomatic should not use public swimming pools, and to avoid using them for 2 weeks after recovery.

Q I am a dentist. How can I protect my patients?

A Precautions should be taken to minimise the ingestion of drill bit cooling water, and mouth rinses should be made from boiled water that has been cooled. Dentists will normally have a separate tank feed for drill water, and in such circumstances the mains feed can be turned off and alternative safe supplies added directly.

Q I run a bar/restaurant. What precautions should I take?

A All water for drinking and food preparation should be brought to the boil and cooled as necessary. Bottled water may be used as normal. Fizzy drink dispensers should not be used unless they can be adapted to use sources other than tap water. Washing up should be carried out in water which has been heated to at least 70°C and allowed to cool, or in a dishwasher which heats to 70°C. Ice making machines should be disconnected, but ice may be made from water which has been brought to the boil and cooled.

Q I am a food/drink producer. How can I protect my products?

A You should contact your local authority environmental health department for specific advice.
Q I am head of a school/nursery/kindergarten. What precautions should I take?

A Normal precautions should be applied to staff. Children should be offered cooled boiled water or bottled water. However, if children or their parents identify that they have a severely impaired immune system, they should be offered cooled boiled water only.

Q I am head of an old people’s home/nursing home/other residential institution. What precautions should I take?

A Normal precautions should be applied to staff. You should offer your residents cooled boiled water or bottled water. However, if you have responsibility for vulnerable people who have severely impaired immune systems, then you should provide them with cooled boiled water only.
Appendix E Questionnaire for interviews of cases

Local Authority ……………………………………………………………… LA Case Number

Form completed by …………………………………………………

Telephone …………………………… Date ……/………/……

Case details:
1. First Name……………………….. Surname………………………………..

2. Address………………………………………………………………………………

………………………………………………………………………………

Post Code………………… Telephone………………………………………

3. Sex Male ☐ Female ☐ 4. Date of Birth……/………./……

5. Please state occupation (both parents if case is a child)
………………………………………………………………………………

6. If case is at school/preschool group, give name and location
………………………………………………………………………………

………………………………………………………………………………

7. Date of onset of illness ……./………./……

8. Did you have any of the following symptoms (please tick as appropriate)
☐ diarrhoea (3 or more loose stools in 24 hours)
☐ vomiting
☐ nausea
☐ abdominal pain (tummy ache)
☐ blood in stools (faeces)
9. Were you admitted to hospital?
   Yes ☐ No ☐

   If YES, please give date admitted ……/……/…… date discharged ……/……/……

10. Did anyone else in your household have diarrhoea (three or more loose stools in 24 hours) in the 2 weeks before illness started?
    Yes ☐ No ☐

    If YES, please give dates and further information (who in household, age etc).………………………………………………………………………………………………………

11. Name and address of your GP ………………………………………………………

    …………………………………………………………………………………………….

   Travel away from home:

12. In the 2 weeks before the onset of illness did you/your child spend one or more nights away from home?
    Yes ☐ No ☐ Not Sure ☐

    If YES, was this:  Local (within 10 miles)☐ Other UK ☐ Abroad ☐

    Place Visited   Date Returned
    ___________________________   ___________________________
    ___________________________   ___________________________
    ___________________________   ___________________________
Food and drink:

13. In the 2 weeks before the onset of illness did you/your child drink

Name of shop/supplier

Unpasteurised cows milk? Yes □ No □ Not Sure □ ..........................
(green top)

Goats’/sheep’s milk? Yes □ No □ Not Sure □ ..........................

Cold pasteurised milk? Yes □ No □ Not Sure □ ..........................
(exclude hot milk drinks, but include cold milk on cereal)

14a. What is the source of your drinking water at home (please tick as appropriate)?

Mains □ specify water company..........................................

Private □ give details.........................................................

Both □

Other □ give details...........................................................

(eg. Bottled water)

14b. If applicable, what is the source of your drinking water at school or work?

Mains □ specify water company............. ..................................

Private □ give details........................................................

Both □

Other □ give details ...........................................................
Recreation:

15. In the 2 weeks before the onset of illness did you/your child swim in a swimming pool or paddling pool?

   Yes □  No □  Not Sure □

If YES, name of swimming or paddling pool and location………………………….

16. In the 2 weeks prior to illness, did you/your child take part in any activity involving other contact with surface water (e.g. swimming, working or playing in a river, stream, ditch, pond or water trough?)

   Yes □  No □  Not Sure □

If YES, location ........................................................................................................

Type of activity........................................................................................................

Contact with pets / other animals:

Contact with animals means touching, feeding, being licked or other such close contact, and not to just being in the same room or house

17. In the 2 weeks before illness did you/your child have contact with any pets or horses?  

   Yes □  No □

If YES,

   (a) type of animal(s)................................................................................................

   (b) Where (eg. At home) .....................................................................................
(c) Did any of the pets have diarrhoea in those 2 weeks?  Yes ☐ No ☐

18. In the 2 weeks prior before illness, did you/your child have contact with zoo animals?  
   Yes ☐ No ☐
   If YES, type(s) of animal(s) .................................................................
   Name of zoo ......................................................................................

19. In the 2 weeks before illness, did you/your child live at or visit a farm?  
   Yes ☐ No ☐
   If YES,  
   (a) name and address of farm…… ........................................................
       .................................................................................................
   (b) date(s) of visit(s) ...........................................................................

   (c) did you/your child have contact with animals there?  Yes ☐ No ☐
   If YES, type(s) of animal(s) ..............................................................
   ..........................................................................................................

20. Did you/your child have contact with animal faeces, dung, manure or slurry?  
   Yes ☐ No ☐
   If YES, please describe where, and what happened ..........................
   ..........................................................................................................

PLEASE ASK FOR VERBAL AGREEMENT TO BEING CONTACTED ABOUT THE
ZOO N OTIC CRYPTO SPOR IDIOSIS STUDY

Information sheet(s) and consent forms will be sent to all agreeing cases.
Agreement for water / livestock sampling

21. If no-one else in your household had diarrhoea (Q10=No), you did not travel abroad (Q12), AND you reported a private water supply (Q14) or contact with surface water (Q16) or farmed animals (Q19) or their faeces (Q19), do you agree to being contacted by letter about sampling the water or animal faeces?

Yes ☐ No ☐

Agreement for pet sampling (dogs, cats, birds, horses or rabbits)

22. If no-one else in your household had diarrhoea (Q10=No), you did not travel abroad (Q12) AND you reported contact with a pet dog, cat, rabbit, horse, or bird (Q17), do you agree to being contacted by letter about sampling from dogs, cats, rabbits, horses or birds?

Yes ☐ No ☐

Additional Questions

23. Did you/your child drink fruit juice in the 2 weeks before you became ill?

Yes ☐ No ☐

If yes, which (type of fruit/brand) and how many glasses per day?

.................................................................................................................................

Where do you get this from?..............................................................................................

24. Did you/your child eat shellfish (mussels, cockles, oysters, clams, scallops) in the 2 weeks before you became ill?

Yes ☐ No ☐

Which one, how many and where did you get these from?

.................................................................................................................................
25. Did you/your child visit any local farm shops/pick your own fruit in the 2 weeks before you became ill?

   Yes ☐ No ☐

If yes where and what did you buy?

   ....................................................................................................................................

26. What fruits/salad stuff did you/your child eat in the two weeks before you became ill?

   ....................................................................................................................................

Where do you obtain this from?

   ....................................................................................................................................

Do you wash this before eating?

   ....................................................................................................................................

27. In the 2 weeks before you/your child became ill did you:

   (i) Go fishing

   Yes ☐ No ☐

   (ii) Sailing/canoeing/boating

   Yes ☐ No ☐

   (iii) Dry your dog after he/she had been swimming

   Yes ☐ No ☐

If yes where?

   ....................................................................................................................................
28. In the 2 weeks before you/your child became ill did you attend any major social events e.g. fairs, sports meetings, birthday parties, festivals, church events?

   Yes ☐   No ☐

If so what …………………………………………………………………………………………………………………………….

29. Approximately how many glasses of unboiled tap water did you/your child drink during the day in the 2 weeks before you became ill (include glasses of squash)? …………………………………………………………………………………………………………………………………………………

30. Did you/your child drink bottled (mineral or spring water) in the two weeks before you became ill?

   Yes ☐   No ☐

Which brand and how many glasses per day?
…………………………………………………………………………………………………………………………………….

31. In the 2 weeks before you/your child was ill, did you drink any untreated water (this includes water from private wells, boreholes, springs and rainwater and any accidental gulps or swallows of lake/river or sea water)?

   Yes ☐   No ☐

If Yes, please specify where and when ………………………………………………………………………………….

32. Did you have close contact with children under 5 (bathing/oiling/nappy changing) in the 2 weeks before you became ill?

   Yes ☐   No ☐

State which and how many times? ……………………………………………………………………………………………


Thank you for answering these questions.

Any additional comments

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Appendix F  The Water Supply (Water Quality) Regulations 2001

2001 No. 3911 (W.323)

WATER, ENGLAND AND WALES

The Water Supply (Water Quality) Regulations 2001

PART VII

WATER TREATMENT

Interpretation

25. In this Part -

"regulation 29 requirements" means the requirements of paragraphs (2) and (4) of regulation 29;

"risk assessment", in relation to a treatment works, means an assessment for that treatment works, to establish whether there is, or continues to be, a significant risk from cryptosporidium oocysts in water supplied from the works;

"significant risk from cryptosporidium", in relation to water supplied from a treatment works, means a significant risk that the average number of cryptosporidium oocysts per 10 litres of water supplied from the works for regulation 4(1) purposes, if sampled and analysed in accordance with regulation 29(5) to (15), would at any time be one or more; and

"surface water" does not include water from a spring.

Treatment of raw water

26. - (1) In carrying out such of its functions under Chapter III as comprise the supply of water for regulation 4(1) purposes, a water undertaker shall not, subject to paragraph (2), supply water from any source which consists of or includes raw water unless the water has been disinfected and, in the case of surface water, subjected to at least such further treatment as is specified in paragraph (3).

(2) Paragraph (1) shall not require a water undertaker to disinfect such groundwaters as are specified in an authorisation given by the National Assembly for Wales for the purposes of this paragraph.

(3) The further treatment mentioned in paragraph (1) is such treatment as is required to secure compliance with Council Directive 75/440/EC (quality required of surface water intended for the abstraction of drinking water); and for the purposes of this regulation, surface water shall be treated as
falling within category A1 or A2 or A3 set out in Annex I to that Directive if it is abstracted from waters for which the classification to be currently satisfied in accordance with section 82(1) of the Water Resources Act 1991 is, as appropriate, DW1 or DW2 or DW3, as set out in the Surface Waters (Abstraction for Drinking Water) (Classification) Regulations 1996.

(4) Except with the consent of the National Assembly for Wales, water shall not be abstracted for supply for regulation 4(1) purposes which include drinking except from waters to be treated as falling within category A1 or A2 or A3 in the Annex mentioned in paragraph (3).

**Risk assessment for cryptosporidium**

27. - (1) Where at any time before 1st January 2002 a water undertaker has been required to comply with regulation 23B of the 1989 Regulations at a treatment works, it may on or after that date carry out a risk assessment.

(2) Where a risk assessment has not been submitted to the National Assembly for Wales pursuant to regulation 23A(1) of the 1989 Regulations, in respect of any treatment works from which water was first supplied for regulation 4(1) purposes after 30th June 1999 and before 1 January 2002, the water undertaker operating that works shall carry out a risk assessment on or before 28 February 2002.

(3) Where, at any time after 31 December 2001, a water undertaker proposes to bring into operation a treatment works from which it intends to supply water for regulation 4(1) purposes, it shall carry out a risk assessment in respect of that works.

(4) Where a water undertaker becomes aware of any factors which make it likely that a risk assessment will establish that there is a significant risk from cryptosporidium it shall notify the National Assembly for Wales in writing, specifying the relevant factors.

(5) The National Assembly for Wales may at any time by notice in writing require a water undertaker to carry out a risk assessment by a date specified in the notice to establish whether there is a significant risk from cryptosporidium.

**Procedure following risk assessment, and prohibition of supply**

28. - (1) Where a water undertaker carries out a risk assessment under any provision of regulation 27, it shall submit to the National Assembly for Wales a report of the assessment.

(2) A report of a risk assessment shall set out the results of the assessment, including -

(a) a statement that the assessment has established -

(i) that there is a significant risk from cryptosporidium; or

(ii) that there is no such risk; and

(b) a description of the methods used to carry out the assessment.

(3) Where the National Assembly for Wales considers that the assessment that is the subject of a report submitted to it in accordance with paragraph (1) has not been carried out satisfactorily, the National Assembly for Wales shall serve a notice on the water undertaker which -

(a) sets out the National Assembly for Wales' reasons for considering that the assessment has not been carried out satisfactorily; and

(b) requires the water undertaker, by a date specified in the notice, to carry out a further risk assessment and submit to the National Assembly for Wales a report of that assessment.
and the water undertaker shall comply with the requirement by the date specified.

(4) Where -

(a) a report submitted to the National Assembly for Wales in accordance with paragraph (1) includes a statement that the assessment has established that there is no significant risk from cryptosporidium; and

(b) the National Assembly for Wales is satisfied, on the basis of the report, that the risk assessment has been carried out satisfactorily,

the National Assembly for Wales shall notify the water undertaker that it is so satisfied; and if at the time of the submission of the report the water undertaker was, or was treated as, required to comply with regulation 29 requirements, the water undertaker shall cease to be required to comply with them from the date on which it receives the notification.

(5) Where -

(a) a report is submitted to the National Assembly for Wales in accordance with paragraph (1);

(b) the report includes a statement that the assessment has established that there is a significant risk from cryptosporidium; and

(c) the National Assembly for Wales is satisfied, on the basis of the report, that the risk assessment has been carried out satisfactorily,

the National Assembly for Wales shall notify the water undertaker that it is so satisfied and shall require the water undertaker to provide it with an estimate of the earliest practicable date by which it can comply with regulation 29 requirements.

(6) A water undertaker which has received a notice under paragraph (5) shall provide the estimate required by the notice within three months of the receipt of the notice.

(7) Where the National Assembly for Wales receives an estimate pursuant to a notice under paragraph (6) it shall give the water undertaker notice of the date which it considers to be the earliest practicable date by which the water undertaker can comply with regulation 29 requirements; and the water undertaker shall comply with those requirements from that date.

(8) Where a water undertaker is required to comply with regulation 29 requirements at a treatment works, it may at any time carry out a further risk assessment for that treatment works to establish whether there continues to be a significant risk from cryptosporidium.

(9) A water undertaker shall not supply water for regulation 4(1) purposes from any treatment works on or after 1st January 2002 unless -

(a) it has received a notice under regulation 23A(9) of the 1989 Regulations or paragraph (4) above in respect of that works; or

(b) where, pursuant to a notice given under paragraph (7) above, or regulation 23A(7) of the 1989 Regulations, it is required to comply with regulation 29 requirements or, in accordance with regulation 29(1), is treated as subject to those requirements, it is taking steps to comply with those requirements.
Treatment for cryptosporidium

29. (1) A water undertaker which, immediately before 1st January 2002, is subject to a requirement under regulation 23A of the 1989 Regulations to comply with the requirements of regulation 23B of those Regulations shall, for the purposes of the following provisions of this regulation and of regulation 28 of these Regulations, be treated on and after 1st January 2002 as subject to a requirement under regulation 28 to comply with regulation 29 requirements.

(2) A water undertaker which is, or is treated as, required under regulation 28 to comply with regulation 29 requirements shall, in carrying out such of its functions under Part III of the Act as relate to the supply of water for regulation 4(1) purposes, use a process for treating the water intended to be supplied which secures that the average number of cryptosporidium oocysts per 10 litres of water is less than one.

(3) For the purposes of paragraph (2), a process secures that the average number of cryptosporidium oocysts per 10 litres of water is less than one only if -

(a) the water is sampled, and collection devices are analysed, in accordance with the following provisions of this regulation; and

(b) each collection device, when analysed under paragraph (12) or (13), indicates that the water sampled has been treated so as to secure that the average number of cryptosporidium oocysts per 10 litres of water is less than one.

(4) A water undertaker which is, or is treated as, required under regulation 28 to comply with regulation 29 requirements shall, in using the process referred to in paragraph (2), monitor its effectiveness by securing compliance with the requirements of paragraphs (5) to (15).

(5) Subject to paragraph (6), a continuous sample of water, consisting of at least 40 litres per hour on average during each sampling period, shall be taken from each point at which water leaves the treatment works and steps shall be taken to ensure that the sample is not contaminated when being taken.

(6) Where water which is subjected to the same treatment at the same treatment facilities before it leaves a treatment works leaves the works from more than one point, paragraph (5) shall require a continuous sample to be taken at only one of those points.

(7) For the purposes of the requirement in paragraph (5) to take a continuous sample of water, no account shall be taken of -

(a) an interruption in the taking of the sample of less than one hour due to the changing of a collection device in accordance with paragraph (9); or

(b) an interruption in the taking of the sample during a period when water is not being supplied from the monitoring point.

(8) A sample of water taken pursuant to paragraph (5) shall, as it is taken and without any further treatment, be passed through an approved collection device contained in approved sampling equipment which records the volume of water sampled.

(9) Subject to paragraph (10), a water undertaker shall change the collection device through which water is being passed in accordance with paragraph (8) at least once a day by removing it in an approved manner from the relevant sampling equipment and replacing it in an approved manner with a clean collection device; and a record shall be made of the volume of water passed through the collection device which has been removed and that record shall be retained for a period of one year or
such longer period as the National Assembly for Wales may, by notice in writing to the water undertaking, require.

(10) Where, due to interruptions in the taking of a sample during periods when water is not being supplied from a monitoring point, the rate of water passed through a collection device is less than 200 litres per day, a water undertaker shall not be required to change the collection device in accordance with paragraph (9) until the day on which the total volume of water that has passed through the device equals or exceeds 200 litres.

(11) A collection device removed from sampling equipment shall, prior to being analysed, be maintained in an approved manner so as to secure that there is no material alteration of the state of the device which could affect the results of the analysis.

(12) A collection device shall, subject to paragraph (13), within three days of the date on which it is removed from the sampling equipment be analysed for the purposes of establishing whether it contains cryptosporidium oocysts at a level which indicates that the water sampled has not been treated so as to secure that the average number of cryptosporidium oocysts per 10 litres of water is less than one.

(13) Where -

(a) there is a significant increase in the turbidity of water being sampled for the purpose of this regulation; or

(b) some other indication that the number of cryptosporidium oocysts in the water may have increased,

a water undertaker shall immediately change the collection device through which the water is being passed, and the removed collection device shall be analysed as soon as practicable and in any case not later than the end of the day after that on which it was removed.

(14) The analysis of collection devices for the purposes of this regulation shall be carried out at an approved laboratory using approved equipment and approved analytical systems and methods.

(15) Following the analysis of a collection device for the purposes of this regulation, the person by whom or under whose supervision the analysis has been carried out shall, within the applicable time limit for the analysis set out in paragraph (12) or (13), certify the results of the analysis, setting out the average number of cryptosporidium oocysts per 10 litres of water contained in the water sampled, as indicated by the level of cryptosporidium oocysts contained in the collection device.

(16) In this regulation -

"approved" means approved by the National Assembly for Wales for the purpose of this regulation; and

"day" means the period of 24 hours commencing immediately after midnight.
Appendix G Correspondence

Letter from Drinking Water Inspectorate to water suppliers advising revision of risk assessments

DRINKING WATER INSPECTORATE

Room M06, 55 Whitehall
London SW1A 2EY

Direct Line: 020 7082 8048
Enquiries: 020 7082 8024
Facsimile: 020 7082 8028

E-mail: jeni.colbourne@defra.gsi.gov.uk
DWI Website: http://www.dwi.gov.uk

13 December 2005
Information Letter 17/2005

To: Board Level and Day to Day Contacts of Water and Sewerage Companies and Water Companies in England and Wales

Dear Sir/Madam

Cryptosporidiosis in England and Wales

1. The subject of this letter is the increase in cases of human Cryptosporidiosis in England and Wales reported to the Health Protection Agency this autumn. It is not unusual for there to be a rise in the number of reported human cases during autumn but you will probably be aware that this year this has led to the setting up of several outbreak control teams in parts of South England and North Wales. In some instances, precautionary advice to boil water has been given to consumers. The purpose of this letter is to ensure that there is in place an appropriate and proportionate level of risk management by all water companies during this period of heightened public awareness of, and concern about, cryptosporidiosis.

2. Risk Assessments

All companies undertook specific risk assessments as part of the implementation of the Cryptosporidium Regulations in 1999. These assessments were based on knowledge available at that time. In particular, companies had access to the Third Report of the Expert Group on Cryptosporidium in Water Supplies (DWI Information Letter15/98). Subsequent advances in typing of the parasite, Cryptosporidium, have identified that the nature of the risk to water supplies in the autumn may be different to that arising during springtime. Health surveillance...
and specific studies have provided evidence that water company risk assessment and control measures have had a beneficial effect in reducing cases of cryptosporidiosis caused by *C. parvum* (mainly of animal origin). However, many cases that occur in the autumn are caused by *C. hominis* (human origin). In light of this knowledge it is recommended that all companies review their existing risk assessments and operational risk management arrangements for surface water derived water supplies. Companies are advised that this recommendation constitutes a written notification as set down in regulation 27 (5) of the Water Supply (Water Quality) Regulations 2000 (England) 2001 (Wales).

3. **Risk assessment criteria**

When reviewing existing risk assessments using the document entitled “Guidance on Assessing Risk from *Cryptosporidium* Oocysts in Treated Water Supplies” (available on the Inspectorate’s website [www.dwi.gov.uk](http://www.dwi.gov.uk)), companies are advised to particularly consider and document risk on a seasonal basis, as well as overall. Your attention is drawn below to those criteria in the above-mentioned guidance that may be of particular value in the identification of risks relating to *C. hominis*.

a) the location of all sewage discharges, regardless of size, in relation to the location of intakes to water treatment works.

b) the presence in the catchment upstream of intakes to water treatment works of communities without sewerage services (where premises or other dwellings, including for example camp sites) are reliant on other arrangements for sanitation such as cess pits or septic tanks.

c) the capability of each intake to a water treatment works to be shut down in response to heavy rainfall. This capability should be evaluated in the context of not just the existence of alternative treated water supply arrangements for the zones served by the works but also in terms of the information available to the company to predict when heavy rainfall is imminent and the nature and timing of its impact on source water quality.

d) the sufficiency of information about source water quality with particular reference to deciding on the likelihood of the source water at the treatment works being subject to occasional or very short duration sewage pollution events.

e) the reliability of information about source water storage times and, where this is estimated, rather than measured by specific studies, whether the weighting applied to this criteria within the overall risk assessment process remains appropriate.

f) updating of information about raw water samples and results for E.coli, cryptosporidium and other microbiological parameters or indicators, documenting any differences in max, mean, median values between seasons, predictions of peak numbers and an assessment of the capacity of the water treatment processes to remove oocysts from the raw water under revised worst case conditions.

g) water treatment: the risk assessment should make clear if water treatment is only "basic" in microbiological terms. In these situations other control measures should be in place and

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these should be documented. For example, appropriate and frequent, preferably continuous, monitoring of the source water quality for relevant (named) operational indicators. Basic treatment in this context would include any or all of the following: screens, roughing and pressure filters, filtration designed or optimised for non microbiological treatment purposes such as manganese or taste/odour control, reliance on residence time in downstream treated water storage structures or distribution mains to achieve adequate chlorination (deficiencies in measured $C_t$).

### 4. Risk Information

Companies are advised to consider the quality, content and sufficiency of the risk information available to them directly on an operational basis or indirectly from other parties. The following scenarios are suggested as a framework for reviewing whether the arrangements in place are adequate in respect of evaluating risk relating to $C.\text{hominis}$.

“residents returning from holidays abroad in August who then suffer diarrhoeal illness; young children with symptoms returning to nurseries, schools, swimming lessons etc in early September; heavy rainfall in the catchment potentially impacting on local sewerage and sanitation facilities or surface water quality in early October”

“end of season closure of a local caravan park, camping site or other holiday centre and the nature of the “over winter” maintenance arrangements at that site with respect to the sanitation facilities and their vulnerability at a time of heavy rainfall”

“generally in the catchment, knowledge of poorly performing sewage works, cess pits, septic tanks and/or recurring problems of sewer flooding or blocked drains”

### 5. Risk Management

Companies are strongly reminded that their cryptosporidium risk reviews should be undertaken regularly\textsuperscript{123} and be fully integrated into the company’s overall risk based approach to the management (operation and maintenance) and the production and supply of safe drinking water supplies.

Note 1: recommendation 5.2.2 of The Third Report of the Expert Group on Cryptosporidium in Water Supplies


Note 3: paragraph 1.5 of DWI Guidance on Assessing Risk from Cryptosporidium oocysts in treated water supplies SI 1524

### 6. Monitoring

Companies are reminded that operational monitoring of source water quality is an essential control measure. The information generated by such monitoring (whether on site or by
laboratory analysis) should be reviewed by a competent person as soon as it becomes available. If exception reporting systems are used, then companies should regularly review, and where necessary revise, the reporting criteria on which exception reporting is based. Companies are strongly encouraged to review and satisfy themselves as to the adequacy of both the frequency and scope of their operational monitoring regimes.

7. Communications

7.1. In addition to notifying the Inspectorate [regulation 27 (4)], a prudent water company would have taken steps to ensure that the local health authority and the Environment Agency locally were fully informed, and then kept updated, with regard to the risk assessment status of each water treatment works and water source within their area of responsibility. Likewise, all relevant risk information would have been provided to water company contractors carrying out any role in respect of the design, operation and maintenance of a water treatment works.

7.2. As part of their working relationships with local health authorities and environmental health officers, water companies should have taken steps to ensure that *criteria for decision making* on the issue and withdrawal of notices advising consumers to boil water were set out and regularly reviewed.

Note 4: Recommendation 5.5.2 and 5.5.3 of the Third Report on the Expert Group on Cryptosporidium in Water Supplies.

8. Revised Risk Assessments

Companies should submit all revised risk assessments to the Inspectorate by 30th April 2006 at the latest (these should be sent to Jo Gigg at joanna.gigg@defra.gsi.gov.uk). However, it is expected that companies will take immediate action to mitigate any significant risks identified in the light of new information.

**Regulations 26, 27, 28, 29 and 33**

The Inspectorate undertakes to review the relevant parts of the Water Supply (Water Quality) Regulations 2000 (England) 2001 (Wales) and related guidance, in light of any lessons learned from companies’ revised risk assessments and the reports of outbreak control teams currently established in south England and north Wales. We will consult with the industry on this review process at the earliest possible opportunity, which will be after completion of the Inspectorate’s independent incident investigations that are underway at the present time.

Companies are advised to give a copy of this letter to Local Health Authorities and Environment Agency contacts.

Copies of this letter are being sent to Pamela Taylor, Chief Executive, Water UK; Richard Wood, Water Supply and Regulation Division, Department for Environment, Food and Rural Affairs; June Milligan, Environment Division, Welsh Assembly Government; Colin McLaren, Drinking Water Quality Regulator for Scotland; Randal Scott, Drinking Water Inspectorate for Northern Ireland; Chairs of the Consumer Council for Water Committees; Rowena Tye, Office of Water Services; Tony Smith,
Chief Executive, Consumer Council for Water; Tony Warn, Environment Agency; Nigel Harrison, Food Standards Agency; Gary Coleman and Gordon Nichols of the Health Protection Agency and Hilary Aldridge, Environment Agency.

This letter is being sent electronically to Board Level and day to day contacts. Please acknowledge receipt by email to dwi.informationletters@defra.gsi.gov.uk. Hard copies are not being sent but the letter may be freely copied. Any enquiries about the letter should be addressed directly to Professor Jeni Colbourne, via e-mail to susanne.calmels@defra.gsi.gov.uk

Yours sincerely

Prof. Jeni Colbourne MBE

Chief Inspector of Drinking Water
Letter to Dwr Cymru from Water Consumer Council for Wales

BY EMAIL

Mr Nigel Annett
Managing Director
Dwr Cymru Welsh Water plc
PO BOX 8
Nelson
TREHARRIS CF46 6YG

Out ref: 800/0070
20 December 2005

Dear Nigel

CRYPTOSPORIDIUM INCIDENT IN NORTH WALES

Thank you for your email update of the current situation (19/12/05). This was useful to clarify some of the current issues given the ongoing investigations into the water supply in parts of Gwynedd and Anglesey. The Consumer Council for Water (CCWater) Wales Committee is very concerned about the implications for consumers’ health, and that public confidence in the provision of safe, quality water has been severely undermined.

The Wales Committee has been closely monitoring the incident, taking note of consumers’ concerns that have appeared in the media, been reported to us, and have been raised by the Committee. This has led us to a series of questions and we would be grateful for your response. As an independent body set up to represent consumers’ interests we judge these questions to be in the public interest and as such we intend making them available in a press release tomorrow (21/12/05). Since these are obviously wider implications of this incident this letter is being copied for information to the Drinking Water Inspectorate, OFWAT, the Outbreak Control Team, and the Welsh Assembly Government.

Restoration of safe, quality water

- Following the Outbreak Control Team (OCT)’s statement that the Capellyn reservoir, is the probable source of the outbreak (Report of the OCT meeting 14/12/05) what is Dwr Cymru Welsh Water doing now to restore a safe, quality water supply to customers?

We look for early assurance that there will be immediate action to eliminate the possibility of infection from the water supply and to restore normal supply arrangements.

- When can customers expect the boil water notice to be lifted?
It would be helpful if you could provide the Committee with a detailed action plan and timetable for the lifting of the boil water notice and restoration of normal supply arrangements.

Risk assessment and precaution

In our opinion the current risk assessment and water treatment procedures appear to be inadequate since it seems from this, and other similar incidents, that there could be an ongoing threat to public health. There are obviously wider implications for the water industry, and for public health, to ensure an appropriate level of public health protection, proportionate to the risks.

- Are you confident that the current risk assessments and water treatment initiatives, as implemented by the Cryptosporidium Regulations (1996) are both adequate and sufficient?

- What is wrong with the risk assessment and water treatment procedures as there is a serious public health incident - yet water quality monitoring - according to the current regulations, appears not to be able to find the source of the problem, nor be able to confidently prevent a reoccurrence elsewhere?

Customer care and compensation

We welcome the fact that, at last, a goodwill ex-gratia payment of £25 has been offered to customers. But in our opinion this is not enough - it cannot possibly compensate for the disruption to peoples’ lives and livelihoods given the inconvenience and extra costs associated with boiling water, and especially for those who have been made ill.

With regard to the amount offered for the inconvenience caused by the issue of a boil water notice, our benchmark is industry best practice, as documented in the WaterVoice Best Practice Register'. This shows Wessex Water is pledged to pay £35 for the issue of a boil water notice. South East Water goes further with a promise of £10 plus £10 a day for any additional period of more than 5 days. We would expect Dŵr Cymru Welsh Water, a not for profit company dedicated solely to serving its customers, to have regard to industry best practice when deciding the total amount of the payment to be made to customers.

- What additional compensation is Dŵr Cymru Welsh Water going to award its customers, and when?

Provision of free bottled water

We are aware that many people are finding it difficult to comply with the boil water notice and are therefore buying bottled water.

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1 WaterVoice Best Practice Register 2005: [www.watervoice.org.uk] (accessed 06/01/12)
• Will Dyfed Cymru Welsh Water make available free bottled water to all customers finding it difficult to follow the boil water notice, for example, if they are elderly or disabled?

It would be helpful if you could make it clear that free bottled water is already available to those on your special needs register, and in addition, publicise how those customers who qualify but are currently not registered on this list, might do so.

Consumer information

Questions have been asked about whether the company acted quickly enough to alert customers to boil their drinking water (as a precautionary measure) given the increased incidence of an illness often associated with the water supply.

We understand that the Drinking Water Inspectorate was notified of the possibility of increased risk from the water supply on 4 November 2005. Customers will therefore wish to know why they received no notification until 29 November 2005, after a period of some three weeks had elapsed.

• In view of the presentation of the ‘boil water notice’ as a precautionary measure (and in no way prejudging any conclusion as to the cause of the outbreak) we need to ask why its issue was delayed until 29 November 2005 and why it was not issued immediately on 4 November 2005 to ensure more effective risk reduction?

We accept that at this present time there appears to be no conclusive proof that Cowlynn is the proven source of the infection. However, we note that according to the Boschoir Report2 into cryptosporidium in water supplies:

"Outbreaks of water related cryptosporidiosis do not just 'happen'. There appears to be a strong correlation between outbreaks and situations where an inadequacy was identified in the treatment provided or in the operation of the treatment process or where there was overloading of the treatment process."

Initial notification

We are disappointed that we appear not to have received copies of information provided to the Drinking Water Inspectorate in accordance with the Water Undertakers (Information) Regulations 1998. We do not appear to have copies of the Initial Notification issued on 4 November 2005, nor of the First Report (72 hour) issued on 8 November 2005. Please could you send copies of these documents by return, as well as an explanation of the reasons for the earlier omission?

Customer helpline

We received a report from a customer (19/12/05) who had apparently failed to obtain a response from the emergency Helpline 0845 850 9650 number that you have published in your letter to customers. We were dismayed to find that he told us he had been holding on for periods of 30 and 40 minutes respectively over the weekend. We followed this up and checked the line yesterday and again today. After.

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about 2 minutes we simply heard a repeated message referring us to a web-site. There was no indication of a queuing system or any way of speaking to someone. We gave up after 5 minutes. We appreciate that the must be a large demand for information but clearly, this is not satisfactory: consumers are not able to access the helpline in a timely manner.

- Can you give an indication of the volume of calls being received and the resources being deployed to deal with them? What is the waiting time to get a response?

Finally, we are aware that this is a difficult time and that your priority must be to address this incident, but we would appreciate your response to these questions, as soon as possible, and certainly within the next 10 working days.

Yours sincerely

Diane McCrea
Chair, CCWater Wales Committee

Copies sent for information to:
Prof J Colbourne, Drinking Water Inspectorate
Dr J Milligan, Welsh Assembly Government
Mr P Fletcher, Director General, OFWAT
Dame Yve Buckland, Chair, Consumer Council for Water
Mr Tony Smith, Chief Executive, Consumer Council for Water
The Outbreak Control Team
4th November 2005

To General Practitioners in Gwynedd & Anglesey

DIARRHOEAL ILLNESS

Dear Doctor,

We have seen a recent increase in cases of *Cryptosporidium* notified in Gwynedd and Anglesey. I am writing to request that you consider this in your patient consultations over the next weeks and that when you submit stool samples from patients that you name *Cryptosporidium* as one of the organisms to be tested for. The arrangements for such samples are otherwise as normal for your local laboratory.

If you identify any such cases our department will be happy to answer your queries on 01352 803255.

Many thanks for your help.

Yours sincerely

Dr Dolors Carnicer-Pont

Locum Consultant in Communicable Disease Control
Letter to clinicians caring for patients with severely impaired immune systems

For action
General Practitioners in Anglesey and Gwynedd
Medical Director, North West Wales NHS Trust
Medical Director, Anglesey LHB
Medical Director, Gwynedd LHB
Consultant in Genitourinary Medicine, North West Wales NHS Trust
Paediatricians, North West Wales NHS Trust
Renal Physicians, North West Wales NHS Trust
Haematologists, North West Wales NHS Trust
Oncologists, North West Wales, and Conwy & Denbighshire

For information
Medical Director, Anglesey LHB
Medical Director, Gwynedd LHB

November 2005

Dear Colleague

Cryptosporidiosis and patients with severe T lymphocyte deficiency

I am writing to ask you to contact some of your patients as a matter of urgency.

This is because there has recently been an increase in incidence of cryptosporidiosis in Anglesey and Gwynedd. The possible causes of this increase are being investigated by an Incident Management Team including Local Authorities, Local Health Boards, the National Public Health Service for Wales and Welsh Water.

In the meantime, please contact those of your patients who are most at risk (see list below) to issue or reinforce existing national advice on reducing the risk of cryptosporidiosis. I attach a draft letter you may like to use to help do this.

National experts have defined the patients at particular risk of cryptosporidiosis and have advised that they should boil their drinking water. The level of T cell function and the duration of any immunosuppression were considered to be crucial factors in susceptibility to cryptosporidium. In normal healthy individuals, cryptosporidiosis is usually characterised by an acute and self-limiting diarrhoeal illness from which the patient recovers fully. However, in people with severe deficiency of T lymphocyte function, cryptosporidiosis often results in a chronic life threatening gastroenteritis with a high mortality.
Patients at risk:
- HIV infected patients with CD4 counts less than 200
- Those taking high dose steroids, equivalent to a dose of prednisolone of 40 mg or more per day, for at least one week in the last 3 months (the equivalent dose in children is 2 mg/kg body weight per day for 1 week in the last 3 months, or 1 mg/kg/day for at least month in the last 3 months)
- Patients who have had bone marrow, stem cell or organ transplants
- Children with severe combined immunodeficiency
- Patients with specific T-cell deficiencies, such as CD40 ligand deficiency (Hyper IgM Syndrome)

Occasionally patients who are receiving anticancer chemotherapy will have depressed T-cell function – cancer specialists are asked to advise on this issue.

Recommended precautions
- to boil drinking water, as an ongoing routine precaution (this includes tap or bottled water – ice cubes should be produced from boiled and cooled water)
- to maintain good personal hygiene, particularly hand washing (before meals, and after contact with persons with diarrhoea)

Communications
I would be grateful if you could write to the patients at risk – as defined above – as a matter of urgency. Please can you confirm to me when you have done this.

We have set up a bilingual helpline with NHS Direct on 0845 850985. This is available for your patients or the public to use and will be open seven days a week from 9am – 5pm.

We will also need the help of the media to explain what we are doing and the levels of risk. We had planned to issue a press release in two days time, but we have had to bring this forward in response to approaches from the media. It is therefore likely that individuals may hear news reports before hearing from you.

Yours sincerely

Mark Walker
Consultant in Communicable Disease Control, on behalf of the Incident Management Team.
Letter to oncology unit, Ysbyty Gwynedd

22 November 2005

To: Jackie Jones, Deputy Unit Manager, Alaw Oncology Unit, Ysbyty Gwynedd

Dear Ms Jones

We have recently received an increase in notifications of cryptosporidiosis in residents of Gwynedd and Anglesey and I am writing to request your assistance in managing this situation.

In view of the fact that cases continue to be notified and the pattern of illness in the community suggests that drinking mains water may be a factor in transmission of the disease at present, a meeting has been held between the Health Protection Team of North Wales, the Local Authorities of Gwynedd and Anglesey, and Welsh Water. It was agreed that it would be prudent to advise certain members of the public, who are at increased risk from acquiring cryptosporidiosis, to boil drinking water before consuming it. This includes individuals that are immunocompromised, those on immunosuppressive therapy, and those on renal dialysis. The advice to boil drinking water does not apply to all members of the public, only those at increased risk, as identified above.

Cryptosporidium is killed by boiling and the boil water notice has been issued as a precautionary measure. Water can be boiled in a standard household kettle and then left to cool. Other advice that these individuals should be given is:

**Brushing teeth:** use cooled boiled water for brushing teeth

**Ice cubes:** ice cubes made prior to the boil water notice should be discarded. Make ice cubes with cooled boiled water or fizzy drinks.

**Washing and bathing:** it is quite safe to wash and take a bath: the route of infection is by swallowing the water.

**Washing up:** dishes should be washed using boiled water if possible, but it is probably sufficient to rinse washed dishes with boiled and cooled water before they are dried. Dishwashers are unaffected if used on a hot wash cycle.

**Water filters:** Domestic filters should not be relied upon unless they are designed for the purpose of removing micro-organisms (i.e. not just designed to improve palatability). Please refer to the manufacturer's brochure if in any doubt. Domestic filter cartridges may trap contamination, and...
particular care is required in hygienic disposal of these. Water purification tablets are not recommended as an alternative to boiling.

I would be grateful if you could ensure that all of your patients, living in Gwynedd or Anglesey, that fall into one of the risk groups described above, receive the attached letter which includes the advice set out above. Your assistance is invaluable in managing this problem.

Your sincerely

Dolors Carnicer-Pont
Locum Consultant in Communicable Disease Control
Letter to patients with severely impaired immune systems

Dear Sir/Madam

We have recently seen an increase in reporting of Cryptosporidiosis in people living in Gwynedd and Anglesey. This is a diarrhoeal disease of humans and animals, caused by a microscopic parasite called *Cryptosporidium*.

The pattern of illness in the community suggests that drinking mains water may be a factor in transmission of the disease at present, and it is therefore advisable for certain people to boil water before they drink it. These people are those with a weakened immune system due to illness, those on medication that can weaken the immune system, and people on renal dialysis.

You have been given this letter because your doctor feels you may be at increased risk if you were to become infected. Listed below is some advice that can help to prevent you from being placed at risk.

Cryptosporidium is killed by boiling and the boil water notice has been issued as a precautionary measure. Water can be boiled in a standard household kettle (it just needs to be brought to the boil) and then left to cool. Other advice that you should follow is:

**Brushing teeth:** use cooled boiled water for brushing teeth

**Ice cubes:** ice cubes made prior to the boil water notice should be discarded. Make ice cubes with cooled boiled water or fizzy drinks.

**Washing and bathing:** it is quite safe to wash and take a bath: the route of infection is by swallowing the water.

**Washing up:** dishes should be washed using boiled water if possible, but it is probably sufficient to rinse washed dishes with boiled and cooled water before they are dried. Dishwashers are unaffected if used on a hot wash cycle.

**Water filters:** Domestic filters should not be relied upon unless they are designed for the purpose of removing micro-organisms (i.e. not just designed to improve palatability) and are absolute 1 µm filters.

Preswylfa
Ffordd Hendy
YR WYDDGRUG
Sir Y Fflint
CH7 1PZ
Ffon: 01352 803234
Ffacs: 01352 700043

Preswylfa
Hendy Road
MOLD
Flintshire
CH7 1PZ
Tel: 01352 803234
Fax: 01352 700043

22 November 2005
Please refer to the manufacturer’s brochure if in any doubt. Domestic filter cartridges may trap contamination, and particular care is required in hygienic disposal of these. Water purification tablets are not recommended as an alternative to boiling.

Your sincerely

Dolors Carnicer-Pont

Locum Consultant in Communicable Disease Control
Letter to water customers advising boiling of water, etc.

Important information for water customers

BOILING DRINKING WATER

Dear Customer

Following a recent increase in the number of cases of illness caused by cryptosporidium in parts of Gwynedd and Anglesey, the National Public Health Service for Wales has advised customers to boil drinking water as a precautionary measure.

Cryptosporidium is a tiny parasite found in humans and animals and can cause a temporary diarrhoeal illness lasting about two weeks followed by full recovery. Bringing water to the boil will kill the cryptosporidium parasite.

Since the beginning of October there have been 65 cases of illness caused by cryptosporidium in the area served by Welsh Water’s Cwellyn water treatment works and another 22 cases in other parts of Gwynedd and Anglesey. This is higher than usual.

Protecting public health is our highest priority, and we have been working closely with the National Public Health Service for Wales, local health authorities, local councils, Environment Agency Wales and the Drinking Water Inspectorate to investigate and understand the cause of this increase.

Your tap water is supplied from our treatment works at Cwellyn, which is monitored 24 hours a day and both its operation and the drinking water it produces are continuously checked. This works is operating normally and our increased monitoring tells us that the treatment we provide to water abstracted from Llyn Cwellyn has not been compromised in any way. It has shown very low levels of cryptosporidium in the water, well within the treatment standards.

At present we do not know whether the water supply has been the cause of the increase in incidents of illness. However, the National Public Health Service for Wales believes it is the most likely source. We are continuing to work closely with other organizations to find the source of the problem. However, because outbreaks of illness caused by cryptosporidium are often associated with tap water and there is statistical evidence of a link, we are putting safety first. To help with the investigation into the outbreak, we have agreed with health experts to issue a six week boiling order to all customers in areas served by the Cwellyn works.

This boiling notice will operate from now until Monday 9 January 2006. Please find enclosed a standard “Boiling Water Notice”, which includes important information.

If you have any concerns about illness caused by cryptosporidium you can contact the NHS helpline on 0845 850 9850 between 9am and 5pm seven days a week. Other information can be found at: www.nphs.wales.nhs.uk and on our own web-site www.dwrcymru.com.

We regret this inconvenience, but until we know for certain why there has been an increase in the number of cases of illness caused by cryptosporidium, boiling tap water is a sensible precautionary measure. Everything possible is being done to find the cause, and we will let you know when you no longer need to boil your drinking water.

Yours sincerely

Nigel Annett
Managing Director
Letter to GPs

General Practitioners in Anglesey and Gwynedd

December 1 2005

Update: Cryptosporidiosis in North West Wales

Dear Colleague,

I would like to update you on the cryptosporidiosis outbreak in North Wales. As of 12 noon 30/11/05, there were 110 laboratory confirmed cases of Cryptosporidium in the Gwynedd and Anglesey areas. A further increase in the number of cases reported is expected.

Investigations are continuing into the source of the outbreak, focusing on Cwellyn reservoir and catchment area. These are likely to take up to five weeks.

A boiled water notice to residents served by the Cwellyn reservoir has been issued as a precautionary measure to reduce the risk of infection in local residents whilst investigations continue.

As you know, advice to patients with lowered immunity who are at higher risk of serious disease has already been issued (23rd November) and remains unaltered; we are grateful for your help in propagating this message.

As is usual, some cases have arisen from person to person spread within family and community groups. People can help to limit the number of cases by preventing transmission of the parasite through careful attention to personal hygiene and through early recognition of illness and we would appreciate if you would continue to relay this message.

Occasionally, swimming pools can become a source of infection and the Outbreak Control Team are advising people who have been affected by diarrhoea not to go swimming until two weeks after they are fully recovered. Environmental Health Officers will be communicating with swimming pool managers in the affected areas.

To prevent the parasite spreading within families and communities, we have advised the public to:

- Report diarrhoeal illness which persists for more than 48 hours or is particularly severe early to their general practitioners.
- Wash hands thoroughly, particularly before food preparation and eating, and after using the toilet.
- Be particularly careful when changing nappies and toileting small children (< 5 years), and supervise young children's hand washing
- Adhere to the boiled water notice – bring to the boil and cool before use all water for drinking, food preparation, baby feeds, brushing teeth and ice making.
- Not use swimming pools, paddling pools or jacuzzis until two weeks after fully recovering from diarrhoeal symptoms

All cases of gastroenteritis should be regarded as potentially infectious and should normally be excluded from work, school or other institutional settings, at least until 48 hours after the first normal stool; this is particularly important for food handlers and staff of healthcare facilities (while 48 hours is specified for these activities, affected persons should be excluded until 14 days after recovery from swimming pools).

I should also be most grateful for your cooperation in providing Environmental Health Officers with contact details on their request. There is a sound public health justification for this: EHO enquiries are the means by which we have identified the principal source of this outbreak and they provide families with valuable advice on the prevention of secondary transmission.

A Help Line remains in place through NHS Direct, and concerned individuals can ring 0845 850 9850 for further advice between 9am and 6pm weekdays (extended hours from yesterday) and 9am to 5pm at weekends.

Dwr Cymru Welsh Water has written directly to all 70,000 customers in the area supplied by Llyn Cwellyn to advise of the need to boil tap water

Yours sincerely

Mark Walker
Consultant in Communicable Disease Control, on behalf of the Incident Management Team.
Letter to Welsh Assembly Government

Dear Phil,

Cryptosporidiosis in North Wales

You asked for my technical advice on the question “why is it difficult to confirm whether, or not, the water supply is the source of the outbreak of cryptosporidiosis”. I understand that this question has arisen as a result of dialogue with the Acting Deputy Chief Medical Officer, Welsh Assembly Government.

In addressing this question it is necessary to first recognise that water is not the only source of Cryptosporidium infection in humans. The organism can be acquired from other sources such as swimming pools, food, and milk, as well as through contact with farm and domestic animals and person-to-person transmission. That said there are several unique and complicating factors involved with the investigation of outbreaks of disease thought to be related to a supply of drinking water. These include:

- Water treatment works tend to produce relatively large volumes of water which supply a large geographic area
- The water supply to an area can be a blend from more than one treatment works, not all of which may be under suspicion
- By the time an outbreak is recognised, any contamination event has usually passed therefore pathogen testing of responsively collected samples rarely, if ever, informs as to the causative events, I will return to such testing later.
- The mere presence of low numbers of Cryptosporidium oocysts in drinking water does not imply that water is the source of an outbreak; there are many situations where such findings occur in the absence of disease.
The widespread and general nature of exposure of the population to mains water can obscure the actual source of contamination.

Gastroenteritis, the illness most often caused by waterborne outbreaks, is not uncommon in the population and has many causes. Many cases, even in the midst of an outbreak, turn out not to be due to water exposure or cryptosporidium.

Descriptive epidemiology can lead to the relatively early finding of a statistically significant association between being ill and residence in a particular water supply zone but this alone does not necessarily mean that illness was caused by the water. However, in conjunction with the finding of oocysts in mains water or the occurrence, in an appropriate timescale, of an event potentially impacting on the water supply (source, treatment or distribution network), such epidemiological findings provide strong support for a hypothesis that mains water is the vehicle of infection. It is this hypothesis that then generates the impetus for a public health decision to be taken about the need to immediately implement control measures.

The next step to be taken is to test the hypothesis by carrying out an individual based analytical study however before making the decision to proceed in this way, two factors, known to reduce the power of such a study, must be considered very carefully. These factors are

- If the population has had a previous exposure this can lead to a higher level of immunity
- If advice to boil notice has been issued this will influence (bias) the responses of cases and controls

When an analytical study is done and where the population at risk is large, as is the case in nearly all outbreaks where mains water is a possible vehicle of infection, a case control study is the most appropriate methodology. Here it is relevant to explain that the methodological approach that would be taken for a private water supply outbreak is not the same as for a public supply because the exposure is typically restricted to a small easily identifiable at risk population. In such situations a cohort study can be used. The statistical power of a cohort study is generally far greater than can ever be obtained with a case control study and furthermore, a cohort study can usually be completed in a shorter timescale.

Since, as stated above, an analytical study of an outbreak where mains water is under suspicion requires a case control study approach, it is further necessary to understand that such studies will only generally convey whether or not there was a dose response relationship between tap water consumption and infection rates. It can also provide evidence for associations with other factors and infection rates and, a probability based assessment of the most likely vehicle by which infection was spread. Thus on its own, the science of a case control study, however well it is carried out cannot “confirm that mains water is the cause of an outbreak” and it is necessary for the findings of such studies to be verified by other information and facts.

It should be appreciated that the gathering of these other relevant facts will not be confined solely to matters relating to the operation of the water treatment works or the results of water tests, they are far more wide reaching and will involve, for example, evidence provided by consumers and other relevant persons through the taking of formal statements using PACE procedures. All this takes time and effort once the epidemiological results become known. There exists precedence that means the nature of epidemiological studies is such that alone
they cannot be relied upon to attribute cause in respect of mains water and an outbreak of cryptosporidiosis.

I would draw your attention to the tendency for the “results of water tests” to become the focus of public attention during an outbreak and to thus attract a significance far beyond that which can ever be scientifically justified. There is an old but very useful adage that best summarises the limitations of water testing - the result of a single set of water samples tells you only what was in the sample bottle/device at the time when it was analysed in the laboratory – on its own it tells you nothing about the quality of the water source/supply from where the sample was drawn. Another common misapplication of the science of water testing is the comparison of a set of results of samples of raw and treated water and the presumption that what is measured going in, is the same as, or can be related to, that measured coming out of, for example, a filter. There are many excellent peer reviewed studies and PhD theses that demonstrate why such simplistic comparisons are invalid but despite this knowledge, many “experts” as well as lay people (and the media) fall into the trap of making conclusions of this nature.

As you know, my inspectors are carrying out their investigation of the incident in North Wales and in drawing their conclusions they will take into account the epidemiological findings of the Outbreak Control Team together with all other relevant information gathered in the course of their formal investigation. The water company is fully co-operating with my inspectors and we will advise the company, the OCT, the Consumer Council for Water and you of our findings, including whether there are grounds for us to initiate either prosecution or enforcement (Water Act 1991). Obviously it would be prudent for all interested parties to exercise caution about making statements as to “cause” whilst our investigation is ongoing, not least because this can increase the length of time of our investigation considerably. You will appreciate that anyone who makes such a statement could have material information and we thus have to consider if we need to interview them to establish if that is indeed the case. You may wish to brief officials and ministers on this particular point, as nobody is exempt.

You can rest assured that the Inspectorate and the Health Protection Agency will be working together to understand what if any, further guidance we can jointly give to health authorities, local authorities and water companies to control and prevent outbreaks of cryptosporidiosis. I am so far unconvinced that the outbreaks this autumn in Wales and England are due to unique circumstances requiring additional research, rather it is probably a matter of refocusing attention and refreshing guidance on the way risk assessment, risk management and risk communication is carried out by all the various agencies.

However, at the present point in time it can be safely concluded that there is evidence to support the hypothesis of an association between exposure to water in Cwellyn reservoir and infection in the community. What has not yet been established is the origin of the source of contamination of the reservoir and the extent to which, if any, the treatment at the works either contributed to, or mitigated, the extent of the outbreak – both are equally plausible – it is often forgotten in the heat of an outbreak situation that the treatment of the water will have had some beneficial effect irrespective of whether the treatment could be improved upon and thus provide a more robust barrier in the future. It can be stated with some certainty that not all the cases of infection will have been due to consumption or contact with contaminated water. It should be appreciated that the actual source of the outbreak will have been one or more infected persons living in or visiting the community combined with the specific
conditions that subsequently encouraged both person-to-person transmission and further spread of the organism by contamination of the water environment with their excreta.

In their wish to quickly establish and attribute a cause and a cure, it is quite natural and easy for commentators to focus on water treatment (and the water company) but it behoves all the responsible agencies to address with equal energy the human source and the community dimension (in other words how was it that the reservoir water was contaminated with excreta from infected persons and what can be done to prevent a future occurrence of such circumstances). Time is obviously required for all concerned to identify and evaluate the most, sustainable and cost effective long-term solution(s). I advise that any interim measures taken by the water company, for example, the installation of additional treatment such as UV, whilst helpful as regards offering reassurance to consumers and the OCT and enabling cessation of short term precautions (boil water notice) should not be seen as an end point (or a proof of cause) by any of the agencies – investigations need to continue.

I hope this advice proves helpful but please do not hesitate to contact me again if I can be of further assistance.

Yours sincerely,

Prof. Jeni Colbourne MBE

Chief Inspector of Drinking Water

Cc Jim O’Sullivan, Dŵr Cymru Welsh Water

Diane McCrea, Consumer Council for Water Wales
Appendix H Environment Agency discharge consent for Rhyd Ddu Sewage Treatment Plant

ENVIRONMENT AGENCY WALES
NORTHERN AREA
CONSENT REVIEW 2004

UWWTD

[URBAN WASTE WATER TREATMENT DIRECTIVE 1991]

FILE NOTE

A snapshot of WRA 91 Discharge Consents qualifying for review under UWWTD was extracted from WIMS (EA electronic Public Register) on the 21st April 2004. All details shown on this file note are based on the permission extant as of this date.

CONSENT REF: CG0024101
OPERATOR: DWR CYMRU CYFYNGEDIG
DISCHARGE SITE: RHYD DDU STW
EXTANT CONSENT ISSUE DATE: 02/09/1987
EFFECTIVE DATE: 03/09/1987
DWF (m³/day): 14.5
MAX DAILY VOL. (m³/day): UNSPECIFIED

Records held on WIMS show RHYD DDU STW (CG0024101) to be extant under version 2 issued 03/09/1987 with descriptive consent conditions, effective 03/09/1987. The works is currently consented to discharge a max daily volume of UNSPECIFIED m³/day effluent to the GWYRFAI at NGR SH5708553080.

UWWTD directive aims to deliver a standard level of sewage treatment throughout EC member states. This has been interpreted as prescribing a minimum of secondary biological treatment (package plant or equivalent) on all discharges made to a controlled surface water, or a minimum of primary (septic tank or equivalent) treatment on all discharges made to ground.

The discharge of UNSPECIFIED m³/day effluent to GWYRFAI, for the purposes of this review, is described as 'secondary treated effluent to surface waters'. This treatment/receiving water combination has been assessed* as APPROPRIATE under the UWWTD review. This consent is reviewed as APPROPRIATE under UWWTD as of 01/09/2005.

* Note the licence of this Discharge Consent to meet UWWTD 'Appropriate treatment' criteria is based solely on provision of the appropriate 'motorised' level of minimum treatment for discharging effluent. This review does not assess appropriateness in terms of the specific river reach of the receiving water catch.

Iwan Williams
Regulatory Team Leader (Water Quality)

Version: 6
Date: 28th November 2006
Author: Outbreak Control Team
Status: Approved for publication
Page: 176 of 184
CONTROL OF POLLUTION ACT 1974: SECTIONS 34 AND 55
THE CONTROL OF POLLUTION (DISCHARGES BY AUTHORITIES) REGULATIONS 1984
CONSENT FOR A DISCHARGE

1. The Welsh Water Authority (hereinafter referred to as 'the Water Authority') proposes to discharge sewage effluent from the Rhym Ddu Sewage Treatment Works to the Afon Owyfai at National Grid Reference SH 3703 5308 in accordance with the application dated 9 January 1987.

2. The proposal requires the consent of the Secretary of State for Wales in pursuance of sections 34 and 55 of the Control of Pollution Act 1974 and the Control of Pollution (Discharges by Authorities) Regulations 1984.

3. THE SECRETARY OF STATE FOR WALES hereby consents to the proposed discharge subject to the discharge conforming at all times to the terms of the certificate attached hereto.

Dated this 3rd day of September 1987

Signed on behalf of the Secretary of State for Wales

P. R. Marsham
THE CONTROL OF POLLUTION ACT 1974: SECTION 38
THE CONTROL OF POLLUTION (DISCHARGES BY AUTHORITIES) REGULATIONS 1994 (SI 1994 NO 1209)

CERTIFICATE TO BE SUBMITTED WITH A REQUEST FOR A DESCRIPTIVE DISCHARGE CONSENT

On behalf of the Welsh Water Authority we certify that, in respect of the discharge from the Authority's sewage treatment works at _______________
(National Grid Reference _______________)

1. The effluent derives from domestic sewage from a population of ________________ or less and contains no authorised trade waste.

2. There are no potable water supply intakes downstream which are likely to be adversely affected.

3. As far as is reasonably practicable, the works shall be operated so as to prevent:
   i. any matter being present in the effluent which will cause the receiving water to be poisonous or injurious to fish or to their spawn or spawning grounds or food or otherwise cause damage to the ecology of the receiving waters; and
   ii. the treated effluent from having any adverse visual and other environmental impact.

4. The authority will operate the works having regard as far as is relevant to the guidance set out in the National Water Council's Occasional Technical Paper Number 4, "The Operation and Maintenance of Small Sewage Works" dated January 1980. In particular the works shall be maintained properly such that:
   a. it remains fully operational except at times of mechanical or electrical breakdown;
   b. any such breakdowns shall be attended to promptly and the equipment returned to normal operation as soon as possible; and
   c. tanks shall be de-sludged at sufficient frequency and in such a manner as to prevent problems with septic sludge, rising sludge for excessive carryover of suspended solids.

Signed ________________________________  Signed ________________________________
(Name) ________________________________ (Name) ________________________________
Divisional Operations Manager District Scientist

Dated this ________________
Day of ________________ 19__

DGN/KLP/1W/7.2b
### Notification of Variation of Consent

**To:**

**Welsh Water Authority**

This Notice is issued under the above-mentioned Acts and Order and all other enabling powers as a NOTICE DECLARED TO HAVE BEEN GIVEN BY THE SECRETARY OF STATE FOR WALES, in respect of the existing discharge of treated sewage effluent from the Authority's: **RHYG-DBU SEWAGE TREATMENT WORKS**

via an existing outlet and subject hitherto to a previous consent as specified below.

**The Existing Outlet** is to: the Afon Gwyrfal

**National Grid Reference:** SH 5705 5308

**Discharge Point**

**On the attached Plan, No.:** RW/0391/1/1

**The Previous Consent** was:

- **Reference No.:**
- **Granted on:** 10th February 1984
- **Granted by:** Gwynedd River Board
- **To:** Gwyrfal Rural District Council

The Authority submitted this Notification of Variation on: 19th August 1981

to the Secretary of State for Wales in the form of a draft and the Secretary of State has NOT, within the relevant period, given notice of his intention to determine this matter. This discharge is therefore (in substitution for all the conditions hitherto in force) subject only to the following conditions as from: 15th November 1983.

### Conditions

1. The discharge shall consist only of treated sewage effluent from the above works.

2. The quality and quantity of effluent shall not exceed the following maximum values:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemical Oxygen Demand (BOD) over 5 days at 29°C</td>
<td>22 milligrams per litre</td>
</tr>
<tr>
<td>Suspended Solids dried at 105°C</td>
<td>26 milligrams per litre</td>
</tr>
</tbody>
</table>

- **Rate of discharge**: 0.5 litres per second
- **Volume during any period of 24 consecutive hours**: 1.3 cubic metres
- **Volume discharged under 'dry weather conditions' during any period of 24 consecutive hours**: 15 cubic metres

3. Adequate facilities shall be provided for the taking of samples of the effluent at the outlet from humus tank.

The terms of this Notice will not, without the consent in writing of the person to whom this Notice is given, (or his successor), be altered before the expiration of the period ending with the Nineteenth day of November 1983.

This Notification is issued by the Directorate of Scientific Services, Headquarters, Welsh Water Authority, Cambrian Way, Brecon, Powys.
CONSENT VARIATION

RIVERS (CONTROL OF POLLUTION) ACTS 1951–1961

THE WATER AUTHORITIES (CONTROL OF DISCHARGES) ORDER 1978

I am directed by the Secretary of State for Wales to refer to the discharge consent in respect of the Sludge Treatment Works dated 19 November 1981.

The Secretary of State for Wales, having consulted with the Welsh Water Authority, hereby gives notice that in exercise of his powers under Articles 4(8) and 6 of the Water Authorities (Control of Discharges) Order 1978 (SI 1978 No. 1210), the conditions imposed on the said consent shall be varied in the following terms:

CONDITIONS

The quality and quantity of effluent shall not exceed the following maximum values:

- Biochemical Oxygen Demand (+ ATU) over 5 days at 20°C: 1.4 mg/l.
- Suspended solids dried at 105°C: 50 mg/l.
- Ammonical ammonia expressed as nitrogen: 2 mg/l.
- Dry Weather Flow: 10 litres per second or 0.001 m³/s cubed per day.

This variation takes effect from the 3rd January 1985.

This notice should be retained with the consent dated 19 November 1981.

[Signature]

WEP Division
Welsh Office
GWYNEDD RIVER BOARD
RIVERS (PREVENTION OF POLLUTION) ACT 1961—SECTION 1
CONSENT TO A PRE—1951 DISCHARGE

To:
The Clerk,
Gwyrfai Rural District Council,
Cwellyn,
Caernarvon,

Best Treated Sewage Effluent Discharge - Bryn Ddu Sewage Disposal Works.

The GWYNEDD RIVER BOARD HEREBY CONSENT under sub-section(4) of Section 1 of the Rivers (Prevention of Pollution) Act 1961 to the continuance of a discharge of trade or sewage effluent which commenced before 1st October 1951 to a stream within the area of the Board, viz:

to Afon Gwyrfai at a point on the right bank immediately downstream of Sewage Disposal Works.

This Consent is given subject to the following conditions:

1. The treated sewage effluent discharged shall at no time:
   (a) Contain suspended solids in excess of 30 parts per million (dried at 105°C).
   (b) Take up more than 20 parts per million of dissolved oxygen in 5 days at 20°C.
   (c) Contain any matter to such an extent as to cause the stream water to be poisonous or injurious to fish, fish spawn or the food of fish.

2. The volume of treated effluent discharged shall not exceed 3,200 gallons (dry weather flow) in any period of 24 hours.

3. Sampling facilities being provided and maintained at the outlet pipe to the stream.

The terms of this consent will not, without the consent in writing of the person to whom this consent is given (or his successor), be altered before the expiration of the period ending with the 1st day of March 1966.

Highfield,
Caernarvon.

10 FEB 1964

Attention is drawn to the extracts from the Act printed on the back of this consent.
Water Resources Act 1991
amended by the Environment Act 1995
Consent to Discharge
Certificate of Holder

Part A
To: DWR CYMRU CYFYNGEDIG
CONSENTS REGULATION OFFICER
PLAS-Y-FYNNON
CAMBRIAN WAY
BRECON LD3 7HP

The Environment Agency ("the Agency") hereby confirm that the above named person is a/the registered holder of consent CG0024101

Nature of Discharge(s): SEWAGE EFF/TREATED EFF/CONTINUOUS
at RHYD DDU STW

Note: This certificate should be kept with the consent document for future reference. If you transfer responsibility for the discharge to somebody else you must pass the consent to them and tell the Agency within 21 days. Responsibility for the consent cannot be discharged by the holder but the registration of holder may be transferred to a successor. To do this please complete the form below, then tear it off and return it to the address shown. If you fail to transfer the consent, even though you are no longer on the site, you may still be liable for prosecution for pollution. If you transfer the consent but do not tell us, you will be committing an offence. In case of any queries please contact your local Environment Agency office.

Part B
Please complete in block capitals or type.

To:

Water Resources Act 1991: Notice of transfer of consent to discharge

Consent: Name:
Address:

I/We* hereby serve notice on the Agency that I/we* am/are* no longer a/the* Holder of the above consent which will be/was* transferred to:

Name(s) of new holder(s):
Address:

Post Code:

Date of Transfer to new Holder(s): ____________________________

Signed: ____________________________ Dated: ____________________________

Name (block capitals): ____________________________ Position: ____________________________
Appendix I Map of Cwellyn water treatment catchment