Householder's Guide to Private Water Supplies

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1 Introduction

This booklet is intended to assist those who live in a house that has a private water supply (PWS) and who want to ensure the water is safe and pleasant to drink. You may have just moved into a house or flat with a private water supply or you may have had one for many years. The safety of drinking water is always paramount and you will be keen to ensure that your water is safe for you, your family and your visitors. It is a little known fact that the majority of private water supplies are contaminated at various times during the year. Unlike mains water, which is reasonably constant in quality, the quality of water in a private water supply is often very changeable and the supply system needs to be regularly checked to ensure it remains safe. This booklet will help you understand the system, so that you can protect it. The booklet will also help you deal with the local authority and any treatment installers, if they become involved.

This booklet starts with some information about private water supplies and potential problems. It then explains the different types of supplies and the components of the supply system. It addresses supply protection, the treatment systems available and what they will remove from the water. Then the role and responsibilities of the local authority are discussed. An explanation of what you can expect from the local authority and a brief guide to the rules and regulations covering PWS is given. Finally, there is a checklist for householders and answers to some frequently asked questions.

2 Abbreviations and Definitions

Commercial supply This is any PWS that supplies water to premises where the public have access, people are employed or food is produced for sale. Examples include cafes, bed and breakfast establishments, hospitals, schools, hotels, offices and on-farm pasteurisers. Supplies are still classed as commercial if there are domestic premises on the supply as well. The requirements for commercial properties are quite stringent and these will also apply to the domestic properties. They are risk assessed every five years and monitored annually by the local authority. The requirements for commercial supplies are also the same for large domestic supplies providing water to more that 50 people. For convenience these two types of supply (commercial and large domestic) are treated as one.

Domestic supply – a PWS that is used only by householders. Where these supply more than a single property (see below) the local authority has a duty to risk assess and monitor the supply every five years. If the supply is unsafe to drink or is unwholesome the local authority has to make sure it is brought up to standard.

Indicator organisms – These are bacteria used for monitoring the safety of water. They are present in faecal material and thus show that water is contaminated. In the laboratory, it is easier to look for these indicators than to search for specific pathogens.

Parameters These are the various substances, organisms and other characteristics of water that are listed in the Regulations and tested in the laboratory.

Private distribution systems (PDS) These are supplies where a water undertaker or licensed water supplier supplies water to a site and the owner of the site then supplies it to other people, sometimes for an additional charge. PDS need to be risk assessed by the local authority at least once every five years and the testing frequency is based on the results of the risk assessment. Previously exempt from regulation, all PDS are now covered by the PWS regulations. This booklet is intended for householders who have a PWS and this part of the Regulations will therefore not apply to you as it refers to mains water supplies. If you think that it may apply to you, you should ask the local authority, who can confirm whether your supply is a PDS or not and what, if anything, you will have to do to satisfy the Regulations. Additional guidance can be found on the website www.privatewatersupplies.gov.uk.

Private Water Supply is a supply of drinking water not provided by a water undertaker or a licensed water supplier, i.e. all supplies of drinking water, other than mains water. These include springs, wells, boreholes and surface water supplies from streams, rivers, lakes and lochs. There are four categories of PWS. These are:

- A large or commercial supply. This is one providing drinking or food preparation water as part of a commercial activity or to a building with public access. Or, if it is a domestic only supply, it uses more than $10m^3$ per day (or if this cannot be easily calculated, supplies 50 people or more). In Scotland this is called a Type A supply.

- A domestic-only supply that serves more than one dwelling but less than 50 people (or provides less than $10m^3$ per day).

- A supply to a single dwelling. These two domestic categories in Scotland are jointly called Type B supplies. Thus in Scotland there are just the two types of supply, and

- A Private Distribution System.

There are different monitoring and risk assessment requirements for each of the above categories.

PWS Regulations – These are the regulations covering the safety and wholesomeness of PWS. There are different ones for each country in the UK. The Scottish Regulations took effect in 2007; the English Regulations came into force on 1st January 2010. The Regulations list the duties and requirements on local authorities. They basically require PWS to be risk assessed, monitored and where necessary brought up to standard. The requirements are similar across the different countries and the Private Water Supply Regulations 2009, which came into force in 2010, are used in this document, unless otherwise stated.

Relevant person is defined in the Water Industries Act 1991 as the person who is responsible for the supply. This is the person or persons on whom any notice would be served and against whom enforcement action would be taken. It is up to the local authority to decide which of the possible relevant persons a notice is to be served on. The term is defined as: (a) The owners and occupiers of the premises; and (b) The owners and occupiers of the premises where that source is situated and any other person who exercises powers of management or control in relation to that source.

Responsible person The Northern Ireland Regulations use this term instead of relevant person. This term is similar and refers to the person who owns or occupies the land supplied, or any other person who exercises powers of management or control in relation to the supply. The Scottish Regulations have both these definitions, but in Scotland this particular term means the person responsible for just the domestic plumbing to a property.

Single property supply – a PWS that only goes to one domestic property. These are largely exempt from regulation and it is up to the householder to look after their safety.

Source – this is the point where water is abstracted for use as a PWS, i.e. the spring, borehole, land drain, well, stream or surface water used for the supply.

Wholesome - water that is safe to drink and palatable is described as wholesome. There is a legal definition of wholesomeness in the PWS Regulations. The definition is based on a list of chemicals and bacteria and their allowable levels. Wholesome water is water that:

- Does not contain anything that causes a potential danger to human health,
- Satisfies all the concentrations specified in Part 1 of Schedule 1 of the Regulations and
- Satisfies the nitrate / nitrite formula (i.e. nitrate (mg/l)/50 + nitrite (mg/l)/3 is less than or equal to 1).

Note that water can fail to be wholesome without being a health risk. In Scotland there are two definitions of wholesome; Type A (see section 10 for an explanation of the two types of Scottish supplies) have the same definition as described above but Type B have a lesser standard; the nitrate / nitrite formula does not apply and neither does the long list of parameters used in schedule 1. A shorter set of 10 general parameters defines wholesome for Type B supplies.

3 What is a Private Water Supply?

PWS are those small water supplies fed by springs, wells, boreholes and watercourses, providing water to individual houses, farms and businesses, small settlements and villages. They were around long before the water companies were set up and have provided drinking water for millennia. The oldest well ever discovered is over 7,300 years old. A well protected supply can provide safe drinking water at little or no cost and there is no reason why all PWS cannot be provided with suitable treatment to eliminate risks to health. Nearly every PWS is unique and therefore each one needs individual attention and treatment.

The legal definition of a PWS comes from the Water Industries Act 1991 and is any supply of water that is not provided by a water undertaker or a licensed water supplier. The undertakers are the large water companies such as Thames Water, Yorkshire Water or Severn Trent. So if you do not receive a water bill from one of the large water companies then your water is from a PWS. The organisation responsible for ensuring the safety of a PWS is probably the local authority (the Council) in your area.

Supplies are classified according to the number of people using the supply. The European Union's 1998 Drinking Water Directive[1] exempts from its controls any domestic supply serving fewer than 50 people ($10m^3$ per day of water). This means that in the UK there is a distinction between supplies serving more or fewer than 50 people, with the requirements for the larger ones being significantly more stringent. In England and Wales single property supplies are largely exempt from regulation.

Although the exact number of PWS in the UK is unknown, there are probably more than 60,000. These supplies provide water to about 1% of the population. About 60% of these supplies are to single dwellings. All supplies, whether domestic or commercial, will usually be situated in rural areas where it has been uneconomical to connect the properties to the mains. People on PWS are usually very fond of them and often proud of their supply, particularly if it does not contain the treatment chemical chlorine, which is sometimes noticeable in mains water supplies. Interestingly mains water is usually more consistent in quality and often safer, by virtue of this chlorine content. Over 70% of PWS are intermittently contaminated with animal faeces. This contamination may be in minute quantities and most people will be unaware that their water can contain this faecal material. Nevertheless, faecal material contains enormous numbers of microorganisms that can cause illness, particularly in young people or those who are not used to the supply such as visitors and houseguests. Because the quality of water changes with weather conditions, even if a test result showed no problems, there may be contamination of the supply at other times of the year. Most supplies tend to be safer during periods without rain but with the exception of boreholes, may be at risk of contamination after periods of heavy rain. Most outbreaks of diseases associated with PWS occur after heavy rain.

Isolated rural properties, houses and cottages, situated away from villages and in particular, those with a rural drainage system are likely to have a PWS. Occasionally, there will be PWS closer to towns and larger villages. These have often been kept as a PWS because the owner prefers the taste or convenience of their own supply, or because the supply is used for commercial purposes e.g. brewing. PWS can supply domestic premises, commercial premises or a mixture of both. Where there is more than one property on a supply, the various people using that supply should decide between themselves the best way to make sure it is maintained in a safe condition. Where this is not possible, it is often the local authority that has to decide what needs doing and who is responsible. The Local Authority must do this in a fair and equitable manner and will be happy to explain the reasons for their decision.

[1] Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

Occasionally people have joint supplies and combine both mains water and a PWS. Some people may retain an old PWS or invest in a new one and use the untreated private supply for washing or cleaning and the mains water for drinking and food production. It is important to make sure that the PWS does not put health at risk as a result of this. This can happen where the water from the PWS is at a higher pressure than the mains supply and this pressure difference causes backflow from the PWS into the mains system at the point where the two are connected via the house or business's internal plumbing systems. The Water Fittings Regulations[2] (which apply to public water supplies) are very strict on this point and householders with a dual supply must ensure that suitable anti-backflow devices are in place. If you are unsure, your plumber may be able to help. As the cost of water from the water suppliers increases, this joint use of a PWS and mains supplies may become more attractive.

4 Problems likely to be encountered in a PWS

Unless the PWS comes from a lake, spring or other surface water supply (or from the roof as is sometimes the case) it comes from underground. The water will have fallen as rain some distance away from the source, travelled over and underground, through soil, clay and rocks, picking up chemicals and perhaps, microbiological contamination along the way. Sometimes this water has travelled long distances over a long time period (some PWS have water that is thousands of years old) others provide water that was rain a day or two earlier. As a general rule of thumb, older water contains fewer microorganisms, since they die off or are filtered out by the rock structure. On the other hand, older water contains more chemicals because of the greater contact time of the water with the rock structure. Rainwater is slightly acidic and this promotes dissolution of chemicals when rainwater percolates underground.

If you have a surface supply, the water may have been contaminated with faeces of wild or domestic animals. It is not a good idea to assume that because the stream is in a remote area it is in pristine condition. Because it is virtually impossible to know where the water has come from in your supply, or indeed whether your spring or borehole has water from more than one source, it is important to be realistic about the potential for contamination.

One of the problems environmental health people from the local authority face when talking to users of PWS, is when it comes to discussing the health risks associated with sample results. Usually this discussion involves failures for indicator organisms with the Council official explaining that these failures mean pathogens could be in the water and may make people ill. As the person receiving this information drinks the water daily and has not been ill for a long time, this information seems both illogical and patently wrong. A fit and healthy adult often needs a number of pathogenic organisms to make them ill. As well as having a good immune system, they will have built up some immunity to any contaminants in the water. Unfortunately this will not be the case for the young, the old and any visitors. Recent research has shown that contaminated supplies are unlikely to make healthy adult, regular users of supplies ill, but are potentially very dangerous to visitors, especially young children. For them, the

[2] The Water Supply (Water Fittings) Regulations 1999

risks from *E coli* O157, for example, are severe and can cause kidney failure, brain damage and in rare cases death.

There is very little official information available on illnesses associated with PWS. Where a big or serious outbreak occurs this is recorded and reported but as most of this disease will be diarrhoeal, sufferers will often not bother to go to the doctor or get their stools tested and so this illness will not show on official records. In fact, authorities suspect that for every case of gastrointestinal disease (e.g. food poisoning) they find out about (and can thus investigate the cause) there are another 130 or so in the community they don't know about. However, in the case of PWS, just because the evidence is not readily available, this does not mean that illness is not being caused. This is a good reason for householders to make sure their supply is safe.

To ensure this safety, a multi barrier approach should be used. The source should be protected as far as possible from contamination, the system should be water tight (to prevent water contamination getting in as much as stopping leaks) and a final disinfection treatment system should be installed. That way, if any one of these protective barriers breaks down, another one should help protect the safety of the supply.

The quality of water in a lot of supplies particularly springs and wells, changes from day to day, sometimes hour by hour. A test of the water taken on one day can be completely different to one taken on another day. Sampling only provides a "snapshot" of the supply and cannot be relied upon to predict future quality. The quality can be affected by rainfall or snow melt, animals in fields where the rain feeding into the supply fell, the geology the water passed through and any farming practices or man made structures, such as septic tanks or landfills along the way. Again it is important to keep these problems in perspective. The water is usually neither completely pure nor "chemical-free" (which is actually technically impossible) nor grossly contaminated.

Most outbreaks of disease from small water supplies happen after heavy rain. The water can become turbid (cloudy) and is more likely to be contaminated. Because of this contamination, a treatment system can be stretched to its limit to cope with the problem. A supply that is normally safe can be a risk after heavy rain and you therefore need to ensure your supply is safe all the time and not just when the weather is fine.

5 Specific Quality Issues

Microbiological Risks

Microorganisms in water can either be viruses, bacteria or protozoa. Some have no effect on health whilst others will make people ill. The effects can range from a mild stomach upset through to death. It would be impossible to test water for every known pathogen, both in terms of time and costs, so what is done is to look for representative organisms that show that pathogens could be present in the water. These are called "indicator organisms" and they indicate a potential problem. There are three main ones and used together can give a good idea about the quality of the water. They are *E. Coli* or to give it its full name *Escherichia coli* (also know as faecal coliforms or thermotolerant *E coli*.), Enterococci and *Clostridium perfringens*. These all originate solely from the guts of mammals, including humans, and, if found, show that faecal matter is in the water. And if faecal material is there, there can be disease-causing organisms such as Salmonella and campylobacter as well. The difference between the three indicator organisms is that they survive for different periods of time in the environment. *E. coli* survives for about three days, Enterococci about seven to ten days, and *C perfringens* a lot longer. Thus, depending on what microorganisms you find and in what combination, you can work out roughly how far away from the supply the contamination occurred.

Viruses are the smallest microorganisms found in water and are little more than parcels of RNA or DNA. There are several that are known to cause problems in water. Bacteria are a major cause of illness associated with drinking water. PWS are likely to be contaminated with those that can be transferred between animals and man. Examples include Campylobacter and E. coli O157. Protozoa are small unicellular creatures such as amoebae. Cryptosporidium is an example.

The following three sections cover these different types of microorganisms and discuss each of the major disease causing ones.

Viruses

Viral gastroenteritis
Viruses associated with waterborne viral gastroenteritis include Rotavirus and Norovirus. Incubation time is very short, a few hours for Norovirus and about a day for Rotavirus. Onset is abrupt with vomiting, fever and diarrhoea. The illness usually lasts a day or two. The illness stops by itself and medical help usually consists of the replacement of fluids.

Viral hepatitis
The most common hepatitis virus associated with PWS in the UK is Hepatitis A. Hepatitis is inflammation of the liver. The virus is usually found in surface water sources with faecal contamination upstream. Hepatitis A survives for a long time in water and it is highly infectious. The incubation period ranges from ten to fifty days.
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Bacteria

Campylobacter
Campylobacter is the most common cause of bacterial gastro-enteritis in the UK. The disease usually produces mild, watery diarrhoea but can cause severe inflammatory gastro-enteritis. It has also been thought to be a factor of Guillain-Barre's syndrome, which is a paralytic condition like polio. The abdominal pain can occasionally be so bad that it can be mistaken for appendicitis. Campylobacteriosis normally only lasts two to three days but can be longer. The disease is usually self-limiting and replacement of fluids is generally the only treatment necessary. It will however, respond to antibiotics.

Escherichia coli
This organism is not only used as the main indicator of pathogenic organisms in water but it is increasingly becoming a pathogen in its own right. Interest in Escherichia coli

has been high for some time, following a major food poisoning outbreak in Scotland in 1996, which caused twenty deaths. This outbreak was associated with the toxin producing type of *E. coli* known as O157:H7, which has gone on to become infamous worldwide. However, there are many other strains, many of which will not cause illness. Nevertheless WHO recently identified over one hundred *E. coli* serotypes that do. The various illnesses caused by the organism are watery diarrhoea, stomach cramps, septicaemia and haemolytic uraemic syndrome (HUS). HUS is very serious and causes acute kidney failure. Once it begins there is no formal treatment for it. Onset times range from eight hours to four days depending on type, as does the duration of illness, which varies from twenty-four hours to several weeks. Younger people appear to be much more likely to develop HUS if infected.

The main reservoir for *E. coli* O157 is the intestines of healthy cattle although all mammals can carry it. Where there is the possibility of PWS being contaminated with rainwater washing cattle excreta into the source, *E. coli* may be a problem. Typical free residual chlorine levels of at least 0.5 mg/l following standard water treatment will inactivate them as will correctly fitted and maintained UV treatment systems. Those responsible for small supplies have to be careful that the spreading of slurry does not contaminate the water and that farm animals are kept away from the source.

Protozoa

Cryptosporidium
This organism is found in many animals. It is excreted from hosts in cyst form, known as an oocyst. The oocyst is very hardy and can live in the environment for many months. There is no specific treatment for cryptosporidiosis. In healthy patients the organism causes an unpleasant, self-limiting, gastrointestinal illness that may last up to twenty-eight days, but is usually of seven to fourteen days duration. Amongst the immuno-compromised however, it can be life threatening. Two thirds of those in the UK who contract cryptosporidiosis are children. The infective dose is considered to be below ten oocysts and some experts think it may be as low as one.

Cryptosporidium is popularly, but wrongly, thought to be exclusively associated with water. In fact cryptosporidiosis is commonly associated with direct contact with animals or their faeces, for example when children go on educational visits to farms or indirectly via raw milk.

Because the cell wall it is very tough, *Cryptosporidium* can withstand massive doses of chlorine (20,000 mg free residual chlorine per litre), doses that would easily inactivate other organisms. Ultraviolet disinfection is becoming a popular method for Cryptosporidium deactivation; it can be successful in both medium and low-pressure units. Because of the cost of laboratory identification, routine monitoring for oocysts in PWS is not carried out.

Because of the poor protection of many small supplies, during times of heavy rain, particularly those following dry periods, faecal matter containing *Cryptosporidium* oocysts will be washed into the water system. It is likely that the organism may contaminate many small supplies. This is due to a variety of reasons including the proximity of farm animals to many supplies in remote rural areas, their inadequate protection, the lack of treatment and disinfection and the inability of most small-scale treatment systems to remove the organism. It has been argued that people who regularly drink water from a small PWS will become immune to *Cryptosporidium*. However, people visiting farmhouses, campsites or other isolated dwellings using small water supplies will still be at risk.

Giardia

This organism causes a severe diarrhoeal food poisoning-like disease called giardiasis. Cysts of *Giardia* are passed out in animal faeces and swallowed via water or food in the classic faecal-oral route. Symptoms are acute diarrhoea - which is often explosive, abdominal cramps, bloating and flatulence. Unlike cryptosporidiosis, giardiasis can be treated.

Many of the properties and problems of *Giardia* are similar to those of *Cryptosporidium*. It is found in many animal species. It is more resistant to treatment by chlorine than coliforms and is capable of survival in the environment for long periods of time. Incidence of giardiasis has often been associated with drinking from surface waters and it is also likely to be found in poor quality PWS. The presence of *Giardia* is much more prevalent in the autumn than other times of the year.

Chemical Problems

Water is often referred to as the universal solvent and it has the ability to dissolve virtually everything with which it comes into contact. After rainfall, the water passes into the soil. As it passes downwards, it comes into close contact with soil and rocks and will dissolve chemicals from the geological structure. It is a general rule that the lower the pH of the water, i.e. the more acidic it is, the greater will be the amount of chemicals that can be dissolved from the soil and geological deposits. Fortunately a lot will not do you any harm and some (essential elements) are good for you. Where there are chemicals in your water, if they are not beneficial, there are maximum amounts allowed in the water. These maximum amounts err on the side of safety and most upper limits for chemicals (the maximum allowable concentration or MAC) have a large built in safety factor.

The following sections discuss some of the more important chemicals that may be relevant to PWS. The MAC is given with a description of the chemical, its effects on health and the likelihood of finding it in PWS. The sections begin with an alphabetical list of inorganic chemicals (often considered the more “natural” contaminants of water, such as iron, manganese and arsenic), followed by organic chemicals, which are often the man-made ones that are associated with health concerns e.g. disinfection by-products or industrial solvents, and then radioactive chemicals such as radon. It concludes with a discussion of the physical attributes of water (also know as aesthetic problems) such as hardness, conductivity and pH that will affect the quality of water generally but are not confined to the effects of a single chemical.

It is not possible to discuss every single contaminant of water in this guide; only the major, regularly found contaminants are discussed. The “bible” of water safety is the WHO online drinking water guide, if you need further details or need to check on any up to date situation with any chemical in drinking water you should consult its website. http://www.who.int/water_sanitation_health/dwq/guidelines/en/index.html

Inorganic chemicals

Aluminium
UK maximum concentration allowed: 200 µg/l
WHO Guideline Value: None set – complaints will be expected at 200 µg/l

WHO classes aluminium as an aesthetic rather than health-related contaminant. They state that there is little evidence that orally ingested aluminium is acutely toxic to humans. High amounts can be reduced to acceptable levels with treatment systems that raise pH and cause the metal to precipitate out. This can then be removed by physical filtration or settlement.

Arsenic
UK maximum concentration allowed: 10 µg/l.
WHO Guideline Value: 10 µg/l for excess skin cancer risk of $6x10^{-4}$.
Arsenic is an acute poison. It occurs naturally and can be found in untreated water that has passed through arsenic-rich rocks, particularly certain types of sandstone. Arsenic is not a major problem in the UK, although it can be found in some aquifers in the Midlands and the Northwest. Where arsenic has been found in drinking water, the first option should be to identify an alternative source. Another option is to blend the water with arsenic-free supplies to lower the overall content to an acceptable level. Treatment systems to remove arsenic in small supplies are available but are not simple to use and need maintenance and care in operation. Where alternative sources are not available, it may be appropriate to separate water for drinking from water used for other purposes such as washing and flushing the toilet. Bottled water could then be used for drinking.

Calcium
UK maximum concentration allowed: No standard set in legislation.
WHO Guideline Value: None set.

Calcium is a natural trace element and is needed for bone and tooth development, particularly in children. Calcium is obtained from water and food and as it is a component of water hardness, it is removed when water softening is applied to reduce damage to plumbing systems. Where potable water is softened, a supply of unsoftened water from upstream of the softening unit should be retained for potable purposes.

Fluoride
UK maximum concentration allowed: 1.5 mg/l.
WHO Guideline Value: 1.5 mg/l.

Fluorides occur naturally as mineral constituents of the rocks in the earth's crust. High fluoride intake causes mottling of teeth. Above 5 mg/l pitting of teeth occurs and in extreme cases, there may be brittleness and damage to bones (fluorosis). WHO has found no convincing evidence that fluoride is carcinogenic and considers that its guideline value will prevent any ill-health problems. Removal of naturally occurring fluoride has been carried out with activated carbon or activated alumina.

Iron
UK maximum concentration allowed: 200 µg/l.
WHO Guideline Value: None set – complaints will be expected at 300 µg/l.

Iron is classed as an aesthetic contaminant with no particularly harmful effects at the concentrations normally found in water. It is an essential trace element. An excess of iron can cause a bitter taste in water and will stain clothes and sanitary fittings brown. WHO considers that levels up to 2 mg/l of iron in water will not present a health hazard. The solubility of iron, as with many other contaminants of water, is bound up with the pH of water. This property however provides a useful way to remove iron from water. Raising the pH of water will cause iron to precipitate. This can then be physically removed by a filter or sedimentation.

Lead
UK maximum concentration allowed: 50 µg/l in PWS, 25 µg/l in public supplies reducing to 10 µg/l from 25th December 2013.
WHO Guideline Value: 10 µg/l (other measures to reduce total lead exposure should also be taken).

The health problems associated with lead are well known. Lead is toxic to both central and peripheral nervous systems. Prolonged exposure may lead to serious neurological damage, especially in children and pregnant women. Lead has been associated with ischemic heart disease, hypertension, renal insufficiency, gout, premature birth, impaired cognitive ability and behaviour problems. The problem is not that the water normally picks up lead from geological deposits but that it dissolves it from the inside of old pipes, particularly when the water has stood for some time. Lead pipes are no longer fitted because of the dangers associated with them. PWS often have much more acidic water than is provided in public systems. This can result in significantly higher levels of lead in the water. In the UK, this is particularly true of moorland areas where the water is very acidic. Although the problems in water are mainly from lead piping, there are certain geographical areas that contain lead-rich geological formations. Some parts of the UK (West Yorkshire, Derbyshire and Cornwall) have significant lead deposits.

Where lead is a problem the obvious remedy is to remove all lead piping. Installing a water treatment system will remove lead but it is a secondary choice. Obviously, if the source of the lead is the groundwater itself, then apart from finding an alternative supply, treatment is the only option. In the short-term, householders should be encouraged to drink bottled water until the treatment or an alternative supply is connected. This is particularly important if there are young children in the household.

Manganese
UK maximum concentration allowed: 50 µg/l.
WHO Guideline Value: None set – complaints will be expected at 100 µg/l.

Manganese is not regarded as a health-related contaminant of water. Manganese thus is an aesthetic contaminant and high levels cause staining of household utensils and sanitary fittings, as well as imparting a metallic, bitter, astringent or medicinal taste to the water. If a treatment system is fitted that raises the pH, and creates oxidising conditions in the water, the dissolved manganese will form a solid precipitate that can be removed by filtration or sedimentation.

Nitrate
UK maximum concentration allowed: 50 mg/l as NO_3.
WHO Guideline Value: 50 mg/l as NO_3.

Nitrates are naturally occurring and are readily soluble in water. Nitrates are vital for normal growth in plants. The majority of PWS where nitrates may be a problem are in arable areas or regions with large farm animal populations. East Anglia and the south of England are particularly prone to high concentrations of nitrates in water. The principal risk associated with excessive consumption of nitrates is methaemoglobinaemia or 'Blue Baby Syndrome.' This only affects very young babies. The last case in the UK was in 1972 and the water causing the problem was from a highly polluted, sewage-contaminated private well. To prevent the possibility of illness it is recommended that babies under six months do not drink water with high nitrate content.

Results of a number of epidemiological studies have implied an association between nitrates and stomach cancer. In its "Background Document for Development of WHO Guidelines for Drinking water Quality"[3] WHO states that there is no convincing evidence for an association between nitrite and nitrate exposure via drinking water and incidence of gastric cancer.

Where the nitrate concentrations in water are such that treatment is thought necessary, treatment using nitrate specific ion-exchange resins or, blending with a low nitrate source of water should be considered.

Organic Contaminants

There are a number of organic compounds in water that arise from source contamination or are produced by reaction with chlorine during treatment. A number of these are known to present a risk to health at high concentrations. The more important ones in drinking water are described below.

Disinfection By Products (DBP) and Trihalomethanes (THM)
UK maximum concentration allowed: Trihalomethanes 100 µg/l.
WHO Guideline Value: Values are set for individual disinfection by-products, these range from 200 µg/l (chloroform) to 1 µg/l (trichloroacetonitrile).

Disinfection by-products are a group of chemicals formed during disinfection (mainly with chlorine) of drinking water containing naturally occurring organic substances. The main group attracting interest is the trihalomethanes. Although some disinfection by-products have been found to cause cancer in laboratory animals, the studies relate to concentrations greatly in excess of what is normally found in drinking water. Numerous epidemiological studies have been made in relation to drinking water exposure but there is no conclusive evidence that exposure via drinking water causes actual disease in humans.

There is certainly potential for production of THM in a PWS, especially because the control of chlorination levels will be less accurate than for public water supplies.

[3] Nitrite and Nitrate in Drinking water. Background Document for Development of WHO Guidelines for Drinking water Quality. WHO 2007.

However, THM formation is relatively slow and a typical PWS may not have the long retention time of many public water supply systems. Where high concentrations of THM are identified in a PWS, the solution may be better control of chlorination or the use of an alternative disinfectant.

Pesticides
UK maximum concentration allowed – individual pesticides 0.1 µg/l, total for all pesticides 0.5 µg/l. An individual lower limit has also been set for pesticides considered to be particularly toxic.
WHO Guideline Value: Values are set for individual pesticides.

Pesticides have become a very emotive issue. All pesticide compounds potentially pose an environmental health worry as they are chemically tailored to be toxic. The limits in the 1998 European Drinking Water Directive however, are not health related. It has been suggested that the reason the limits are as low as they are is because the European Union accepted that pesticide contamination should be kept to an absolute minimum. Thus the limits specified were effectively a 'surrogate zero' level. Some pesticides are very long lived and in deep aquifers they may persist for many years.

It is unlikely that pesticides will be looked for routinely in a domestic water sample. It is important therefore that risk assessments identify potential sources and that the risks are reduced by keeping any agricultural chemicals well away from the source of the supply. Reverse osmosis and granular activated carbon treatment systems can remove pesticides.

Polynuclear or Polycyclic Aromatic Hydrocarbons
UK maximum concentration allowed: 0.1µg/l.
WHO Guideline Value: Values are set for individual chemicals.

Polynuclear aromatic hydrocarbons (also referred to as PAHs) are widely found in the environment and most human exposure is via food and air, rather than water. Some have been found to be carcinogenic to laboratory animals. PAHs in water are usually associated with the degradation of coal tar pitch linings in water pipes. Many cast iron water mains laid between the beginning of the last century and the 1970s were lined with coal tar pitch.. Bitumen-lined pipes are now used instead and these have considerably lower amounts of PAH. PWS that are over thirty years old and have long runs of iron pipe work may contain PAHs. Where a problem is found and the MAC is being consistently exceeded, the pipes should be replaced or relined with a modern material. The latter option will only be economically viable for systems with very long runs of cast iron supply pipes.

Radiochemicals

Radioactive Contamination
WHO Guideline Value: Gross alpha activity 0.1 Bq/l, gross beta activity 1 Bq/l.
UK maximum concentrations allowed –total indicative dose for radioactivity (including gross alpha and gross beta activity) of 0.1mSv/year.

Levels of radioactivity are measured in becquerels (Bq). The WHO has advised that the best way to limit radiation exposure would be to measure the total combined activity. The WHO limits for water are considered to be very precautionary.

Radon
No standard set for UK concentration or WHO guideline value.
Draft European action level: 1,000 Bq/l.

Radon is a colourless, odourless gas. It is highly soluble in water and is easily given off if the water is aerated. Groundwater picks up radon as it passes upwards through small spaces between particular rocks where the gas is produced. Boreholes usually carry a higher load of radon than spring or surface supplies.

Radon normally comes from two different types of rock. The principal source is granite, where the rocks contain naturally occurring uranium; the other is highly fractured limestone. Radon can occur in limestone areas, due to large-scale natural underground drainage that allows water from deep aquifers containing radon to reach the surface quickly. Radon presents a greater health risk via inhalation, rather than ingestion. It attaches to airborne particles that then lodge in the lungs. Radon may be a problem in kitchens and bathrooms of houses using private boreholes. Where problems are found the first consideration would be adopting an alternative supply. If this is not possible aeration and GAC filters will remove radon.

The European Union (EU) has proposed that

- for private water supplies that are part of a commercial or public activity (for example, a hotel or bed and breakfast) remedial action should always be taken when the radon concentration exceeds an Action Level of 1000 becquerels per litre.
- for individual water supplies (no commercial or public activity) consideration should be given to remedial action when the radon concentration exceeds an Action Level of 1000 becquerels per litre.

This Action Level of 1000 becquerels per litre is set so that the risk to a typical person drinking such water is similar to, but probably a little lower than, the risk which would arise from breathing air which contains radon at the Action Level of 200 becquerels per cubic metre. This comparison takes account of the different way that radon affects the body if swallowed, compared to being breathed in.

All exposures to radiation are assumed to carry some risk, though the risks from very low doses are very small. The Action Level does not mark a boundary between safe and unsafe, but rather a level at which action will usually be justified. Some people may choose to take action when the Action Level is approached. Further information on radon in PWS is available from the Health Protection Agency[4].

[4]www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/Radon/radon_RadonInDrinkingWater/

Uranium
UK maximum concentration allowed – no standard set, but there is a total indicative dose for radioactivity (including gross alpha and gross beta activity) of 0.1 mSv/year.
WHO Guideline Value: 2 µg/l provisional value set for acute chemical effects. No value set for radioactivity.

Uranium is a radioactive element found naturally in the earth's crust. It can be a health problem as a toxic chemical, causing damage mainly to the kidneys in excessive amounts and as a radioactive element with carcinogenic properties. Where problems are found an alternative source should be sought. If this is not possible, expert advice should be sought as this problem is not common. GAC, reverse osmosis and ion exchange are all possible treatment systems.

Physical Parameters

Conductivity
UK maximum concentration allowed: 1500 µS/cm at 20^{o}C
WHO Guideline Value: None set for conductivity but 1000 mg/l for total dissolved solids.

Conductivity is measured to give an idea of the amount of dissolved chemicals in water. Conductivity is measured in micro-siemens per centimetre (µS/cm) at 20^{0}C. WHO guidelines do not mention conductivity but there is a guideline for total dissolved solids (TDS). They both measure roughly the same thing, so a standard for either is quite satisfactory. Conductivity is not a problem in itself and because it is above a certain level does not mean that the water will cause ill health. When the conductivity of the water suddenly goes up, it may indicate that a pollution incident has happened and, as with turbidity, suggests other contamination may now be in the water, particularly pathogenic organisms. This often follows a sudden bout of heavy rain, but may also indicate that chemical contamination has occurred.

Hardness
UK maximum concentration allowed – no standard set in legislation.
WHO Guideline Value: None set.

Hardness is the property of water that makes it difficult to get lather when using soap. The hardness or softness of water is usually related to the amount of calcium but it is also caused by magnesium salts. All natural water sources contain some of these elements, so that all water has some hardness. Water that has less than 60 mg/l of calcium carbonate or its equivalent is considered to be soft water. Hardness levels of greater than 200 mg/l may cause scaling in kettles and damage to hot water systems. There are two types of water hardness, temporary and permanent. Temporary hardness is removed when the water is boiled, permanent hardness is not removed by boiling.
Hardness is dependent on the type of rock the water has passed through. In England, most water southeast of a line between Scarborough and Lyme Regis is classed as hard to very hard. The rest is a mixture of slightly hard – the Midlands and Lancashire, and soft – Devon, Cornwall, West Wales, Yorkshire and Cumbria. In Scotland and Wales, water is usually soft.

Soft water tends to be acidic and aggressive towards plumbing systems and will dissolve copper, lead and zinc from pipes and fittings. WHO has not set a guideline value for hardness, as water hardness is not considered to be a health issue.

Water softeners are ion exchange units and they often replace the calcium and magnesium ions in hard water with sodium ions. High sodium intake may be of concern for a number of reasons but some will nevertheless want to soften their water. It is important that if this is done, a supply of unsoftened water from upstream of the softening unit is provided for drinking and cooking.

Hydrogen Ion concentration or pH
UK maximum concentration allowed – 9.5 pH value
UK minimum concentration allowed - 6.5 pH value
WHO Guideline Value: None set, although skin problems occur at levels greater than pH 11. Optimum range is between pH 6.5 and 9.5

The pH scale is a measure of water's acidity. Water with a pH of three or less is highly acidic and with a pH of ten or above, very basic. 'Pure' water has a pH of 7; this is classed as being neutral. If the pH is above 7 this will be due to the rock the water has passed through, probably limestone or chalk. It also indicates that it will probably be hard water with high concentrations of calcium or magnesium. If the pH is low, it is likely to be soft water and therefore may be aggressive to plumbing installations. It will also have greater potential to dissolve dangerous chemical salts than neutral or basic water.

Taste and Odour
UK maximum concentration allowed for both taste and odour: 3 dilutions at 25^{o}C
WHO Guideline Value: None set.

Water readily takes up unpleasant chemical tastes and odours. These may be apparent at the tap or when the water is heated. Strong tastes or odours make the water unfit to drink. In rare cases this may be due to toxicity of the chemical causing the taste or odour but more commonly it is unfit by virtue of being unacceptable to the consumer. The standards for taste and odour are expressed as a dilution number, i.e. the water should no longer taste or smell of the contamination after it has been diluted three times with purified water.

Turbidity
UK maximum concentration allowed: 1 NTU at a treatment works, 4 at the tap of a PWS
WHO Guideline Value: None set – complaints will be expected at 5 NTU

Turbidity is simply the cloudiness of water and is caused by suspended particulate matter. It can consist of silt, organic residues from animals and plants or living organisms such as algae. Turbidity has been recognised as an important measure of water quality for many years. WHO has not set a health-based limit because turbidity, like pH, is not necessarily harmful in itself. However, it does have health-related consequences - the cloudier the water, the more likely it is to contain unwanted chemical and microbiological contaminants. If water is normally turbid it is probably easily contaminated. Particulate matter will also protect microbiological contaminants during disinfection. For disinfection to be effective, water is normally required to have less than 5 NTU (this is a standard measure of cloudiness). WHO has recommended that water should have an average of 1 NTU with a maximum of 5 NTU. This is usually the level at which turbidity will also be noticed in a glass of water. People do not like drinking cloudy water, even if it is safe to drink. As with many other problems in an inadequately protected supply, turbidity is more likely to be present following heavy rain or snowmelt. Thus, if turbidity suddenly goes up, this will indicate that unwanted contaminants may be present and the water should not be drunk without being boiled.

Other problems

Insufficiency
During the summer months PWS can occasionally run dry or have their flow severely restricted. This is particularly so when spring supplies do not tap into large aquifers. Where water usage is restricted or the supply runs dry, not only is there a need to provide an alternative supply of water for drinking but insufficiency may cause health problems due to there being not enough water for washing or flushing the toilet. When supplies run dry there are several alternatives available; short-term measures such as bowsers or bottled water can be provided, voluntary restrictions can conserve supplies or an alternative supply can be located and used. If the existing supply is a borehole, it may be possible to enlarge or deepen the bore. Sometimes increasing the capacity of storage tanks will provide a solution as they can fill up overnight to provide a normal day's supply.

Corrosion
As well as dissolving contaminants that may cause a risk to health, the corrosion caused by soft acidic waters may damage pipes, storage tanks, pumps and central heating systems. These are obviously expensive to replace and so it is best to deal with the cause. Installing treatment that raises the pH to about 7 can do this.

6 Types of PWS

Springs and Land Drains

Some springs come from deep underground where the water has travelled a great distance through porous rock. Others collect water from close to the surface and are regularly contaminated by faecal material. The water may also be a mixture of both. Thus, a spring supply that normally consists of good quality water may sometimes become contaminated in times of drought or due to changes in underground water movement.

The problem with a spring is essentially one of getting water from where it emerges into a pipe, while excluding contamination by soil, animals or birds. There are two main methods. One is to push the pipe up the hole or to dig into the rock for a while and then position and protect the pipe. The other is to build a collection chamber at the point where the spring emerges and have an outlet from the chamber attached to the pipe leading to the tap. Whatever method is chosen, the water should be protected. Collection chambers should be made of impervious material such as engineering brick or concrete, with a watertight, substantial lid, locked in position. The top of the chamber should be at least thirty centimetres above the surrounding ground level to prevent floodwaters entering. The collection chamber will also need an overflow pipe. The overflow pipe should have fine metal mesh around the end to prevent access for insects, leaves, litter and small animals. See Fig. 1.

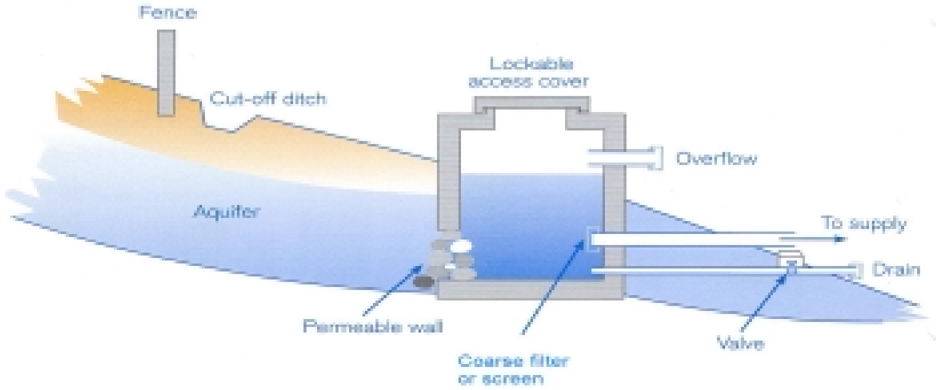

Fig. 1
Spring Protection

The other method is not recommended but the pipe should be pushed as far into the spring as possible. It should be securely fixed in place and covered to prevent mechanical damage with a large concrete apron sloping towards ground level. The concrete must be skimmed to provide as smooth and waterproof a surface as possible. It is important that there are no flat areas that allow ponding. Where the hillside has been dug into to find a more solid and better-protected starting point for the pipe, similar methods are used. The concrete should extend as far as possible. This should be at least two metres. Where the spring is connected directly into the pipe there may have to be a pressure release point or overflow further down the system. Suitable access points and rodding eyes should also be incorporated into the system.

All springs should be surrounded with a stock-proof fence at least four metres away to keep animals out. There should also be a small ditch around the spring, just inside the fencing. It should be lined with impervious material. This is to collect any rainwater running downhill from above the source and channel it around the spring and away. It is placed inside the fence to stop it attracting animals as a watering hole. See Fig. 2.

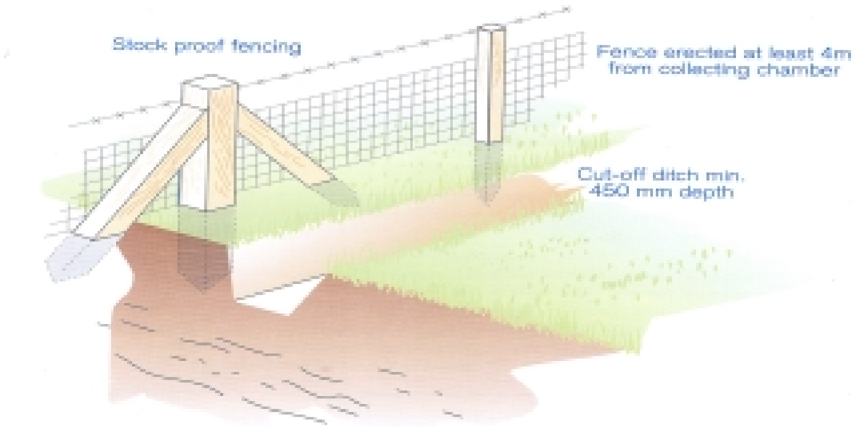

Fig. 2
Fence and ditch detail

One type of “spring” supply that is sometimes encountered is, in reality, an old land drain. Land drains are butt-jointed clay pipes or plastic pipes with holes cut in them. Older ones can also be made with stone slabs or flat rocks protecting the sides and top of the trench. They are usually laid in a ‘herringbone’ pattern, at a small distance underneath the surface of badly drained fields. They collect the rainwater and channel it to the bottom of the field where it runs downhill until it meets a stream or a more permeable surface layer. This can then look like a spring supply. Because land drains collect water from just under the surface, as soon as there is a downpour the droppings of any animals grazing in the field are washed into the land drain, contaminating the water supply.

Other types of supply that are occasionally encountered that are wrongly called springs but are not include: chambers dug in boggy ground to collect the water and in at least one case, water tailings from an old lead mine.

Wells

Wells are one of the best-known and most traditional forms of PWS. Most are about a metre in diameter, normally over 100 years old and they tend to produce water of poor quality. Constructed by hand, the digging would proceed downwards until a water-bearing layer of rock was found that produced an adequate supply of clean water. See Fig. 3.

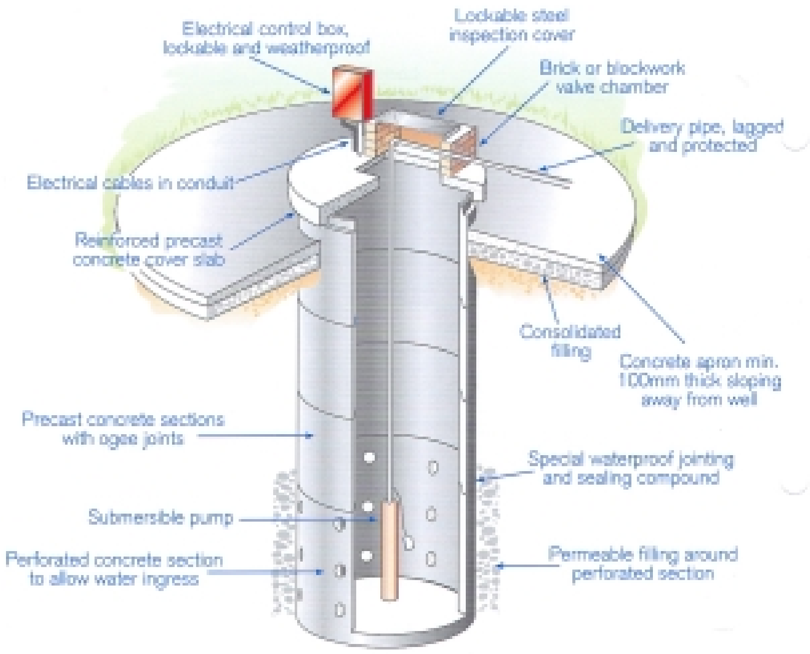

Fig.3
Well and pump details

It is rare for a well to be regularly maintained, so if a portion of the wall has collapsed, particularly below ground level, it will probably not have been repaired and the area where the collapse occurred may provide access for polluted water. It will also cause soil and debris to be washed into the well. Wells are usually left to look after themselves until a major problem occurs. It is unlikely that they will have been cleaned nor will the bottom layer of silt and detritus have been periodically removed.

A well that has an inadequate lining can sometimes yield a mixture of different waters if it has passed through several layers of permeable and impermeable rock during construction. Occasionally, during drought conditions, the water in one or more of the layers will dry up or have a reduced flow. This can have a major effect of the quality

of the water. In some instances the effect on water quality may be so severe that the treatment system will no longer be able to cope.

Another problem with certain wells and boreholes is that iron bacteria build up at the bottom of the well. They grow by metabolising the naturally occurring iron in the water. When the bacteria die off and decompose they give off a sulphurous ‘rotten eggs’ odour to the water. Although it is not toxic, it is very unpleasant to drink or bathe in. The usual treatment for this problem is to periodically put sufficient chlorine into the well to kill the bacteria. This is called shock or super-chlorination. Another method is to introduce heating elements or steam pipes into the water to raise its temperature sufficiently to kill the bacteria. Treatment has to be repeated periodically as the numbers tend to build up regularly. Treatment systems can be installed to remove taste and odour problems from private and small water supplies but iron bacteria will often test the capabilities of the most efficient treatment systems.

Boreholes

The usually reliable microbiological quality of water from boreholes makes them a good source of water. In a deep borehole, water has been filtered by the underground rock structure and any bacteria should have died off. The borehole, which will be drilled by a specialist company, may be 30 metres or more deep. It consists of a narrow hole, typically 100 or 150 millimetres across. The company’s experience and skill usually ensure that the water is protected from contamination. It is important to check that the borehole drillers are dedicated to good practice, particularly the sterilisation of the drill bit before and after drilling.

When a borehole is drilled, it is important that the depth is sufficient to provide enough water for year round needs. Ideally the amount of water drawn out of an aquifer by a well or borehole should be in balance with the amount flowing in. When too much water is extracted, this is known as water-mining. Other than the effect on crops and other boreholes, this will eventually lead to the supply drying up and it may have to be abandoned or re-drilled.

It is also vitally important that the people drilling the bore hole make sure everything is kept as scrupulously clean as possible, that they wash their hands after visiting the toilet, prevent animal manure falling down the hole and make sure equipment is clean and sterilised.
Rather than just picking somewhere at random, hydrogeological maps can be useful when drilling boreholes, as can knowledge of the local area. The initial cost of drilling a borehole is high, so it is best if the first bore is the only one.

When the drilling is complete, samples of the water need to be taken to check the water's bacteriological and physico-chemical characteristics. The bacteriological quality should be good but sometimes groundwater is high in certain chemical contaminants. These are usually aesthetic, such as iron or manganese, but sometimes borehole water will contain chemicals that may present a risk to health.

The testing of the water, both for quality and quantity, should go on as long as possible to mimic the expected normal operating conditions of the borehole. Three days or more is recommended as a minimum. When a borehole is drilled, sheathing is installed to prevent water from higher levels getting into the drinking water. This is particularly important where a higher, more easily contaminated aquifer is bypassed to reach a deeper, purer water source. A suitable watertight packing material should be used to protect the water supply between the sheathing and the actual hole in the ground (this is known as the annular ring). In the bottom portion of the borehole, where the aquifer provides the water, the sheathing has to support the surrounding rock structure (unless it is self-supporting) but has to be sufficiently permeable to allow enough water in.

A permanent pump has to be connected when the borehole is finished. This is either located in a purpose-built structure above the borehole or is a submersible pump that is lowered to the bottom of the hole. With submersible pumps, the head works will be smaller and consist of an access point, the sheathed electrical wires entering the bore and the water pipe leaving it. See Fig. 4. As with all water sources, it is important to protect the head works of the borehole from risk of contamination and physical damage. See Fig. 5. It should for example, be sited away from traffic, so that it does not get damaged. The borehole head works should also be raised to prevent accidental ingress by floodwater. Animals should be kept away and the housing and covers kept locked so that access is restricted.

As well as excluding bacterial contaminants from the borehole, it is very important to ensure the iron bacteria do not get into it as contamination on the bit from a previous drill. Any bacteria must be removed and this can only be done by physically removing the dirt and then soaking the bit in a strong chlorine solution. This will not only remove pathogenic organisms but also the iron bacteria that would otherwise multiply at the bottom of the bore.

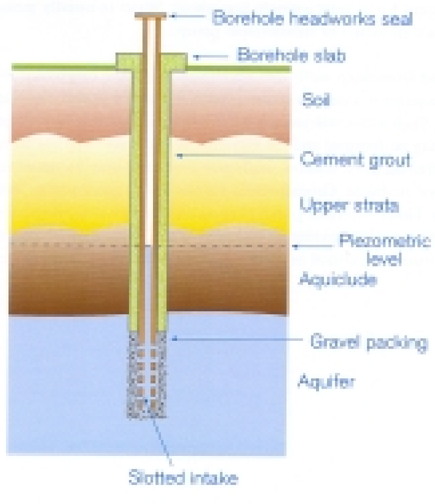

Fig.4
Borehole headworks

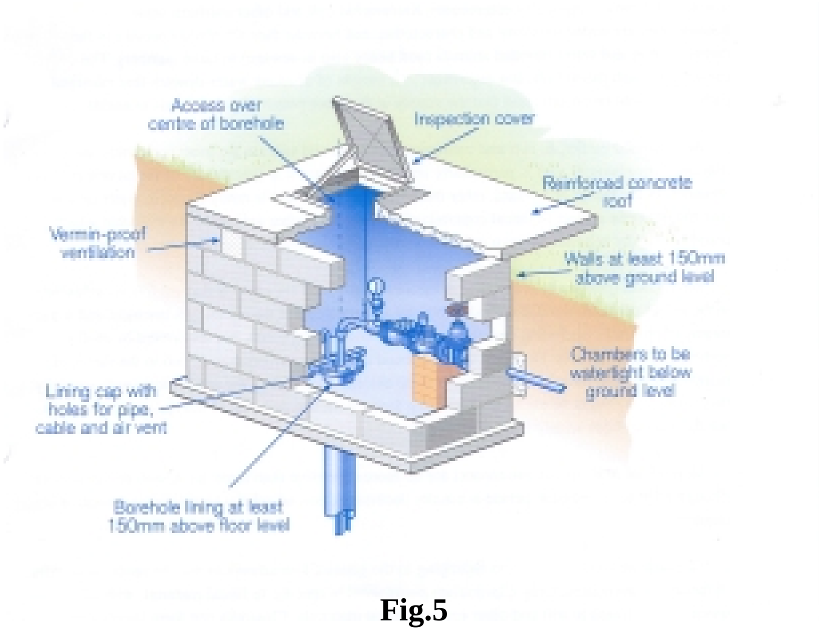

Fig.5
Borehole construction

If a borehole is abandoned it is important to ensure that it is properly capped to prevent any future contamination of the aquifer. If this is not done, it becomes an easy route for contamination from the surface to pollute the aquifers below. When an aquifer becomes polluted, particularly from fuel oil or organic chemical spillage, it is virtually impossible to entirely clean it up. Pouring concrete down the abandoned hole or using impervious clay or other suitable local materials can prevent this.

Surface Water

Surface water supplies use water from lakes, streams and rivers and should only be used as a last resort. The water from surface sources will usually be of poor quality as any open body of water is subject to pollution from birds, run-off from fields along the banks, as well as point sources of pollution such as sewage works effluents. Water quality will often be subject to rapid quality changes, depending on the weather and local pollution sources.

For surface supplies, a pipe is run from the lake or stream nearest the property to the house or a storage tank. The inlet to the pipe should be submerged and fitted with a filter to remove particulate matter. The stream or riverbed can be dug out to a sufficient depth to install an encased box of sand and gravel to act as a filter around the pipe. Ideally, it should also have a fine metal mesh filter attached. This provides further filtering action as well as stopping the sand and gravel entering the supply. When this type of supply is installed, the water should be allowed to run to waste until it becomes clear. Because it is clear however, does not mean it is safe to drink.

A slightly better quality of water can be obtained by a variation on surface water provision. This involves digging a hole in the land next to the lake or stream, close enough for the water to filter through the soil and rock matrix into the receiving pipe. See Fig. 6. The hole should be big enough to allow a sufficient rate of water flow to the pipe. This is called 'bankside filtration' and can be reasonably successful, although it must never be relied on to produce water that can be drunk without further treatment. Again, a fine particulate filter of sand and gravel should surround the pipe and a metal mesh should be fixed on the end.

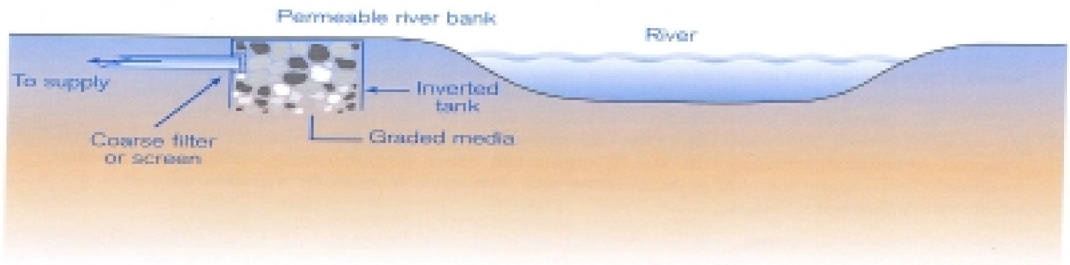

Fig.6
Bankside filtration

Normally an electric pump is used to transfer the surface water to a storage tank above the property. The water is then fed under gravity to the house. Another type of pump that is occasionally encountered is known as the ‘hydraulic ram’. The hydraulic ram uses the power of the mass of the water moving in a stream or river to raise a much smaller amount up a pipe. It can be very useful in areas where electricity is not available. As with the other types of supply employing pumps, the water from a surface supply will need to be kept in a storage tank or pressure vessel. This is so that there is not only a sufficient volume of readily available water in the system when loads are high but also allows the pump to run for a set amount of time to fill the tank.

Roof and Rainwater Collection

Because of the inherent dangers of microbiological contamination, this type of supply is only considered where there is no alternative. The roof is used as the collecting area and the rainwater is channelled via the gutters and down pipes to a storage unit. These storage tanks are only filled during heavy rain. When a major rainstorm begins, the first flush of water goes to waste taking the leaves, bird droppings and other debris with it. After a time, the down pipe is moved so that it runs directly into the storage tank. The water from rainwater collection systems is therefore often of very poor quality and therefore must be used with a reliable disinfection system.

Dual Systems

Sometimes properties will have more than one type of water supply. This can be where a mains water supply is used for drinking and cooking and a PWS used for toilets, watering the garden, animal husbandry and other non-drinking uses. Or it may be that one type of PWS has an alternative supply as a back up in case of drought when the normal supply fails. There is no problem with this as long as both types of PWS are safe to drink. Another possibility that is considered in environmentally aware households, is the use of either rainwater or grey water (once used water such as bath water) for toilet flushing. This practice reduces overall water usage, but the systems must be kept physically separate to ensure the grey water does not contaminate the drinking water. Advice on rainwater harvesting and water reuse may be found in the FWR Guide “Urban Rainwater Harvesting and Water Reuse” (See List of Useful Publications).

Alternative Water Supplies

Sometimes clean water is needed for temporary purposes, particularly emergencies. In such cases, instead of installing expensive or short-term treatment, alternative sources of water can be used. While the problem is being attended to, bottled or boiled water can be used for drinking, washing teeth and preparing food intended to be eaten raw.

In emergencies local authorities or water utilities may provide drinking water bowsers for those on PWS. A bowser is a wheeled container filled with mains water that is taken to the point of use. As with other alternatives, a bowser is a short-term measure and an expensive system of water provision. They are also difficult to clean properly and usually rely on rinsing with highly chlorinated water.

7 Construction and Components of PWS

Source

The source is the spring, well; borehole or surface water from which the water supply is taken. The main aim of any collection system is to take the water from the source without exposing it to contamination. Protection around the source should be sound, robust and designed to remain wind and weather-tight for many years. In addition, a safety protection zone should be established around the source to prevent the water becoming contaminated in the first place. This should normally include a stock-proof fence to keep out animals. There has been some discussion as to how big this zone should be and a pragmatic approach is for a protection zone with a radius of four metres. Whatever the size of the protection zone, it will never be a complete replacement for a final disinfection system, but it will reduce some of the pollution load. It is also important that the various protection mechanisms are regularly inspected and maintained.

Roof water system and surface waters cannot be similarly protected, but effort should be made to protect even these open sources as much as possible.

Storage

If water is stored for any length of time there will be a natural reduction in the amount of microbial and particulate contamination. Most pathogenic organisms will start to die-off. In addition, solid particles will begin to settle out and this will not only remove the particles themselves but as many microorganisms attach themselves to particulate matter, these also will be removed. In fact, public water supply treatment works, where river or surface water is used, often use ‘bankside storage’ to improve water quality before the main treatment processes begin. In PWS that rely on surface water, well-maintained storage will improve the effectiveness of subsequent treatment stages by reducing the sediment load on filtration processes and at the same time reducing the dosing requirement for disinfection.

Pipework

This should be watertight to prevent leaks or ingress of water. It should be made of materials that do not contaminate or taint the water. Such products are listed in Part B of the Secretary of State's List of Approved Products which is published on the DWI website[5] . Pipes must be capable of withstanding the pressure exerted by the pumps or the head of water if the supply comes from some way up-hill of the premises. The pipework should be blue, to indicate that it contains drinking water and should be buried at a suitable depth to prevent it freezing in the winter (normally about 30 centimetres). Modern or renovated supplies will usually have polyvinyl chloride (PVC-U) or polyethylene pipework, which is specifically designed to carry water. Pipes should also be protected from any rodents that may gnaw them. A plan of the pipework and associated storage systems should make it easier to find them in the event of a problem.

Older supplies may have iron pipes, which can become corroded, particularly where the water is soft and acidic. The corrosion may lead to the ingress of contaminated water or leakage with a consequent loss of pressure. A few of the larger PWS may have 1960s or 1970's iron pipes with coal tar linings. These linings have been found to leach Polycyclic Aromatic Hydrocarbons.

Long lengths of garden hosepipe are occasionally used to connect a water source. These are not suitable as they have not been designed to withstand physical damage, nor are they constructed of materials that have been approved for use in contact with drinking water.

Another form of 'pipework' consists of brick channels or small culverts made from large flat stones. These are usually associated with very old supplies. As well as allowing access to small mammals and insects, they tend to cause the ground above them to collapse as the water running through the channel surcharges from time to time and gradually erodes the soil.

Inside the property the pipes will either be made of copper, lead or galvanised iron. Copper pipes may be attacked and leak if the water is acidic. This can be avoided if the pH (acidity) of the water is raised to pH 7 by treatment with an alkali. In the case of lead pipes, the corrosive effect of soft water can lead to dangerously high concentrations of lead in the water, especially when the water has stood for some time in the pipes. Lead pipes are no longer used because of this risk. With galvanised iron pipes, similar corrosion and leakage problem occur. There may also be discolouration of the water from the corrosion products of galvanised iron pipes but this is usually an aesthetic problem, rather than a risk to health.

Pressure Breaks

These are used where the source is located uphill from the premises and the pressure in the lower end of the pipe would tend to burst it or damage the plumbing system. The pressure break relieves this pressure and prevents the possibility of such damage. The normal type is similar to a small storage tank. Water comes in at one end, there is

[5] http://www.dwi.gov.uk/31/ApprovedProducts.shtm

an outlet pipe running to the premises (or another pressure break further down) with an overflow for excess water to run to waste.

Pressure breaks need the same protection measures as storage tanks. They also need regular cleaning to prevent build-up of settled debris.

Storage tanks

The design of the tank and the position of the inlet and outlet pipes are important. If the tank is too small, when it is filled or emptied there may be mixing of the water with re-suspended, settled debris. See Fig. 7. The inlet pipe should be designed to enter below the surface of the water and baffles need to be put in to reduce turbulence and facilitate settlement. If the outlet pipe is positioned too high in the tank, it may remove floating detritus from the water and if it is too low, it may pick up settled debris from the bottom of the tank. Storage tanks should be sized to hold at least a day's supply of water. They should be of sound, robust and watertight construction, neither allowing leakage nor ingress of water. They must be fitted with an overflow pipe that allows excess water to escape. The overflow pipe must have a fine-meshed outer covering to stop birds, insects and small animals from entering.

The tank should have a watertight lid with access to allow cleaning. Where they are sited outdoors, it is also necessary for the lid to be lockable or have a strong iron bar bolted and padlocked over it. There should be a small ditch around the tank to channel rainwater away from the tank. The top of the tank and the lid should be well above ground level so that rainwater and mud will not pond around and over it. Like the water source, a stock-proof fence or strong wall should surround any tank to prevent access by animals.

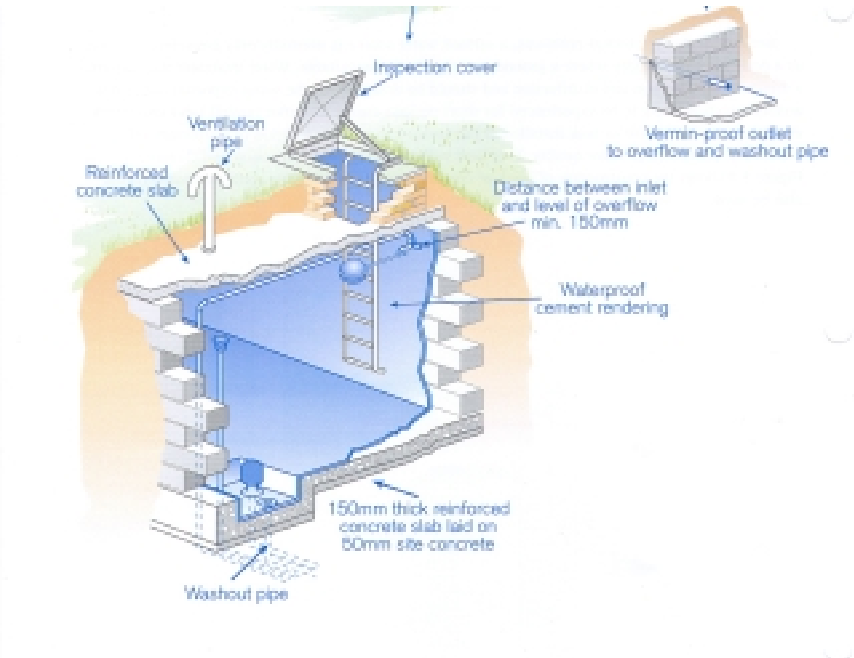

Fig.7
Reservoir tank detail

The storage tank should be regularly maintained, cleaned out, shock-chlorinated and flushed through. The lid should be checked and replaced if damaged, the overflow pipe should be looked at to ensure the fine mesh screen over the end has not been damaged or lost and the fencing should be checked to make sure it is still keeping animals out.

Taps

The final point in the system is the tap. Although most people ignore them for years, the tap may become dirty or contaminated and needs to be cleaned out occasionally. Sometime bacteria and algae build upon the inside of the tap. To make sure water quality is not compromised, they should be regularly cleaned with a small brush or cotton bud, disinfected with a bleach solution and run for a little while to make sure all the loosened deposits have gone. When your supply of water is tested, the person taking the sample will clean the tap to make sure the sample fairly represents the quality of the water and not how the tap has affected it.

Treatment

Unless you are absolutely certain that the water in your PWS is of consistently good quality, it should have some form of final disinfection treatment. Many PWS will be contaminated with a variety of substances and if this is the case with your supply, in addition to disinfection, a more comprehensive treatment system will need to be installed.

Modern treatment systems are effective at removing chemical contamination and dealing with physical problems such as low pH and excess turbidity. It is important when sizing a treatment system to use a realistic estimate of the maximum throughput. Often the estimate is simply based on the flow from the kitchen tap. If a house has a shower, a dishwasher and a washing machine that can all be used at the same time, then a correspondingly larger unit should be fitted so it can cope during times of peak flow.

It is important that the treatment system is tailored to the specific characteristics of the supply, rather than installing an off-the-shelf package that may not provide the appropriate treatment. It should also be borne in mind that a treatment system serving several properties may be more efficient and cheaper to run than separate smaller units for each property. If you share your water supply it may therefore be a good idea to get in touch with your neighbours to see if you can pool resources and save money.
The safety of drinking water always relies on more than one protective measure being in place (the ‘multiple-barrier approach’). Once the chemical and physical aspects of the water are dealt with, some form of disinfection system may be required. Ideally the disinfectant should be chlorine or another chemical that will provide a residual disinfectant action through to the tap. Some find the taste and smell of chlorine unacceptable and there are other effective disinfection methods, such as ultraviolet irradiation, that, if fitted close to the tap, will adequately treat drinking water without leaving any noticeable taste or smell in the water.

The question of whether it is better to have a point-of-entry or point-of-use treatment system must also be considered. A point-of-entry system treats all the water entering a property and the point-of-use system treats just one tap, normally the one used for drinking. The point-of-use unit will therefore be attached to the kitchen tap and fitted next to, or under the sink.

The potential problem with point-of-use devices is that not all the water in the house is treated and there could be a health risk from using other taps, such as when brushing teeth in the bathroom. If the water is disinfected or bacteriologically safe, as happens with some well-protected boreholes, there may be some advantage in using a point-of-use system if nitrate or organic removal is needed. This is because there will be a minimal health risk unless there is prolonged consumption from the other taps in the property. If there are bacteriological problems however, whole-house treatment should be used. It will ensure microbiologically safe water is available to everyone in the house at all times, if maintained properly. Where health is concerned it is better to err on the side of safety.

When considering a treatment system, a reputable installer should be contacted. Many installers are members of the United Kingdom Water Treatment Association (UKWTA) or British Water (see section 12). Local authorities may also have lists of local contractors but being public bodies will not be able to officially recommend anyone.

Use of approved products in distribution systems.

The 2009 PWS Regulations in England and Wales require that all substances and products used in contact with water satisfy the requirements of regulation 31 of the Water Supply (Water Quality) Regulations 2000. This requirement, which previously applied only to public water supplies, now applies to new and replacement units and to all water treatment chemicals used in PWS treatment and distribution systems. This requirement ensures that potentially dangerous chemicals do not leach into water from construction materials or treatment chemicals. It also ensures that construction materials do not promote the growth of bacteria.

When you have treatment fitted or replaced, you should make sure that the installer provides evidence that components of the installation have the necessary approvals. The Secretary of State has a List of Approved Products, which can be viewed on the DWI website: www.dwi.gov.uk. Guidance is also available about other products that do not need official approval but have been tested and found satisfactory (e.g. WRAS – see below). Small surface area components may be exempt from the approval requirements. If you are in any doubt the DWI or your local authority will be able to advise you.

Precautions for avoidance of contamination within water supply systems

The Water Regulations Advisory Scheme (WRAS) promotes knowledge of the Water Fittings Regulations[6] (WFR) throughout the UK. The WFR (or Byelaws in Scotland) are national requirements for the design, installation and maintenance of plumbing systems, water fittings and water-using appliances. Their purpose is to prevent

[6] The Water Supply (Water Fittings) Regulations 1999

misuse, waste, undue consumption or erroneous measurement[7] of water and, most importantly, to prevent contamination of drinking water.

Although the WFR are primarily for public water supplies, where there is "further distribution of public water supplies" by a second party, regulation 8 of the 2009 regulations now makes this situation a PWS. Thus the rest of the regulations apply, including the need for a risk assessment and an altered monitoring regime based on that assessment. The WFR apply also to any premises having both a PWS and a connection to a public water supply.

Nevertheless, even when the circumstances referred to in the previous paragraph do not apply, the advice and guidance issued by WRAS is extremely relevant to PWS. In particular, their Information and Guidance Notes (IGN), which can be freely downloaded from the publications section of the WRAS website[8] provide important advice and contain useful diagrams and figures relating to:

- Commissioning of plumbing systems
- Avoidance of contamination and waste of water
- Separation of mains and PWS
- Connection of storage cisterns
- Avoidance of backflow
- Specific guidance on agricultural premises and holiday and residential parks.
- Use of approved fittings

8 Treatment Systems

Disinfection

There are several disinfection systems applicable to PWS that will remove or inactivate pathogenic organisms. Their effectiveness is usually measured in log (logarithmic) reductions. A one-log reduction implies that the numbers of microorganisms are reduced by a factor of ten. Another way of describing the effectiveness of disinfection is to quote the percentage decrease in microorganism count e.g. a two log removal is equal to a 99 per cent removal and a three log removal is equivalent to a 99.9 per cent removal. Microorganisms are often found in huge numbers and unless there is a substantial reduction by the treatment process, it may make little difference to the chance of infectious disease. For instance, a three-log reduction may sound impressive, but if there were 10^9 (a billion) microorganisms in a litre of water this means that there are still 10^6 (a million) left. For many pathogenic microorganisms, the infective dose may be lower than 10.

The most commonly used disinfection system is ultraviolet (UV) but chlorination, ozonation and ceramic filters are also used. Some system will use two different technologies to increase the level of protection.

[7] Water fittings must not cause erroneous measurement of water supplied by a water undertaker.
[8] www.wras.co.uk/Publications_DEFAULT.HTM

Ultraviolet Irradiation

Ultraviolet (UV) units consist of a long metal canister containing one or more lamps that resemble fluorescent tubes. A well-designed system can eliminate even high levels of pathogenic organisms. UV is usually installed at the end of a treatment system to provide final disinfection. They are electrically powered and are reasonably cheap. UV treatment does not impart taste or smell to the water and is easy to install. For these reasons, UV is a very popular system for disinfecting a PWS.

If the water is turbid and there are suspended particles in the water, or there is a high level of colour in the water, the microorganisms can be physically protected from the UV light. For UV to be effective, turbidity and colour must therefore be low. It is important to have the water tested and to install appropriate pre-filters to reduce particulate contaminants before UV treatment. This is especially important in water sources containing iron or manganese, where the UV treatment unit can become coated with a brown deposit. It may be necessary to install iron and manganese removal as part of a treatment package. In hard water areas, scale can form on the quartz glass sleeve in which the UV lamp is located. This can reduce the effectiveness of the lamp. Treatment of the water hardness or frequent maintenance is essential to ensure effective disinfection.

If the lamp fails, the water from the unit will not be treated. It is possible however, to fit an alarm that alerts the users to this failure. Efficiency will also diminish with time and the lamps have to be periodically replaced. This frequency is typically once a year. The replacement frequency allows for a safety factor to be incorporated, as manufacturers expect most lamps to remain perfectly satisfactory for at least two years. The unit should also have a removable cover or small window to allow periodic inspection to check that the lamp is still operational and not covered by iron deposits.

Chlorination

Chlorine is a powerful oxidant that inactivates pathogenic bacteria and viruses. Salmonella, Campylobacter and E. coli O157 are all destroyed by chlorine. Chlorine can be added to water in a variety of ways: as a solid (calcium hypochlorite tablets or powder), as a liquid (sodium hypochlorite solution) or as chlorine gas. It can also be electrically generated on-site from a solution of common salt.

One of the most important aspects of chlorination is that the chlorine carries on working after being added to the water. The amount of chlorine that needs to be added will depend of the level of contamination in the water. Where treatment is fitted, it is recommended that 0.5 mg/l of chlorine is added with a contact time of thirty minutes, to allow the chlorine to disinfect all the pathogens.

It is better to remove as much of the organic contamination as possible from the water before chlorinating it because this not only reduces the chlorine demand but also reduces fluctuations in water quality. The amount of residual chlorine at the tap should be minimised because chlorine imparts a taste to the water and ideally there should be a non-detectable amount in the water when it is consumed. In practice, 0.1 to 0.2 mg/l has been found to be a reasonable amount at the tap. Levels in excess of 0.5 mg/l are likely to give rise to taste or odour problems. Because a PWS is subject to variations in water quality, the dosage calculations need to take account of the water when it is most contaminated.

Many environmental health practitioners and other professionals have a few concerns about the use of chlorine for PWS. As well as the health and safety aspects, they consider that ensuring accurate dosing and regularly testing for free residual chlorine is a job for specialists. Despite the advantages of residual chlorine, many people feel that systems such as ultraviolet, which can be installed and serviced by trained personnel, are far more effective.

Chlorination is ineffective against Cryptosporidium at practicable dosing levels. Where a supply is likely to become contaminated with the faeces of farm animals, alternative treatments such as ultraviolet irradiation should be considered.

Some water treatment plants use chloramines as a disinfectant. However, chloramines are generated by dosing chlorinated water with ammonium salts and such systems are only suitable for a large PWS where trained specialists are available.

Ceramic Filters
A ceramic filter is usually a small, cylinder of fired clay that physically removes small particles and organisms from a water supply. Clay consists of very fine particles and when fired, the spaces between them are very small and will remove suspended contaminants. Contaminants are collected in the outer pores, as well as the outer surface. Because bacteria tend to clump together and stick to small particles in water, physically removing these particles also effectively disinfects the water.

Ceramic filters require regular cleaning as the filter surface becomes covered with a layer of contaminants. This reduces the flow rate of water passed by the filter, thus alerting the user to the need for cleaning. The filter is then dismantled, scrubbed clean, boiled and replaced. Unlike some treatment methods, ceramic candles are usually fail safe as they eventually block up and the flow of water stops. The ceramic filter can become damaged, but the user will usually be aware of the problem. A more common problem arises when the filter is not refitted properly after cleaning and the raw water bypasses the candle.

Ozonation
Ozone (O_3) is a colourless, acrid gas that is a very strong oxidising agent. It is effective against Cryptosporidium but is unlikely to find application in a small PWS because of cost and maintenance considerations. Large community systems however, may choose to use it where they have particular problems that are not adequately dealt with by other treatment systems.

Contaminant Removal

Water may need to be treated to remove unwanted contaminants that could present a health risk or aesthetic problem. There is a range of treatment systems available but the treatment provided is often specific to a particular contaminant or group of contaminants. No single system is likely to remove all the water quality problems that are encountered. A useful summary of many of the treatment systems that are applicable to PWS can be found on the UKWTA website www.ukwta.org/

Activated Alumina
Activated Alumina is a granulated form of aluminium oxide. Water containing the contaminant is passed through a cartridge or canister of activated alumina, which adsorbs fluoride, arsenic and other contaminants. The cartridge of activated alumina must be replaced periodically.

Activated Carbon
Activated carbon filters remove contaminants from water by adsorption and to a lesser extent by filtration and entrapment. The removal is therefore physical rather than chemical. Activated carbon units have been found to remove a great number of organic chemicals and if there is a specific chemical causing a problem in your supply, activated carbon should be considered. Activated carbon for water treatment is usually called granulated activated carbon (GAC). GAC systems normally consist of a cartridge packed with GAC within a sealed filter unit. Water goes in at one end, passes through the GAC, leaving the contaminants attached to the activated carbon. Many modern carbon cartridges are provided in “block” form in which the activated carbon particles are bonded together with a polymer providing a tighter and more efficient matrix. Some cartridges are available that contain more than one medium for multiple contaminant reduction; for example, a carbon cartridge may also contain an ion exchange medium (see below) to remove organics and heavy metals such as lead.

GAC is normally used as a point-of-use treatment. For many small water systems, pre-treatment may be required to remove suspended matter before it reaches the GAC filter. This will ensure that the cartridges last longer and will work more efficiently.

GAC units are relatively cheap and because of this, owners of PWS may fit one when told they need some form of treatment. It is important to realise that most filters provide poor removal of pathogens and they have a limited life. Some suppliers state that their product should not be used for water that may contain pathogenic bacteria. The assumption being that their filters are intended only for use in public water supplies and cannot cope with the variable quality of PWS. It is very important to take advice from a reliable supplier who is aware of the intended use of the product.

When a GAC filter is first commissioned, it should be tested to assess:

- whether the filtration system can cope with increases in contaminant load following persistent rainfall
- how long the filter will last before needing changing.

When the filter has stopped working, the carbon needs to be reactivated. This will usually be carried out by the supplier. Smaller GAC cartridges are thrown away and replaced with a new unit. Without recourse to expensive monitoring, it is not possible to tell whether the cartridge is exhausted. Therefore it is important to follow the supplier’s recommendations concerning replacement frequency.

The ability of GAC to adsorb organic material creates an ideal environment for microbial growth. The problem of microbial growth increases if the manufacturer's recommended cartridge replacement periods are not observed. The build up of the bacteria also requires that any first flush of water be run to waste.

Aeration
In practice, aeration is most commonly used for removal of hydrogen sulphide (which causes a rotten egg smell) or for iron removal. This is normally achieved in aeration towers with the water passing downwards over an inert media whilst compressed air is pumped upwards and ventilated at the top. Aeration will also remove a significant proportion of the dissolved carbon dioxide that is responsible for the acidity and hence corrosion potential of some types of water. In the unusual situation where water has been contaminated with volatile organic chemicals after a spillage, the contaminants can sometimes be removed or 'stripped' by aerating the water.

Coagulation, Flocculation and Sedimentation
These processes remove particles and microorganisms from water. Because of the expense and need for expert supervision, these processes will only be encountered in large treatment works.
Distillation
Distillation involves boiling the water and then collecting the condensed water vapour. This system produces very pure water but is a very expensive process in relation to other treatment methods. It is most often used where the only available source of water is seawater. Where clean water is a rare commodity, distillation may be used for producing a small amount of water for drinking, personal hygiene and cooking.

Ion Exchange
When chemical salts dissolve in water, they separate into charged particles (positively charged cations and negatively charged anions). Ion exchange units contain resin beads that can remove cations and anions from water passing through the unit. The ions that are removed are replaced with other ions that were previously attached to the resin. When fitting an ion exchange unit, the water needs to be tested when the maximum concentration of the ion is present to ensure that the unit can cope with peak demand levels. A water softening system also needs to be sized to cope with the volume of water required for washing, rather than just for potable use.

Cation exchange units are used as water softeners and also for removal of iron and manganese. Softened water will normally meet the wholesomeness criteria specified in the PWS 2009 Regulations, but a separate tap of unsoftened water should be provided at the kitchen sink for drinking and cooking purposes. Those on a low-sodium diet should also be aware that softening the water increases its sodium content since the ion exchange resin replaces calcium and magnesium ions with sodium ions. Softened water should not be used for drinking if the water hardness is such that the sodium level in the softened water will exceed the 200 mg/l limit[9]. In this situation, a point-of-use reverse osmosis system can be used to reduce the sodium level.

Anion exchange is usually used to remove nitrates.. At the small scale usually encountered in PWS, nitrate removal by other techniques is not economically practicable. The ion exchange removal of nitrate releases chloride ions into the water. This may give rise to taste problems when treating water that is already high in

[9] Building Regulations Approved Document 2010:
http://www.planningportal.gov.uk/uploads/br/100312_app_doc_G_2010.pdf and
WRAS IGN on softeners: http://www.wras.co.uk/PDF_Files/IGN9-07-01.pdf).

chloride. Anion exchange can also remove the mercury ion ($HgCl_3^-$), as well as nitrites, some forms of arsenic and sulphates.

Ion exchange units have to be periodically regenerated. Many units, water softeners included, use a strong solution of common salt (sodium chloride NaCl) for this purpose. This process can be automated and the units consequently need only minimum attention. For PWS, units can be purchased with replaceable cartridges and this eliminates the need for regeneration. Regeneration with common salt to some extent disinfects the resin so microbial growth within the ion exchange unit should not be a problem.

Membrane Filtration
Membrane filters use a thin film of semi-permeable membrane to remove particles, large molecules and microorganisms from water. The term covers a variety of different processes such as ultrafiltration, nanofiltration and reverse osmosis. Membrane filters often work in "cross-flow" mode, with a portion of the feed-water flushing the surface of the membrane. This helps make them self-cleaning, with the unfiltered water removing detritus on the membrane surface. To work efficiently, the water must be low in particulate matter and pre-filters are often used in the treatment of small supplies.

The most common type of membrane filter found in PWS is reverse osmosis. Reverse osmosis can be very effective at removing protozoa (4 log removal), viruses (6.5 log removal) and bacteria (7 log removal). They also remove many contaminant chemicals as well as unacceptable levels of naturally occurring ions such as Sodium or Sulphate. Power is needed to provide a pressurised flow of water to the units so electricity must be available.

Problems associated with reverse osmosis include:

- If it becomes worn or damaged, contamination may pass through imperfections in the membrane. To counteract this, many units are fitted with a cut-off switch that is activated when the pressure drops below a specified level.
- There is a large reduction in water pressure as water passes through the membrane and a very high proportion of the water pumped into the unit is lost in the wastewater stream.
- Reverse osmosis water will be low in dissolved solids and alkalinity so it can be corrosive towards metals (this is sometimes called aggressive water) and installers should make sure pipework is protected from this (this does not apply to ultrafiltration).

pH correction
The pH, alkalinity and hardness of water can be raised by filtration through an alkaline filtration media such as dolomite. Dolomite is a natural sedimentary rock: calcium magnesium carbonate. As well as reducing corrosion, filtration through dolomite also aids removal of iron, manganese and aluminium from acidic groundwaters or upland catchment areas. The filter will eventually start to block up and will need to be cleaned by back washing. This is usually done automatically on a

timed cycle. It is important that where this form of treatment is installed, a regular maintenance programme is in place to ensure consistent quality of the drinking water.

Another benefit of dolomite filtration is a reduction in plumbo-solvency (the ability of the water to leach lead from pipework). Thus the removal of lead from pipes and the general corrosive attack on other plumbing materials such as copper will be reduced.

Radon Treatment
Although not a particularly common problem, where radon is present it can be very worrying. Fortunately, if PWS are found to contain high levels of radon, the removal of the gas is relatively simple, but an expert should be employed to design the system. Various methods using aeration will generally solve the problem. Radon removal can also be achieved by using activated carbon filters. It must be borne in mind when using GAC for radon removal, the equipment should be located as far away from the dwelling as practicable, to ensure dispersal of the gas and accumulated radiation. Disposal of the GAC cartridge must therefore be undertaken very carefully.

Sand Filters
There are two types of sand filter, slow and rapid. Slow sand filters use biological processes to clean the water, and are non-pressurised systems. Slow sand filters use relatively fine sand and do not require chemicals or electricity to operate. They are typically 1 to 2 metres deep, can be rectangular or cylindrical in cross section and are used primarily to treat surface water.

Rapid sand filters use relatively coarse sand and other granular media to remove particles and impurities that have been trapped through the use of flocculation chemicals, such as salts of aluminium or iron. Water flows through the filter medium and the flocculated material is trapped in the sand. In PWS, rapid sand filters are commonly used without flocculation chemicals because of the need for expert supervision and maintenance of the dosing system.

9 Check List for Householders

- Understand your system. Get to know about the different parts of your system. Find out where the source is and any storage systems, what type of treatment you have and who maintains it.

- Establishing ownership and responsibilities. Is the supply just your responsibility, or do you share it with others? Find out about ownership of the source. Are there any papers about it? If the source is on land you do not own, who owns it? What would you do if the owner cut off the supply? Do you have any rights to the water? Is the treatment system shared? If so what needs to happen if it breaks down?

- Protecting the source. Check the source on a regular basis. Is the fence still there, is the lid still well fitting and locked? Are any storage tanks in good condition?

- Ensuring animals are kept away from the source. The biggest causes of illness from PWS are animals such as cows and sheep defecating too close to the source and this manure getting into water supplies. Make sure that this cannot happen to your supply.

- Keeping other causes of pollution away from source and catchment area. Is there a septic tank or landfill site near to the source of your water? These can often cause pollution problems. Try to get them moved or make sure that the effluent cannot get into your water supply.

- Checking the system regularly. Make a note to have a quick look at your water supply on a regular basis. Out of sight is often out of mind, but with PWS it is best to have a quick look to make sure everything is safe every now and again (monthly is suggested). That way if a problem starts, you can quickly get it put right.

- Cleaning the storage tanks. A lot of debris can accumulate in storage tank. It is recommended that every year the tank be drained down, cleaned out and given a thorough disinfection (with sufficient time allowed for the disinfectant to do its job). Then the tank can be refilled and the water run to waste for a little while to make sure that the disinfectant is flushed away.

- Have some form of treatment using a multiple barrier approach. All supplies should have some form of disinfecting treatment. It is not wise simply to rely on source protection and good luck to keep your family safe.

- Regular maintenance. Make sure that your treatment system is regularly maintained (at least once a year). The media in filtration systems may lose its effectiveness, UV lamps can start to run down, membranes may become damaged and pumps may stop working. To make sure the supply is always safe, get a maintenance contract with a reliable company.

- Care of taps. Taps need cleaning as well. Get your plumber to check them over and clean them from time to time.

- If you are concerned, request a risk assessment and monitoring. The local authority has to risk assess and monitor large domestic supplies every five years and all commercial and large supplies annually. They can decide however, not to look at single domestic supplies. Nevertheless, if you are worried about your supply, you can contact them and talk over your worries. If you ask them, they must risk assess and monitor your supply but they may charge you for this. It is always best to be safe and the local authority will have experts on PWS to advise you.

10 Legislation and Role of The Local Authority

Legislation on PWS

The Water Industries Act 1991 ("the Act")
The Water (Scotland) Act 1980 ("the Act" in Scotland)
The Water and Sewerage Services (Northern Ireland) Order 2006.
The Private Water Supply (Scotland) Regulations 2006
The Private Water Supply Regulations 2009
The Private Water Supply Regulations (Northern Ireland) 2009
The Private Water Supply (Wales) Regulations 2010
The Water Supply Regulations 2010

The PWS regulations use a risk-based approach to identify potential problems by risk assessing and then testing the water. Once any problems have been investigated, the supply can be made safe and the water rendered wholesome. Where this cannot be done voluntarily or via temporary agreements (called authorisations) the Local Authority can serve one or more notices requiring works to be carried out to the supply and / or restricting its use. Where this doesn't work the authority can prosecute or carry out works in default (depending on which notice is served).

The regulations are basically

- Stringent for commercial supplies, supplies to buildings with public access and domestic supplies larger than 10 m^3 per day (or that serve more than 50 people).
- Less stringent for domestic only supplies greater than single dwellings up to those serving less than 50 people.
- Virtually non-applicable to single dwellings, unless the owners want them looked at.

In Scotland there are two types of supply – Type A - which are the commercial and large supplies (greater than 50 people or more than10 m^3 per day). Type B are all the rest, including single supplies.

Statutory enforcement for PWS involves both the regulations and the Act (and its Scottish equivalent). In order to follow a logical progression from identifying a supply through to formal enforcement, this section refers to both as appropriate. There are four separate sets of regulations, for the four countries in the UK. They are similar but different and it is not easy to explain them all at the same time. In order to try and simplify this process, this booklet will explain the English Regulations and the regulation numbers listed refer to them. Where the other countries' regulations differ, this will be highlighted. The Welsh Regulations are the most similar, but have a few important differences. The Scottish regulations are much more detailed plus there are additional regulations detailing grant provisions and a separate section on this is included at the end. The Northern Irish (NI) Regulations are quite similar to the English ones but are more specific as to the risk assessment process and there are no charges for work such as risk assessment or monitoring. Requirements that are over and above the English regulations are detailed at the end if not included in the main body of the text.

Local Authorities are the people who enforce these regulations, except in Northern Ireland, where it is the Department of the Environment. The role of the Environmental Health Department is to identify the PWS in its area, arrange for the water to be tested to see if it is safe, carry out risk assessments to find those areas of the supply that need additional protection from contamination and to either advise owners or users of the need to improve the supply or where this fails, to use legal remedies such as serving notices, prosecuting or carrying out the works themselves to bring about an improvement so that the water is safe.

The main government bodies with responsibility for drinking water quality are the Drinking Water Inspectorate (England and Wales), the Drinking Water Regulation Team in the Scottish Executive and The Water Service for Northern Ireland. These bodies are also the overall guardians of PWS. They provide the local authorities with advice and assistance where problems occur.

All drinking water legislation in the UK originates from the 1998 European Union's Council Directive on the Quality of Water Intended for Human Consumption. The aim of the Directive is to protect human health from the adverse effects of the contamination of drinking water.

The Directive requires that all water should be wholesome and clean. Water should be of sufficient quality that someone on the supply is able to drink it for seventy years without any ill effects. The Directive sets water quality standards based on firm scientific principles. Where the science is uncertain, it uses the precautionary principle.

Our parliament translates the requirements of the Directive into UK law - the Acts, listed above. Detailed requirements are then listed in regulations.

The regulations define the water that is covered by these regulations. **Regulation 2** covers water for human consumption, whether treated or not, for drinking, cooking, food preparation, and other domestic purposes including washing and showering. This means that the water to bathrooms must also be safe and wholesome. In Northern Ireland and Scotland the regulations only apply to water intended for human consumption (**NI Regulation 3, Scotland** the **Act section 76HA (2) (1)**)

Obtaining information about the supply

In order to be able to check and report on a supply, the Local Authority will need information about it. Ordinarily, it will not be necessary to require this formally as it can be asked for by letter or during a site visit. However, the Local Authority can require information on anything that is reasonable to carry out their duties. If they need formal proof of these details they can serve a notice under **Section 85** of the Act on the relevant person and in Scotland under **Section 76I**.

This information can include:

- Ownership of land where the source arises
- Names and addresses of "relevant persons"
- Addresses and numbers of people being served by the supply
- Use of the supply - e.g. domestic only, commercial or food production
- Daily volume
- Any other people having an interest in the supply
- Treatment systems used and details of any maintenance contract
- Location of the source

It is an offence under these sections not to comply with these requirements or to provide false information.

Getting Access
When this information is received, the Local Authority can then classify the supply, work out when to carry out the risk assessment and how often to monitor it. They then need to visit the premises. This is normally done by prior agreement. If there is a problem getting access, the authority has powers of entry in **Section 84 (76I in Scotland)** of the Act. If necessary, they can also take a constable with them. If you are worried at all, you should ask for proof of authorisation. If they are legitimate local authority officials they will have it and are legally required to produce it if requested. You can also ring the number on the card, in the phone book or on the council's web site to double check. The officials will be happy with your checking on them as they want to make sure bogus officials are not let in by unwary householders. If entry is needed to domestic premises, 24 hours notice should be given.

Obstruction
It is an offence to obstruct anyone carrying out these duties. Where the officers reasonably expect to be obstructed, **Schedule Six** of the Act allows for a warrant to be obtained from a Justice of the Peace.

Risk Assessment
Regulation 6 says that a risk assessment must be carried out on all supplies except for single property supplies within 5 years of 1st January 2010 and then every 5 years thereafter.

In Scotland, the requirement (**Regulation 16**) is that the assessment should be done within 12 months for Type A supplies. There is no requirement for Type B supplies to be risk assessed but under **Regulation 27** a Local Authority may carry one out, whether or not requested to do so. They should give advice and help to anyone wanting to do their own risk assessment. In England and Wales a risk assessment must be carried out on a supply to a single dwelling if requested by the owner or occupier. The risk assessment must establish if there is a significant risk to health from the water. Most supplies will be classed as high risk due to the way the official forms have been designed. The assessment mainly identifies which parts of the system need attention.

Monitoring
Regulation 7 (**8** in NI, **19** to **26** in Scotland for Type A supplies and **29** and **30** for Type B's) requires that the water to PWS is sampled and tested (except single dwellings, see below).

Mixed commercial and domestic supplies (Type A in Scotland)
Regulation 9 (19 and **20** Scotland) says this testing must be at least annual (more for larger supplies) and consists of two types:

- Check Monitoring - to make sure it is safe and fit to drink.
- Audit Monitoring – to make sure it is wholesome and is basically the same quality as mains water.

The parameters that need to be monitored for both are listed in **Schedule 1 (**Audit) and **Schedule 2** (Check). Frequencies are described in **Schedule 2** and basically are more frequent the larger the volume of water used (**Schedule 3** in NI, **2** in Scotland). The Scottish regulations also make it a duty for the Local Authority to additionally monitor a Type A supply if requested to do so (**22 (5)**).

Whilst the regulations list 17 parameters for check monitoring and 58 for audit monitoring (with a tiny bit of overlap), they allow the sensible approach of:

- For check monitoring: allowing a reduction in monitoring to half the listed frequency for individual parameters if certain conditions are met. These rules are specified in **Table 1** of **Schedule 2** (**Schedule 3, Table A** NI, **Schedule 2, Table 2 (2)** Wales and **Schedule 2, Table A** in **Scotland**).
- For audit monitoring: there is no need to sample for a parameter if it is considered unlikely to be found approaching the maximum allowable concentration (MAC) (**Schedule 2 (3)**, **Schedule 3 (3 (a))** in NI, **Regulation 26** in Scotland). Although Local Authorities often like to err on the side of caution, the fewer parameters tested means the lower the cost is to the customer. Thus it is important they only sample for those parameters likely to cause a problem. However, where parameters are not being looked for, the information provided to the consumers of the water should include a sentence to the effect that if they are worried about these chemicals they can either get the water tested for them themselves or pay the Local Authority to do it.

Domestic only supplies (less than 10m^3 per day or 50 people supplied)

Regulation 10 deals with monitoring smaller domestic premises. Monitoring is mandatory and needs to be done in conjunction with the risk assessment, i.e. once every five years. This is once a year in NI, however, section **10 (3)** states this can be reduced to every 5 years if the results of a risk assessment indicate that is a safe option. A set of 5 parameters is listed in the regulation - pH, turbidity, conductivity, *E. coli* and Enterococci – and they will give a good picture of the quality of the water without being too expensive to analyse. If the risk assessment identifies a particular potential problem, the water should be checked for this as well. In Scotland this list is slightly expanded to include coliform bacteria, lead, nitrates and qualitative taste and odour (i.e. tasting and smelling in the laboratory) **Table C Schedule 2**.

In Scotland the rules are slightly different because there is no separate set of rules for single dwellings. Type B supplies can be monitored if the Local Authority wants to and must be sampled if there is a request from a consumer or the Relevant Person. Where Authorities choose to sample these Type B supplies they can do so as often as they consider is appropriate (**30 (4)**).

If the local authority wants to (as part of its general responsibility to public health) or owners or occupiers request it, they must sample the water supply to a single dwelling (this is not an option in the NI regulations. In NI all the DoE is required to do for single dwellings is to give advice). The list of parameters includes the same 5 parameters as above and anything else found in a risk assessment. The Local Authority can charge for this if requested.

Regulation 11 (**12** in NI) discusses where to sample the water. This is:

- A tap normally used to supply water for human consumption
- If the water is for "food production purposes" – the point where it is used.
- If the water is from some sort of container, the tap on the container.

The other countries' regulations specify a similar set of sample points.

Action on Receipt of Monitoring Results

Obviously, when the results of the monitoring are received the local authority must let those interested in the supply know the results. **Regulation 14** has this duty to inform all the people drinking the water if it is a potential danger to human health (in NI it is **Regulation 15**). They must explain the degree of danger (if possible), and give advice on what to do. If the water is satisfactory, it is enough just to say this, if it is not, the information should be more specific.

Investigations

Where a water sample fails the standards, the Local Authority **must** investigate the failure. This is **Regulation 15**, **16 in NI** and **17** and **18** for Type A supplies in Scotland. For Type B supplies (**Regulation 28** in Scotland) this is not an absolute requirement but Local Authorities can investigate the causes of failures if they want to. The Scottish regulations have more detailed requirements and the regulations require the responsible person to notify all consumers of the problem (Type A only).

When the failure has been investigated and the problem(s) identified, the Local Authority then has to decide what to do. They should involve you in this process. If the problem is due to a fault with the plumbing in an individual property they can just advise the householder. This will usually be to remove lead piping or introduce pH balance in the water to stop it leaching lead or copper from pipe work. It may also include fitting lids and protected overflows to storage tanks.

In all other circumstances they **must** take action as required by this regulation. This can either be:

- Obtain **improvements informally**. This must be a firm agreement and subject to a concerted response by the relevant persons to improve the supply. Lack of progress **must** result in a notice being served. Or;

- Give an **Authorisation** allowing the supply to be brought up to standard within a specified time (as soon as is reasonable but no longer than three years). This cannot be given for any health-related failure of the standards.

The authorisation must be formally applied for and the regulations list what needs to be on the application form, including the details of the supply, the grounds for the application, the plan for improvement of the supply and a timetable. The authority should consult with all people using the supply before granting an authorisation. Authorisations have to be given in writing and all the people using the supply need to be informed of the decision. Authorisations in Scotland are covered in **Regulations 8 and 9** for Type A supplies. Further details about authorisations such as refusals to grant them and publicity follow up to **Regulation 15**. There are no powers to grant an Authorisation for Type B supplies.

Serving Notices
Where the above two options are not possible, the Local Authority **must** serve a notice either under **Regulation 18** (only if the water is a potential danger to human health) **or Section 80** of the Act (if it is not a danger but is unwholesome as detailed in **Schedule 1, Part 1**) or both. As already discussed there is no requirement in NI to do anything for a single dwelling other than to give advice.

In NI, the notices regulation is **19** and the main piece of legislation is not section 80 of the Act but **Article 119** of the **Water and Sewerage Services (Northern Ireland) Order 2006**.

In Scotland, notices are served under sections **76G** to **76HA** of their **Act**. Notices are to remedy unwholesomeness and insufficiency of water for human consumption and can require works to be carried out or, interestingly, the Local Authority can require itself to take action to sort the problem out. For Type A supplies the notice must be served if the water is unwholesome and may be served for Type B supplies. The notice is served on one or more relevant persons and can also require payments to the local authority for the work it has done or to another relevant person who has had to do work. Where the relevant person cannot comply with the notice, the Local Authority can default the notice by getting Scottish Water to install a mains supply.

The notice is served on the relevant person/s. In many cases there will be several relevant people on whom the Local Authority could quite legally serve the notice. The notices apply to water intended for human consumption and water used for domestic purposes. The notices give the relevant person a set time to improve the supply. A notice under this regulation can require the water quality to be improved by source protection (including protection of tanks, pressure breaks, etc.) and/or the provision of treatment. The notice must specify the relevant person, identify the supply, the reasons for the notice, the parameters that have failed the standard, what needs to be done and the time limit. The notice allows equivalent works to be done if the relevant person would prefer to take equally satisfactory but different action. Failure to comply with this notice is an offence. And the works cannot be carried out in default.

A notice under this Regulation must also include a prohibition or restriction on the use of the water. The notice can stop the supply from being used or restrict its use - i.e. putting signs up and requiring that all water used for drinking and personal hygiene is boiled to kill all pathogens. The notice can also require the relevant person to tell everyone drinking the water about the notice.

The powers under **Section 80** of the Act (or **Article 119** of the Order in NI) allow an English or Welsh Local Authority (DoE in NI) to serve a notice to get a supply improved that is unwholesome (**Regulation 16** specifically allows this) but they are not allowed to use this type of notice if the supply has the potential to be a danger to human health. Failure to comply with a **Section 80** notice (and a NI **Section 119** notice) is not an offence and cannot be prosecuted for. It can however, be defaulted and the monies recovered and put as a land charge on the property. Two notices may have to be served if supplies are both unwholesome and unfit.

Regulation 5: This requires that all substances and products used in PWS after 1st January 2010 comply with the requirements of **Regulation 31** of the **Water Supply (Water Quality) Regulations 2000** This requires approval by the Secretary of State or conformity with appropriate European or national standards. This is to stop potentially dangerous chemicals leaching out of the fittings and pipes and into the drinking water. In Scotland the PWS Regulations do not contain this requirement. In NI this requirement applies only to new installations. The Welsh regulations originally omitted this requirement but it was subsequently added in as regulation 4A. Local Authorities will demand confirmation that this regulation is complied with from installers when treatment systems are fitted following a notice.

Interestingly, the Welsh regulations have a different Regulation 5, which requires that any disinfection treatment process keeps disinfection by-products to a minimum. Records of maintenance also need to be kept for 5 years by the relevant person. Even more interestingly, the English regulations have had this requirement added as regulation 5(1) in their own subsequent water regulation. The person responsible for the treatment, i.e. the relevant person (which may be the householder) must also verify that the system keeps disinfection by-products to a minimum, which means they must get them tested but the requirement to keep any records has been omitted.

Appeals

Regulation 19 for a Regulation 18 notice and **Section 81** of the **Water Industries Act 1991** for a **Section 80 notice (Section 120 NI)**

In England and Wales only there are two different systems and rules for appeals against these notices, depending on which one (or both) is served. Anyone served with a **Regulation 18** Notice can appeal within 28 days to the Magistrates' Court. The Notice will **not** be suspended if there is an appeal. The court can dismiss the appeal, cancel the notice or alter it. In Northern Ireland, **Regulation 19** notices and **Section 119** notices are appealed against to the Appeals Commission. Again this must be done within 28 days and for **Regulation 19** only, the notice will not be suspended. Not suspending the notice ensures that the use of the water continues to be restricted, and people's health protected while the legal process unfolds.

Anyone served with a notice under **Section 80** of the Water Industries Act 1991 **can only** appeal to the Secretary of State**.** This is done by sending a letter. The Notice will **normally be suspended** if there is an appeal. The Secretary of State (in practice the DWI) can dismiss the appeal, cancel the notice or alter it.

In Scotland a notice has an in-built period to allow for an appeal, before work needs to start as well as a time period for compliance. Firstly people who are not happy with the notice will write to the Local Authority. If agreement cannot be found, section 76H allows appeals to the Secretary of State. Failure to comply with a notice can mean that the Local Authority can carry out the works in default and recover expenses (**76H** (**5** and **6**) or prosecution with a fine not exceeding level 5 (**76HA (11)**).

Penalties - **Regulation 20 (22** in **NI)**
Where someone is found guilty of an offence under these regulations they can:
a) On summary conviction (i.e. Magistrates' Court) receive a fine up to £5000 and / or up to three months in jail
b) On indictment (Crown Court) receive an unlimited fine and up to two years in jail.
Directors, managers and secretaries of corporate bodies can be found individually guilty, as well as the corporate body itself.

Fees
Schedule 5 deals with the fees that can be charged by local authorities. This covers items like the cost of a risk assessment, a visit or processing an application for an authorisation. Charges have to be reasonable and should not be more than what it actually costs the Local Authority. Charges can also be split between the properties on the supply and apportioned accordingly. Attention however, must be paid to any agreements or responsibilities for water that may exist. The regulations also make it clear that anyone requesting anything to be done is liable to pay for it – this clarifies the situation for single dwelling supplies. Repeat samples cannot be charged for.

In Northern Ireland there are no powers to recover any costs for either risk assessing or monitoring. In Scotland fees are covered in **Regulation 33**. The fees are less than Schedule 5 and included in brackets after the English and Welsh amounts below. In Scotland, no fees seem to be payable for Investigations or Authorisations, but reasonable costs can be charged for additional monitoring. N.B. In 2010, the Welsh Assembly decided that for the first year of the regulations, risk assessments will be free in Wales.

The fees are:

Risk assessment (each):	£500 *(£50 plus £70 for preparatory work)*
Sampling (each visit):	£100 *(£70)*
Investigation (each):	£100
Granting an authorisation:	£100

Analysing a sample—

Taken under regulation 10:	£25 *(£48 N.B. this if for more parameters)*
Taken during check monitoring:	£100 *(£75)*
Taken during audit monitoring:	£500 *(£435)*

Grants
There are no grants available for any works (except in Scotland see below) but in cases of hardship the Local Authority private sector housing section should be approached as loans may be available in certain circumstances.

In Scotland there is a separate set of regulations outlining grant provisions for improvements to PWS. These are the **PWS (Grants) (Scotland) Regulations 2006**. The grant is for up to £800 per property. If the works cost less than this the grant is for the amount spent. The grants are available to the relevant person, the responsible person and/or the owner and the occupier of the premises **(Regulation 3 (a)**). The grant is designed to be easy to get and is not means-tested. Where one or more properties club together for joint treatment or source protection, the grants are added up, i.e. if there are ten properties on one supply needing treatment, £8000 is available.

In order to get the grant there must be an authorisation (temporary departure), a risk assessment or a notice served on the property under **Section 76G** of **the Act** (**Regulation 3 (b)**). There is a list of details that need to be on the application form (**Regulation 4**) and the works that the grant will pay for must be likely to improve the nature or quality of the water. This includes treatment or providing a new supply (**Regulation 5**). **Regulation 6** discusses various technical details such as the ability to change the grant, the ability to refuse a grant and a requirement to consult with interested persons before granting the approval. Unless there is a good reason, a grant cannot be paid where work has started or been completed (**Regulation 7**).

Payment can be made in stages or as a lump sum when all the work has been done satisfactorily. Further grants can be applied for after 5 years if another risk assessment is carried out or not considered necessary by the Local Authority. A few properties cannot get a grant, mainly ones that are empty, unfit (not meeting the tolerable standard for housing), dangerous, closed or with a demolition order on them. Where there are problems – works not done, the applicant is no longer eligible or there was inaccurate information in the application form the Local Authority can withhold, reduce or recover any money due (**Regulation 11**).

11 Sources of Information and Assistance

Your Local Authority. These are the first people to ask for information or advice. They will be in the phone book or on your Council's web page. The department that will deal with PWS is normally the Environmental Health or Public Protection section
British Water. British Water is the trade association for the water industry supply chain, representing the industry collectively to government, regulators, other institutions, customers and the media.
Contact details 1 Queen Anne's Gate, London, SW1H 9BT telephone: +44(0)207 957 4554 fax: +44(0)20 7957 4565. Email: info@britishwater.co.uk
www.britishwater.co.uk

Chartered Institute of Environmental Health. This is the official body of environmental health practitioners, the people who work for local authorities and will inspect and risk assess your supply.
Contact details CIEH, Chadwick Court, 15 Hatfields, London SE1 8DJ
Tel: 020 7928 6006 | Fax: 020 7928 5862. E mail via web site only
http://www.cieh.org/

Drinking Water Inspectorate. DWI is the technical regulator for the privatised water undertakers. DWI also provides advice to Government on all aspects of water supply

including PWS. They issue guidance to owners and occupiers as well as to local authorities. This guidance can be found on the PWS web site detailed below.
Contact details Room M03, 55 Whitehall, London, SW1A 2EY, Telephone: 0300 068 6400 Fax: 0300 068 6401 E-mail: dwi.enquiries@defra.gsi.gov.uk
http://www.dwi.gov.uk/

Drinking Water Quality Regulator for Scotland. DWQR ensures that drinking water in Scotland is safe to drink. DWQR oversees the regulation of PWS by local authorities. **Contact details** PO Box 23598, Edinburgh, EH6 6WW Telephone: 0131 244 0224 E mail via web site only http://www.dwqr.org.uk/

Foundation for Water Research. FWR is an independent, not for profit, membership-based organisation, having charitable status that shares and disseminates knowledge about water, wastewater and research into related environmental issues.
Contact details Allen House, The Listons, Liston Road, Marlow, Bucks SL7 1FD, U.K. +44(0)1628 891589 fax +44(0)1628 472711 e-mail DebbieRuck@fwr.org.uk
http://www.fwr.org/

Northern Ireland Department of Environment. This is the organisation that risk assesses, monitors, gives advice on and enforces regulations on PWS in Northern Ireland.
Contact details Clarence Court, 10 - 18 Adelaide Street, Belfast, BT2 8GB
Telephone: 028 9054 0540 Email: doe.iemonitoring@doeni.gov.uk
Web: http://www.doeni.gov.uk

The Private Water Supply Web site. A government-organised web site providing a wealth of information for owners and users of PWS. www.privatewatersupplies.gov.uk

Scottish and Northern Ireland Plumbing Employer's Foundation. Trade association for water treatment installers
Contact details Walker Street, Edinburgh, EH3 7LB. Telephone: 0131 225 2255 Email: info@snipef.org http://www.snipef.org/

UK Water Treatment Association. The UKWTA is the UK's leading Trade Association for companies involved in Point-of-Entry (POE) & Point-of-Use (POU) water treatment. **Contact details** Innovation Centre, Epinal Way, Loughborough, Leicestershire, LE11 3EH Telephone 01509 22 88 50 E mail via web site only
http://www.ukwta.org/

Water Regulations Advisory Scheme (WRAS). This organisation promotes knowledge of the Water Regulations throughout the UK and encourages their consistent interpretation and enforcement, for the prevention of waste, undue consumption, misuse, erroneous measurement or contamination of water.
They also provide an advisory service for and on behalf of Water Suppliers and for any other person or body seeking guidance on the principles of Water Regulations.
Contact details Fern Close, Pen-y-Fan Industrial Estate, Oakdale, Gwent NP11 3EH.
Telephone 01495 248454. Fax 01495 249234. E-mail: info@wras.co.uk
http://www.wras.co.uk/

World Health Organisation (WHO) Drinking Water web site. This provides very useful and detailed explanations of the safety of contaminants of water. www.who.int/water_sanitation_health

12 Useful Publications

Private Water Supplies. Clapham D (2009) Aqua Enviro, Wakefield.

Small Water Supplies: A Practical Guide. Clapham D (2004) Spon Press, London and New York.

Finding Water (Second Edition) Brassington, R. (1995) John Wiley and Sons Ltd (Chichester, New York, Brisbane, Toronto and Singapore).

Clay's Handbook of Environmental Health (Nineteenth Edition). Editor – Bassett W H. Spon Press, London and New York

Manual on treatment for small water supply systems. P J Jackson, G R Dillon, T E Irving and G Stanfield (2001) WRc-NSF Medmenham.

Urban Rainwater Harvesting and Water Reuse, A J Rachwal and D Holt (2008) Foundation for Water Research, Marlow.

13 Frequently Asked Questions

- *I have just moved into a house with a PWS. What should I do?*

The first thing to do is to explore your system and make sure that you understand where everything thing is and how it works. Find out where the source is and trace it back to your house. Does everything look safe and well maintained? Is there a fence around the source to keep animals away from it? Is there a proper lid on any storage tanks? Does the overflow to the tank or spring collection chamber have a grill to stop creepy-crawlies getting in? Is there a treatment system? Is it maintained? Next check with the local council to see if they know about your water supply and what was the result the last time they tested the water. Finally, find out if there is a maintenance contract for the supply, to make sure that someone regularly checks it and any treatment systems.

- *My water supply is not very good. When it is tested if fails the standards; I am thinking of replacing the existing system with a new borehole, is that a good idea?*

Where it is not possible to improve a spring, surface or well supply, drilling a borehole or going onto a mains supply is sometimes a good option. A well-drilled, correctly fitted and protected borehole is capable of providing a sufficient and safe supply of water. Always make sure you use an experienced contractor, who tests the water in different conditions and who understands the importance of not contaminating the water in the borehole and sterilising the drill bit to prevent iron bacteria causing future problems.

- *Since we moved into our new house, we keeping getting ill, mainly with diarrhoea, could our PWS be causing this?*

Yes it could. The best thing to do it to get it tested for microbiological faecal indicators. Many PWS are contaminated from time to time during the year and visitors and newcomers to a supply are most at risk. Make sure that the sample of the water is taken after a heavy down pour of rain – that way the supply will be tested when it is most likely to fail the standards. The local authority can test the water for you, or your local PWS treatment installer may be able to help. Where you find that the water is contaminated you should arrange for the source to be protected and install some form of disinfecting treatment such as UV or chlorination.

- *Sometimes the water to my house gets cloudy, is this something to worry about?*

Yes. If the water gets cloudy this means two things – one, your water is influenced by surface water, that is, it is easily and quickly contaminated; secondly, when water is cloudy this puts a strain on any treatment system you may have and it may not work during these periods of cloudiness. Make sure the source of the supply is wind and weather-tight and that the lid is close-fitting and in place. Are animals kept away from the source by a stock-proof fence? Then make sure that there is a filter on the system that will remove small particulate matter from the water. There are several that will work well. Again ask your local council or treatment installer for advice.

- *The water tastes and smells of rotten eggs, what is causing this problem?*

This occasionally happens when iron-bacteria build up at the bottom of a borehole. They are usually transferred via the drill bit when it was first drilled. These bacteria feed off iron in the water at the bottom of the bore and can build up into quite large numbers. When they die and start to decompose they give off hydrogen sulphide – this is the rotten eggs smell. There are several options; one is to try and remove the bacteria from the borehole. This is an expensive and specialist job. The process uses either a heating element put down the bore to boil the bacteria or a large dose of chlorine. Then the water needs flushing through. Hopefully this will do the trick but sometimes it needs to be repeated as the bacteria build up again. Another option is to try treatment to remove the gas. This again needs a specialist. Depending on the exact nature of the problem, the water can be aerated away from the house. The gas bubbled through the water picks up the hydrogen sulphide and it can be vented to somewhere where no-one will notice. Otherwise a GAC device or other specialist filter may reduce or remove the problem.

- *Our water keeps running out, is there anything we can do?*

The technical term for this is insufficiency. There are several answers to this. If the problem is only very occasional, a bigger storage tank may help eliminate the problem. Otherwise you will need to find another water source or drill a borehole to get sufficient water. Some people arrange to get a bowser during very dry spells or drink bottled water. Although this may help over very short periods it is not really an answer to the problem.

- We *have a commercial supply. The cost from the local authority seems very expensive, is there anything we can do to reduce it?*

The local authority is not supposed to make a profit from PWS. Therefore, if their charges seem excessive, you should ask them how they arrive at the amount they charge you. If you are not happy you should contact your local councillor who is your representative and should help. The maximum costs are laid down in the regulations and the authority cannot exceed these. Another way to reduce costs is to find out about your supply and any details of ownership and control over the supply. That way, when the risk assessment is done, it will take a shorter time and thus, hopefully will be cheaper.

- *Is it necessary to have a maintenance contract for the treatment system?*

Yes, all treatment systems need checking at least annually. The UV light, for example, needs replacing regularly, as do the various contents of the filters. It is also a good idea to have a regular system of checking the safety of the source of the supply and any tanks or pressure breaks. This often merely means going and having a look to make sure everything is as it should be.

- *I think that we are not the only people on the supply, how can I check?*

Talk to your neighbours, they will probably know. They may also be helpful in finding out where the source is and what the history of the water supply is. You can also try asking your local authority.

- *Can I take my own sample of water?*

Of course, your local authority will know of suitable laboratories that will help. The laboratory can provide you with sample bottles and give advice on taking the sample without inadvertently contaminating it. Or you could ask the local authority to take a sample, but they may charge you to do this. Your water treatment engineer may also know which laboratories in your area can test water from a PWS.