UK Rainwater Management Association

helping avoid future floods & droughts

Rainwater Harvesting Workshop Manual

For use by UK-RMA member companies only

A pre-course guide to the installation of rainwater harvesting systems, for use in conjunction with training workshops run by UK-RMA members

Re-branded: 1/1/15

Context

1. The UK Rainwater Management Association (UK-RMA) is the trade-body for the manufacturers, suppliers and installers of rainwater harvesting (RWH) systems in the UK.

2. All UK-RMA member-companies, recommend that their systems be installed by trained installers, to which end Installer-grade membership of the Association can only be achieved by one of two routes:

   a. By holding a BPEC (or equivalent) qualification in RWH, backed by the recommendation of a Full Member with first-hand experience of their work

   b. By attending a training workshop run by a Full Member covering the syllabus within this publication and achieving a 90% pass-mark in the "open book" test it includes

3. This manual is therefore aimed at providing the material used by members for running training workshops, and acts as both pre-workshop study material and a post-workshop reference; before attending the workshop, mark this manual with any queries you have.

Pre-qualification

4. The training workshops run by UK-RMA members are aimed at construction industry professional tradesmen or managers who fit one of the following categories:

   a. Qualified and experienced to undertake plumbing, electrical or ground-works

   b. Qualified and experienced in the management and supervision of site works

Workshop Aims

5. The aims of training workshops run to this syllabus are to enable delegates who meet the pre-qualification criteria and achieve the required written-test pass-marks to:

   a. Assist clients in selecting the most appropriate RWH system to meet their needs

   b. Supervise and project manage the installation of RWH systems in accordance with the manufacturer's instructions

   c. Undertake aspects of an installation that are relevant to their trade qualifications

   d. Provide maintenance and repair services for RWH systems, in accordance with manufacturer's instructions

6. The workshops are therefore industry generic, although deliverers of the workshops are encouraged to illustrate principles using their own products.

Syllabus Scope

7. In the limited time available, the workshops will principally focus upon domestic systems and concepts; essentially, operating principles remain the same with commercial systems which are not covered in depth by this manual. However, a short section is provided to highlight the main differences between domestic and commercial systems, and to provide images of typical commercial components.

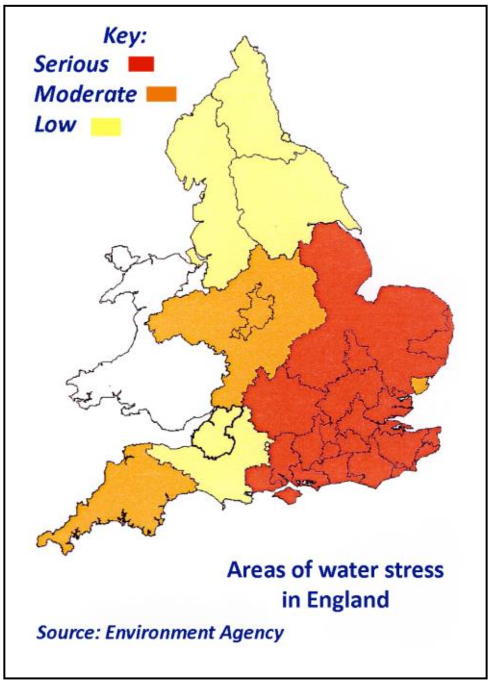
Syllabus Contents

The following alerts are used throughout this manual

Potential H&S risks or legal requirement

Potential pitfalls

National Drivers for RWH



… module aim …

8. The aim of this module is to gain an understanding of the environmental, policy and legislative drivers behind the rapid growth in the UK of the RWH sector.

… water shortages …

9. Mains water supplies in the UK are under stress due to a steady increase in consumption. These stresses are at their most severe in the relatively driest parts of the country, and those parts with the highest population density.

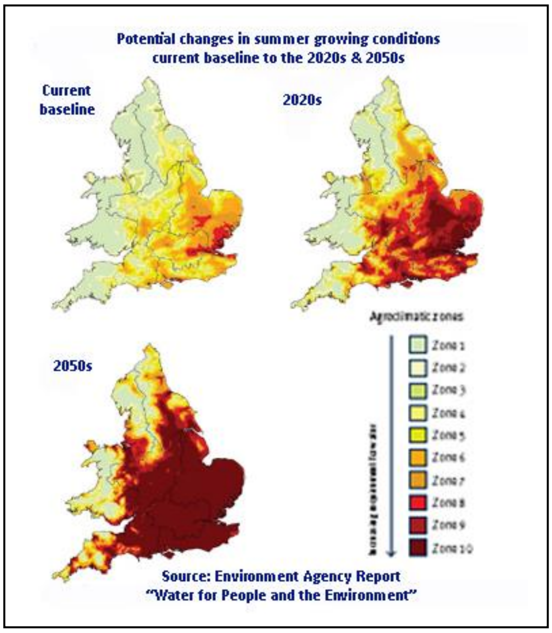
10. This combination of factors means that water supplies throughout most of England south of the Humber are under stress, severely so on the eastern side of the country

… population growth & climate-change …

11. The 2009 Environment Agency report *"water for people and the environment"* predicts that current stresses on water supplies will worsen under the twin impacts of substantial population growth and climate change.

12. The report concludes that the population of the UK will increase by around 20-million by the year 2050, whilst changing weather patterns will lead to prolonged summer and winter dry spells, broken by periods of intense rain. To avoid increased flood risk from this pattern of rainfall, surface water needs to be expedited to sea thus reducing infiltration and retention for use.

13. These twin impacts are predicted to reduce available water supplies by between 10% and 15%, lowering summer river levels by as much as 80% with associated severe impacts on agricultural growing conditions as illustrated opposite:



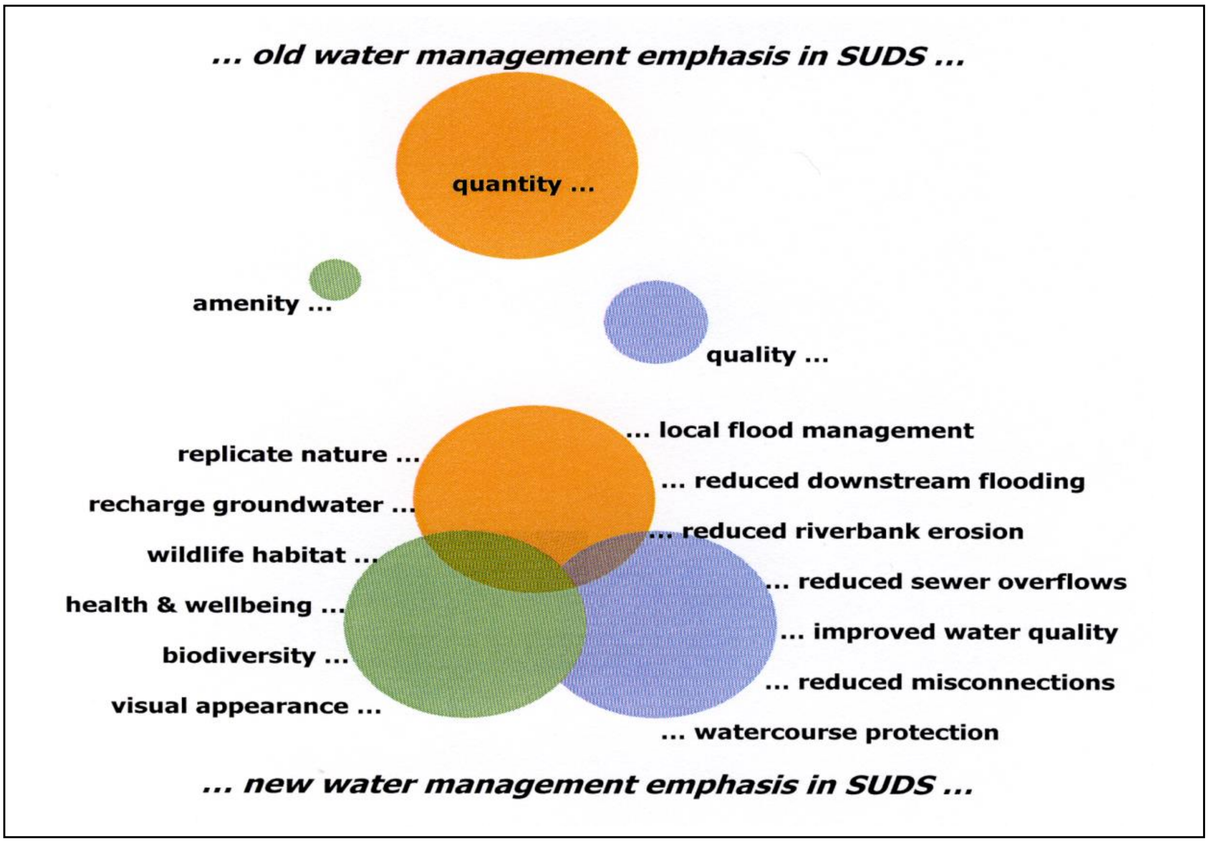
… sustainable drainage …

14. The first issue arising from climate-change impacts is the need to ensure that surface-water run-off from new developments does not increase the risk of local or down-stream flooding.

15. This is reflected in the *2010 Flood & Water Management Act* which brought into play a number of factors that will inevitably lead to an increased future requirement for sustainable urban drainage systems (SUDS).

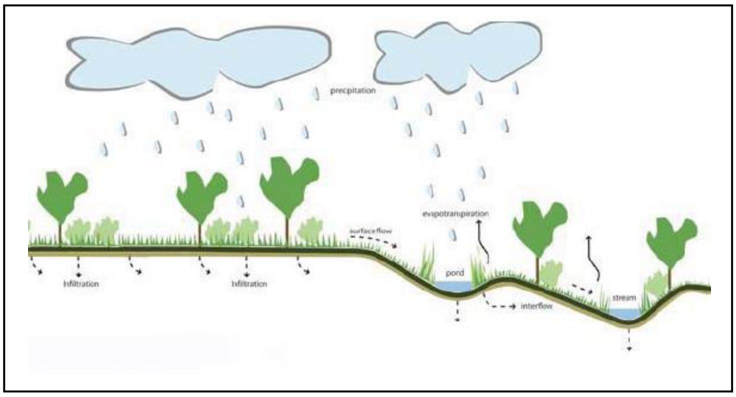
16. The first and foremost requirement of future new-build projects is that no more surface water must be allowed to leave a site post-development than was the case beforehand; this will usually mean that during certain weather events, such as very heavy and/or prolonged rainfall, the surface water will need to be held-back on site ("attenuated") before being slowly released at a rate that can be handled by the drainage infrastructure.

17. Allied to this, the Act requires that not only the quantity of water must be managed, but also its quality and its contribution to the environment; this change of emphasis is illustrated below:



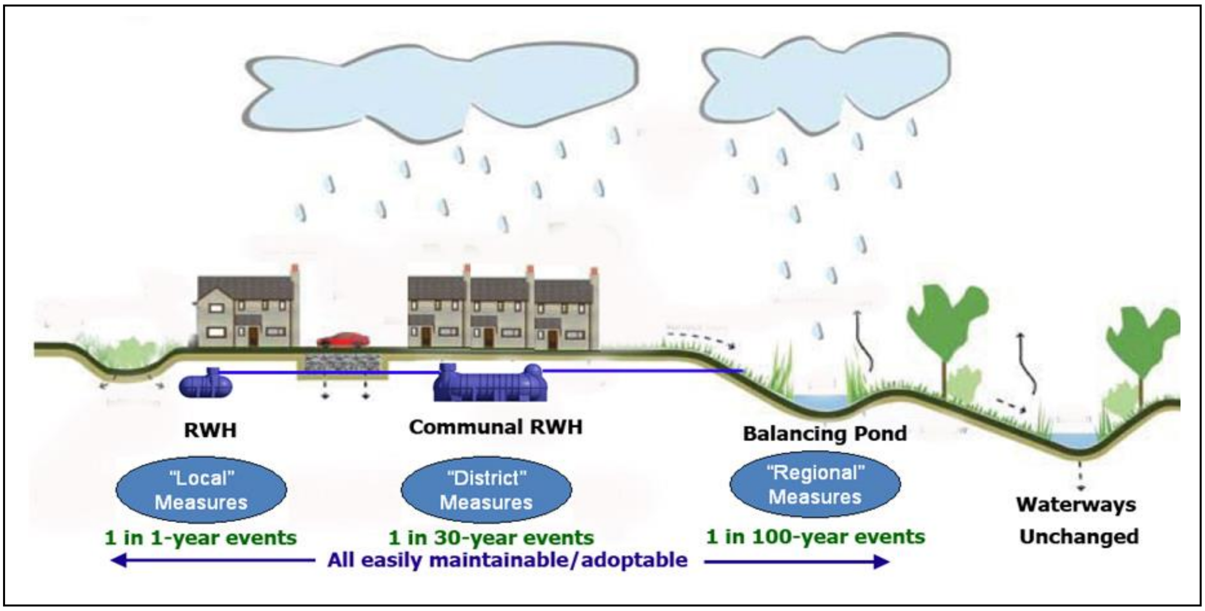
18. Alongside this change of emphasis, is a requirement to demonstrate that the proposed SUDS will replicate as far as possible the way in which green-field sites dissipate water, that is through a combination of:

- Infiltration
- Evaporation
- The forming of puddles & ponds
- Running-off via historical water-courses to streams, rivers & the sea



19. Another key requirement of the Act is that future SUDS must be adopted by a "Local SUDS Adoption Board", likely to be the local County or Unitary Authority, to ensure that its performance at handling surface water does not deteriorate over time. This in turn means that the system must be capable of both inspection and maintenance.

20. Taking all these factors into account, allied in times of overall water shortages to the simple principle that water should be used rather than wasted whenever possible, an integrated SUDS/RWH system becomes an elegant and cost-effective solution to both water-shortage and surface water management issues:



… Building Codes & Regulations …

21. These environmental and climate-change considerations are also fully reflected in Government Policy, which in turn acts as a significant driver for the incorporation of RWH systems.

22. The *Code for Sustainable Homes (C4SH)*, for example, identifies current national average domestic mains water consumption as 150-litres per person per day and aims to bring this down to 80-litres in all new homes by 2016. Although economising measures such as smaller toilet cisterns, dual-flush cisterns, aerated taps and shower-heads, smaller/no baths, smaller sinks/wash-basins, and low water-usage dish and clothes-washing appliances all assist greatly in working towards that target, realistically it can only be achieved by substituting water from other sources for mains-water.

23. This in turn is recognised in the latest update to *Part-G of Building Regulations* which came into force on 6th April 2010. These, for the first time, permit the use of two standards of water in new dwellings, namely “wholesome water” (ie mains-water) for bathing, showering, cooking and drinking, and “non-wholesome water” that can be used for applications such toilet-flushing, clothes-washing and the outside tap.

24. Building Regulations also helpfully identify possible sources of non-wholesome water, the most readily-available and cost-effective of which will often be harvested rainwater. The Regulations then move on to set an upper consumption limit of 125-litres per person per day in new dwellings, a figure to be derived using an associated “Water Efficiency Calculator”.

25. The assumed amount of any non-wholesome water to be substituted for mains-water must also be derived using the Calculator, but can then be deducted from the household’s usage of mains-water, thus bringing the target of 80-litres per person per day within reach.

26. A typical spreadsheet-based version of the paper-based Water Efficiency Calculator is illustrated for information on the next page.

27. BREEAM assessments work in a similar way for other (non-housing) developments. As water supplies come under greater stress in future years, there may also be impacts on water-pricing policies; this will strengthen the economic case for the more widespread use of RWH, alongside the very strong existing environmental case.

Water Consumption Calculator:

Water Efficiency Calculator for New Dwellings (V1e)

east midlands LABC

Project Details

Adress/Reference		Case Reference	
Number of Bedrooms		Occupancy for Calculation Purposes	1

Appliance/Useage Details

Taps (Excluding Kitchen Taps)

Tap Fitting Type	Flow Rate Litres/Min	Quantity (No.)	Total per Fitting type
			0.00
			0.00
			0.00
			0.00
			0.00
			0.00
Total No. of Fittings (No.)		0	
Total Flow (l/s)			0.00
Maximum Flow (l/s)			0.00
Average Flow (l/s)			0.00
Weighted Average Flow (l/s)			0.00
Flow for Calculation (l/s)			**0.00**

Showers

Shower fitting Type	Flow Rate Litres/Min	Quantity (No.)	Total per Fitting type
			0.00
			0.00
			0.00
			0.00
			0.00
			0.00
Total No. of Fittings (No.)		0	
Total Flow (l/s)			0.00
Maximum Flow (l/s)			0.00
Average Flow (l/s)			0.00
Weighted Average Flow (l/s)			0.00
Flow for Calculation (l/s)			**0.00**

Baths

Bath Type	Capacity to Overflow	Quantity (No.)	Total per Fitting type
			0.00
			0.00
			0.00
			0.00
Total No. of Fittings (No.)		0	
Total Capacity (l)			0.00
Maximum Capacity (l)			0.00
Average Capacity (l)			0.00
Weighted Average Capacity (l)			0.00
Capacity for Calculation (l)			**0.00**

WCs

WC Type	Full Flush Volume	Part Flush Volume	Quantity (No)
Total number of fittings			**0**
Average effective flushing volume			**0.00**

Dishwashers

Dishwasher Type	L per Place Setting	Quantity (No.)	Total per Fitting type
			0.00
			0.00
Total No. of Fittings (No.)		0	
Total Consumption (l)			1.25
Maximum Consumption (l)			1.25
Average Consumption (l/s)			1.25
Weighted Average Consumption (l)			0.88
Consumption for Calculation (l/s)			**1.25**

Washing Machines

Washing Machine Type	L per Kg Dry Load	Quantity (No.)	Total per Fitting type
			0.00
			0.00
Total No. of Fittings (No.)		0	
Total Consumption (l)			8.17
Maximum Consumption (l)			8.17
Average Consumption (l/s)			8.17
Weighted Average Consumption (l)			5.72
Consumption for Calculation (l/s)			**8.17**

Kitchen Taps

Tap Fitting Type	Flow Rate Litres/Min	Quantity (No.)	Total per Fitting type
			0.00
			0.00
			0.00
Total No. of Fittings (No.)		0	
Total Flow (l/s)			0.00
Maximum Flow (l/s)			0.00
Average Flow (l/s)			0.00
Weighted Average Flow (l/s)			0.00
Flow for Calculation (l/s)			**0.00**

Other Fittings

Waste Disposal Y/N	
Water softner	
Consumption beyond 4% l/p/d	

Use of grey water and harvested rainwater

Total Grey water from WHB taps (l)	
Total Availble Grey Water Supply (l)	0.00
Possible Demand (l)	0.00
Grey/Rain Installed Capacity (l)	
Figure for Calculation lit/person/day	0.00

Water Use Assessment

Installation Type	Unit	Capacity/ Flow Rate	Use Factor	Fixed use (l/p/day)	Total Use (l/p/day)	
WC Single Flush	Volume (l)	0.00	4.42	0.00	0.00	
WC Dual Flush	Full Flush (l)	0.00	1.46	0.00	0.00	
	Pt Flush (l)	0.00	2.96	0.00	0.00	
WC's (Multiple)	Volume (l)	0.00	4.42	0.00	0.00	
Taps Exc. Kitchen	Flow Rate	0.00	1.58	1.58	0.00	
Bath (shower present)	(l/s)	0.00	0.11	0.00	0.00	
Shower (bath present)	(l/s)	0.00	4.37	0.00	0.00	
Bath Only	(l)	0.00	0.50	0.00	0.00	
Shower Only	(l/s)	0.00	5.60	0.00	0.00	
Kitchen Taps	(l/s)	0.00	0.44	10.36	0.00	
Washing Machines	(l/kgdry)	8.17	2.10	0.00	17.16	<< Note - these may be default values.
Dishwashers	(l/place)	1.25	3.60	0.00	4.50	<< You can change them by entering
Waste Disposal	(l/s)	0.00	3.08	0.00	0.00	the actual applicances in the
Water Softner	(l/s)	0.00	1.00	0.00	0.00	appropriate sections above
Total Calculated Water Use (l/p/day)					**21.66**	
Grey/RainWater Reused (l)					0.00	
Normalisation Factor	(Factor)				0.91	
Total Consumption CSH (l/p/day)					**19.71**	
External Water Use Allowance (l)					5.00	
Total Comsumption Part G (l/p/day)					**0.00**	

Assesment Result	

Regulations & Risk Management

… module aim …

28. This module aims to provide you with an awareness of the main legislative requirements associated with the design, manufacture, installation and use of RWH systems, and the management of any associated risks.

… general responsibilities …

29. It is the responsibility of the industry and its tradesmen to provide RWH systems that are fit for purpose, pose no health risks, and cannot cross-contaminate the mains water supply. Installers also have a responsibility for the quality of their work.

30. Alongside the statutory requirements that have to be observed before any building works can take place, there are requirements that apply particularly to RWH systems. As these requirements may vary across the UK, the local planning authority and local water authority should always be consulted.

… planning …

31. Generally, RWH systems do not require planning permission unless the tank is to be sited above-ground. However, as permission needs to be sought from the local planning authority before carrying out any development, it needs to be ascertained whether or not a proposed RWH system is considered to be a development not otherwise covered by a planning consent.

… building regulations …

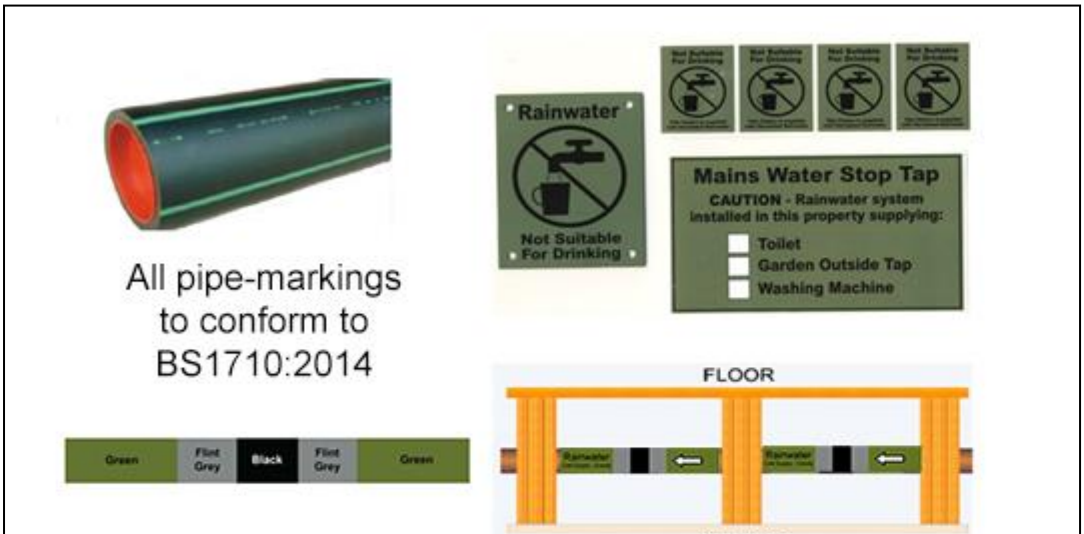
32. The local planning authority may require plans to be provided to show that a planned installation complies with general building regulations; particular points of compliance note are:

    a. **Part-A:** Storage tanks are to be buried a minimum distance away from the foundations of a building, depending upon the depth of the excavation and the height of the building

    b. **Part-B:** The fire-integrity of a building must be maintained when pipe-work passes through walls and/or floors

    c. **Part-G:** RWH systems can be used for toilet-flushing, clothes washing machines and irrigation purposes only; their use must not be likely to cause waste, misuse, undue consumption or contamination of wholesome water. The system design must also incorporate measures to minimise the impact on water quality from the failure of components, failure to undertake maintenance, power failure, or any other assessed risks.

d. **Part-H:**All pipe-work must be clearly identified and tap outlets clearly marked "Not drinking water" as illustrated below *(see also WRAS News – Spring 2016*). Underground tanks must also have a heavy-duty cover or be secured by screws



Courtesy of WRAS Ltd

Notes:

1. *Above ground pipes must also be marked at 500mm intervals as given in IGN 9-02-05*
2. *References to "wholesome" and "non-wholesome" water carry the same meaning as "potable" and "non-potable" respectively*

… water regulations …

33. There are two types of "Water Supply Regulations", commonly referred to as:

- Water Fittings Regulations
- Water Quality Regulations

34. Each country in the UK has its own set of regulations, covered by:

- Water Supply (Water Fittings) Regulations 1999, as amended, in England & Wales
- Water Byelaws 2004 (Scotland)
- Water Regulations (Northern Ireland) 2006

Private Water Supply Regulations applicable, for example, when systems are used off-grid as the sole means of water supply, are similarly covered by:

- The Private Water Supplies Regulations 2009, as amended, in England
- The Private Water Supplies (Northern Ireland) Regulations 2009, as amended
- The Private Water Supplies (Scotland) Regulations 2006, as amended
- The Private Water Supplies (Wales) Regulations 2010, as amended

35. The aims of Water Supply Regulations include prevention of waste and undue consumption, misuse, contamination and false metering of water. They also require that the local water authority be notified under a range of circumstances, which means that installation of a RWH system would generally be notified before work commences.

36. Points of particular note include:

a. **Notifications:** There is a general need to provide Advance Notification to water suppliers; this is a mandatory requirement for all installations in Northern Ireland, and for new properties or alterations in existing non-domestic properties elsewhere. Under all circumstances notification is good practice, and also a requirement of BS-8515

b. **Back-up feeds:** Lack of use of back-up feeds (via the appropriate air-gaps described below) may pose water-quality issues to upstream uses; this should be avoided by positioning a single check-valve or other suitable fluid category 2 device immediately adjacent to the back-up feed branch

c. **Service Valves:** All float-operated valves, typically as used in header cisterns as explained later, require a service valve; it is also good practice to install one on backup feeds so that they can be readily isolated to prevent waste in the event of some malfunction or failure.

d. Air Gaps:

i. The mains supply must be protected from back-siphoning of the harvested rainwater using a Type-AA or Type-AB air-gap, as shown in BS-8515[1] and illustrated below

ii. A Type-AA air-gap is to be used either when the mains back-up is fed into the main rainwater storage tank, or into a header cistern which is not fitted with a float operated valve

iii. A Type-AA air-gap must have unrestricted over-spill, with a minimum air-gap of 20-mm, or twice the inlet bore whichever is greater

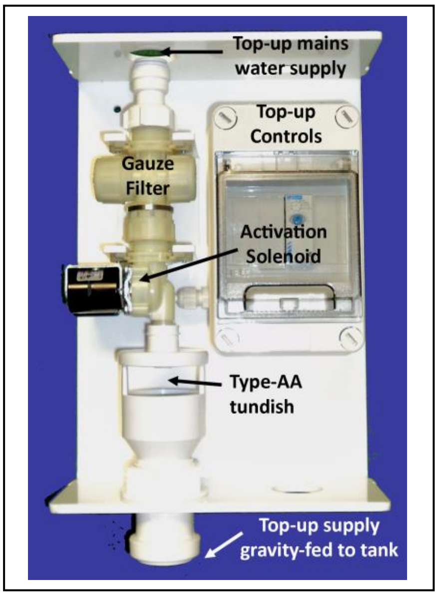
iv. A Type-AB air-gap is usually used if mains back-up is via a header cistern fed by a float-operated valve; the air-gap must be achieved by cutting a weir overflow into the side of the cistern, which conforms to WRAS Guidelines[1]

v. A Type-AA can be used with header-cistern systems if the cistern does not have a lid, and is configured above the cistern rim (spill-over level)

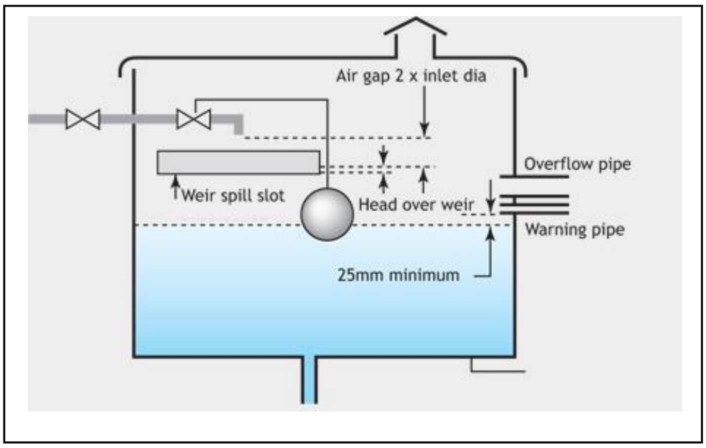
Note: Comprehensive information on the specification of air-gaps may be found in WRAS information & Guidance Note No 9-04-04 dated August 2005.

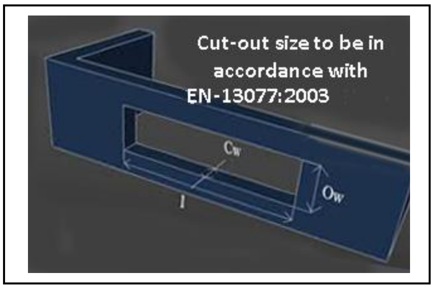
… air-gap illustrations …

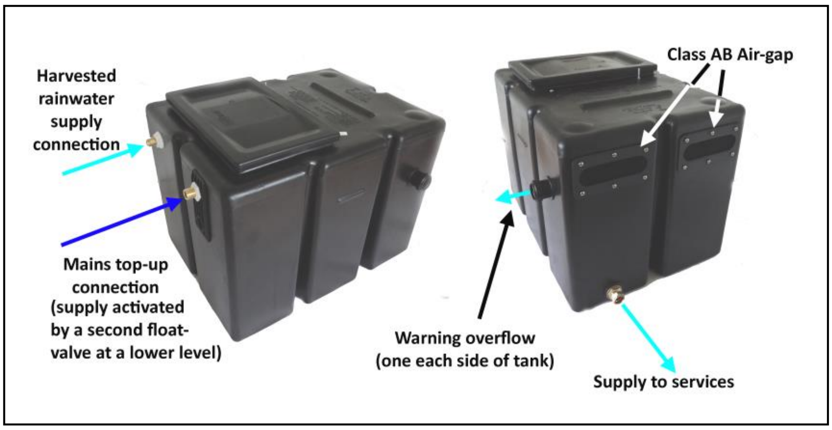
Type-AA



Type-AB







… electrics …

37. All electrical work must be carried out in accordance with IEE regulations, and the work notified if it involves (which it usually will) electricity use exterior to the building.

… codes of practice …

38. BS-8515 is the UK Code of Practice for the "on-site collection and use of rainwater as an alternative to the public mains water supply for non-potable water uses in the home, workplace and garden." Its purpose is to meet the "need for standardization to protect the public and to ensure that reliable systems are designed, installed and maintained".

39. It is a condition of the UK-RMA Bye-Laws that members are committed to meeting the requirements of BS-8515 which covers matters such as:

    - System sizing
    - Water collection, filtration & storage
    - Materials & fittings
    - Power supply
    - Back-up water supply and backflow prevention
    - Pumping & distribution pipe-work
    - Installation, overflow & drainage
    - Controls & metering
    - Water quality, maintenance & risk management

40. The UK-RMA Bye-Laws also require members to commit to the Association's own Code of Practice which covers matters such as:

    - Misleading system performance claims
    - Bringing the technology into disrepute
    - Negative marketing of competitor products or services
    - Adherence to National Standards and Regulations
    - Meeting customers expectations that systems will perform as specified

… risk management

41. Installing and maintaining RWH systems requires all the normal H&S measures to be taken, with risk assessment being carried out for every stage of a project from design, through shipping, on-site receipt & handling, to installation and subsequent use and maintenance.

42. The risk assessments should consider the effects of exposure to, and potential impacts of, the system on people, the environment and the property.

43. The risk assessment should also consider water quality, potential sources of contamination, and any necessary water quality control methods.

Working with the customer

… module aim …

44. The aim of this module is to provide you with the general information about RWH systems you will require to identify and meet customers' needs.

… general considerations …

45. The most straightforward way of harvesting rainwater is to collect it from a conventional sloped roof and route it via sealed pipe-work (ie no open gullies) and pre-tank filtration into the storage tank.

46. In a correctly sized full domestic system (ie in accordance with BS-8515), and in UK climatic conditions, rainwater will be regularly collected and regularly used for non-potable applications such as toilet-flushing, clothes washing machines and irrigation; under these circumstances, BS-8515 will help to ensure that the water quality remains aesthetically pleasing (ie clear and free of matter), albeit not wholesome.

47. Collecting the water from a flat-roof will reduce the quantity of water collected from a given roof area, but should not degrade its quality; collecting water from a "green" roof will severely degrade both the quantity and the quality of the water harvested and is therefore not recommended by the industry.

48. On commercial scale projects where there is a requirement to collect from hard-standings as well as roofs, and particularly where RWH has been integrated with SUDS, additional specialist filters must be employed before the water is stored to remove the hydro-carbons and other contaminants to be found at ground level. This additional cost is worthwhile on a commercial project or for communal domestic systems, but is not cost-effective for single dwellings.

49. The rainwater harvested in the above ways is non-wholesome and suitable only for non-potable applications; it can be brought up to a standard suitable for potable use by additional filtration, but this involves meeting Private Water Supply Regulations and is not normally recommended unless special circumstances apply (off-grid, for example).

50. Bringing harvested rainwater up to potable standard for non-potable use by vulnerable groups (such as young children in schools, for example) as an additional H&S precaution is straightforward and achieved using additional measures such as carbon and/or UV filtration.

51. Full domestic systems are generally only appropriate for new-build domestic or commercial developments, or for buildings being refurbished, due to the disruption to drainage and delivery pipe-work involved with existing buildings. Where integration with a greywater system (not covered by this manual) is required, overflow connections to the foul sewer may also be necessary.

52. For retrofit projects, irrigation-only systems would therefore normally be recommended as this alters a number of important factors:

- The pattern of collection & use changes from frequent/regular, to seasonal
- The aesthetic quality of the water may be less important than quantity, so an oversized storage tank can be considered to maximise available water when needed
- Even with a large storage tank, collection can be limited to a single roof-slope and down-pipe which limits/removes, the need to interfere with existing drainage runs
- Mains back-up would normally be omitted to avoid being subject to hosepipe bans

… tank sizing …

53. To ensure good water quality is maintained in full domestic systems, three considerations are taken into account when calculating the size of the storage tank in accordance with BS-8515 (intermediate approach):

a. **Yield:** This is a straightforward calculation based upon:

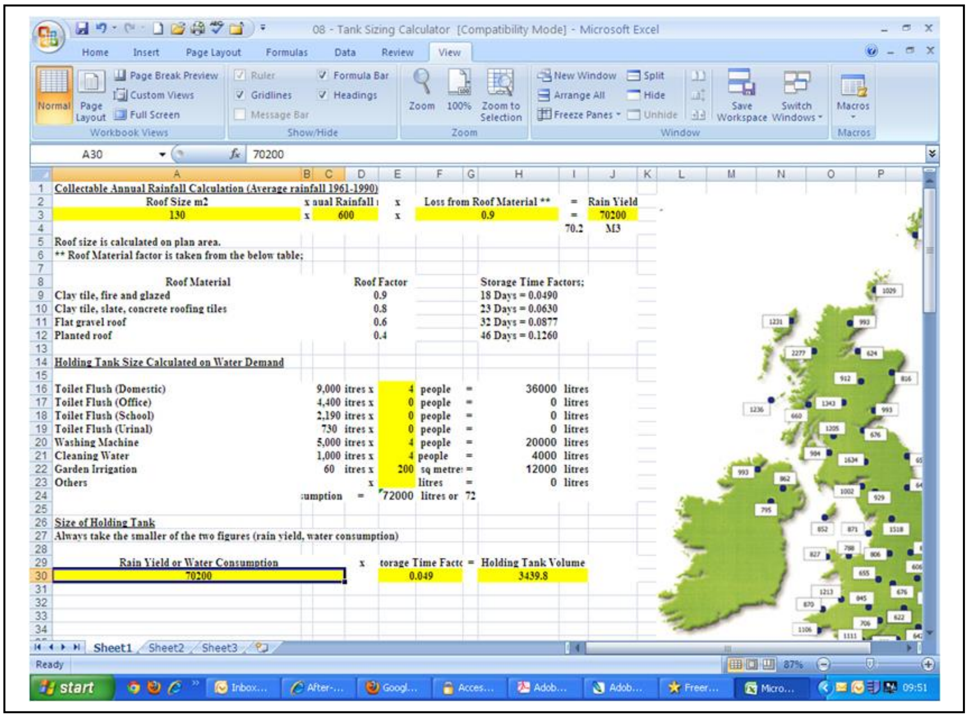
Roof plan area (m^2) x annual rainfall (mm) x roof type coefficient = annual yield (litres)

b. **Consumption:** Based upon industry standard per-capita consumption figures

c. **Water Quality:** Ensured by calculating a size of tank that when full will provide a turn-over of the water it contains every 18-days, calculated as follows:

The lower of the Yield/Consumption calculations above x 0.05 = storage tank size(actual)

54. These calculations are usually automated using a spreadsheet as illustrated below:



… impacts on mains-water consumption …

55. Rainwater harvesting reduces demand on mains water supplies by intercepting rainfall that would otherwise be unrecoverable and substituting it for non-wholesome applications such as toilet-flushing, clothes-washing and irrigation. These applications account for around 50% of daily consumption, or around 75-litres per person per day in the home.

56. The formula for calculating the amount of mains water saved in this way is quite straightforward being a function of the area and type of the collection surface, and local average rainfall. In domestic applications the quantity of water that can be substituted in this way is limited to the about 75-litres per person per day, the remainder of domestic water use requiring wholesome water for bathing, drinking, cooking and dish-washing.

57. As a typical example, a small modern new-build home with an 80-m^2 roof will harvest around 43,000-litres annually in the relatively dry south-east of England, thus reducing household consumption by about this amount whilst meeting close to 80% of the non-wholesome water requirements of two people *(ie 2 x 75 x 365 = 54,750-litres)*; other example yields are shown in the table on the next page.

58. In non-domestic applications, the parameters change substantially as usually there is a very strong bias towards the use of non-wholesome water in the workplace, often in excess of 90% of total consumption. Non-potable water consumption in the workplace is estimated at around 25-litres per person per day, which can be met entirely by harvested rainwater in the relatively dry south-east of England whenever the ratio of roof area to workforce is at least 10-m^2 per person (pro-rata savings below this ratio).

59. Over the timescale of the Environment Agency report noted earlier, 8-million new homes will be needed in the UK to cope with population growth, each home capable on average of harvesting 40m^3 per year; this would add 320m^3 per year to national supplies, equal to around 5% of current consumption.

60. This contribution could potentially be more than doubled by a combination of new-build commercial developments, the retrofitting of systems to existing commercial buildings, and retrofitting to some existing homes.

61. Taking the market in Germany as a reasonable RWH take-up comparator, studies undertaken in 2009 showed that about 65,000 systems were installed that year (ten-fold the UK rate), bringing the total installed nationally to around 1.8M (around thirty-fold the number of installations in the UK).

… example yields …

62. Typical examples of the maximum annual yields available, together with the associated exactly matching tank sizes for full domestic systems are shown in the table below:

Roof –m²	Local rainfall in mm per year (exact tank-match yield shown in red)					Tank Match
	500	600	700	800	900	
60	27,000	32,400	38,000	43,200	48,600	1,900-L
80	36,000	43,200	50,000	57,600	64,800	2,500-L
100	45,000	54,000	62,000	72,000	81,000	3,100-L
120	54,000	64,800	76,000	86,400	97,200	3,800-L
140	63,000	75,600	88,000	100,800	113,400	4,400-L
160	72,000	86,400	100,000	115,200	129,600	5,000-L
180	81,000	97,200	110,000	129,600	145,800	5,500-L
200	90,000	108,000	126,000	144,000	162,000	6,300-L

63. It can be seen that only occasionally will the calculation coincide exactly with the tank sizes offered by a particular manufacturer. The "nearest fit" will therefore often be selected, which is a technically acceptable compromise, bearing in mind that some of the inputs to the underlying calculation are based on annual estimates.

… factors affecting yield …

64. System yield can be affected by system faults such as:

- Leaks before or after the storage tank
- Premature mains top-up caused by faulty or badly calibrated top-up sensors
- Faulty or blocked top-up valve seats
- Installation errors

… water restrictions …

65. End-users must also be made aware that full domestic systems must not be used in association with hosepipe distribution during periods when hosepipe bans are in operation, as their system is being topped-up from the mains-supply; conversely, this restriction does not apply to garden irrigation systems that are not topped-up from the mains.

Systems Working Principles

… module aim …

66. The aim of this module is to provide a practical understanding of the generic operating principles of RWH systems.

… variations on a theme …

67. RWH systems are designed to meet a variety of operational requirements that can be categorised as:

    a. **Full domestic systems:** The storage tanks for these on a single dwelling might range in size from, say 1,000-litres up to more than 6,000-litres, depending upon the size of the dwelling and the number of occupants; typically these systems will collect and use water regularly for applications such as toilet-flushing, clothes washing machines, and irrigation

    b. **Commercial systems:** Systems serving anything other than a single dwelling are usually termed "commercial" due to their bespoke characteristics and, in some cases, increased complexity; the storage tanks for these might start at 6,000-litres upwards, and could on large projects be much more than 100,000-litres. Such systems will provide the same range of uses as domestic systems, but might also provide water for industrial processes and fleet-washing.

    c. **Irrigation systems:** These can vary in size from less than 1,000-litres for use in private gardens to much larger systems for commercial use; they are usually simpler in their operations and do not employ a mains back-up feature

68. Notwithstanding these permutations of complexity, size and use, all RWH systems work on one of the following basic principles:

    a. **Direct Pumped:** Where the water is delivered direct under pump pressure via the distribution pipe-work to services; variations on this principle include:

        - Pressure pumps situated in the main storage tank
        - Suction pumps external to the main storage tank
        - Intermediate booster pumps and purpose-made modules

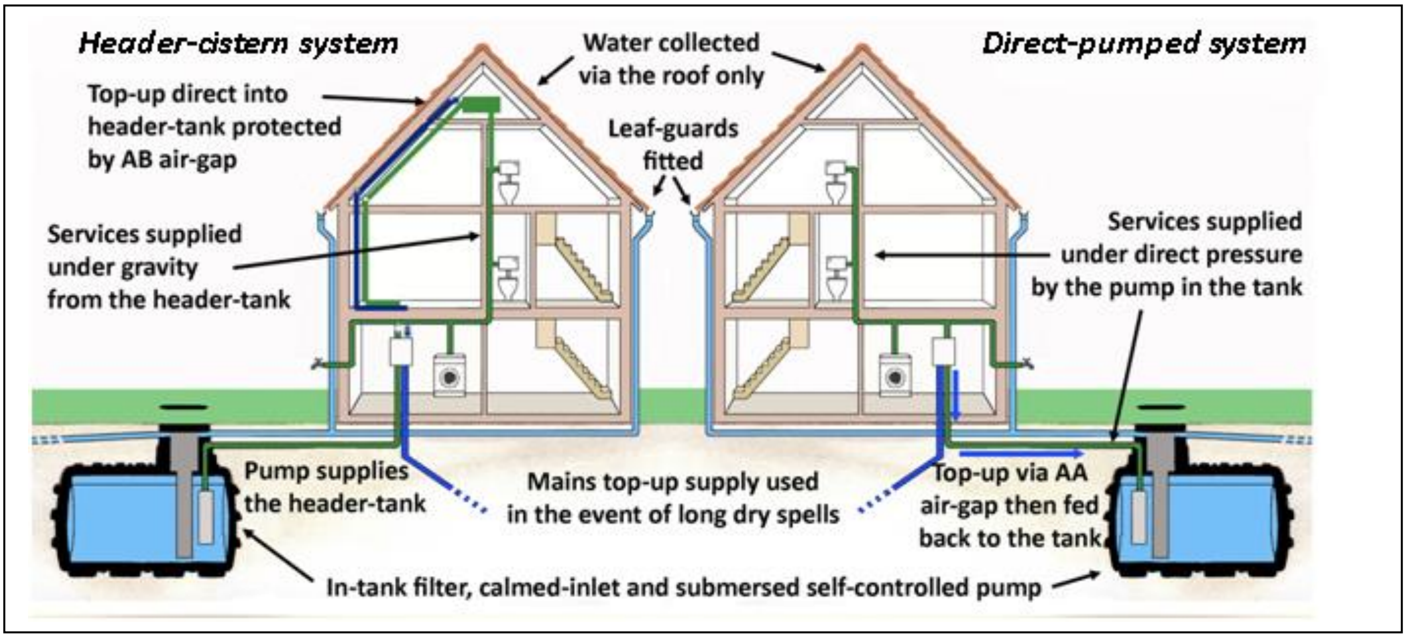
    b. **Header-cistern:** Where a pump is still required, but the water is gravity-fed to services, via an intermediate header-cistern

    c. **Gravity Systems:** Where the whole system relies upon gravity alone, and no pump is therefore required

69. Examples of some of these are explained below, and later under "Commercial Systems".

… systems overview …

70. The diagrams below shows the schematic layouts of typical “Direct Pressure” and “Header-cistern” systems, where the harvested rainwater is first collected into a main storage tank.



Points to Note:

1. **The main storage tanks need to be able to overflow to soak-away or storm-drain which must be adequate to cope with the rate of flow to avoid contaminated water back-flowing into the storage tank**
2. **Mains water supply to provide top-up, when needed, must be via an air-gap as specified in WRAS information & Guidance Note No 9-04-04 dated August 2005**
3. **Supply to services must be via dedicated pipe-work, which must not be cross-connected to the mains pipe-work**

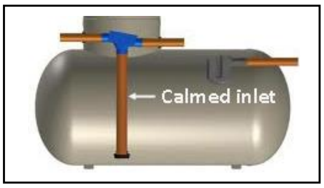
… direct pumped systems …

71. Domestic systems would normally use only the property roof for collecting the rainwater which is then usually stored in an underground tank to provide non-wholesome water for toilet flushing, clothes washing machines, and the outside tap.

72. Collection from a conventional roof is recommended, avoiding “green” and sedum roofs wherever possible. The roof water is channelled through the normal guttering and down-pipe arrangements, before being brought together into one or more drainage runs which feed into the storage tank.

73. In accordance with the requirements of BS 8515, the water is filtered before entering the storage tank to remove solid particles; the filter needs to be maintained by a programme of regular servicing to ensure its harvesting efficiency

74. Having passed through the filter, the water enters into the tank via a calmed inlet designed to avoid splashing and gently introduce the fresh and highly oxygenated rainwater into the bottom of the tank. This helps to avoid stagnation at the lowest level, and assists maintenance of the quality of the water stored in the tank.



75. The stored water is then supplied to the non-wholesome services on-demand; this demand, which is sensed by either a Control Unit or the pump itself, activates the electric pump in the tank to meet the demand. When the demand for the water supply ends, this too is sensed and the pump stops. Under this “direct pressure” arrangement, the pump output is effectively linked direct to the service concerned

76. In periods of prolonged rain, the storage tank will become full and overflow through the connection provided to the surface water management arrangements for the project (ie soak-away, storm drain or attenuation system) and may be protected from back-filling by a back-flow prevention valve. Annex-A of BS-8515 should be used to calculate the contribution that the storage tank makes to the overall SuDS calculations for the project.

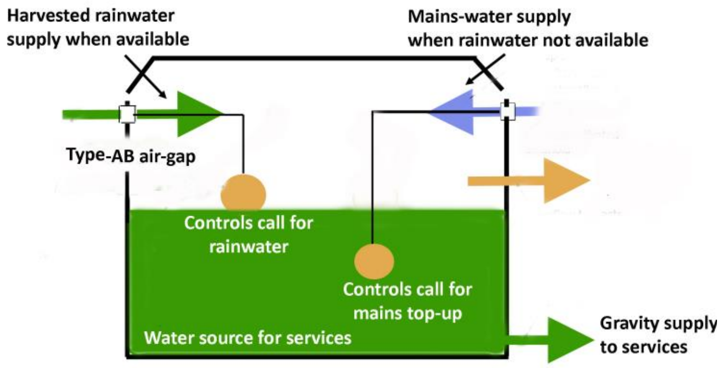
77. Conversely, in dry spells the tank contents may be in danger of becoming exhausted and need to be supplemented by mains water to ensure continuity of supply to the services. This too is detected automatically by the system which then activates a solenoid to allow a limited quantity of mains water to enter the tank via a Type-AA air-gap; this prevents back-flow from the non-wholesome pipe-work/water to the mains-water supply. The mains top-up should be delivered via the calmed inlet to avoid disturbing sediment

78. **Irrigation-only Systems:** These operate on the direct-pressure principle noted above, but the tank size may not be constrained by BS-8515 as applied to full domestic systems; this enables more water to be stored for irrigation purposes. However, when used in spray-form, it must be born in mind that the water provided is non-potable and ***ingestion must therefore be avoided***. It is also recommended that these systems do not have a back-up supply, making them exempt from hosepipe bans.

79. **Purpose-made Modules:** On large commercial projects, a header-cistern system might in principle be preferred to cater for peaks demands; where, however, the characteristics of the project preclude installation of a header-cistern, then intermediate “booster sets” (sometimes known as Break-tanks) and other purpose-made modules may be included to provide additional pumping power. These combine some of the working characteristics of a header-cistern system, including possible use of a Type-AB air-gap, and are covered in greater detail in the Commercial Systems section below.

… header-cistern systems …

80. Many of the working principles of direct pressure systems apply equally to header-cistern systems; the main differences between the systems being:



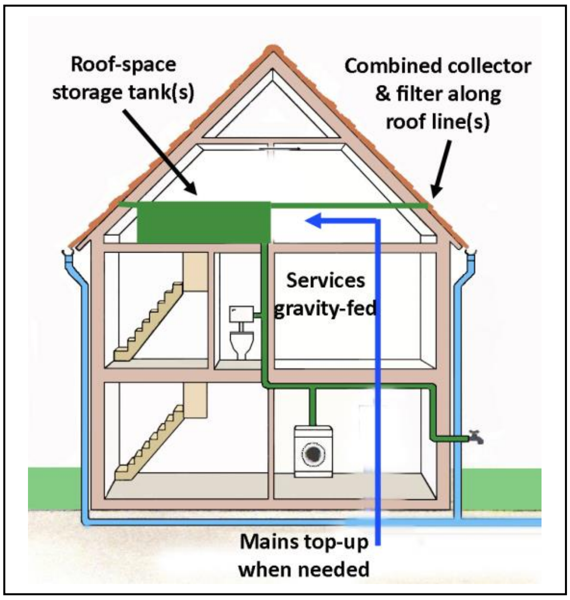
Header-cistern operating principles for RWH systems

- ➢ The services are fed from the reservoir of water held in the header-cistern, rather than direct from the pump in the main storage tank
- ➢ The water level in the header-cistern is maintained by:
    - o Activation of the pump in the main storage tank as before; or by:
    - o Top-up direct from the mains water supply if the main storage tank supply is exhausted

81. Most header-cisterns used in RWH systems work on the basis of two water-levels in the tank, both controlled by their own float-valves. The upper level is maintained by pumping water from the main storage tank until it becomes exhausted; the water in the tank then drops to the second (lower) level at which stage mains water is allowed to enter the tank direct. Contact between the mains water and the harvested rainwater already in the tank is prevented by a Type-AB air-gap between the two, although a practical check must be performed to ensure that during filling operations, from either the mains or rainwater, the mains water inlet valve does not get splashed by any liquid within the cistern.

… gravity-fed systems …

82. These are still relatively new in the UK market, with general systems generic patterns yet to evolve; the basic operating principles however, are show opposite, and comprise:



- ➢ An arrangement to intercept roof water at a suitable level along the roof line(s)
- ➢ An integral filter
- ➢ Water storage tank(s) at a high level in the building
- ➢ All connected services to be gravity-fed from the tank(s)
- ➢ A mains top-up arrangement to maintain continuity of supply when the stored rainwater is exhausted

… system broad characteristics …

83. Before ordering a system, the buyer should always discuss their needs with the system supplier who will advise on the best way to meet operational requirements; however, for general information purposes only, the table below summarises the broad characteristics to be anticipated from the three main RWH operating principles:

Customer's Requirements	Header-cistern Systems	Direct Pumped Systems	Booster/Purpose made Systems
Header-cistern cannot be accommodated		√	√
High operating pressure required		√	√
Demand peaks & troughs need to be smoothed	√		
Avoid the need for mains top-up into the rainwater storage tank	√		√
Pump use & energy consumption minimised per litre used	√		
Services continue in the event of failure of a component or power supply	√		
Possible effects of ambient temperature on water-quality minimised		√	√
Irrigation-only system required		√	
Least cost (usually)		√	
Least complexity (usually)	√		

… system integration …

84. The RWH system has "done its job" at the point it provides a water supply to the dedicated pipe-work serving the non-potable services.

85. The system is also connected to the underground infrastructure to allow harvested water to flow into the neck of the tank, and to overflow to waste once the tank is full; to meet the requirements of BS-8515 the water must be filtered before it enters the tank, and usually the drainage arrangements need to allow for invert drop across this filter.

86. There also needs to be an underground services duct between the tank and the property being served to carry cables, such as power to the pump, and any sensor cables required. It also carries the correct rainwater delivery pipe, plus free-flowing mains top-up water in direct pumping systems not using booster-sets. During installation of the service duct, a robust, water-tolerant draw-string is to be installed for subsequent pulling through of cables; this should always be left in-place for subsequent re-use.

Tanks

… module aim …

87. The aim of this module is to provide an understanding of how RWH tanks should be chosen, handled and installed.

… general characteristics …

88. Tanks used for the storage of harvested rainwater are generally durable and should be expected to give many years in normal service (perhaps 50 or more) before they need to be replaced. They must also be durable to the ground conditions in which they are installed, and avoid tainting the water they contain.

… tank materials …

89. Tanks are usually made from:

- Polyethylene (PE):
  - Single-piece (usually rotational-moulded)
  - Two-piece "clam-shell"
- Glass-Reinforced Plastic (GRP):
  - Single piece
  - Sectional (for assembly above ground)
- Metal
- Concrete

90. All tanks regardless of material can be both heavy and relatively fragile until fully installed, and thus easy to damage before and during the installation process; they are, accordingly, to be handled and installed strictly in accordance with the instructions provided by the manufacturer.

… tank selection …

91. Tanks will normally be buried to ensure the quality of the water being stored, and should be selected for a project taking fully into account factors such as:

- Required capacity and any dimension constraints
- Site access and routes to site
- Filter and other fitments requirements
- Ground conditions, re: soil type, water table, contamination etc
- Depth of excavation, adjacent structures, their foundations and proximity to utilities
- Traffic-bearing characteristics
- Topography (adjacent slopes and banks) and proximity to trees
- Delivery timetables

92. Above-ground tanks may also be chosen to meet the specific requirements of a project, although these are generally a more expensive option, and precautions need to be taken to keep the tank frost-free in winter, and cool in summer. Above ground tanks also experience different loadings to their underground counter-parts, a factor taken into account by the system designers.

… look out for! …

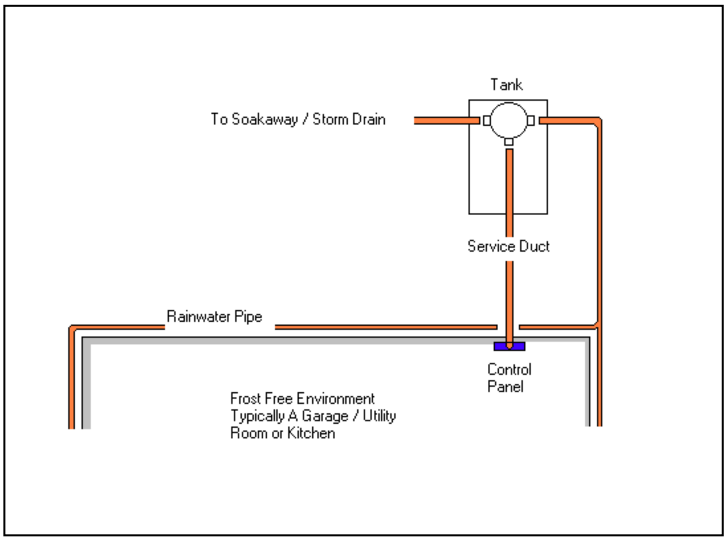
93. When ordering, account must be taken of the need for the tank configuration, and in particular its connections, to be compatible with the planned drainage layout, ie:

   a. The duct ("service duct") which links the tank to the system controls, and which carries a relatively inflexible delivery pipe, needs to be aligned with the system controls (see diagram below)

   b. The service-duct need to have a nominal drainage slope (1:80 minimum) towards the tank in direct pressure systems to facilitate gravity-fed mains top-up

   c. The rainwater feed into the tank, and the overflow from the tank, need to be aligned with the direction of drainage flow (see below)

   d. Due allowance will need to be made in the overall drainage scheme for any invert drop across the filter



… tank handling …

94. All risks associated with receipt of a tank on-site, its on-site handling, its installation and post-installation implications are to be assessed and associated method statements used.

95. Tank transportation to site is normally arranged by the supplier who will coordinate associated arrangements with site personnel, and provide guidance on how the tank is to be handled and installed.

96. Responsibility for the tank passes to the buyer once unloading commences; it is therefore important that the buyer accepts the condition of the tank on arrival before attempting to move it. Tanks are only to be lifted and moved in accordance with the manufacturer's instructions.

97. Tanks are designed to be lifted and manoeuvred only when empty; they are not therefore to be lifted when containing water under any circumstances as this will add considerable weight that the tank is not designed to support until installed.

… tank installation …

98. The tank must be installed in accordance with the manufacturer's instructions, taking due note of stated limitations, including factors such as:

- Installation depth
- Installation sequence
- Ground & water-table conditions
- Proximity to structures and topographical features
- Post-installation load-bearing requirements

BS-8515 also requires that consideration also be given to subsequent access.

… installation checklist …

99. Once the right tank has been ordered, a typical step-by-step guide to unloading and installing a tank would give consideration to:

- Arrangements should be made for the tank to be delivered, coincident with the day it is due to be installed; with this in mind, when delivery is expected ensure:
    - Suitable access and parking arrangements have been made for the delivery vehicle
    - Plant is available to unload the tank
    - A clear route has been designated between the delivery vehicle and the installation site
- The installation site is level and clear of obstacles and site debris and, ideally:
    - The water ingress pipe-work is complete and ready for connection
    - The water overflow pipe-work is complete, ready for connection, and is itself connected to the surface water management system (soak-away, storm-drain or attenuation as appropriate)
    - The service duct is ready for connection
- In accordance with the manufacturer's instructions provided:
    - Mark-out the excavation in plan-view
    - Calculate dig-depth
    - Note any constraints/guidelines on installing and back-filling the tank
    - Note any trafficking limitations once installed
- Complete and sign-off the risk assessment & method statement

Filters

100. Filters are designed to provide full domestic RWH systems with aesthetically pleasing water, ie crystal clear, but non-wholesome. A range of types of filters can be used individually and collectively to achieve this requirement, as follows:

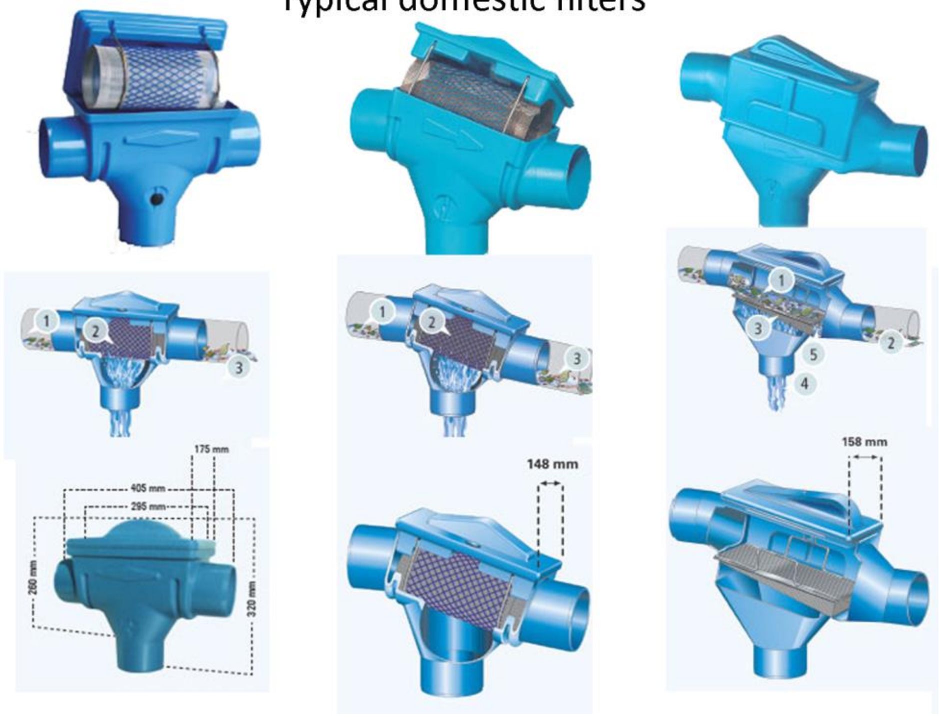
- Leaf-traps at the top of down-pipes
- Pre storage tank filters, to keep all solid particles in excess of 1.25-mm out of the tank (a BS-8515 requirement)
- Fine mesh/gauze filters, designed to remove fine sediment
- Carbon filters, to bring non-wholesome water up to wholesome quality, or to prevent "particle screening" when using:
- UV filters, again for bringing the water up to wholesome standard

101. For pre-storage cleansing of the harvested water, sedimentation traps that are effective in preventing solid particles in excess of 1.25-mm entering the tank are also permitted by BS-8515.

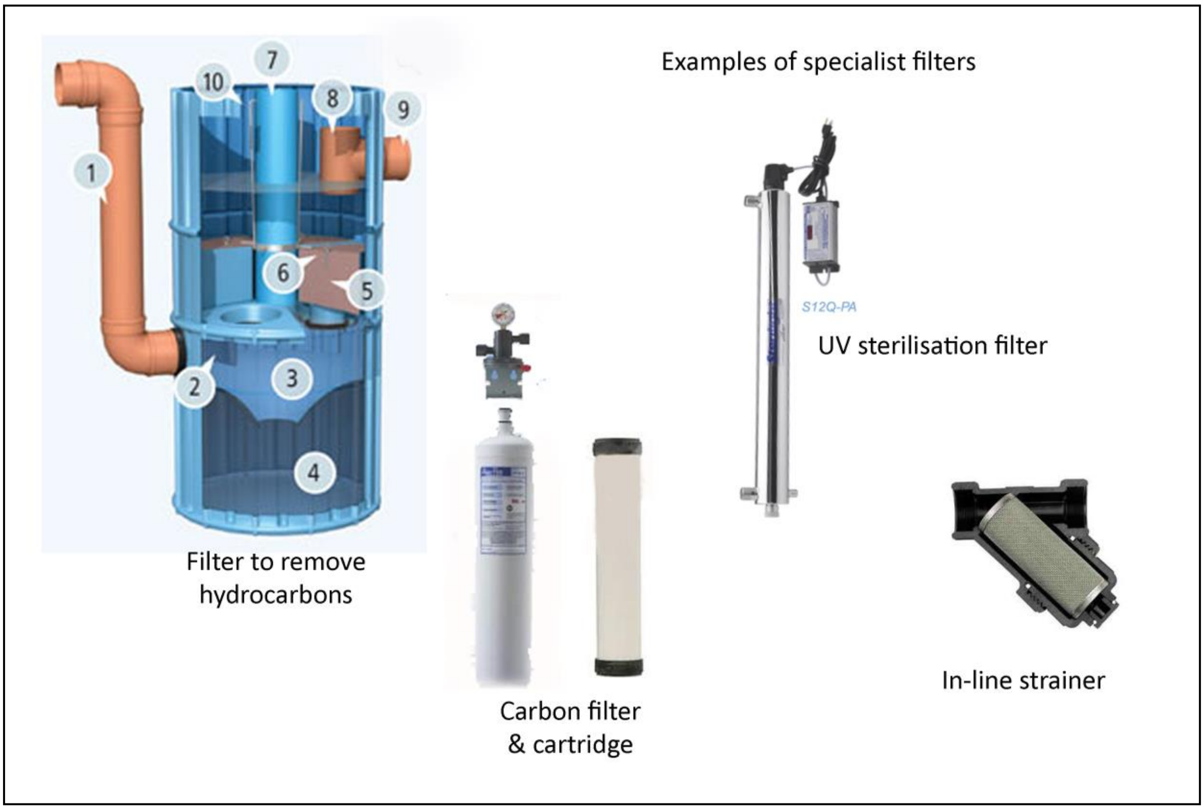
… pre-storage filters ..

102. Of the above filters, only the pre-storage tank filtration of the harvested rainwater is a mandatory requirement of BS-8515. The filter used must be rated to handle the volume of water generated by the roof during heavy downpours, and the invert-drop across the filter must be taken into account when designing the associated drainage runs. Various examples of filters used in RWH systems are illustrated below:

Typical domestic filters



Large commercial filters
Small commercial filters
404 mm
390 mm
451 mm
369 mm



Examples of specialist filters
Filter to remove hydrocarbons
Carbon filter & cartridge
S12Q-PA
UV sterilisation filter
In-line strainer

Pumps & Pump-controls

… module aim …

103. The aim of this module is to provide an introduction to the types and characteristics of pumps in general use in UK rainwater harvesting systems.

… pump types …

104. The pumps used by RWH systems have one or more of the following characteristics, in that they can be:

- In-tank or out of tank
- Self-activated or control-activated
- Suspended or free-standing
- Integrated into purpose-made modules

105. None of these characteristics carry inherent advantages/disadvantages, systems being designed to take into account the recommended pump. However, nearly all share in common the “limitation” that they are intended solely for use with clean water; this means that water that has not been satisfactorily filtered may cause them damage.

106. Typical system pumps are illustrated below:

… self-activated pumps …

107. Self-activated pumps, once primed and connected to the system they are supplying, switch themselves "on" when a demand for water is sensed, and "off" again when the demand ceases.

108. Such pumps usually also incorporate inbuilt dry-run protection, but reliance upon this can give rise to a number of possible undesirable side-effects, such as:

- Cavitation before shut-down
- Intake of poor quality water towards the bottom of the storage tank
- The pump cutting in and out of operation with minor fluctuations in storage tank contents (when intermittent light rainfall is experienced for example)
- The need to re-set the pump once the inbuilt dry-run protection has been activated

109. To avoid these possible side-effects, self-activated pumps are often fitted with a secondary float-operated low-level cut-off switch calibrated to stop the pump's power before the water supply is exhausted. This arrangement does not practically affect the harvesting potential of the system.

… control-activated pumps …

110. Control-activated pumps will run whenever power is supplied to them, and conversely stop running only when the power is removed; this means that they need to be controlled by a management system that usually comprises the following components:

- A **management unit** that makes power potentially available to the pump whenever there is sufficient water in the storage tank; this unit may also incorporate an indication of tank contents and other system control functions such a mains top-up

- A **pump control unit** that:

  - Senses when demand for supply of water starts/stops
  - "Instructs" a pump-capacitor to start/stop the supply of electrical power to the pump
  - Even when demand exists, "instructs" the pump-capacitor to cease providing power to the pump if no water-flow is sensed; this covers two failures which might potentially damage the pump:

    - Failure of the management unit to activate mains-water top-up when needed, hence causing the pump to run dry
    - Rupture or disconnection of the delivery pipe between the pump and the system supply pipe

- The **pump-capacitor** referred to above

… water intake …

111. Water quality at the point of use in a correctly-sized system is maintained by a combination of factors, including:

- Allowing only water harvested from a suitable roof to be collected
- Suitable pre-tank filtration
- Use of calmed inlets

112. Notwithstanding these measure, a fine silt can be expected to settle at the bottom of the storage tank; to avoid ingesting this material, the pump must take its water from a level in the storage tank which is clear of the silt. This is achieved by:

- Suspending pumps at the correct height within the tank and/or
- Using floating intakes (as pictured), which is essential for pumps that simply rest on the base of the tank

… common errors …

113. Common errors made at this stage of the installation, include:

- × Pumps suspended at the incorrect height
- × Pump-pots and integral filters not in place
- × Floating intakes missing
- × Floating intake too long or obstructed by tank wall
- × Float-valves suspended at the wrong height
- × Float-valve weights missing
- × Management sensor-cables at incorrect height or not calibrated
- × Operation of float-valves not checked
- × Cables tangled, preventing proper functioning

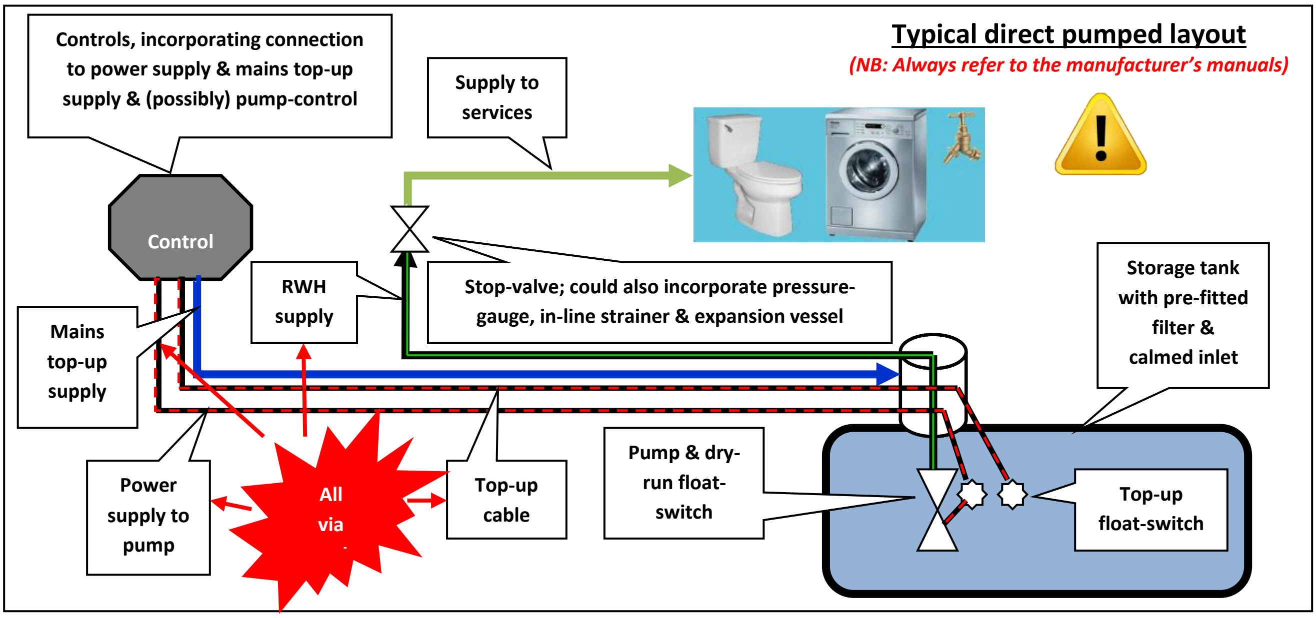
System Schematics

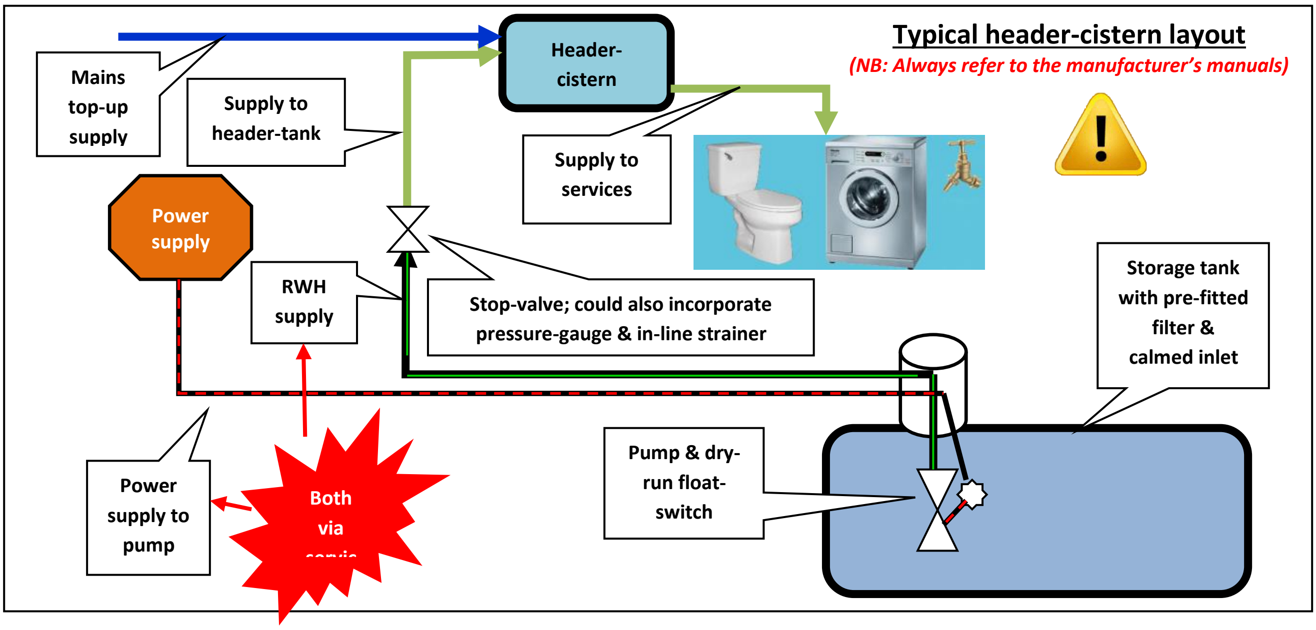
… module aim …

114. The aim of this module is to identify the schematic layout of typical domestic systems, and to illustrate the relationship between their components.

… overview …

115. Although component specifications will vary from system to system, their function and relationships are likely to be similar. The simplified schematics below help to identify commonly-used layouts for domestic systems; commercial systems will also share similarities with these layouts, but on larger projects may be more complex.





Happy Customers!

… module aim …

116. The aim of this module is to identify how best to make a complete success of a RWH project – and keep your customers happy.

… the happy factors …

117. The keys to having a happy customer are providing them with a reliable system at the right price; this entails:

- Choosing the right system (using the information provided above)
- Correct pipes and labelling used throughout
- Installed compliant with BS-8515 and Water Fitting Regulations
- Correctly pre-notified to the local Planning Authority and water supplier
- Comprehensive and informative information provided for the customer/end-user
- Installing it in accordance with the suppliers instructions
- Checked & commissioned in accordance with the manufacturer's instructions
- A proper hand-over to the customer and end-user

118. Checklists covering these last three factors are provided below

… successful installations …

119. The details of every installation will vary from system to system, and must be undertaken strictly in accordance with the manuals provided by the system supplier and by an Approved or WaterSafe accredited Plumber; failure to do so may prejudice the system's fitness for purpose.

120. Bearing in mind that once complete, some aspects of an installation can no longer be visually checked, it is important that the project be supervised throughout by a competent person and that individual tradesmen take a professional pride in their work.

121. The hallmarks of a successful installation are:

- ✓ Leaf-guards are fitted to down-pipes
- ✓ All drainage system joints, including between the neck and the tank, are well-sealed to prevent ground-water ingress
- ✓ Any plumbing/pipe-work using screwed-connectors employ correctly applied jointing paste
- ✓ Water is being collected from a suitable roof only, and there are no open gullies
- ✓ The tank has been kept free of foreign matter throughout
- ✓ All pipes have been sealed when being pulled-through and are free of dirt
- ✓ The pre-tank filter has been sealed pending occupation to prevent stagnant water developing

… commissioning …

122. System commissioning is the final stage in preparing hand-over of the system to the client, the process for which will again vary from system to system and must be undertaken in accordance with the supplier's instructions; typically, commissioning will entail confirming that:

- ✓ The installation has been completed in accordance with the supplier's instructions, and has been pressure-tested
- ✓ Correct pipe-work and labelling used throughout, and supervisory checked at the time of installation
- ✓ Any manufacturer's recommendations for non-supplied parts, such as toilet cistern valves for example, have been followed
- ✓ All electrical and plumbing connections are sound
- ✓ The pump is correctly installed, has been primed and operates on demand
- ✓ Any floating component, such pump intake and float-switches, and associated cabling are untangled and operate freely
- ✓ All operations function correctly, such as:
  - Gauge readings
  - Dry-run protection cut-out
  - The mains top-up function
  - System warnings & alerts
- ✓ The filter is correctly installed (and sealed if end-use is not imminent)
- ✓ The system operates normally and holds pressure when inactive
- ✓ The system has been leak-tested, and there is no evidence of leaks or weeps

… hand-over …

123. The system is now ready to be signed-off by the commissioning tradesman, and handed-over to the client, covering all relevant points such as:

- ✓ Demonstrating use of the equipment, and its controls
- ✓ Explaining any system limitations/constraints
- ✓ Identifying the major components, their inter-relationship and normal function
- ✓ Explaining maintenance requirements
- ✓ Running through the fault-finding guide
- ✓ Providing system support contact information
- ✓ The need to remove the filter seal when the property is about to be occupied
- ✓ Providing the Safety File copies of the O&M Manual (commercial systems) or Installation & User Manuals (domestic systems)
- ✓ Providing copies of the installing plumber's Approved Plumber/WaterSafe certificate, in accordance with their scheme requirements

Arrangements also need to be in place to ensure that the end-user receives an equally comprehensive hand-over.

Maintenance & Repairs

… module aim ..

124. Guidance on the maintenance requirements of systems, and support in the event of system breakdowns, is provided by the system supplier.

125. The aim of this module is to identify the generic maintenance and repair requirements common to most RWH systems

… safety & access …

126. Proper risk assessments are to be made on all aspects of any work undertaken; **under no circumstances provide a cross-connection to the drinking water supply to overcome failure of the RWH system.**

127. For most of the checks to be made during routine maintenance and repair activities, electrical power will need to be "on", and all system stop-valves "open"; however, care must be taken to:

- ✓ Isolate electrical power when appropriate to the work being undertaken
- ✓ Close all stop-valves (including mains back-up supply) and isolate the pump when plumbing connections need to be broken (during removal and cleaning of in-line strainer, for example); re-made connections are to be properly re-sealed with correctly applied jointing paste, where appropriate

… routine maintenance …

128. The routine maintenance requirements of domestic RWH systems is limited to a periodic check (usually quarterly) of:

- ✓ Whether the user has experienced any problems or unusual symptoms
- ✓ The correct operation of services, including dry-run protection & mains top-up
- ✓ No signs of leaks or weeps
- ✓ No sign of wiring deterioration
- ✓ Correct operating pressure (where a gauge is available)
- ✓ Gutters clean, leaf filters in place, and pre-tank and in-line filters removed/cleaned
- ✓ Good water quality in the main storage tank, and to services
- ✓ No "tide-mark" in the neck of the tank to indicate over-filling (ie overflow failure)
- ✓ Tank contents matches contents gauge (if present) and the weather/usage pattern

… customer service …

129. It is important for the development of the RWH industry that developers and end-users experience of the technology should be wholly positive; performing good installations and providing good after-sales support plays a massive part in that.

130. Nevertheless, failures might arise, in which context it is important that end-users are:

- ➢ Provided with the contact details (installer and/or supplier as appropriate) of their primary source of after-sales support
- ➢ Encouraged not to “live with” irritating issues (water-quality, erratic performance etc), but report problems at an early stage
- ➢ Asked to report faults whilst either they or their tradesman are on-site, so that diagnostic support can be provided

… fault finding …

131. The manuals provided with the system by the supplier are the best source of information for tracing faults; most suppliers also supplement their manuals by providing free telephone “hotline” support. As noted above, this is best accessed whilst on-site so that diagnostic advice can be given.

132. Generic reasons why systems malfunction include:

- ✓ **No power** supply to the system; *check fuses etc*
- ✓ **No water** in the tank; *check pre-tank filter is clean and operation of the back-up*
- ✓ **Pump inoperative**; *may need replacing, re-priming or re-setting (power “off”/”on”)*
- ✓ **Incorrect top-up** operation; *check float-valve/sensor suspension and operate manually*
- ✓ **Component failures**; *on systems using control-activated pumps, for example, failure of any one of the management unit, pump control unit or pump capacitor will prevent the pump operating*
- ✓ **Pump “hunting”** (when services not being used); *weep or leak on the delivery side of the system (will shorten pump life and may cause it to fault-out)*
- ✓ **Continuous pumping** (but no pressure to services); *delivery pipe split or disconnected from the pump (system needs to be switched-of as soon as detected to protect the pump and avoid energy waste)*

- ✓ **Continuous topping-up;** *this would be evidence by the water-flow through the tundish on direct pumping systems, or by continuous overflow to drain on header-cistern system; isolate the top-up supply in either case, and locate the fault (likely to be a significant leak of failure of the mains top-up control valve)*

133. **NB:** It should be noted that on header-cistern and purpose-made module systems, a system failure may not be immediately apparent to the end-user, as water will still continue to be available to services via the mains top-up feature. End-users therefore need to be advised:

- How to detect such failures in supplier manuals
- To regularly check their water meter readings

… water quality issues …

134. As noted above, checking quality of the water in the main storage tank is one of the main requirements of periodic maintenance because:

- Poor quality water in the tank will provide poor quality water to the services which is unacceptable
- It may be an indicator of pre-tank filtration issues, which may additionally affect its efficiency at harvesting water
- Poor quality water may damage the pump, or reduce pump life

135. In the event of water-quality issues arising, potential causes include:

- System being left unused between installation and occupancy *(avoided by sealing the filter until the system is ready for use)*
- Foreign matter being allowed to enter the tank during the construction process *(which must be avoided)*
- Ground-water ingress *(avoided by sealing properly all underground connections during installation)*
- Back-flow from under-performing soak-aways *(avoided by installation of one-way valves on the over-flow)*

136. End-users should also note and implement manufacturer's advice in relation to any special precautions that might be recommended to safeguard water-quality during holidays or other prolonged periods when the system is likely to be inoperative.

Commercial Systems

… module aim …

137. Unlike domestic systems, which are usually supplied from a standard stock range, commercial systems are usually bespoke to the specification of their project and can therefore vary greatly in size and complexity.

138. The aim of this module is therefore limited to providing an indication of these variables, as a prelude to gaining the experience needed to install and maintain commercial systems with confidence.

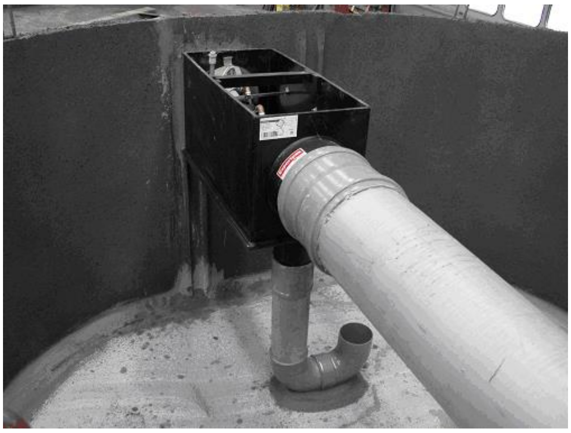
… overview …

139. The working principles of commercial systems are the same as those already outlined above for domestic systems.

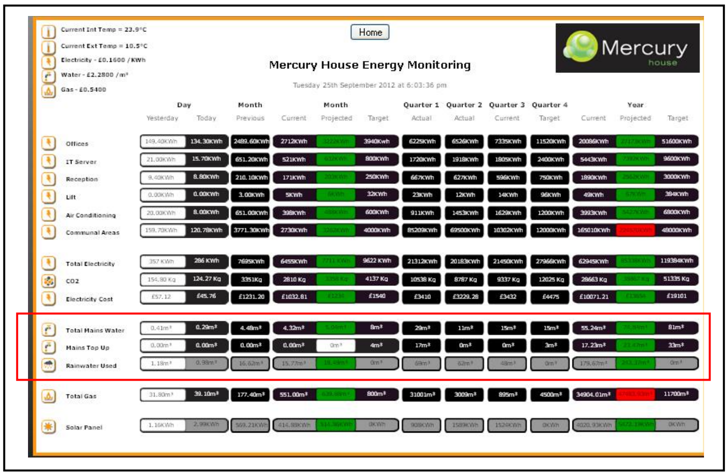
140. There is an overlap between the requirements of the largest domestic systems and the requirements of small commercial projects; where this is the case, there may be no significant difference between the two.

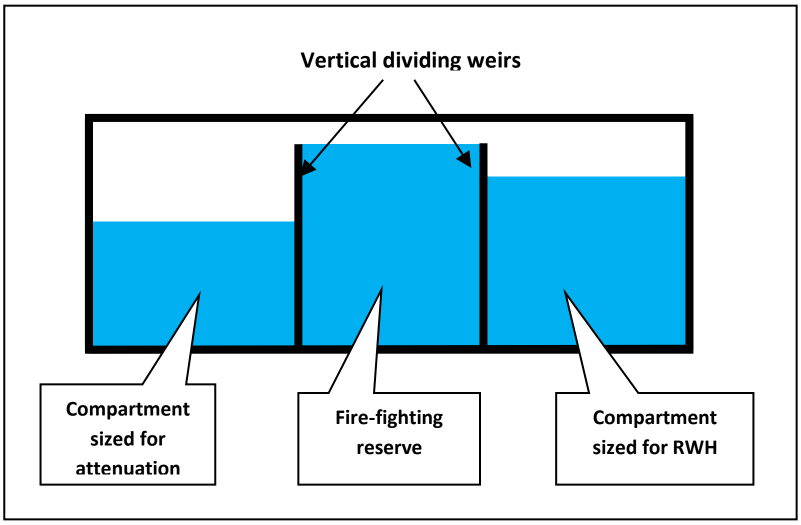
141. As the requirements of a commercial project become more demanding, this can result in the specification increasing to encompass features less likely to found in a system for a single dwelling, including:

- Increasingly large storage tanks (beyond 100,000-litres) or combinations of tanks up to many hundreds of thousands of litres to meet the tank-sizing criteria of BS-8515
- Much larger pre-storage filters, or combinations of filters, to cope with the volume of water generated by very large roofs
- Sophisticated filters able to handle ground, as well as roof, water
- Additional disinfection filters/measures



- Larger pumps and multiple pumps
- More sophisticated controls
- Performance monitoring displays and/or integration with building management systems
- Multi-function use of the storage tank (concept illustrated below) to provide a fully integrated RWH/SUDS system incorporating a reserve of water for fire-fighting purposes





… preparations …

142. Commercial projects are likely to have a much longer gestation period than domestic projects, with more attention needing to be paid, in particular, to:

- Integration of the system with the proposed (likely to be complicated) drainage
- How the system will interact with other systems in the building
- How installation will phase-in with other construction work
- Phasing of tradesmen involvement
- The need to ensure that any externally-sourced customised items, such as the bespoke tank for example, are signed-off by the buyer before firm orders are placed
- The heightened need for good coordination, and clear accountability, if components are being delivered by third-party suppliers direct to site

Self-Assessment Questionnaire

143. This manual is designed to provide pre-reading before attending a training workshop provided by a member of the UK Rainwater Management Association; reading the manual beforehand will enable you to get best value from a workshop that will cover a lot of information in a relatively short time.

144. As you have read through this manual, you have been advised to make a note of any points which are unclear so that you can question them during the workshop.

145. On completion of the course you should have confidence that you can successfully supervise the installation of domestic rainwater harvesting systems, undertaking the work yourself relevant to your trade.

146. The questions below are designed to help prepare you for the workshop, and to confirm afterwards that you have grasped all the necessary salient points. Please refer back to the manual if you are not clear about the answers to any of the following questions.

Background Knowledge:

Q1: List the 3 main factors that are driving the need for RWH in the UK

Q2: List 3 government-backed policy documents that result from the above factors

Q3: List 3 new RWH-related considerations in the 2010 update of Building Regulations

Q4: What is the RWH-related relevance of the 2010 Flood & Water Management Act?

Q5: What is the daily average of mains water consumption in the UK per person per day?

Q6: What percentage of this, approximately, needs to be wholesome?

Q7: List 3 uses of domestic water that can use non-wholesome water

Q8: List 3 ways of reducing household water consumption

Q9: How do you calculate how much water is likely to be used in a new home?

Q10: Why are mains water supplies under stress in the south & east of the country?

/20-marks

Regulations & Codes:

Q11: List 3 types of regulations that affect the installation of RWH systems

Q12: What is the colour code for pipes carrying harvested rainwater?

Q13: List the 2 ways used to avoid rainwater contaminating the mains water supply

Q14: Why do RWH installations need to be notified to Building Control?

Q15: Which Authority needs to approve installation of RWH systems?

Q16: What is the difference between a Type-AA and a Type-AB air-gap?

Q17: When would a Type-AB air-gap be most likely to be used?

Q18: List 5 aspects of a RWH system that are covered by BS-8515

/15-marks

Meeting Customers Needs:

Q18: For what type of domestic projects are full RWH most cost-effective?

Q19: State the principle reason why that is the case

Q20: Give 3 reasons why irrigation-only systems are easier to retrofit

Q21: What governs the size of the storage tank in a full domestic system?

Q22: What governs the size of the storage tank in an irrigation-only system?

Q23: List the 3 main parameters used to calculate tank size for a full RWH system

Q24: List 3 customer requirements that would best be met by a direct pressure system

Q25: List 3 customer requirements that would best be met by a header-cistern system

Q26: List 3 types of filters used in full domestic systems

Q27: Name the main customer requirement that would affect tank installation

/20-marks

Installation:

Q28: List 3 aspects of the tank connections that need to be checked before ordering

Q29: List 2 components one might expect to arrive pre-fitted to the tank

Q30: List 5 things you would check during the installation of a tank

Q31: List the 3 trades involved in the installation

Q32: List 3 of the services that pass through the service-duct

Q33: What is the alternative to a service duct if one cannot be accommodated?

Q34: List 3 site factors that will affect the tank installation

Q35: What is the purpose of a one-way valve on the overflow?

Q36: List 3 installation-related errors that will lead to poor water quality

Q37: Where in the system should a cross-over loop be fitted to ensure continuity of supply in the event of a power cut or system failure?

/25-marks

Maintenance:

Q38: What is you main source of information related to maintaining/repairing a system?

Q39: Failing that, list the first three things you would check on an inoperative system?

Q40: List 5 periodic maintenance checks that would apply to most systems

/10-marks

Getting it right!

Q41: List 5 hallmarks of a job well-done

Q42: List 5 of the things you would check when commissioning the system

/10-marks
/100-marks