Water Management Planning Guidance for Construction Projects

Introduction

It is a misconception that the UK has an abundance of water.

FACT: Already parts of UK have less rainfall per person than many Mediterranean countries

FACT: Increasing demand has resulted in higher costs, both within our homes and on site, as we fund new sources of supply. South West Water increased their charges by 34% between 1993 & 2003 and by 58% between 2003 and 2013 rising from £0.57/m^3 to £2.04/m^3 in 20 years

FACT: Water resources are under pressure and current levels of water abstraction are unsustainable in places

Source: 'Water for Life', the Government White Paper on Water, Dec 2011

Why are we concerned?

Water is a precious, undervalued resource, with many and varied demands on site for its use. It is this variety of uses that gives greater opportunity for reducing consumption and cost saving.

Technology is available, but this alone will not result in a sustainable, water efficient construction site – it is staff on-site who operate machinery and control water outlets that have the power to reduce water consumption.

Figure 1 shows the water stress map of the UK, indicating which areas are under water stress, which is a combination of water demand (linked to population and industrial use) and water availability.

In the coming years, the combined effects of climate change and an increasing population will put further pressure on our rivers, lakes and aquifers.

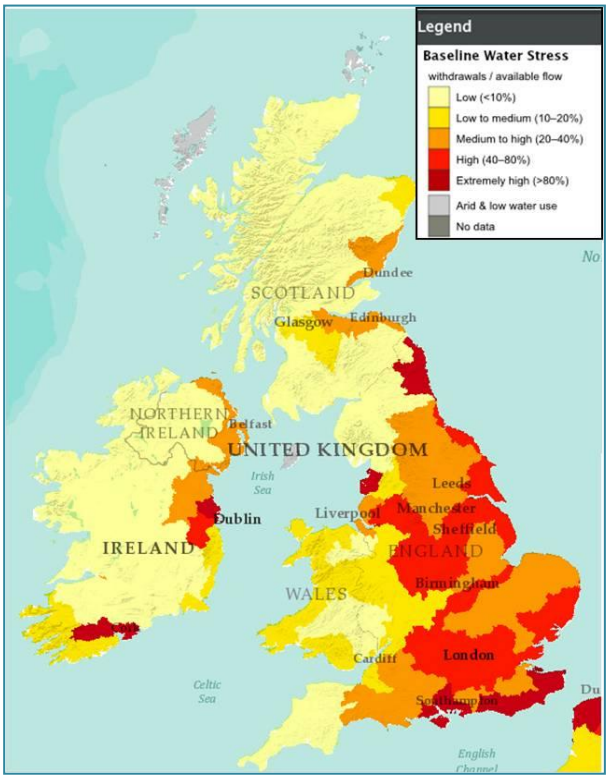
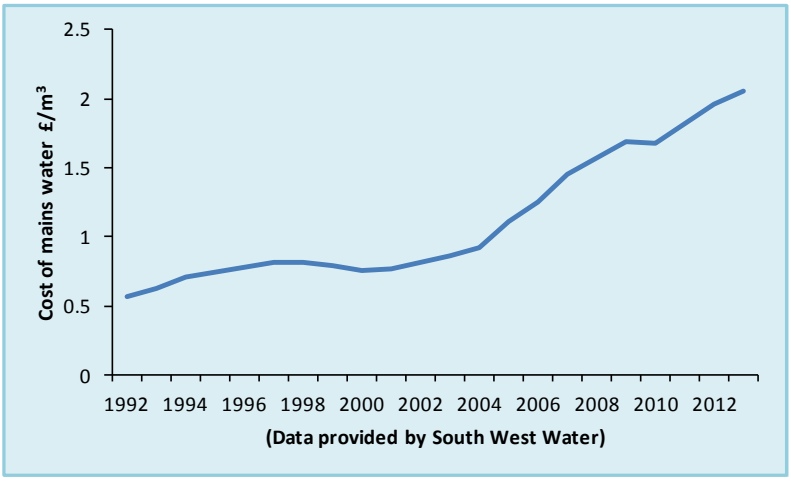


Figure 1 – Water Stress Map of the UK (World Resources Institute data by Aqueduct)

We need to act now to manage demand for water and ensure the security of our water supplies.

It is not just water availability and water stress which is an issue for construction sites; as shown below in Figure 2, the costs of water have increased significantly over the last 10 years.



The graph shows typical costs from South West Water, however the costs vary depending on the Water Supply Company, and these figures are just for water supplied to site. Disposing of water to sewer or tankering water away can often be a lot more expensive than just the supply of water.

Figure 2 – Rising costs of water over the last 20 years

The purpose of the guidance provided is to improve the efficiency of water use on construction sites through better planning and management of water and to encourage consideration of environmental risks associated with construction activities.

The document is designed to support all disciplines across the construction industry, and provide standalone guidance to help with a particular water issue and/or to guide users to complete the Water Management Plan template.

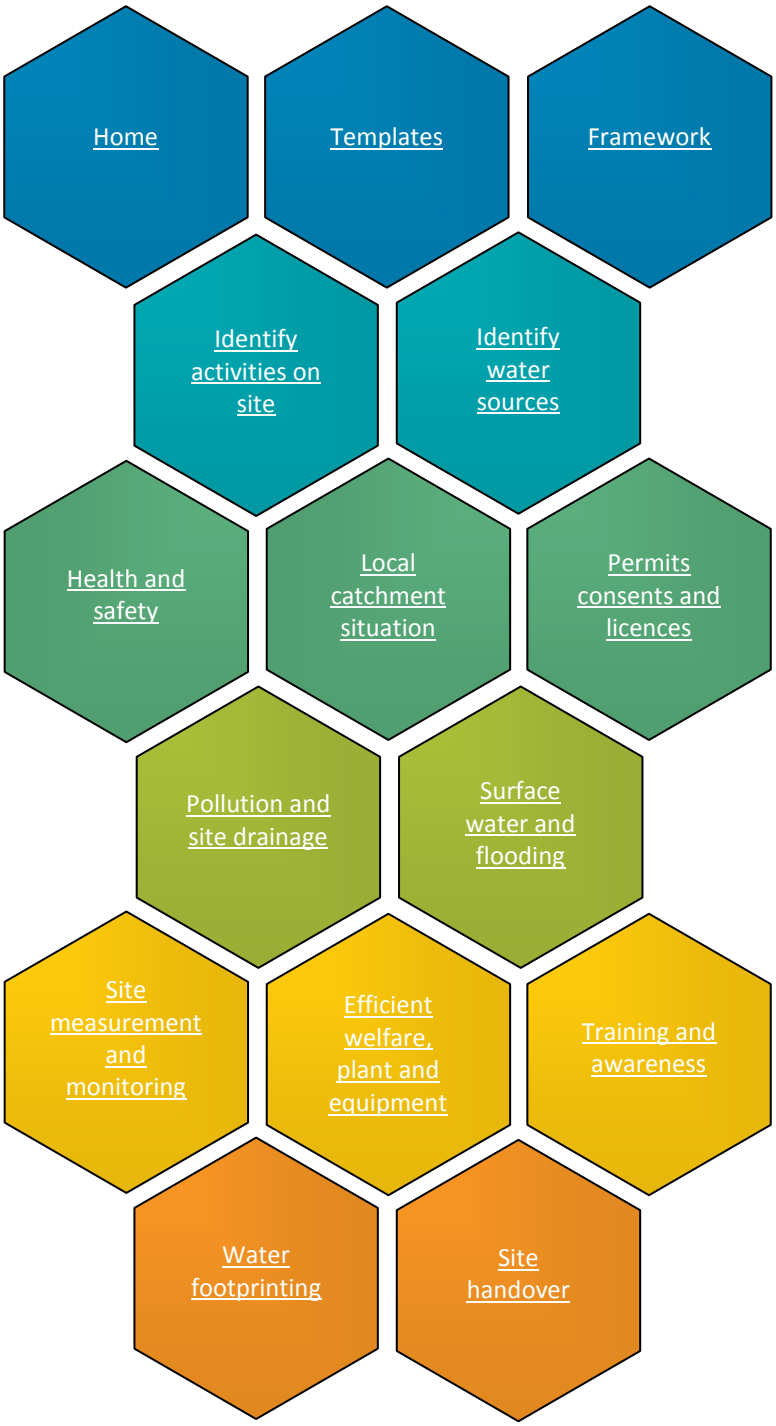
Environmental regulators within different parts of the UK have been collectively termed 'national environmental regulators' throughout this document and specific guidance can be found on their websites. The four national regulators coordinated by Defra and are:

- Environment Agency
- Natural Resources Wales
- Northern Ireland Environment Agency
- Scottish Environmental Protection Agency

Extensive practical examples and links to resources are provided within this document which enables straightforward application of this guidance to a specific project.

Water management planning framework

The following diagram provides links to water management topics which are **hyperlinked.** These can be accessed so the guidance is standalone, or provide detailed guidance for the Water Management Plan template which has been produced alongside this guidance.



Identify activities on site

Most construction activities demand water in one form or another. However, few need to use potable water, unless hygiene, health or product quality could be compromised. It is important to identify the trades, their activities and, if water is required, whether potable or non-potable water would be appropriate.

The ultimate aim is to eliminate demand and use of potable water in construction. It is unlikely that water demand can be eliminated, but efforts can be made to reduce and use alternative sources, as well as reuse water for construction activities. The following table outlines key activities on site where water is needed and further provides an assessment of whether non-potable sources might be appropriate for them. Examples of efficient technology and practices for each activity are also listed.

Activity	Water Use	Potable or Non-Potable	Options to avoid Potable Water demand
Site Cabins	Drinking, kitchen, canteen, toilets and urinals, showers and hand washing.	Potable Non-Potable	Efficient showers, taps, toilets and urinal controls. Trigger control on catering taps & use of vessels for washing rather than under running taps. Rainwater for toilet flushing, floor cleaning. Waterless urinals.
General Cleaning	Tool rinsing and Boot Washing Plant and equipment washing	Non-Potable	Fill containers rather than use running taps or open hoses. Trigger-operated spray guns. Use of a closed water recycling system – like a small scale wheel washing facility.
Demolition Dust Suppression	Hydro- demolition Damping & Misting	Non-Potable Potable	Exploit existing water in the building (eg use of water tanks in building if full. Drain water from tanks to skips as temporary containment. Drain water from water tanks to basement, as a holding tank. Capture for potential use elsewhere
Site Dust Suppression	Damping – dust Wheel wash – road safety	Non Potable	Use of chemical additives. Use of control systems to allow damping activities to be altered for different applications and weather conditions. Use of water efficient road sweepers and dust suppression vehicles which recirculate water and/or have efficient spraying mechanisms such as a hydraulic spinning system. Use water collected elsewhere on site – such as from SUDS – for dust suppression activities. Use drive-on wheel wash systems that recirculate water. Use captured water, or water from elsewhere on site to fill tanks. Consider waterless wheel cleaning systems if space permits.

Drilling			
Piling (all types) **Ground Source Heat Pump Drilling**	Lubricant Bentonite production	Potable if pressure required Non-Potable (where able)	Inspect hose lines for leakage and repair or replace as required. Watertight circulation tanks, rather than pits. Use of meters on supply lines / consumption monitoring for high demand activities
Frame ***Non-issue for Steel/wood***	Concrete cooling	Non-Potable	Use damp sheets/ ice packs as alternative to spray cooling.
Wet Trades			
Bricks & Blocks	Silo mixer	Both	Use of water butts and localised water cisterns for mortar mixing, as alternative to live ring main and long hose pipe runs on site.
Screed	Laying	Both	Apply in early morning, late evening or out of hours, for natural cooling (avoid additional water demand for damping). Use ready mix (avoid onsite water demand/waste/pollution risk) Avoid screed through higher tolerance and finishing specification for concrete slabs.
Concrete Production		Both, follow guidance in EN 1008:2002	Alternative sources can be used provided the risk of contamination from non-cement based materials is minimal. Consider a storage facility on site where water for cleaning could be blended with potable water for use in production.
Concrete Wash Out		Non-Potable	Consider collecting wastewater and, following filtering, reusing as an ingredient in the concrete batching process. Consider use of a 'concrete sock' to cover concrete chutes on wagons. Use trigger guns on hoses.

Rendering & Plastering		Potable	The use of non-potable water carries some risk as contaminants in the water may cause longer term instability. Avoid use of plaster by specifying dry-line finish.
Dry Wall	Taping and jointing	Potable *preferable to avoid long term instability from risk of contaminants in non-potable, unless settled & filtered.*	Use of water butts and localised water cisterns for mortar mixing, as alternative to live ring main and long hose pipe runs on site Use ready mix (to avoid on site water demand/waste).
Painters	Brush/roller cleaning	Potable	Use of proprietary wash plant (e.g. Crown, Dulux, Safety Kleen baths) that reuse water and contain residues that are settled and can be removed from site for reuse. Minimise paint colour changes to avoid the need to wash tools. Keep brushes in plastic bags to prevent drying, and hence the need for frequent washing. Consider a first rinse of brushes with non-potable, but debris free, water.
Core / Diamond Drilling	Wet cut is the traditional approach (but is high volume user of water, often creating safety issues with water cascade to lower floor work areas)	Non-Potable	Preform openings designed in prefabricated sections, avoiding core/diamond drilling. Dry cut where possible. If wet cut is only suitable option, set up water reservoir (wheelie bin) to allow water recycling. At regular intervals remove the sludge and silts from filters into an inert waste bin to prevent blockages.
Curtain walling	Pressure test – use of sparge bars	Potable with pumped reuse	Minimise consumption to test curtain wall integrity standard
Commissioning	M&E Pipe Pools Bund testing	Potable for pipe systems (reuse to be considered)	Planned water use – sequential flushing, sub-valving and reuse where practicable. Isolate water flow as soon water turns clear when commissioning pipes and systems.

		Tanks – 1st test non-potable; final test Potable – (with reuse…)	Use of tanks for storage – fire storage – use in landscaping works or other. Sequential flushing for swimming pools, jacuzzi to reduce volume used Reuse flushed water for landscape irrigation, washdown etc.
Drains	Flushing	Both (reuse to be considered with bunged end and gulley suckers)	Reuse water collected from commissioning activities. Use water from attenuation or rainwater harvest tanks if installed.
Roof testing	Electrical test ponding	Non-Potable with reuse	Reuse water collected from commissioning activities. Use water from attenuation tanks.
Cleaning	Externals	Non-Potable	Use mechanical methods.
Window cleaning		Potable with reuse	Use manual systems, rather than extended hoses. Encourage reuse by contractors.
Green roofs and walls	Delay if necessary	Non-Potable	Direct water application by fixed watering systems, with pressure reduction and timers only. Use harvested or attenuated rainwater.
Pitches, verges, gardens	Delay	Non-Potable	Plant in autumn to limit watering needed during dryer summer period. Avoid planting and subsequent irrigation in heat of day. Ideally water early morning or evening, allowing soil and root take-up.
General	Laying of temporary water supplies	-	- Network integrity and protection. Check for leaks (e.g. hose lines) and repair/replace as required. Use pressure sensor/leakage detection to assist. Isolate supplies whilst site is not occupied e.g. over night.

Identify potential sources of water available

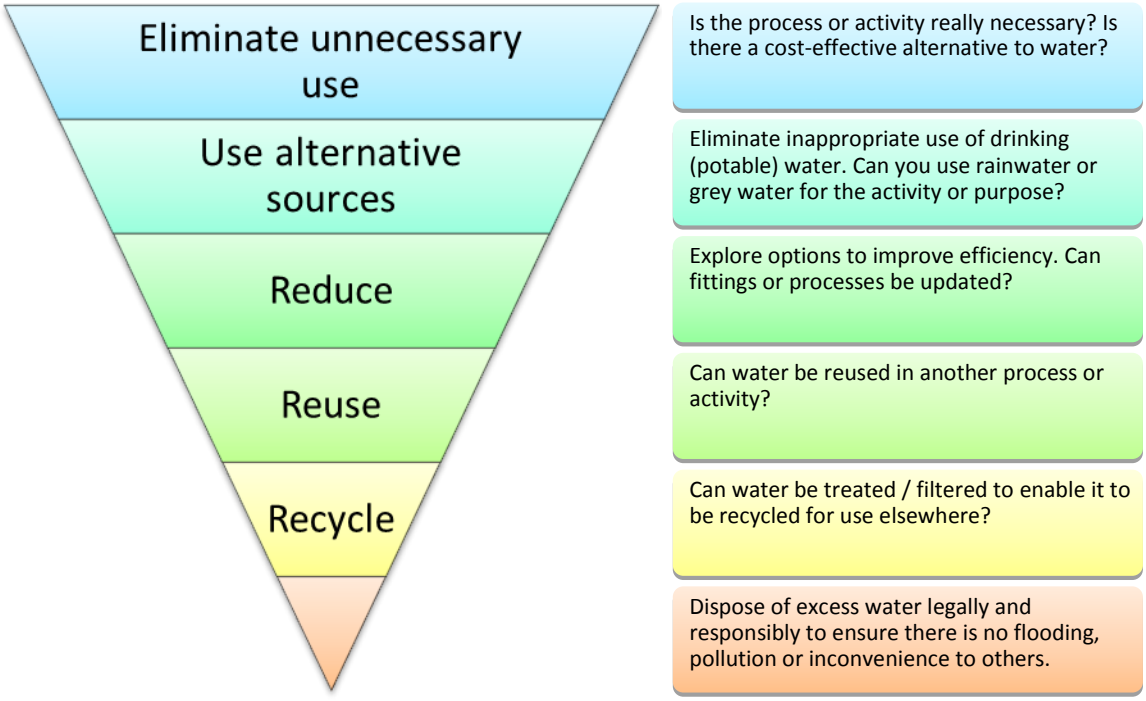
Having identified water needs, it is important to plan for alternative sources within the project, whilst sustaining metered potable supply as back-up supply.

Consider phasing of activities and the use of structures that could be used to:

- Store (covered tank, positioned in shade and optimal size),
- Collect (multiple sources and surfaces),
- Reuse (local tubs and tanks, settlement zone with tap one third up),
- Save (maintain records of metered or estimated volumes used/reused),

…water during the project.

When considering water use on site, the water hierarchy should always be consulted.



Consider cost and potential health impacts if water is to be reused for domestic purposes, e.g. toilets. More information on this can be found here.

Use the Pre-Start meeting to discuss use and solicit/share water saving ideas from and for all Trades.

Supply	Water Source	Considerations
Non Potable	Water Harvest tanks (new or existing)	Install early for non-potable site use (install draw off pipe or for example connect to toilet flush). Use existing tanks (save from demolition) if available. Record tank volume and/or sub-meter use.
Non Potable	Runoff attenuation (tanks/storm water ponds - new or existing)	Install early for non-potable site use (Install draw off pipe). Use existing tanks (save from demolition) if available. Record volume and/or sub-meter/estimate use.
Non Potable	Land Drainage attenuation (discuss risk of increased surface or land drainage issues for the site)	Ensure potential land drainage issues resolved at outset of the project to mitigate impact for site. Reinstate or establish land drainage infrastructure or address segregated land drains in early project phase. Map likely pathways for surface water – divert or avoid flow to work area to mitigate wash-out or safety issue and programme delay risks.
Non-Potable	Dewater attenuation from excavations	Reuse (up to 20m3/day without need for abstraction licence) to avoid trade effluent charge and unnecessary surface water loading to wastewater network and treatment systems.
Non-Potable	Abstraction licence	Sources from river, groundwater, canal.
Re-Use	Storage on site for re-use	Covered tank, positioned in shade and optimal size, with back-up supply on ballcock to sustain supply if critical to operational need.
Re-Cycle	Prepare to treat on site for re-use	Set-up screening, settlement, aeration and retention tanks, with testing regime.
Potable	Mains supply or Hydrant (standpipe) supply or Bowser or Tankered supply	Potable supplies identified in activity.

Extend operational use of attenuated sources and rainwater harvesting in life of project and prepare for how these will be decommissioned or managed in transition at handover (e.g. ensure sedimentation is cleared from attenuation prior to tank handover etc.) It is critical that should the feature be retained for the operational phase, the maintenance requirements are clearly communicated.

Ensure fit for use at handover – no residual liability to catchment quality with risk of detrimental impact on the ecological value of watercourse (mitigate siltation) under Water Framework Directive.

Non-potable sources are not guaranteed and will need potable water back-up where rainwater and attenuated water supplies are exhausted.

Health and safety considerations

Good practice applies to risk management beyond bacterial/biological potential (E.coli etc.) of how water is sourced, where it has come from, how it is stored, for how long and in what conditions that could lead to contamination, plus how the water is used. If small droplets of water created in its use, the risk may be greater dependant on the original water source, how it has been stored, for how long etc.

If water droplets are larger, or not aerosolised, risk is negligible to health. The exception to this is the theoretical circumstance where there is rapid drying and dust created with particulates immediately after use is blown into the atmosphere.

If fine droplets are needed, potable water should be used. For instance for dust suppression in densely urban areas, or use of fan-blowers to create column of misted air within a demolition site.

Storage of Non-Potable Water Sources

Sensible precautions should be taken to avoid bacterial growth. For instance cover stored water, keep cool and avoid heat and direct sunlight. Allow waters to settle and use silt traps and filters appropriately on inflow and outflow to prevent sediment impact downstream.

Local catchment situation

The national environmental regulators are responsible for managing water resources in England and Wales, and SEPA in Scotland, on behalf of the UK Government/Scottish Parliament.

One role of the national environmental regulators (NERs) is to develop Catchment Abstraction Management Strategies (CAMS). These provide an assessment of the amount of water available in each river catchment. As part of this work the NER's periodically review all abstraction licences to determine whether or not they are having an unsustainable impact on the environment.

During a drought, the NERs step up their monitoring actions to make sure that they continue to protect the environment from harm and take action to protect the environment. It is therefore useful for site managers to be aware of the local catchment situation, so that in times of extreme circumstance they are aware if they may be affected by emergency actions such as restrictions on abstraction due to drought orders.

To identify which river basin district and catchment your site is located in, maps can be found at http://www.environment-agency.gov.uk/research/planning/33112.aspx. Relevant catchment abstraction management strategy documents which outline the water scarcity situation and pressures on resources can be found at http://www.environment-agency.gov.uk/business/topics/water/119927.aspx.

The risk of flooding in the local area both for the site and for critical routes to site should be considered. Information on flood risk, including interactive maps, can be found on the national environmental regulators websites (for example; http://www.environment-agency.gov.uk/homeandleisure/37837.aspx)

The flood risk of the area should be considered and a flood plan developed if required to ensure site resilience. The site manager should be made aware of the risk of flooding to the site. If a flood plan has been prepared the site manager should own this document whilst the site is active. Ideally the flood prevention measures and emergency arrangements should a flood event occur should be contained within the site emergency procedures, where health and safety of persons working or present on the site is prioritised and business resilience also a consideration. Business resilience is the positive ability of a system or company to adapt under challenging conditions.

In areas of high flood risk a free service called Floodline Warnings Direct is operated by the national environmental regulators. Warnings can be provided via telephone, mobile, email, SMS text message and fax. You can sign up for this service at http://www.environment-agency.gov.uk/homeandleisure/floods/38289.aspx

If the site has been located in an area of flood risk it is likely that the construction has included flood prevention or alleviation as part of the construction methodology. Details of maintenance or operation of these facilities should be handed over to the site owner upon completion, and documents may be required to be sent to planning officers to discharge key conditions.

Permits, consents, licences & disposal of water

Identify permits, consents and licences needed for the use, transport and disposal of water on site.

The following table provides an outline of types of consent that may be required, these should be reviewed and further information sought as required. The acquisition of a permit, licence or consent may limit the way in which you handle water use and disposal on site and should therefore be considered early in the planning process.

Where a consent, licence or permit has been supplied, the site is required to operate within the relevant requirements. This may include measuring and monitoring activities such as sustaining records of discharge according to consented parameters (sampling, photo evidence, daily records in site diary etc.) and often a method of silt/sediment control (e.g. a settlement tank) prior to discharge of the water.

Remember to extend the consent if the time period is inadequate, and should site activity cease ahead of the anticipated timetable the consent should be revoked.

Appropriate procedures should be followed for surrendering permits, consents and licences at the end of the construction project.

Permission	Activity	England	Wales	Scotland	NI
Abstraction licence	Removal of water from a watercourse / groundwater	http://www.environment-agency.gov.uk/business/topics/water/32020.aspx		http://www.sepa.org.uk/water/water_regulation/regimes/abstraction.aspx	http://www.doeni.gov.uk/niea/water-home/water_resources/abstraction/application_information.htm
	Over-pumping from one watercourse to another or within the same watercourse				
Impounding Licence	Damming / holding back a watercourse				
Environmental Permit	Discharge of water / effluent into a watercourse*	http://www.environment-agency.gov.uk/business/topics/permitting/default.aspx		http://www.sepa.org.uk/water/water_regulation/car_application_forms/discharge_activities.aspx	http://www.doeni.gov.uk/niea/water-home/regulation_of_discharges_industrial/industrial_and_private_sewage_2.htm
Agreement to use herbicides in or near water	Use of herbicides near water	http://www.environment-agency.gov.uk/homeandleisure/wildlife/31350.aspx		http://www.sepa.org.uk/system_pages/application_forms.aspx	http://www.doeni.gov.uk/niea/water-home/agri_regs.htm
Trade effluence discharge consent/ Groundwater permit	Discharge of water / effluent into the sewage system. Identify the relevant sewerage undertaker to liaise with. Discharge of any water other than 'clean uncontaminated rainwater'.	http://www.water.org.uk/home/resources-and-links/links/water-operators/sewerage-operators		http://www.scottishwater.co.uk/business/our%20services/compliance/trade%20effluent	http://www.niwater.com/sewer-trade-effluent-discharge/
Development Licence	Works that may impact protected flora / fauna	http://www.naturalengland.org.uk/ourwork/regulation/wildlife/licences/	http://naturalresourceswales.gov.uk/apply-buy-report/apply-buy-grid/protected-species-licensing/?lang=en	http://www.snh.gov.uk/protecting-scotlands-nature/species-licensing/	http://www.doeni.gov.uk/niea/biodiversity/wildlife_management_and_licensing/wildlife.htm

Fish or Fisheries	Fish removal	http://www.naturalengland.org.uk/ourwork/regulation/wildlife/licences/	http://naturalresourceswales.gov.uk/apply-buy-report/apply-buy-grid/protected-species-licensing/?lang=en	http://www.snh.gov.uk/protecting-scotlands-nature/species-licensing/	http://www.doeni.gov.uk/niea/biodiversity/wildlife_management_and_licensing/wildlife.htm
Flood Defence Consent (England and Wales) Controlled Activity Regulations (Scotland)	Work in, over, under or near a main river or a flood defence (including a sea defence)	http://www.environment-agency.gov.uk/business/topics/143729.aspx	http://naturalresourceswales.gov.uk/apply-buy-report/apply-buy-grid/flood-defense/?lang=en	http://www.sepa.org.uk/water/water_regulation/car_application_forms.aspx	http://www.planningni.gov.uk/index/policy/policy_publications/planning_statements/pps15/pps15_planning_policies/pps15_policy_fld4.htm
Marine	Deposit or removal of a substance or object below the mean high water springs mark or in any tidal river to the extent of the tidal influence	http://www.environment-agency.gov.uk/business/topics/permitting/default.aspx	http://naturalresourceswales.gov.uk/apply-buy-report/apply-buy-grid/marine-licensing/?lang=en	http://www.scotland.gov.uk/Topics/marine/Licensing/marine/Applications/construction11	http://www.doeni.gov.uk/niea/water-home/marine_licence_applications_and_legislation.htm

*** Environment Agency Position Statement on temporary water discharges from excavations (June 2013)**

http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/GEHO0810BSYE_E_E_5215f0.pdf

Environment Agency approach

Will not require an application for an environmental permit for discharges of water from excavations provided :

- the discharge is temporary, for an overall period of less than 3 months,
- the discharge is made to a surface water (such as a river, stream or the sea),
- the discharge does not pollute the surface water or adversely affect aquatic life,
- the discharge location is not within, or less than 500 metres upstream of a riverine or marine European site (see below) or SSSI, or within a site designated for nature conservation (such as NNR, LNR, Local Wildlife Sites).
- The discharge does not cause flooding from the surface water,
- The discharge does not cause erosion of the banks or bed of the surface water,
- Work on the site must follow the advice in Pollution Prevention Guideline No 6 “Working at Construction and Demolition Sites”.

Pollution management and site drainage

The national environmental regulators have jointly published a range of Pollution Prevention Guidance Notes (PPGs) to advise industry and the public on legal responsibilities and good environmental practice.

The primary PPG for construction sites is 'Working at construction and demolition sites: PPG6 Pollution Prevention Guidelines' which is available at http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/pmho0412bwfe-e-e.pdf

Supporting this guidance is a document specific to managing concrete washout on site, this is available at http://www.environment-agency.gov.uk/static/documents/Business/MWRP_RPS_107_Concrete_washwaters.pdf

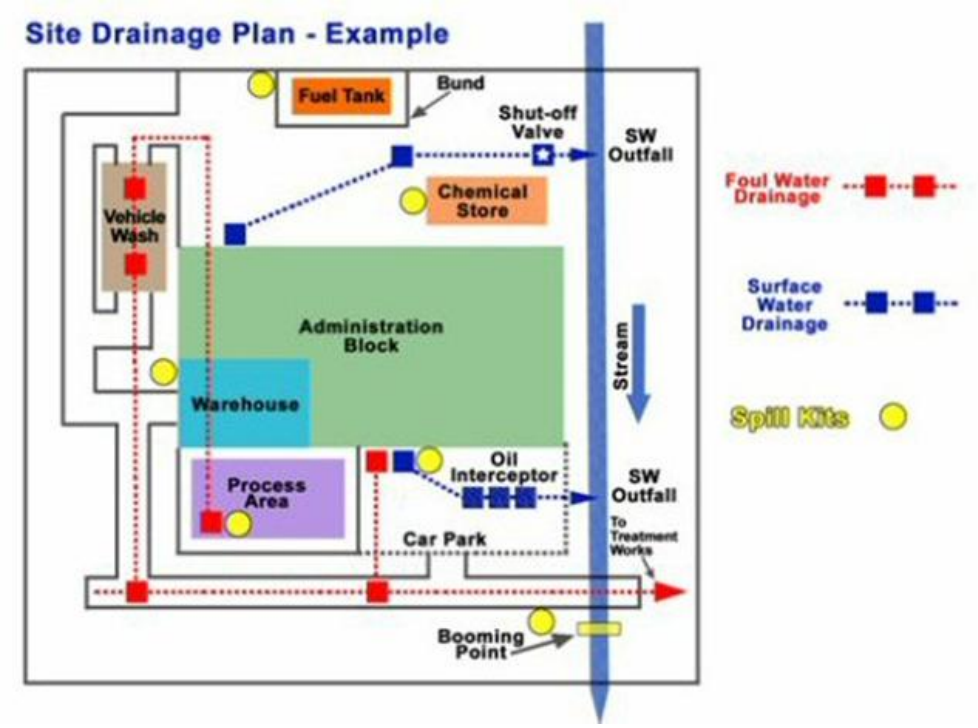
More general guidance can be found at http://www.environment-agency.gov.uk/business/topics/pollution/39083.aspx

Pollution prevention needs to be considered in relation to:

- Watercourses located in the vicinity of your site
- Discharges from your site
- Extreme events: surface water onto site, flooding on site and surface water flow off-site.

Site Drainage

As an example of best practice, a drainage plan specific to site should be drafted and included within the Water Management Plan (refer to example below).



Surface water management & flooding

The Flood and Water Management Act (FWMA) in 2010 provides clarification of accountabilities for local authorities to take a lead role. Storm and rainwaters provide risk and opportunity within the built environment, risk of surface waters creating channels within the built environment and resulting in flooding and opportunity that if attenuated from roofs provide reasonable resource. Planners and designers will account for the flood risk for the building, but teams planning the construction process need to consider the risk and impact for a construction site.

Consideration of surface water management and flooding should cover the following:

1. Are local water courses identified on the site plan?
2. Are the routes to water course identified?
3. Have areas of potential erosion and sediment transport been identified?
4. Is there a plan to mitigate potential erosion impacts?

Erosion and Silt/Sediment Control planning

Erosion and sediment control planning will be increasingly important for large projects with Water Framework Directive and ecological status measures in mind, and also with increasingly erratic weather patterns caused by climate change.

Projects where sediment/silt runoff could be a problem should consider the development of an erosion and sediment control plan which can include, but not be limited to, the following information:

- Property boundaries
- General soil description
- Existing and final contours - including location of cut and fill banks
- Existing and final overland flow drainage paths
- Limits of clearing or disturbed areas where applicable e.g. on large properties
- Location of vegetated buffer strips
- Stabilised entry/exit point (rumble pad)
- Location of soil and sand stockpiles
- Location of all proposed temporary drainage control measures
- Location of all proposed erosion control measures (alternatively, use notes to describe locations) including installation sequence and maintenance requirements
- Permanent site stabilisation measures.

A statement of whom is responsible for establishing and maintaining all erosion and sediment measures.

Land Drainage

Contractors may operate on or adjacent to banksides of main rivers or riparian owned watercourses. In this case, a flood defence consent will be required – link. In either case, notify and work with the national environmental regulator, Local Authority, and in certain parts of the country, the Inland Drainage Board. Each has specific designated duties to protect river channels and ensure flows are free to effectively drain an area and protect the community from flooding.
http://www.ada.org.uk/idbs.html

Flood and Water Management

The areas of FWMA 2010 most relevant to contractors and construction sites are: use of Sustainable Drainage systems (SuDS), process of surface water drainage approvals & adoptions, connection to public sewer and associated provisions, designation of third party flood management assets and note of the powers for water companies to control non-essential uses of water.

Sustainable Drainage systems (SuDS)

SuDS is a technique that manages surface water and groundwater sustainably. If planned and designed, it is an extremely effective approach. Site managers should ensure that SuDs are protected from construction activity.

Site measurement and monitoring

Measurement and monitoring of water use is the most important step in being able to manage consumption on site. The site should be planned to allow adequate information on water use to be regularly collected and reported on so that decisions with regard to consumption can be made.

A useful guide to metering technologies, and specific requirements with regard to metering of abstractions can be found on the Environment Agency at http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/geho0910btao-e-e.pdf This guidance may be useful for other forms of metering in addition to abstraction.

Identifying sources

Ideally all water sources supplying a site should be metered. This may include mains water (which may already be metered by the supplier), standpipes, recycled water and directly abstracted water from rivers or groundwater.

Selecting meters

Selection of the correct meter for any particular site is the first step to obtaining reliable data. This means making sure the meter being fitted is the right technology and the right size. It is necessary to consider all aspects of installation when selecting a meter. BS 7405:1991 (Guide to selection and application of flowmeters for the measurement of fluid flow in closed conduits) defines five basic areas which should be considered in the selection of any meter. Of most relevance to construction sites would be:

- Suitability for clean (mains, borehole) or other water;
- Meter size, based on the flow rates to be measured;
- How, and how often, the meter is to be read.

The only instances where there are set requirements for accuracy in clean water meter applications are:

- Meters used for household revenue metering; and
- Some abstraction metering

The ability of a meter to interface with other systems may be a consideration. Meters are available that can directly interface with a number of common reporting systems and some are available with internal logging capacity. This can help reduce the complexity of an installation and hence minimise equipment and installation costs.

The manufacturer's fitting instructions should be followed, for instance although most types of meter can be fitted in vertical, inclined or horizontal pipelines there are some, particularly jet types, where performance is compromised if they are not mounted horizontally.

The availability of power, or lack of, may limit meter choice. Mechanical meters do not require any electrical power supply, drawing the energy needed to drive the meter from the flow itself. However, power may be needed if an electrical pulse unit, data-logger or AMR transmitter is attached to the meter for remote reading.

Most types of meter require little or no maintenance.

Meter reading

The measurements made by a meter need to be recorded in some way and transmitted to where they are to be used. Common methods of taking a reading from the meter are:

- Visual read. The meter reader looks at the visual display (register) and transcribes the reading manually onto paper or into a computer system. The colours of the digits on mechanical registers have been standardised as:
    - Black digits on a white background or white digits on a black background signify cubic meters; and
    - Red digits on a white background or white digits on a red background signify litres.

  On electronic displays there is typically a black frame around the digits representing cubic meters and a red frame around the digits representing litres.
  Visual reads are suitable for weekly or monthly meter read frequency.
- Generating pulses from mechanical meters. The rotation of the meter operates a switch, the opening and closing of which is detected by circuitry within an external data logger. Meters may have options for different resolution (pulses/litre) depending on the type of system or where it is positioned on the meter.
  This technology may be appropriate where there is a need for more frequent or detailed meter reads.
- Automatic meter reading (AMR). The term AMR is used to encompass a range of technologies used for obtaining readings usually via a radio link. A small battery powered transmitter is positioned on, or in the meter register. It counts the pulses from the meter register and sends the total within a data packet to a remote receiver.
  This technology may be appropriate where there is a need for frequent meter reads with information sent to a central location.

Locating meters

As a minimum each water source should be metered. A better granularity of information could be provided by sub-metering particular uses which allows benchmarks for consumption both within and between sites to be identified along with opportunities for reductions in water use. Sub-metering could be considered for:

- Critical sections of the site.
- Points where different parts of a site are in different phases of work.
- Points prior to specific draw off points for a particular purpose e.g. welfare facilities.
- Points downstream of a specific draw off point so that consumption for a specific purpose can be identified.

A sub metering plan should be prepared to ensure everyone knows where to access the relevant meters.

Frequency of monitoring

More frequent monitoring of water use will result in a better picture of how water is used on site being derived and provide earlier warning of unusually high, or low consumption.

As a minimum it is suggested that monthly meter reads are obtained. In some circumstances it may be useful to collect reads more frequently than this, for instance where there is:

- A critical period on site.
- Periods of extreme weather (wet or dry).
- A need for specific investigation of night use (to identify and quantify leaks).
- A highly variable schedule on site e.g. by number of people or activity.

The monitoring can be set up on a half hourly basis allowing virtual real time monitoring.

Reporting requirements – how, when and who

At the outset reporting requirements should be determined and agreed. Reporting requirements may include:

- To site managers
- To environmental managers
- For corporate reporting systems
- To site staff, to encourage particular behaviours

Reporting will be clearest, and most clearly understood by the audience where water use values are documented in relation to factors such as:

- Number of staff on site
- Value of construction work
- Activities carried out on site during the reporting period
- Other influencing factors during the reporting period (e.g. unusually dry, or wet weather).

A number of online systems for reporting of water are available that may interface directly with appropriate meters. These have the advantage of allowing easy access to a variety of staff and managers through an online login and graphics of performance and targets can easily be visualised.

Reporting against baseline and target

Initially it is useful to derive baseline water use on site, against which future consumption can be assessed. This may be reported against a number of factors such as number of staff on site, or value of construction work.

It is good practice to set a target water use figure appropriate to the site against which progress can be measured. This may be set following identification of the baseline or may reflect a sector or

industry specific target which already exists. Reporting should then be carried out against the target at an appropriate, regular, period.

Procedure for investigating unusual consumption

A procedure for investigating unusual consumption should be devised. The need for this may arise from unusually high, or low meter readings that could indicate problems perhaps through leaks, or a faulty meter.

The procedure should be clearly documented and include:

- Identification of a person who should be notified of an unusual reading & takes the decision for investigation.
- Identification of who is responsible for investigation once a decision has been made.
- Activities to be conducted as part of the investigation, for instance:
  - More regular routine meter reads
  - Site walk-around to identify cause of consumption
  - Review/testing of meters
  - Use of leak detection technology
  - Discussions with site staff to identify unusual activities.
- Reporting route following completion of investigation
- Identification of a person who is responsible for taking the decision to resolve any issues identified.

Meters should require relatively little maintenance, although regular review of meter reads to ensure they are within expected bounds should be undertaken.

Monitoring, reporting, and investigation of unusual consumption should be carried out in accordance with the plan.

If meters are to remain on site following handover to the site owner upon completion then the location should be clearly marked on a site plan, along with details of isolation valves and other relevant pipework or ancillaries. It is useful also to provide details of the make and model of meter, and any calibration information pertinent to it.

Where there is an on-going requirement for metering e.g. of an abstraction which is to continue following handover, this should be made clear to the site owner along with any relevant contact information and historical logs that exist.

Efficient welfare, plant and equipment

There are many ways in which you can ensure that welfare facilities and processes which use water on site are as efficient as possible. A checklist is provided in the accompanying template document.

Welfare activities have been shown through a series of water audits on constructions sites to be one of the largest users of water as they are in place from site commencement through to the end of site operations. Information on these audits can be found at http://www.greenconstructionboard.org/index.php/working-groups/greening-the-industry/water

Welfare facilities

If site cabins are to be procured, arrangements should be made for these to be water efficient. Where existing facilities are to be used for the duration of a project, consideration should be given to improving the efficiency of these to reduce water use.

Site accommodation can comprise the following types of water use:

- toilets;
- wash hand basins;
- urinal flush;
- showers;
- catering and food preparation; and sometimes
- boot washing.

Site accommodation should use plumbed in water dispensers once mains water is connected (albeit more of a cost and carbon saving than a water saving).

It is recommended that the Water Technology List (WTL) is consulted prior to the purchase of toilets. The WTL not only ensures products are of a certain quality, but allows companies to reclaim 100% first year capital allowances through the Enhanced Capital Allowance (ECA) Scheme.

http://envirowise.wrap.org.uk/uk/Topics-and-Issues/Water/Key-Issues/Water-Technology-List.html

Wash hand basins

Generally wash hand basins on site have cold taps that feed directly from mains water, controlled by a turn mechanism. On some occasions percussion (push button) systems are installed. The most common water efficiency problems with this sort of system are:

- Flow from cold taps will vary directly with mains pressure, and will generally be too high (< 5 litres per minute is good practice).
- Potential for taps to be left running for extended period (i.e. no auto-isolation of flow) for taps without percussion mechanism.
- Due to basic flow pattern (i.e. no spraying) more water is required for effective cleaning.

The most practical methods by which basin taps can be ensured to be water efficient on site, without compromising the potential performance of the appliance are:

- Installing taps with percussion mechanism (push button) with appropriate calibration (5 seconds is suggested).
- The use of motion sensors.
- Installing taps with efficient flow patterns e.g. spray taps or aerated taps.

Although pressure reducing valves (PRV) installed on site accommodation can result in reduced flow rates through taps, and hence water efficiency, without a full understanding of the potential siting of the accommodation and water pressure, it is not possible to tell if a PRV would be appropriate. Offering variable PRVs in accessible location is an option, although these might not be adjusted once on-site and hence savings might not be realised.

Toilets

All new toilets must now have a flushing volume of 6 litres or less to comply with Water Supply (Water Fittings) Regulations 1999. However, a number of more efficient options are now available on the market including toilets that flush a maximum of 4.5 litres.

Dual flush toilets are another option, where the 'half' flush (typically 4 litres or less) is suitable for liquid flushes. If dual flush toilets are installed then there should be clear labelling as to how the flush mechanism is operated to prevent occurrences of 'double flushing'.

Urinals

Good practice involves installing a device to control the flushing based on how often the urinal is used. There are a number of options to achieve this, but good practice for the construction sector would normally involve the use of low maintenance hydraulic valves.

A hydraulic valve can be fitted to the inlet pipework of the urinal system, and does not require power to operate. When the inlet water pressure decreases temporarily through water being used elsewhere in the washroom (e.g. toilet flushing or hand washing), the diaphragm-operated valve opens and allows a pre-set volume of water to pass into the urinal cistern. When the cistern is full, the auto-siphon will discharge and flush the urinal. When the washroom is not being used, the pressure remains unchanged and the valve remains closed. Thus, the cistern should not use water out with working hours. It may also reduce water consumption throughout the day, depending on occupancy levels

Waterless urinals are another option to consider.

Showers

If a shower is to be installed in site accommodation then consideration of the flow rate through the device should be made. A flow rate of 6 to 8 litres per minute is considered efficient.

Typically, electric showers are likely to be installed. It is important to note that retrofitting of alternative shower heads is not recommended for electric showers. A low to moderate power electric shower will typically offer efficient flow rates.

Canteens and food preparation

Trigger-control to ensure auto-isolation of flow should be fitted to sink taps. This will prevent taps being left running when not being used.

Plant and equipment

All processes on site that use water will inevitably involve some plant or equipment. Water using activities should already have been identified. The water use of the plant & equipment should be taken into account in the procurement process.

Examples of water efficient technologies can be found in the water audit report available at http://www.wrap.org.uk/content/water-efficiency-construction along with a summary of ten very simple tips for sites to ensure efficiency.

In identifying suitable equipment, the water source being used will need to be accounted for – for instance if using directly abstracted water for dust suppression it may not be possible to use misting techniques due to health risks.

Maintenance

Welfare facilities should require relatively little on-going maintenance to ensure low water use. Basic checks can be carried out to ensure facilities are operating as designed through:

- Checking that taps are not dripping
- Checking that percussion taps do not run for longer than necessary
- Ensuring the sensor driven taps and/or urinals are working correctly
- Ensuring toilets are not leaking through the overflow or valves

Basic awareness raising of these with site staff, and implementation of a reporting system for any problems that are identified should keep water use from welfare as low as possible (see site behaviours and training section)

Plant and equipment will each have individual maintenance requirements. The instruction provided with the equipment or from the hire company should be followed to ensure efficient use.

Training and awareness of water use (site behaviours)

Ensuring staff working on the site are aware of efficient, appropriate and safe water using practices and habits will be critical to reducing wasted water on construction sites.

Appropriate time should be set aside during site initialisation to include water in site staff training, with tool box talks and refresher training repeated in advance of high demand periods. New staff joining the site should be exposed to similar training or materials on induction. The training should include a site behaviours plan, based upon activities which will be undertaken on site, to encourage efficient practices.

Examples of efficient site behaviours can be found within the 'how to' guide available at http://www.strategicforum.org.uk/HowToBrochure.pdf as well as in the more detailed findings from a number of site water audits reported at http://www.wrap.org.uk/sites/files/wrap/Auditing%20of%20water%20use%20on%20construction%20sites%20%20-%20Phase%201%20%2526%202.doc.

A toolbox talk for water has been developed, which should be tailored to individual sites. This is freely available at http://www.strategicforum.org.uk/WatertoolboxTalk.pdf . The Supply Chain Sustainability School (SCSS) may also be a useful resource and registration is free. http://www.supplychainschool.co.uk/issues/water.aspx .

In addition, there are a range of TBT's provided by CIRIA that can be found at http://www.ciria.org/service/toolbox_talks_and_advice_sheets/AM/ContentManagerNet/Default.aspx?Section=toolbox_talks_and_advice_sheets&Template=/TaggedPage/TaggedPageDisplay.cfm&TPLID=121&ContentID=21877

It is useful to display top tips and reminders for staff across the site, for instance in rest areas and around welfare facilities. A poster with ten top tips on reducing water use on construction sites is freely available at http://www.strategicforum.org.uk/HowToBrochure.pdf

Actively engage, encourage and promote alternative sources. Challenge whether water is needed and if so, promote saving techniques and alternative sources to be employed by the build team and the sub contracted trade teams.

Promote water saving behaviour and celebrate innovative examples of water saving, alternative approaches or use of non-potable sources to complete activity safely. Encourage use of environmental observations to identify water loss or expose alternative options.

Water footprinting and embodied water

In parallel with carbon management and reporting, water reporting is emerging as a headline indicator at a corporate level. Normally the water use reported at corporate level considers direct water use only. However water foot-printing is now starting to be an emerging trend and clients are requesting that contractors consider the water footprint of the construction site – or the embodied water of the materials used on site.

Traditionally embodied water refers to the cumulative quantity of water used to produce a product through the supply chain.

More information on embodied impacts* (including water), life cycle assessment (LCA), and Environmental Product Declarations (EPDs) can be found at: http://www.constructionproducts.org.uk/sustainability/products/embodied-impacts/

Useful information on tools to calculate water impacts can be found in the report available at http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17962

A case study of water foot-printing can be found at http://www.wrap.org.uk/content/water-footprinting-case-study-heathrow-t2b-0

*Note that current methodologies for calculating embodied water do not assess water scarcity or quality issues.

Site handover

It is important that the handover to client and end user(s) is supported with comprehensive Operation and Maintenance Manuals that include all aspects, including effective and efficient water use. This will ensure the positive legacy of optimal non-potable water use.

If the site has been located in an area of flood risk it is likely that the build has included flood prevention or alleviation as part of the construction. Details of maintenance or operation of these facilities should be handed over to the site owner upon completion.

Where tanks have been used as a source of water through the construction process, these need to be tested and prepared for site handover. For instance ensuring sediment is cleared from silt traps or sumps prior to handover etc. There should be no residual liability to catchment quality.

Acknowledgements

We would like to acknowledge the work of the members of the Greening the Industry Group Water Subgroup who developed this document on behalf of the Industry. Specific thanks are given to:

Martin Ballard, Group Environment Manager, Willmott Dixon Group

Dawn Love, Head of Environment and Sustainability, Tayor Woodrow the Civil Engineering Division of VINCI Construction UK Limited

Richard Hirst, Sustainability Manager, Skanska UK Plc

Carmen Snowdon, leads the Water Resources Management team, WRc Plc