Technological solutions offer savings at high-staff level site

Road sweepers and welfare facilities could be improved in efficiency to result in savings of around 15% of the total site water consumption, equivalent to between £3500 and £12000 a year dependant on water and wastewater tariff. Further improvements could be realised through improving cleaning operations and boot washing. Leaks should also be identified and repaired on a regular basis.

### Background
A construction site water audit was conducted to identify areas for water efficiency action during April 2012. The construction site is a new build airport terminal.

#### Key Facts
- **Location:** London
- **Construction type:** Civil engineering
- **Project use class:** Airport
- **Sub-structure phase:** October 2010 – January 2013
- **Super-structure phase:** July 2011 – December 2012
- **Fit-out phase:** September 2011 – August 2013
- **Mechanical, electrical and plumbing phase:** July 2011 – August 2013
- **Staff level:** 1,100 staff on site during March 2012
- **Water use since site commencement to March 2012:** 22,200m$^3$ equivalent to 103m$^3$ per £million value.

#### Recommendations for Savings
- Wash hand basins could be improved through installation of pressure reduction valves, along with altering the duration of percussion tap operation.
- A focussed review of activities within the canteen is recommended.
- Recirculating road sweepers could reduce water consumption by 30% for the activity
- Use of high pressure washers or trigger operated spray gun attachments for cleaning
- A number of leaks were identified, for example a decommissioned draw-off point was observed to be leaking continuously. Monthly walk-arounds to identify and fix leaks were recommended.
Water Consumption Summary

Since project commencement, around 22,200 m$^3$ of water has been consumed (up to and inclusive of March 2012 consumption).

Consumption was recorded on a monthly basis, and this is summarised in the graph shown to the right.

The greater consumption in summer months was likely due to the increased requirement for dust suppression activities.

Taking project turnover and average staff numbers into account, the water consumption relative to site activity can be assessed – the results are shown graphically below.

There was a significant variation in the KPI values returned, suggesting that on this occasion staff numbers and turnover alone may not be the best measure of expected water consumption. As noted above, this is potentially explained by the increased presence of dust suppression activities during summer months.

The site was typically below the SFCC Water Sub-group’s sector-wide baseline figure of 148 m$^3$/£million (at constant price in 2008), though this figure is occasionally exceeded.
Water Mass Balance

In order to better understand where water was used across the site, a preliminary water mass balance was created, based on data generated/collected during April 2012 - this is summarised in the table below:

<table>
<thead>
<tr>
<th>Area/Activity</th>
<th>Consumption (m$^3$/month)</th>
<th>Percentage of Total</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Welfare Block</td>
<td>523</td>
<td>35.5%</td>
<td>• Sub-meter was installed on supply to building.</td>
</tr>
<tr>
<td>South Welfare Block</td>
<td>341</td>
<td>23.1%</td>
<td>• Consumption estimated at 65% of the North Welfare Block, which is of similar size but also contains a food preparation canteen.</td>
</tr>
<tr>
<td>Draw-off Point A</td>
<td>13</td>
<td>0.9%</td>
<td>• Sub-meter installed on supply pipework. • Typically used as a back-up supply for road sweeper top-up. • Consumption likely to vary significantly depending on site conditions, weather, etc.</td>
</tr>
<tr>
<td>Draw-off Point B</td>
<td>13</td>
<td>0.9%</td>
<td>• Sub-meter installed on supply pipework. • Typically used for topping up dust suppression vehicle. • Consumption likely to vary significantly depending on site conditions, weather, etc.</td>
</tr>
<tr>
<td>Road Sweeper Top-up (via Draw-off Point C)</td>
<td>164</td>
<td>11.1%</td>
<td>• Consumption estimated based on each vehicle topping up an average of once per day. • Consumption likely to vary significantly depending on site conditions, weather, etc.</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>420</td>
<td>28.5%</td>
<td>• ‘Miscellaneous’ refers to the remaining water consumption which has not been accounted for by the areas/activities listed above, and includes: o Portion of the water used to top-up dust suppression vehicle; o Site-based toilet facilities; o Laboratory; o Booth wash; and o Mortar preparation.</td>
</tr>
</tbody>
</table>

**TOTAL** 1,474

Notes:

- The water mass balance across the site varied over the project duration, and the above data provides an indication of consumption during the monitoring period only.
- It can be seen that the 2 welfare blocks alone accounted for almost 60% of site water consumption over the monitoring period. When considering that the numerous site-based toilets are not accounted for within the figure, and thus the actual welfare consumption is likely to be well in excess of 60%, it is clear that the single largest water consuming activity on site is not actually associated with construction activities.
- The dust suppression vehicle, which was typically topped-up through Draw-off Point A, is likely to account for a significant water volume over the duration of the project. However, as the monitoring period was during the wettest April in the UK for around 100 years (i.e. April 2012), and thus the requirement for dust suppression was minimal, this is not accounted for in the water mass balance above.
## Water Efficiency Assessment

The following table provides an assessment of the main water using activities on this site:

<table>
<thead>
<tr>
<th>Activity/Area</th>
<th>Typical Water Consumption</th>
<th>Potential Savings</th>
<th>Comments/Actions</th>
</tr>
</thead>
</table>
| Road Sweepers          | 35 litres/minute (typical flow capacity of Johnston Sweeper VT650 spray systems) | 49 m³/month (30% reduction from spray systems) - this figure assumes the water use associated with the high pressure washers is relatively insignificant. | • There were 2 contractors operating road sweepers on site, hereafter referred to as Contractor A and Contractor B. Both contractors utilised Johnston Sweepers.  
  • Contractor A operated 2 VT650 road sweepers, which contain 1,300 litre water tanks.  
  • Contractor B operated 1 - 2 VT800 road sweepers, which contain 1,850 litre water tanks.  
  • The road sweepers utilised a front-loaded spray bar and single spray nozzle adjacent to the side channel brush. The operators had on/off control of each of these spray systems, and could also vary the flow rates from within the cab, and as such can be considered relatively water efficient. The systems also had a high pressure washer.  
  • One of the Contractor B road sweeper operators reported on/off control of the spray systems only, which is inconsistent with the make/model of sweeper and information provided by Contractor B’s office-based staff, and at the time discussions with Contractor B were on-going to ensure their road sweeper operators fully utilised the water efficiency capabilities of the systems.  
  • Some road sweepers (including the models noted above) have an optional water recirculation system, whereby a portion of the recovered wastewater is filtered and then recycled to the clean water tank. This can provide water savings of up to 50%, though a figure of 30% may be more realistic. Contractor B was considering a trial of one of these water recirculation systems. Reducing the water consumption of the system will also reduce the frequency of top-up required, reducing operator dead-time, which can sometimes prove a greater benefit than the actual water savings.  
  • Contractor A was considering the use of a settlement pond on site, for wastewater discharge and water abstraction, to reduce or potentially eliminate their mains water requirement.  
  • The typical water consumption shown was based on each road sweeper filling its tank an average of once per day, though in reality this will vary significantly depending on site conditions, weather, etc. |
| Vehicular Dust Suppression | 234 m³/month | None identified. | • The vehicle utilised on site, operated by Contractor A, had a 7,700 litre water storage tank, and used a pump-fed misting (atomising) system to create a more effective water pattern (see photograph). This represents good practice and as a result there is thought to be little opportunity for improvement.  
  • As well as using significantly less water than a traditional "splash-plate" system, typically between 70% - 90% less, the level of dust suppression achieved is normally improved due to the greatly increased surface area of water.  
  • These systems also reduce the frequency of top-up required, reducing operator dead-time, which can sometimes prove a greater benefit than the actual water savings.  
  • The typical water consumption shown is based on the dust suppression vehicle filling its tank once per day, though in reality this will vary significantly depending on site conditions, weather, etc. |
<table>
<thead>
<tr>
<th>Activity/Area</th>
<th>Typical Water Consumption</th>
<th>Potential Savings</th>
<th>Comments/Actions</th>
</tr>
</thead>
</table>
| Cleaning Operations | Variable | Unknown | - There were a variety of cleaning operations on site, some of which are good practice (e.g. trigger operated spray gun within laboratory) and some of which could be improved (e.g. open hose cleaning).  
- The largest concern was the use of open hose points for general cleaning activities, which was reported but not witnessed during the site audit. For future cleaning operations on site, the use of high pressure washers will be considered. Where the scale of use does not merit high pressure washers, trigger-operated spray gun attachments will be considered for installation.  
- Where the hose points are also used for large volume filling (e.g. road sweeper or dust suppression vehicles) trigger-attached are not suitable and will not be used. |
| Dust Suppression (Stockpile) | Unknown | Up to 90% | - Although reported as occurring previously, this activity was not witnessed during the audit, and so could not be fully assessed or quantified. However, manual hosing or larger scale "rain guns" are most commonly used for this application. These are water inefficient and represent significant opportunity for improvement.  
- In future instances of dust suppression, the site will consider using fan misting systems - these create a fine mist which offers improved dust suppression for significantly less water (see photograph). |
| Welfare Blocks | Minimum: 137 m³/month  
Average: 569 m³/month  
Maximum: 864 m³/month | 114 m³/month (20% reduction) | - Welfare water consumption accounted for a significant portion of the site's total consumption, with over 1,100 staff on site at present (March 2012 figure) using toilet facilities and a full food preparation canteen.  
- Specific consumption has been estimated as 731 litres per person per month (34 litres per person per day), not including site-based welfare consumption (e.g. site-based toilets).  
- As site-based welfare water consumption is likely to account for a significant portion of the total welfare water consumption, it is likely that the site's performance was actually above a typical level of 40 litres per person per day (for sites with a full food preparation canteen).  
- Urinal cisterns all appeared to be controlled with a hydraulic valve or were of the waterless variety, and as such represented little opportunity for saving.  
- Wash Hand Basins (WHBs) can account for a significant portion of welfare water consumption, and represented an opportunity for improvement. The flow rate of WHBs fed directly from mains will vary with the mains pressure, and thus the site had little control over their water consumption. Consideration was being given to installing variable Pressure Reduction Valves (PRVs) at strategic locations around the distribution network to improve control. A good practice flow rate is < 5 litres/minute.  
- In general, percussion (push) taps were in use, which can be considered good practice. However, the operating times varied from WHB to WHB, and in some instances were excessive (i.e. > 10 seconds). The site was to undertake a review of each WHB to limit the operating time to a maximum of 5 seconds.  
- The large food preparation canteen, which serves food for up to 1,200 staff each day, consumed large quantities of water. The site was to undertake a focused review of water using activities within the canteen. |

<table>
<thead>
<tr>
<th>Activity/Area</th>
<th>Typical Water Consumption</th>
<th>Potential Savings</th>
<th>Comments/Actions</th>
</tr>
</thead>
</table>
| Boot Wash             | Unknown                   | 30% reduction     | • There was a row of trigger-operated spray guns located at the site entrance, which have a variable spray pattern (and likely flow) depending on the level of trigger depression (see photographs). Each berth also had a brush for dry-cleaning. Whilst the variable flow/spray pattern is good practice, there is still potential for improvement.  
  • Consider installing variable Pressure Reduction Valve (PRV) to manage and reduce the water pressure to the area, which currently appears slightly excessive.  
  • Install signage to promote use of dry cleaning, thus reducing the level of subsequent wet cleaning which is required. |
| Leak Detection & Repair | N/A                       | Variable          | • As with most construction sites, a number of leaks were present, and this represented an opportunity for improvement. For example, a decommissioned draw-off point which hadn't been used in several months was observed to be leaking continuously (see photograph). This was to be repaired.  
  • Following the audit, the site was to undertake monthly walk rounds for the purposes of identifying (and subsequently repairing) leaks in the water distribution system. |
| Bentonite Mixing      | Unknown                   | Expected to be minimal | • This water using activity was not active during the site audit, and so could not be assessed fully.  
  • Water used as ingredient for bentonite mixing accounted for a relatively large amount of site-based water consumption at the time. The site reported that as the mains capacity was insufficient this water was provided by road tanker (and thus is not accounted for in the mains water consumption noted above).  
  • Typically, the water content of a bentonite mix is strictly controlled for quality purposes and offers little opportunity for improvement. |
<table>
<thead>
<tr>
<th>Activity/Area</th>
<th>Typical Water Consumption</th>
<th>Potential Savings</th>
<th>Comments/Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortar Silos</td>
<td>Unknown</td>
<td>Expected to be minimal</td>
<td>• As with bentonite mixing, ingredient water for mortar preparation is strictly controlled for quality purposes and offers no opportunity for saving. With regards to the associated cleaning activities, ensuring the water supply is isolated as soon as the water “runs clear” during pipe flushing will help to minimise water waste.</td>
</tr>
</tbody>
</table>
| Laboratory          | Unknown                   | Expected to be minimal | • Water was used within the laboratory for the following purposes:  
  o Open hose for general cleaning e.g. bucket washing (assessed as part of ‘Cleaning Operations’ above);  
  o Trigger-operated spray gun for sample washing (good practice);  
  o 10 x wash baths (periodic replacement dictated by water quality, little opportunity for saving);  
  o WHB (little opportunity for saving).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Crusher Dust        | Unknown                   | Unknown            | • Although operational at the start of the audit, the plant had been removed from site on subsequent visits when an efficiency assessment was to take place, and so could not be fully assessed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

**Summary**

The site was relatively well managed with respect to metering and monitoring, with monthly consumption recording from the main site meter and financial KPI tracking already being undertaken prior the start of the audit. However, due to the large size of the site, the installation of strategically placed sub-meters is crucial to gaining a greater understanding of where water is used around the site, and to allow improvements to be made. As part of the audit, sub-meters were installed on the North Welfare Block, as well as 2 commonly used draw-off points, which allowed creation of the Water Mass Balance noted above. To improve this mass balance further, an additional sub-meter was to be installed on the South Welfare Block, to more accurately quantify its consumption. As welfare water consumption is often the largest water consuming activity on a construction site, splitting the consumption between welfare and site provides a much clearer understanding of water use on site.

Potential savings of around 163 m$^3$/month have been identified from road sweeper and welfare based opportunities alone, which corresponds to around 12.5% of the total site water consumption. Therefore, taking into account the other opportunities for savings which were identified but could not be quantified at this time, achieving a 20% reduction in the site’s water consumption (as per the SFfC Water Sub-group’s sector target) should be achievable.
Further information on water use in construction and how to reduce use on your site can be found at:

http://www.strategicforum.org.uk/water.shtml

and


Information includes a ‘how to’ guide that can be displayed as a poster, along with a toolbox talk on water efficiency.

The full water audit report is available at:

http://www.wrap.org.uk/content/water-efficiency-construction