# Evaluating FlushRain Retrofittable Rainwater Harvesting: A Pilot Study

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# Summary

1. RWH configurations for UK houses
2. FlushRain Pilot Installations
3. Results
4. Messages

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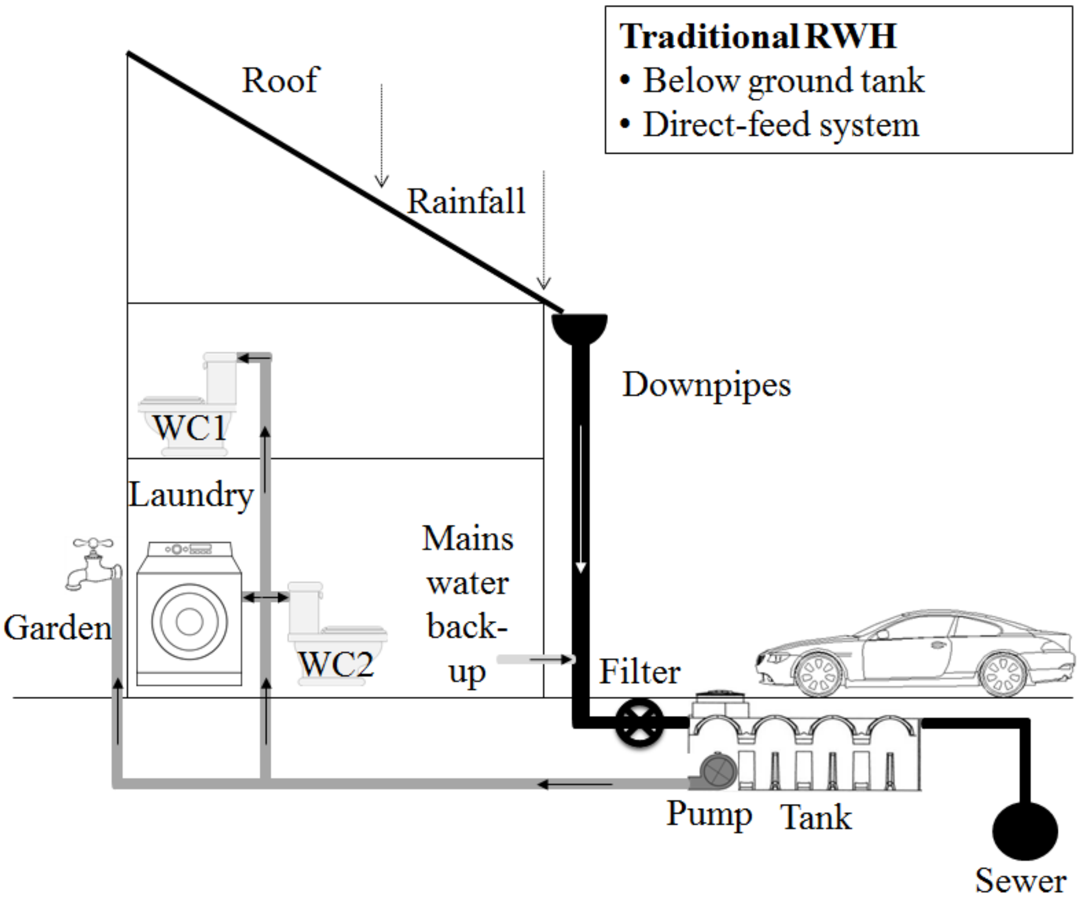
# RWH for UK houses




Residential RWH has long payback periods and is difficult to retrofit. (Roebuck, 2012).

Retrofit costs are high ~£5k?

High energy use?

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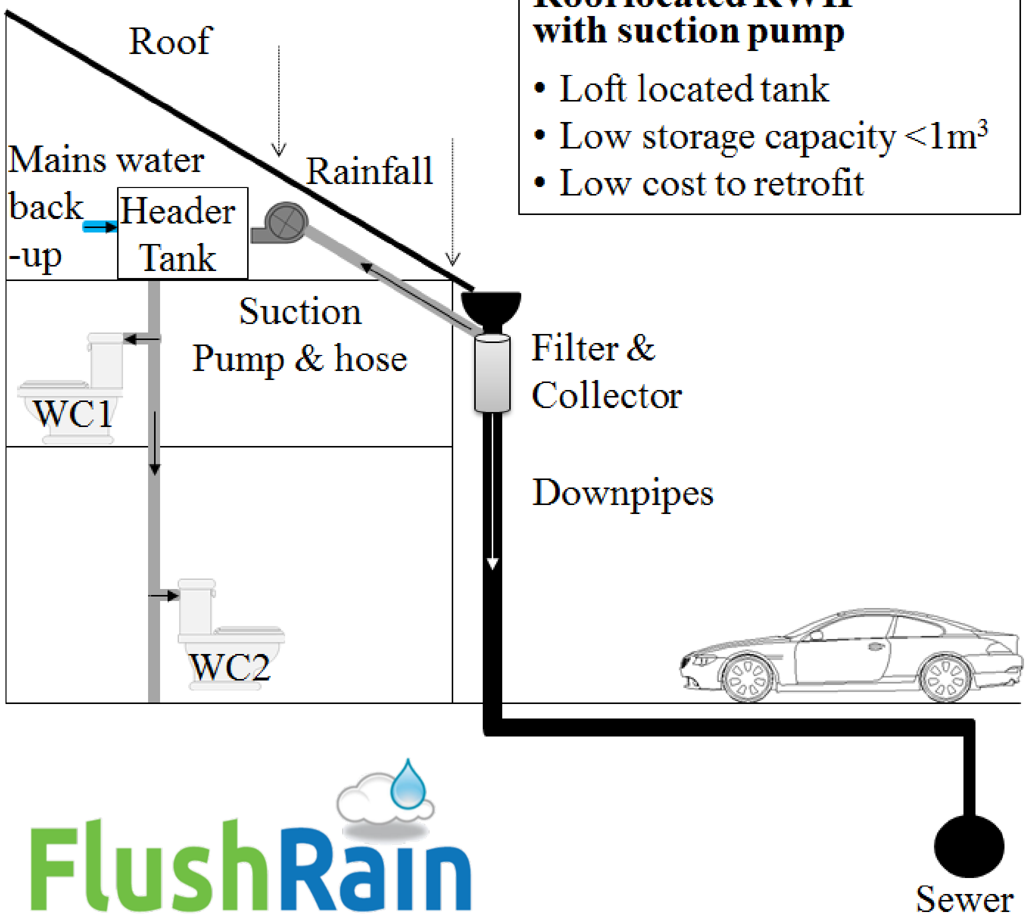
# Retrofittable RWH?

**Roof located RWH with suction pump**

- Loft located tank
- Low storage capacity <1m³

- Low cost to retrofit




FlushRain


~£1k installed?

Small tanks = less benefit?

Low energy use?

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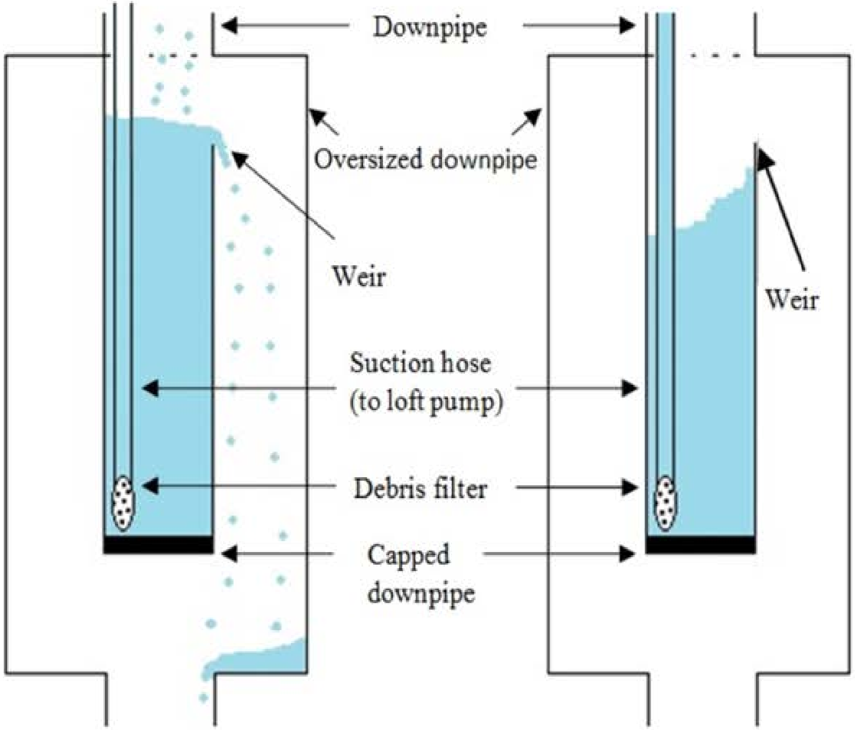
# How does it work?




A) Chamber connected to downpipe B) Illustration of chamber discharging to downpipe C) Illustration of chamber being pumped empty

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# Research Questions

**RQ1: What reduction in annual water demand was achieved by deploying the FRWH system?**

**RQ2: What electricity consumption was needed to operate the FRWH system?**

**RQ3: What were the highest and lowest temperatures experienced in the header tank**?

**RQ4: What proportion of annual rainfall was captured and used by the FRWH system.**

# Methods: Install and Monitor

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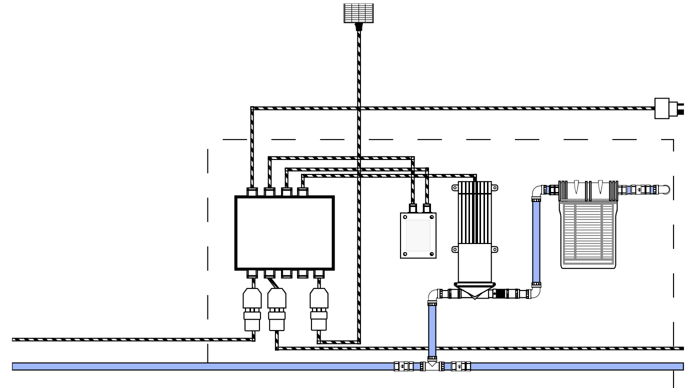
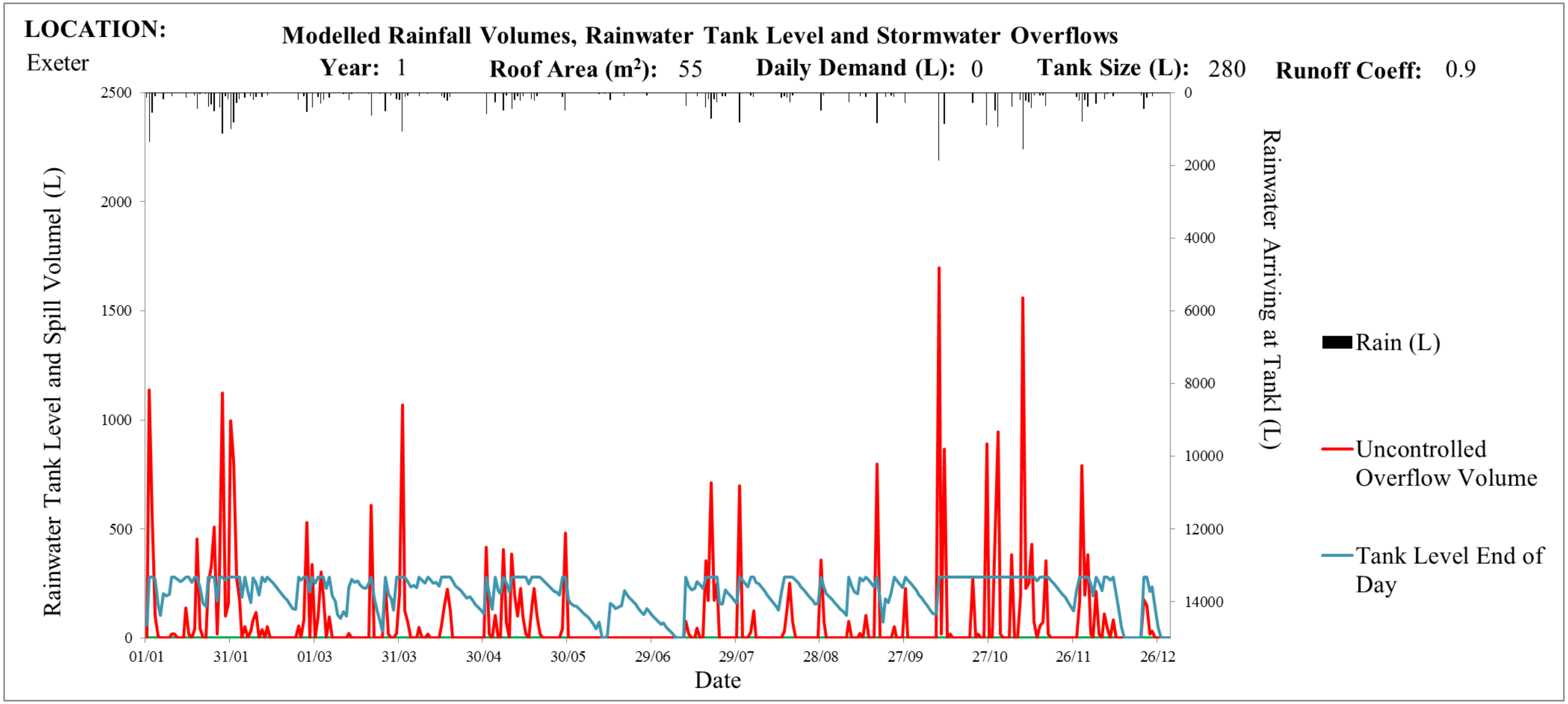


# Results – Tank Levels and Spill Simulation

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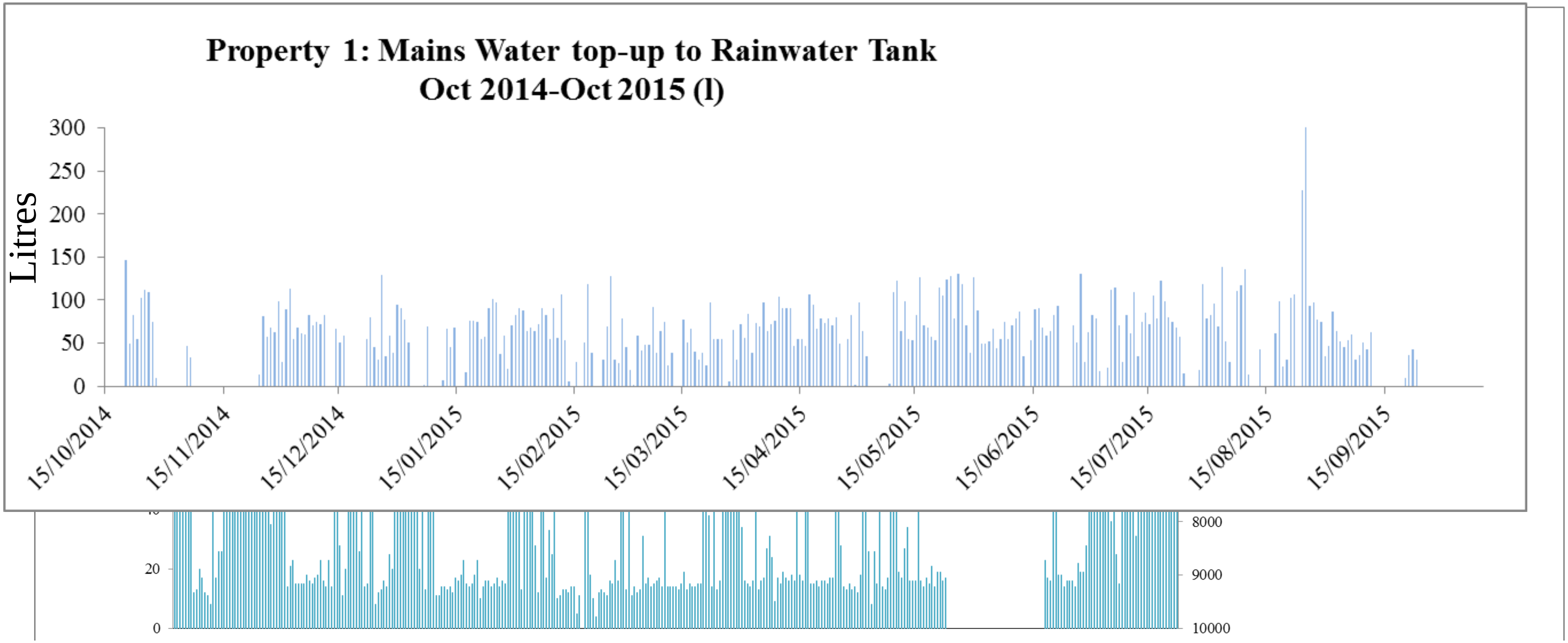
# Water Demand Reduction: Yield

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# Energy Cost

**RQ2: What electricity consumption was needed to operate the FRWH system?**

- 3.08 kWh/m$^3$ = 1.16kg $CO_2$e
- £6.95/year
- (Lab = 0.12 kWh/m$^3$?)


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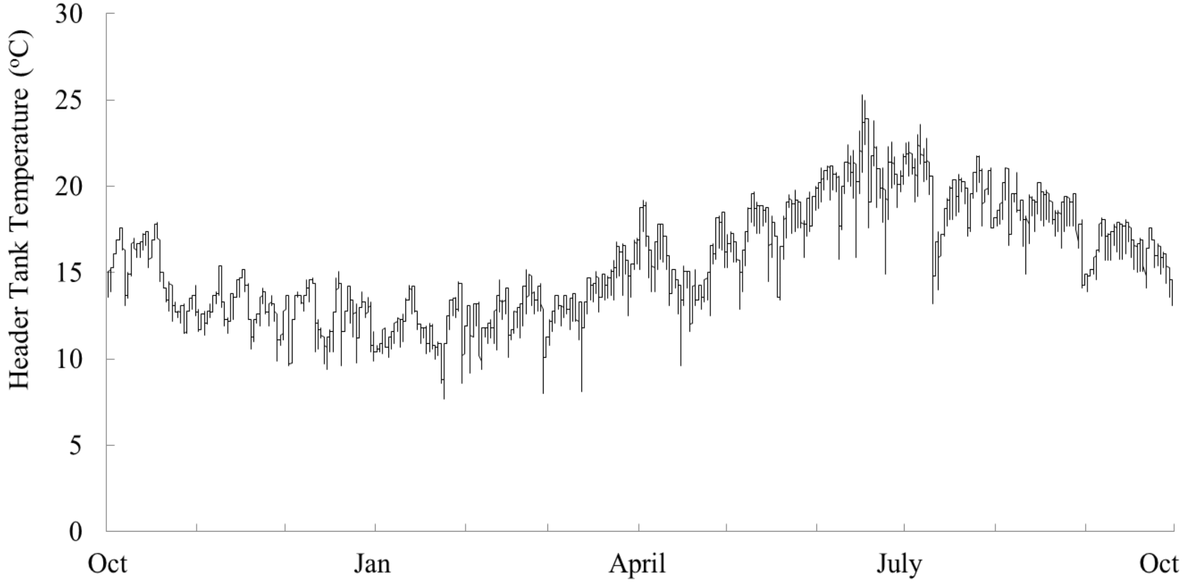
# Water Temperature

**RQ3: What are the highest and lowest temperatures experienced in the header tank?**

- Max summer temperature of 25.3°C
- Min of 7.7°C
- Mains water top-ups (i.e. chlorinated water) on 262 days

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# Source Control

**RQ4: What proportion of annual rainfall was captured and used by the FRWH system.**

- 39.5m$^3$ rainwater fell on roof.
- 15m$^3$ used, giving 38% annual reduction in flows to combined sewer.
- Max 1 day storm = 1.8m$^3$ (flooding locally)
- Loggers show 0.28m$^3$ intercepted (15% reduction).


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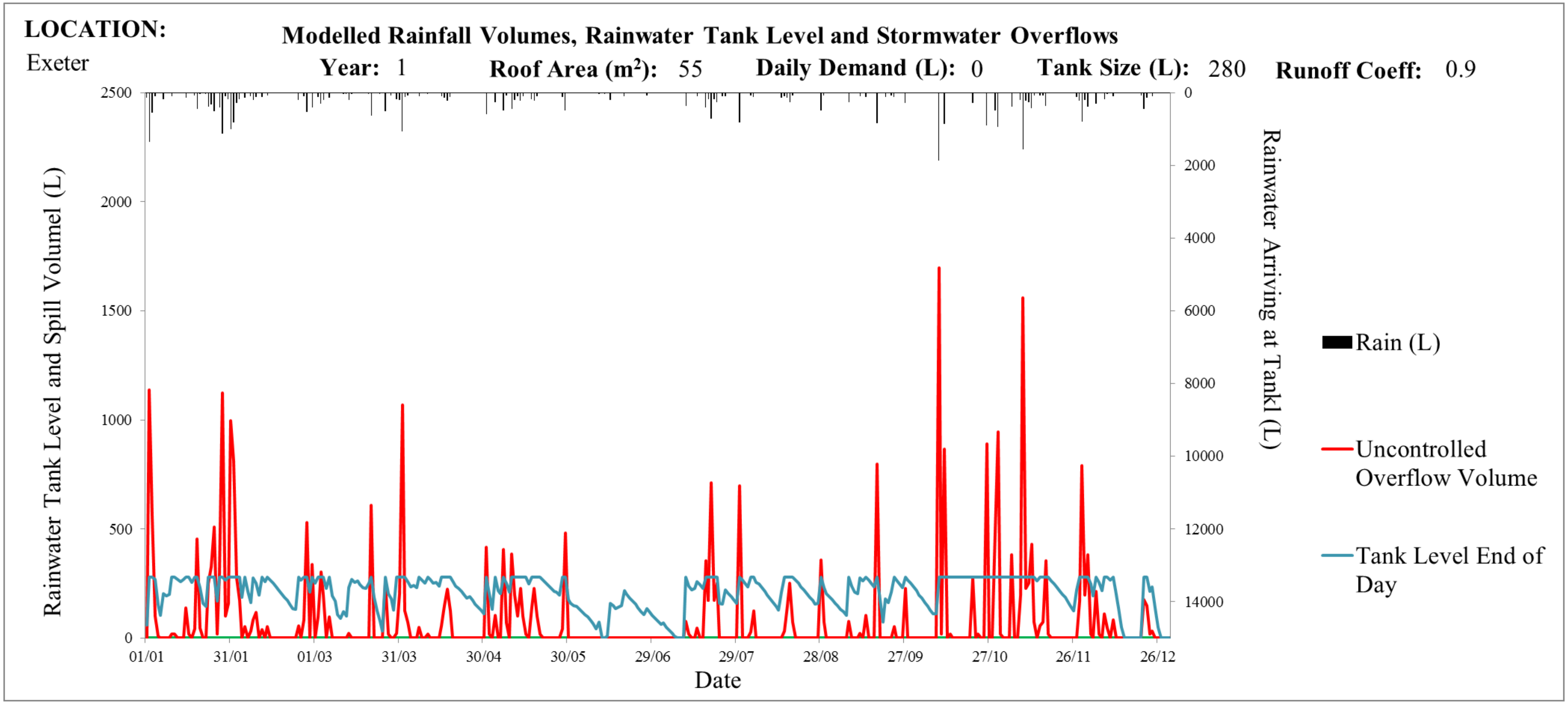
# Results – Tank Levels and Spill Simulation

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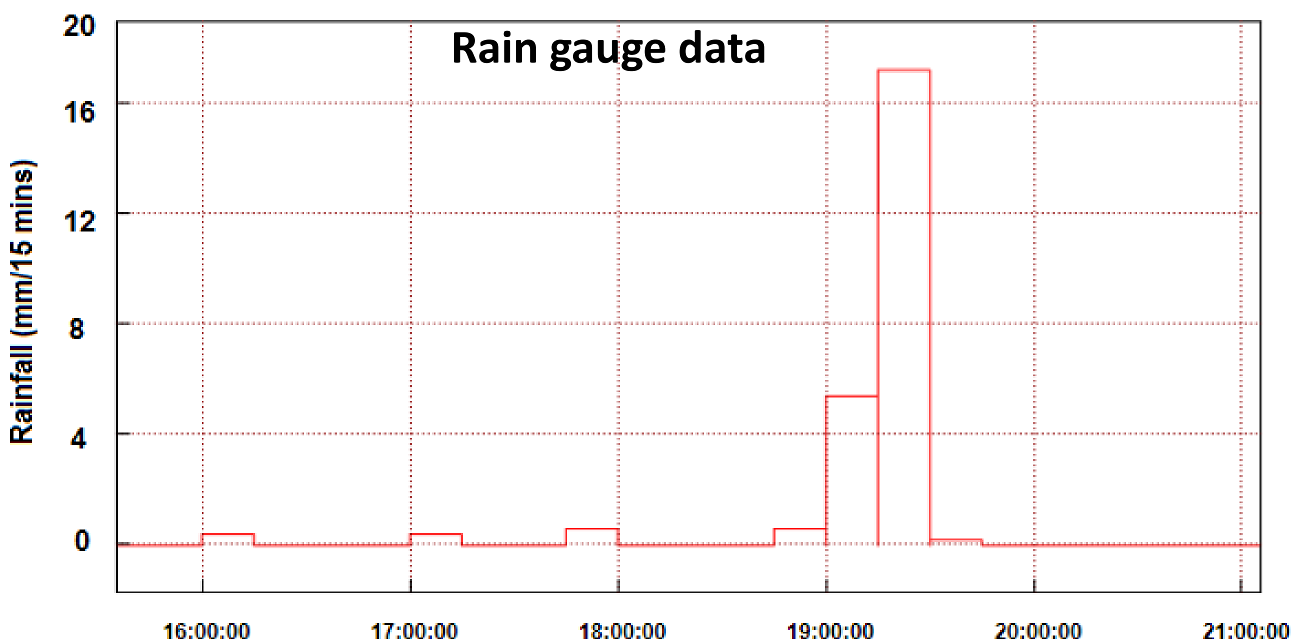
# RWH for stormwater control?

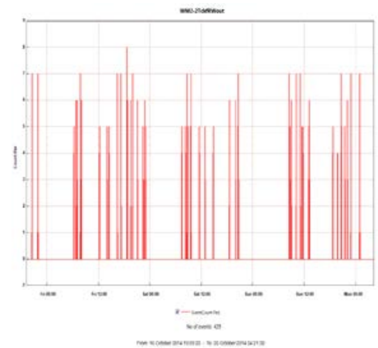
| Duration (min) | Return Period (y) 2 | 5 | 10 | 20 | 30 | 50 | 100 | 200 |
|---|---|---|---|---|---|---|---|---|
| 60 | 14.7 | 19.1 | 23.3 | 28.3 | 31.8 | 36.7 | 44.7 | 54.5 |
| 30 | 11.5 | 15.1 | 18.6 | 23.0 | 25.9 | 30.3 | 37.3 | 46.0 |
| 20 | 9.9 | 13.2 | 16.3 | 20.3 | 23.0 | 27.0 | 33.6 | 41.7 |
| 15 | 8.9 | 11.9 | 14.9 | 18.6 | 21.2 | 24.9 | 31.1 | 38.9 |

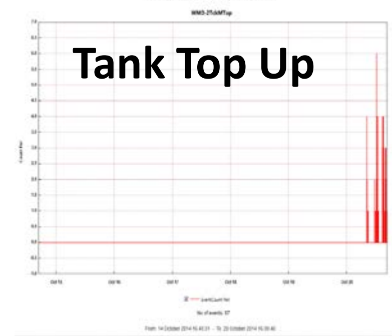
Chen (2014)

- 30 min event (22mm) has a RP of approx. 1 in 18 years.
- RWH system reduced the runoff from the property to an equivalent rainfall intensity of 13.5mm/hour
- Giving a resulting RP of approximately 7.5 years




**WC Usage**



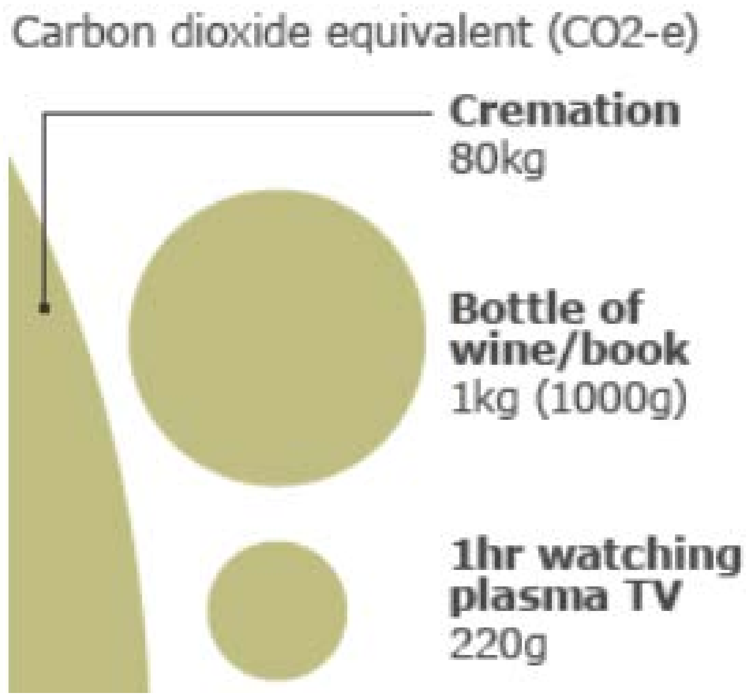


# Key Messages

- RWH can come in many shapes and sizes.
- It can be retrofitted for ~£1,500/house, ~3x cheaper than existing systems.
- 70% of UK houses that will exist in 2050 have already been constructed.
- Where Demand is high… tanks are likely to be empty… So Yield reduces, but…
- When tanks are empty, some level of stormwater control can be achieved.

# Key Messages

- Carbon costs still need refinement as 1m$^3$ rainwater… 1.16Kg$CO_2$e

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