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## Rainwater Harvesting - A Zero Waste Approach to Water

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Books/Book Chapters

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2013

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Liam McCarton

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# Better Building: Water Conservation Strategies

*International Conference for a Sustainable Built Environment  
24<sup>th</sup> April 2013, Croke Park, Dublin.*

## “Rainwater Harvesting – A Zero Waste Approach to Water”



**Liam McCarton, Dr. Sean O’Hogain,**  
DTC Research Group, School of Civil Engineering  
Dublin Institute of Technology

[www.dit.ie/dtc](http://www.dit.ie/dtc)



## Technology Transfer at Community Level:

### To link international expertise with local communities

- *to empower them to adapt water and sanitation technologies to suit socio-economic & environmental conditions*



- **Innovation in Rainwater Harvesting Design**

- **Pilot Rainwater Harvesting Study** 2005 – 2009, DOEHLG
- **School Rainwater Harvesting Study** 2009-2012, DOEHLG

- **Zero Discharge Wastewater Treatment Systems**

- **Reed Bed WWT System**, 1996-2002, - Fingal Co. Co.
- **Hybrid Reed Willow Bed WWT System**, 2007-2012 - South Dublin Co. Co.

- **Appropriate Technology**

- **Sierra Leone** , 2009-2013 – EU Funded Program
- **Water, Wastewater, Solar, Wind, Pump technology**, 2011, EMAS, Bolivia,
- **Low Cost Pump Design** , 2012 CANZEE, UK

- **Training Courses**

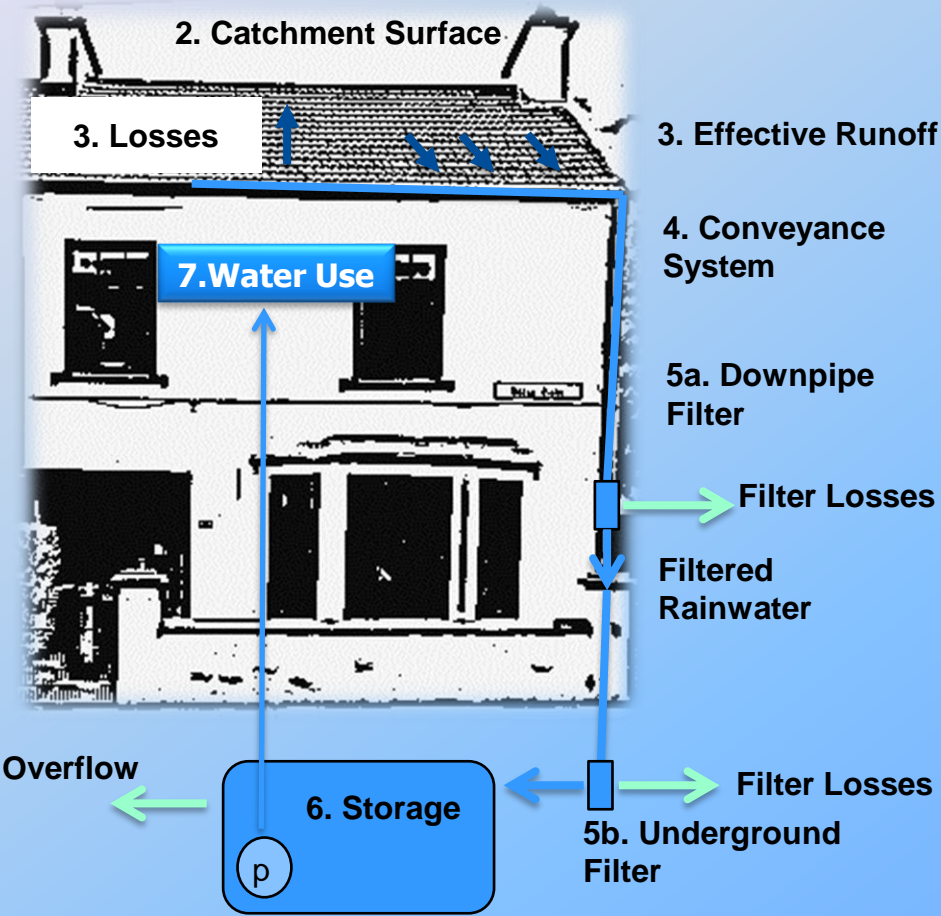
- **TECSPAR Technology Transfer Project**, 2005-2008 EU Alfa Programme in association with Polytechnic University of Catalonia, Spain and the University of Padua, Italy and University of Medellin, Colombia, University of San Luis Potosi, Mexico and the University of Concepcion, Chile.



# Rainwater Harvesting – System Components



## 1. Rainfall



**Filter Characteristics:**

Two basic types of rainwater harvesting systems include:

- Standard:** A system where rainwater is collected by gutters and downpipes, passes through a filter, and is stored in a tank. The filter is located in the downpipe.
- Advanced:** A system where rainwater is collected by gutters and downpipes, passes through a filter, and is stored in a tank. The filter is located underground.

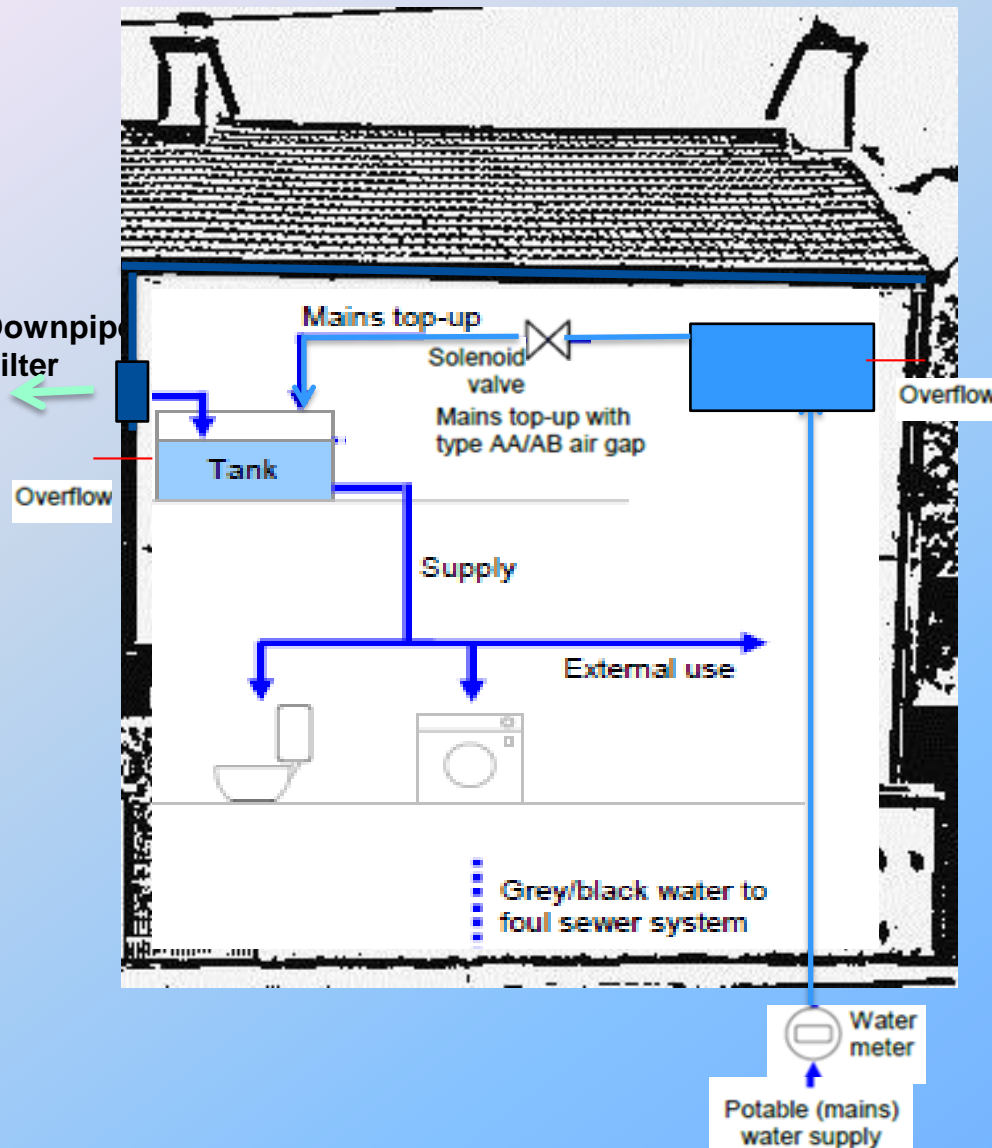
**Filter Characteristics:**

- a filter with a coefficient of efficiency of 0.8 will convey 80% of the rainfall that reaches it to the collection system for use.
- a filter with a coefficient of efficiency of 0.9 will convey 90% of the rainfall that reaches it to the collection system for use.

**Filter Losses:**

- a filter with a coefficient of efficiency of 0.8 will convey 80% of the rainfall that reaches it to the collection system for use.
- a filter with a coefficient of efficiency of 0.9 will convey 90% of the rainfall that reaches it to the collection system for use.

# RWH Systems– Direct Gravity System



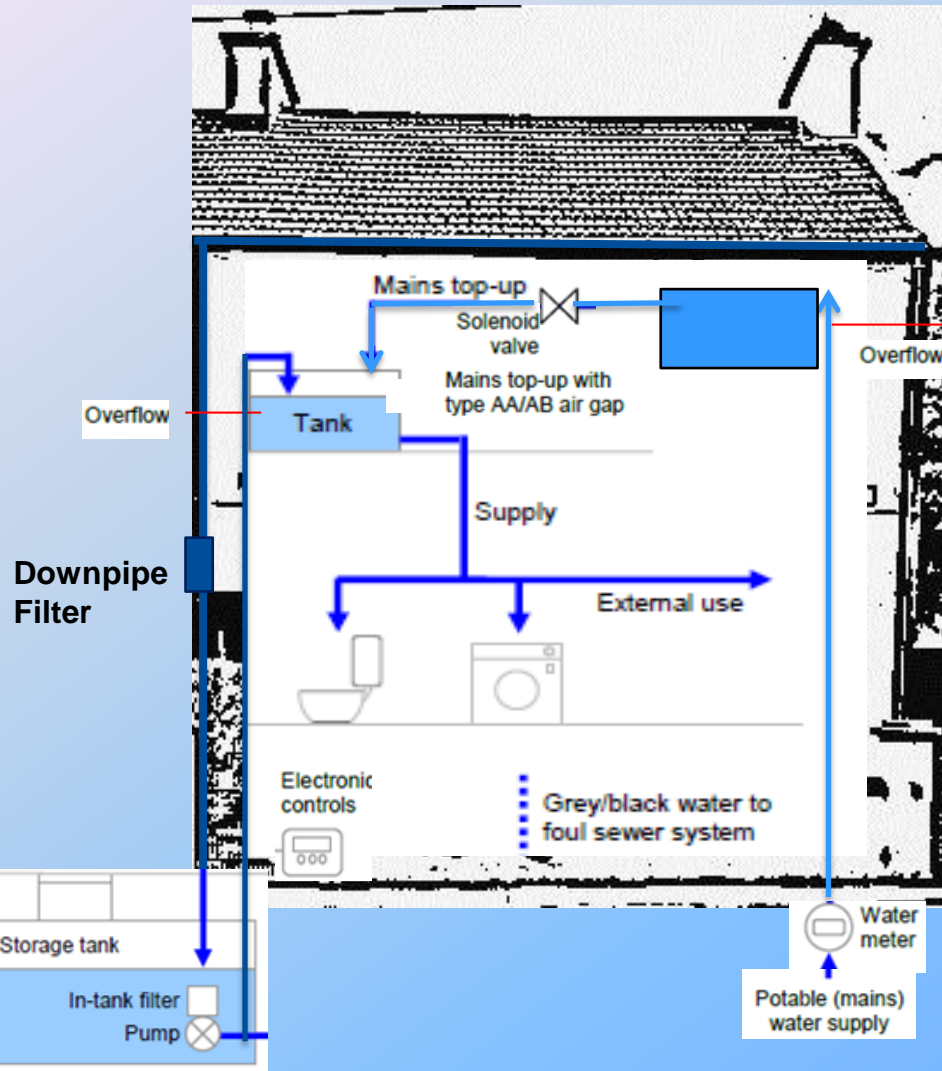
## Gravity Fed RWH Systems:

Rainwater is collected from the roof, filtered and then conveyed directly to the storage (header) tank.

Water is delivered to appliances via gravity.

Top up from the mains water tank is provided via a non return valve or type A air gap.

# RWH Systems– Indirect Pumped System



## Indirect Pumped Systems:

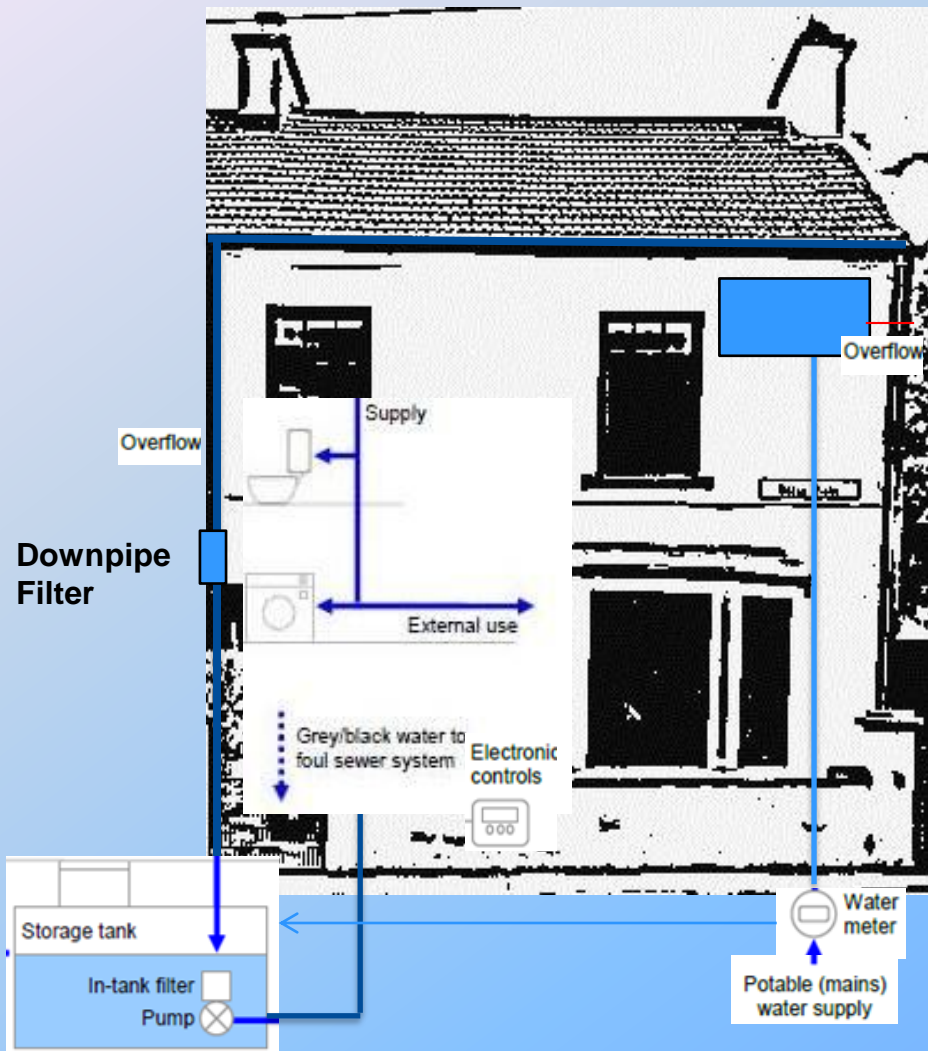
Rainwater is collected from the roof, filtered and then conveyed directly to the rainwater storage tank.

Water is pumped to a rainwater header tank and delivered to appliances via gravity.

Top up from the mains water tank is provided via a non return valve or type A air gap.



# RWH Systems– Direct Pumped System



## Direct Pumped Systems:

Rainwater is collected from the roof, filtered and then conveyed directly to the rainwater storage tank.

Water is pumped to appliances.

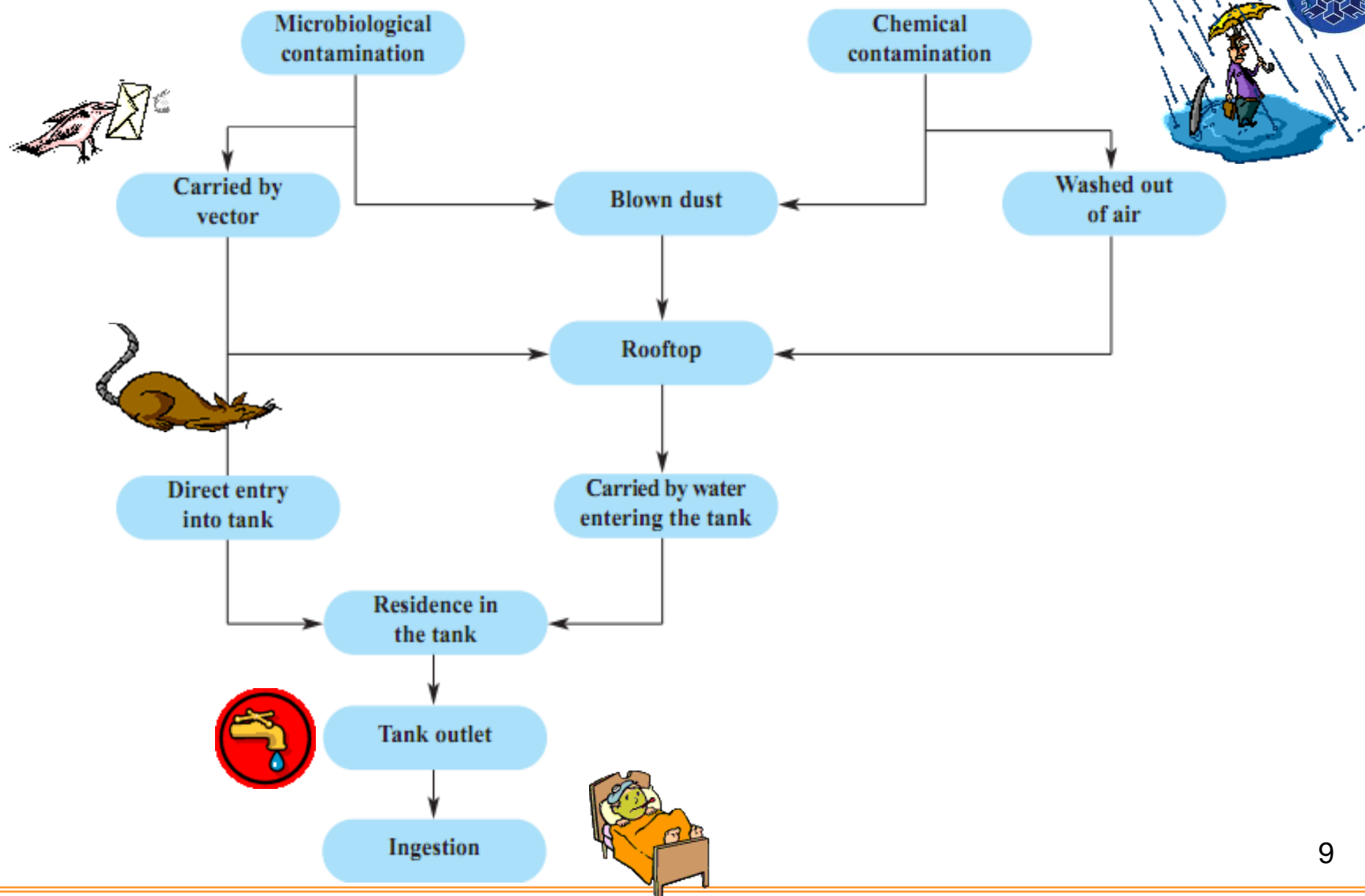
Top up directly to rainwater storage tank from the mains water supply.

# Frequently Asked Questions

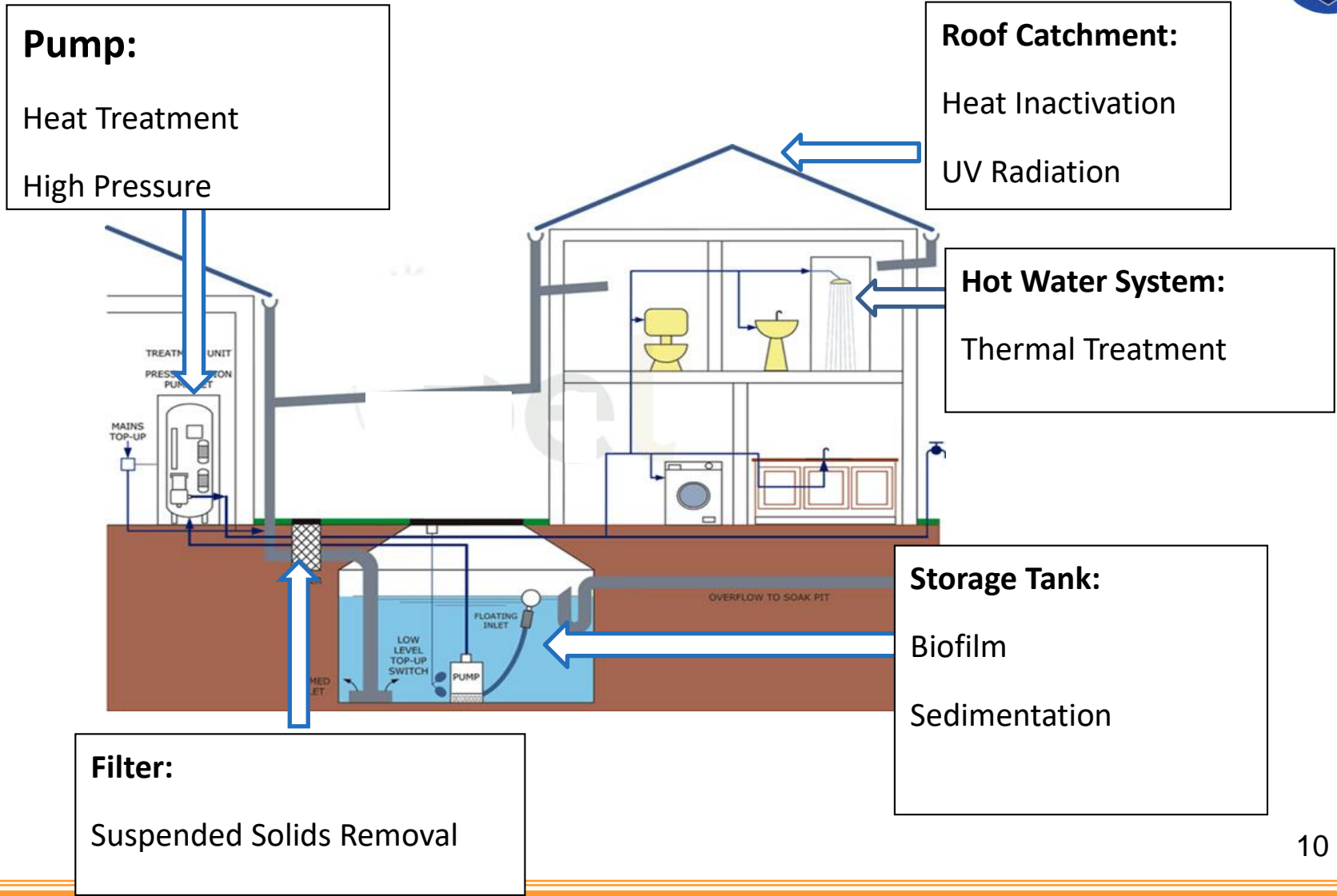


- **What are the hazards associated with rainwater ?**
- **How pure is rainwater ?**
- **What is the risk of the mains supply becoming contaminated by rainwater ?**

# RWH Water Quality: The path of contamination



# RWH Water Quality: RWH Treatment Processes



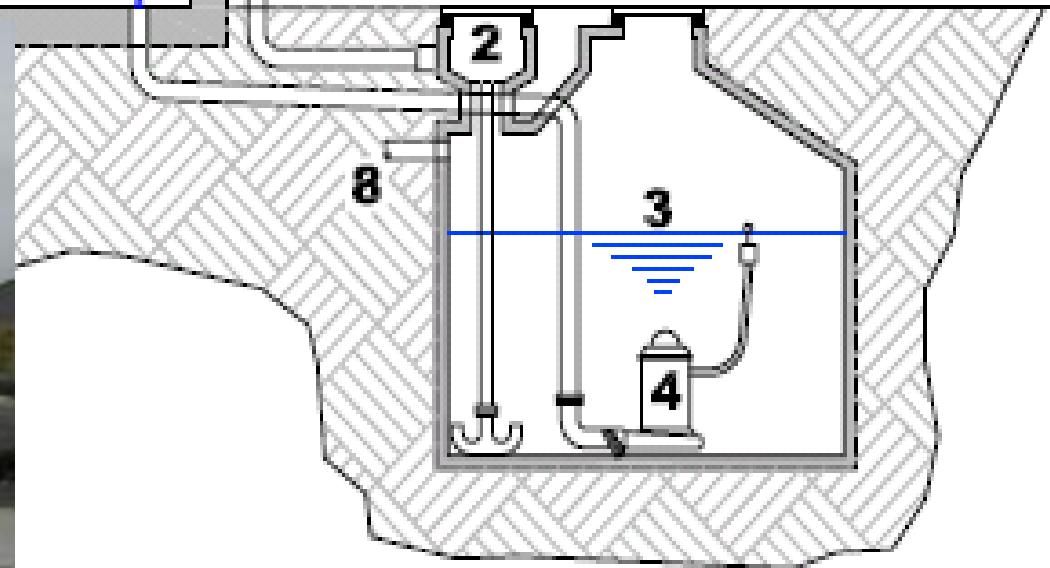
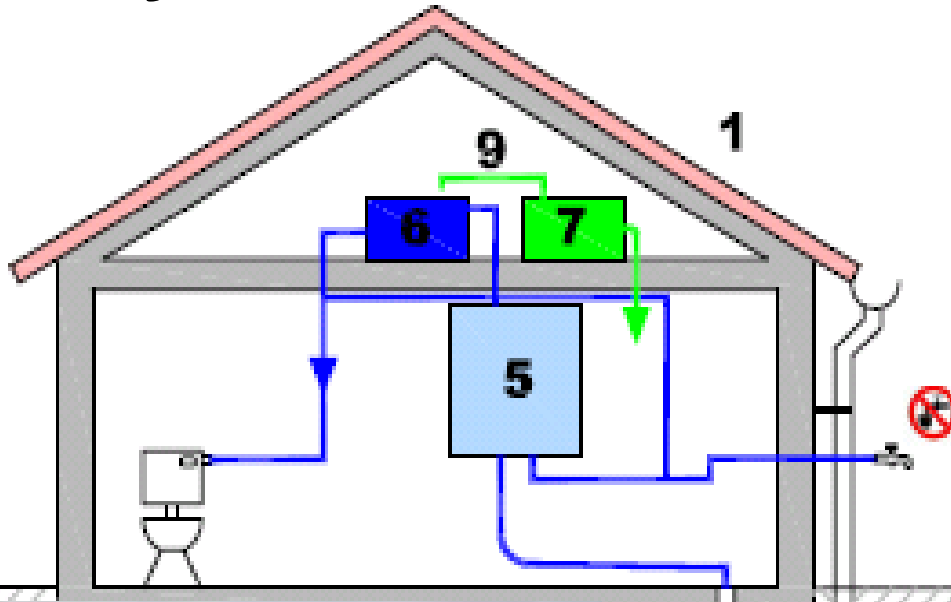


- **Innovations in Rainwater Harvesting Design**
  - **Domestic – Carlow**
  - **Agricultural – Meath**
  - **School - Mayo**
- **Publications available from**  
[www.dit.ie/arrow](http://www.dit.ie/arrow)

# Domestic Installation, County Carlow.

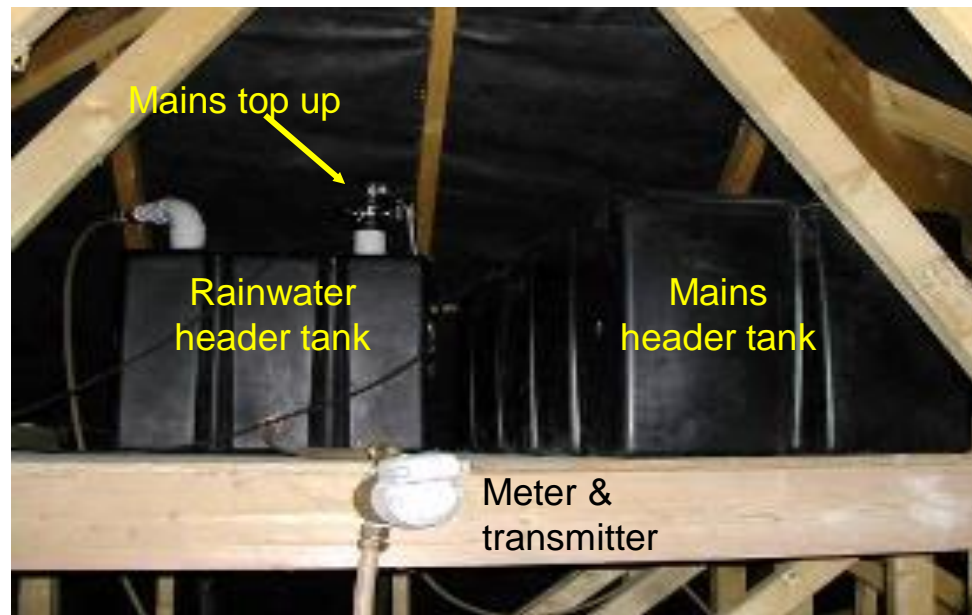
## RWH System Components

1. Roof Surface
2. Rainwater Filter
3. Rainwater Storage Tank
4. Pump
5. Supply Management System
6. Rainwater Header Tank
7. Mains water Header Tank
8. Overflow to surface water drainage system
9. Mains water top-up



RWH House



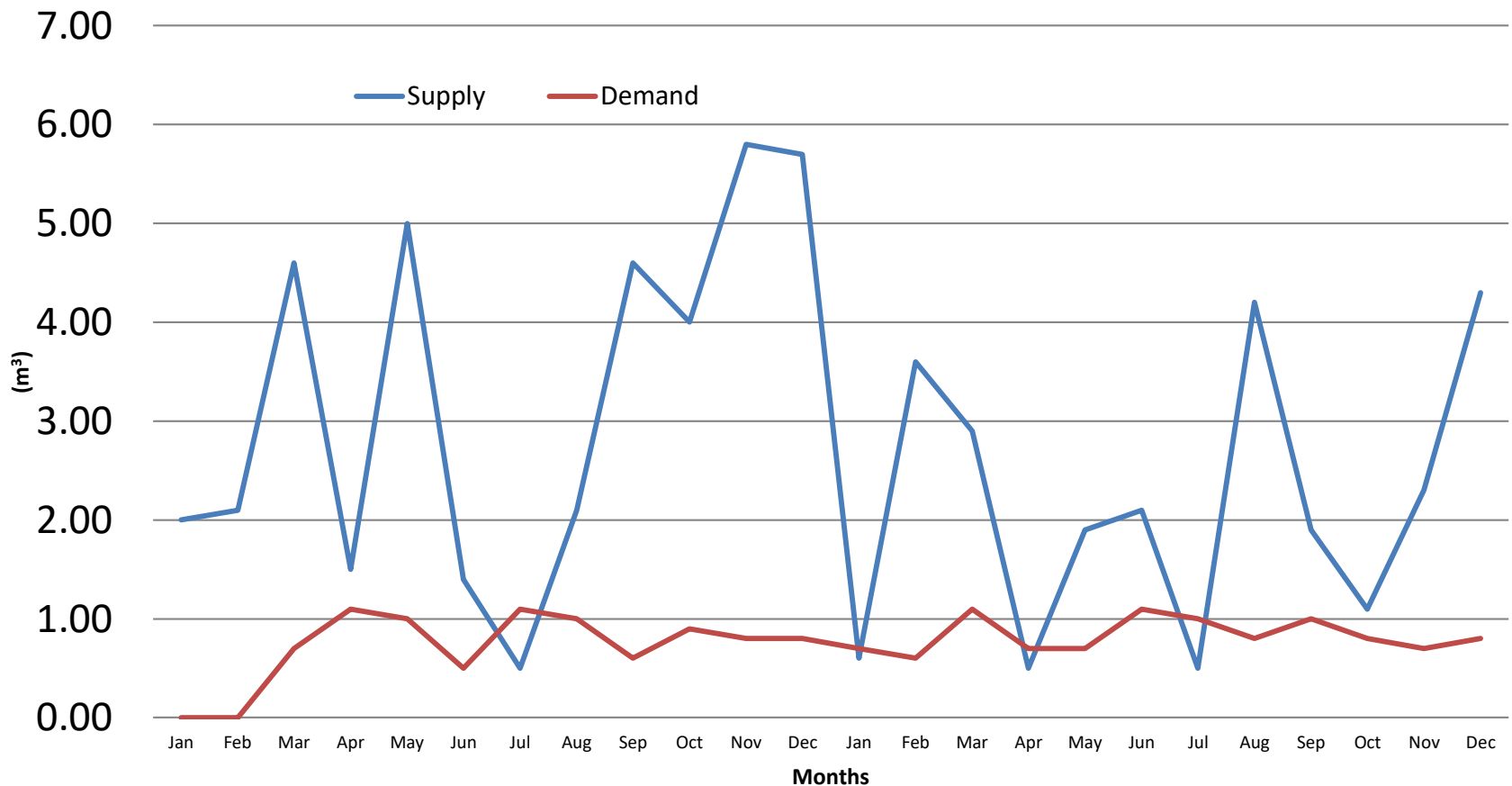




# Domestic RWH: Water Quantity



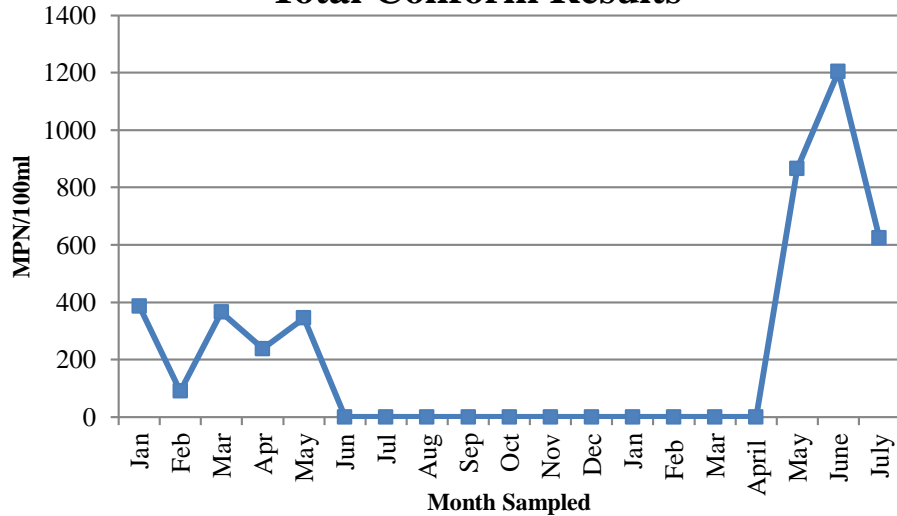
## Monthly Supply-vs-Monthly Demand



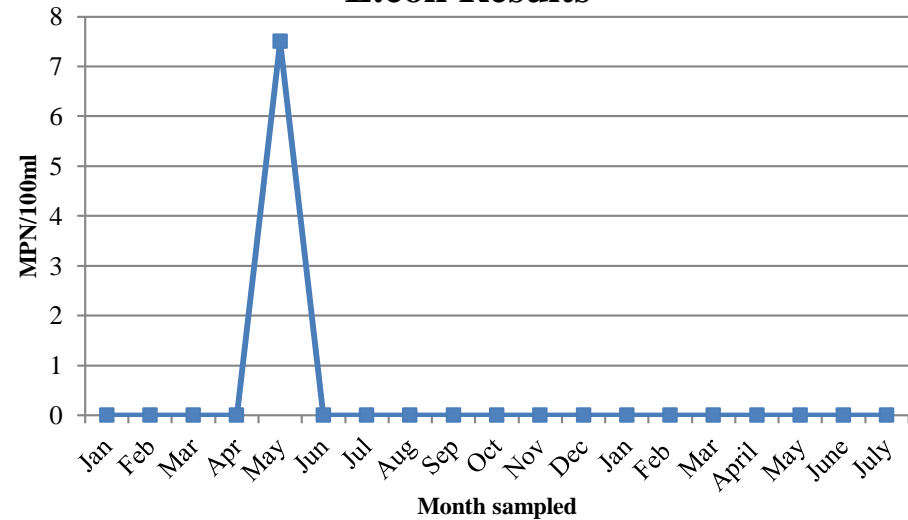
# Domestic RWH: Water Quality



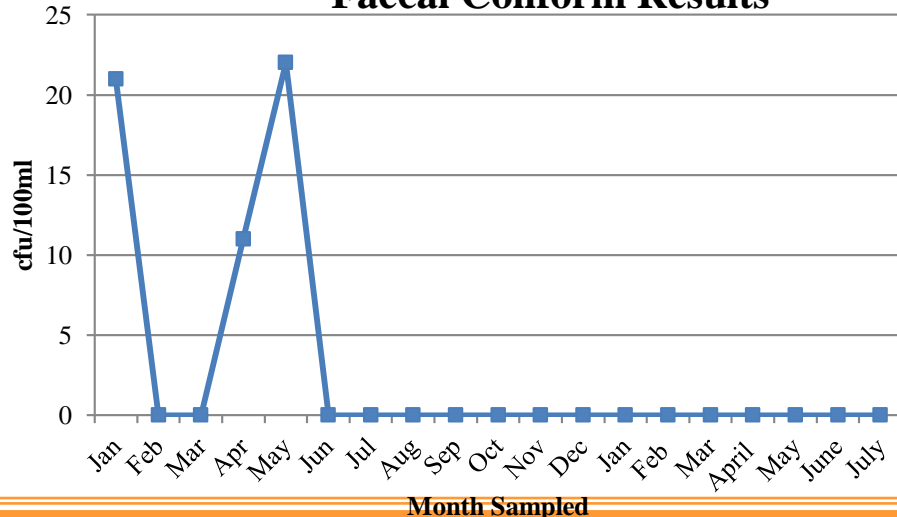
### Total Coliform Results



### E.coli Results



### Faecal Coliform Results



## Water Quality

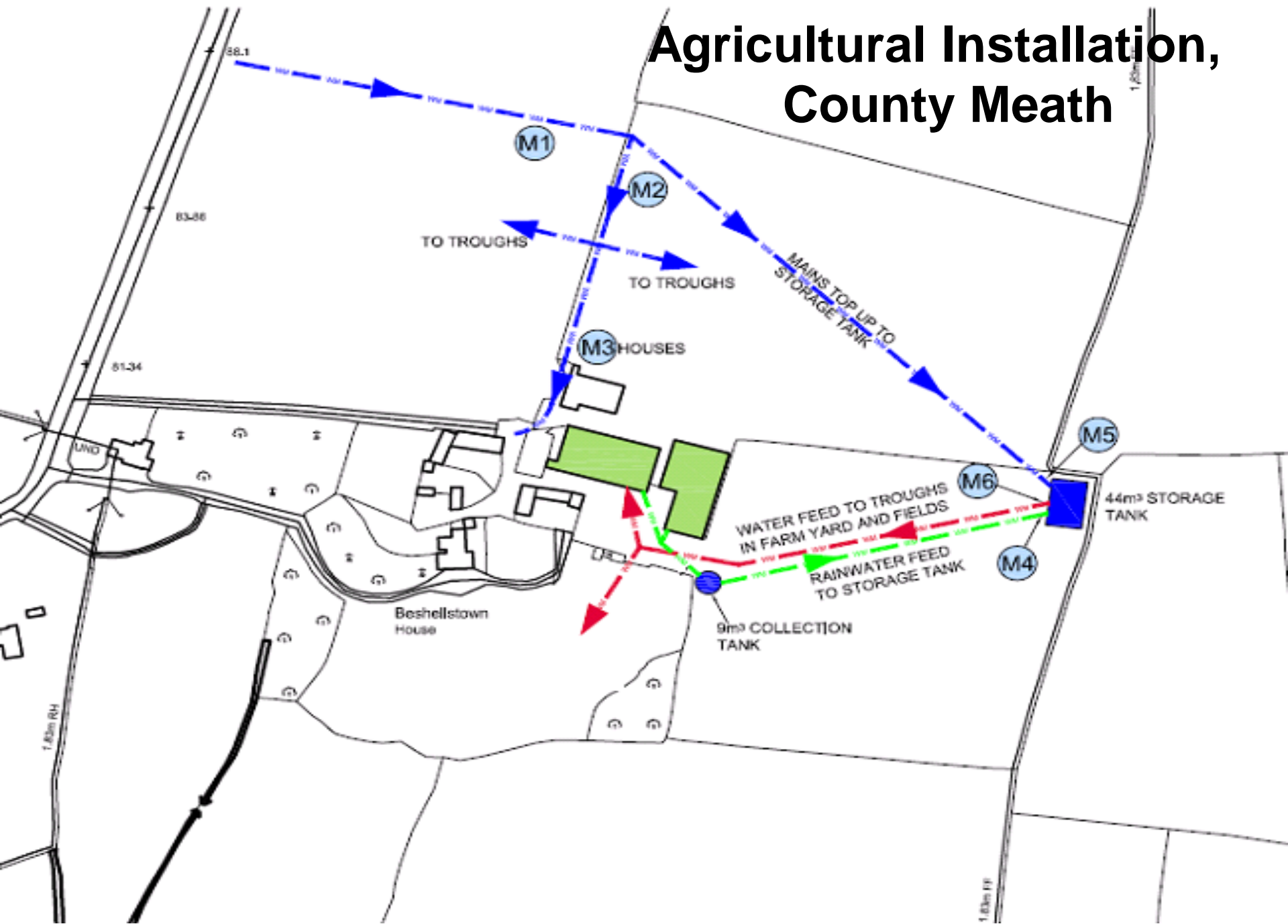
**EU Bathing Water Stds. 100%**

**EU Drinking Water Stds. 37%**

# Agricultural Installation, County Meath



# Agricultural Installation, County Meath





# Water Quality

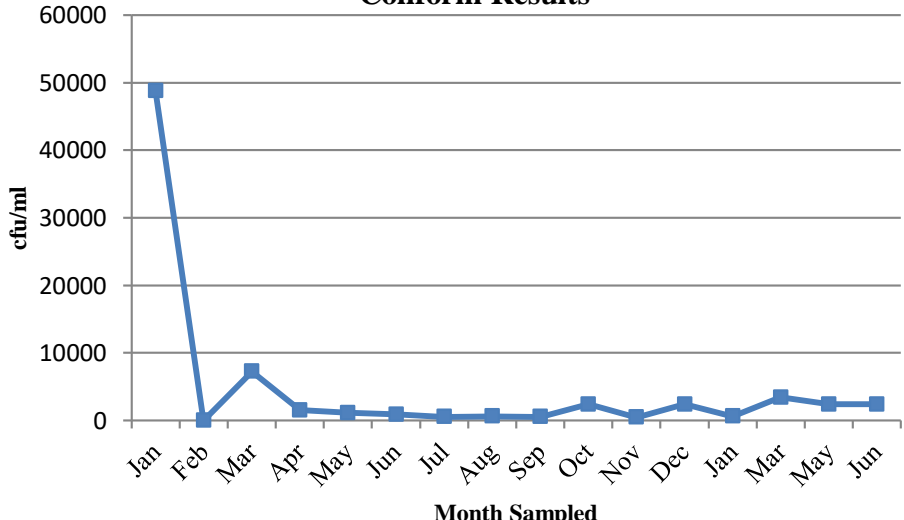
First filtering system installed - **Poor Quality**  
 Second filtering system installed- **Average Quality.**

# Water Quantity

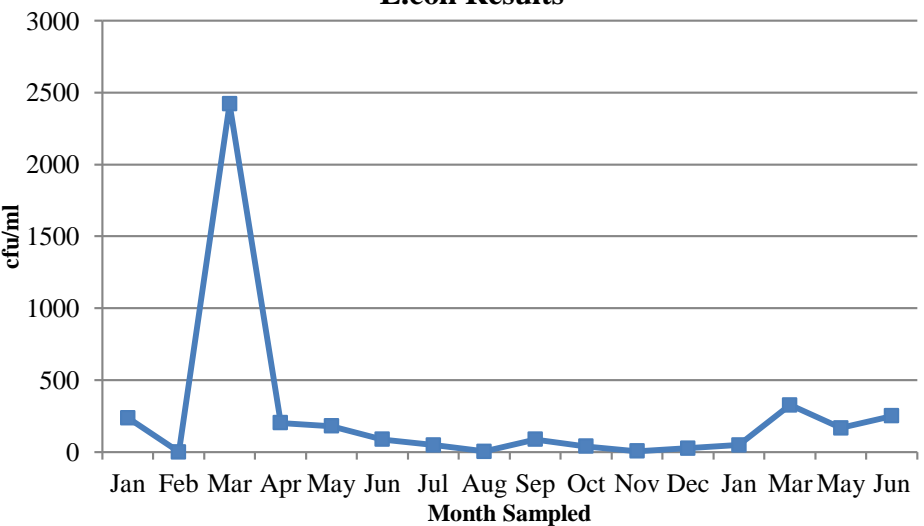
Supplied 43% of Livestock water



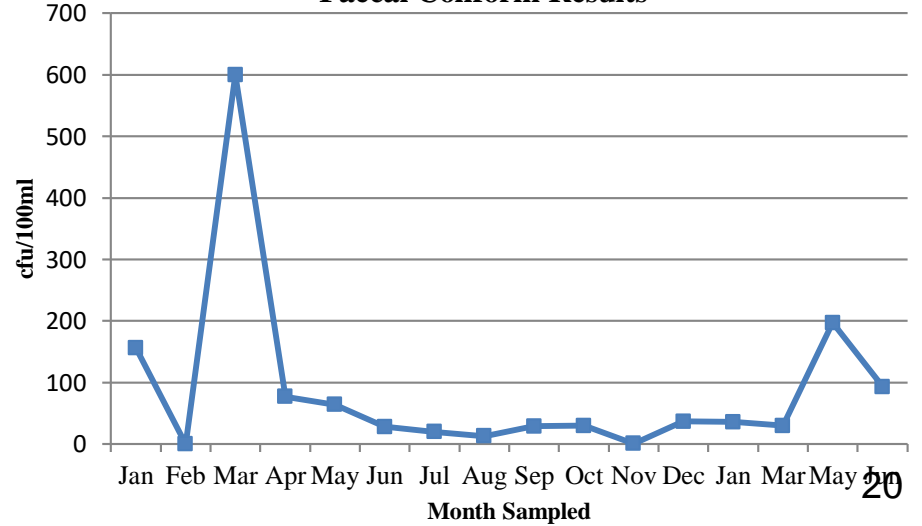
**Coliform Results**



**E.coli Results**



**Faecal Coliform Results**



# Case Study: School RWH



Carrowholly National School, Westport, Ireland

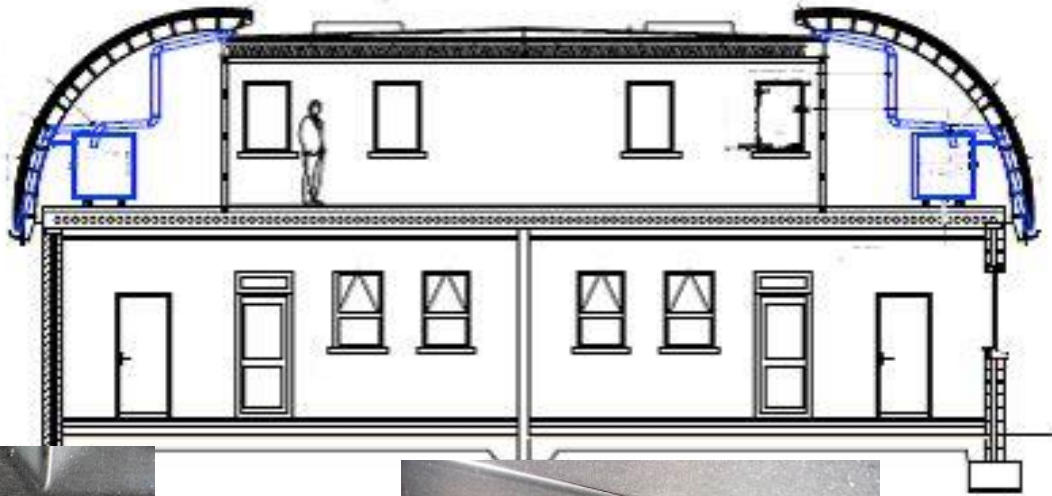




1. ROOF CATCHMENT



2. RWH SYSTEM OVERFLOW & FILTER



3. RWH HEADER TANK

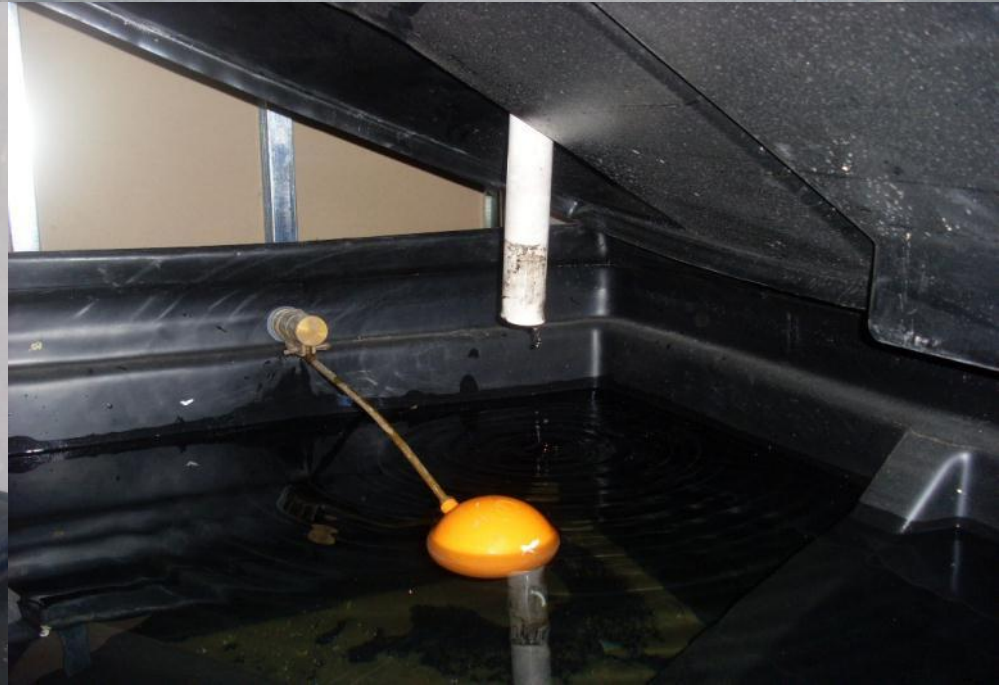


5. RWH OVERFLOW

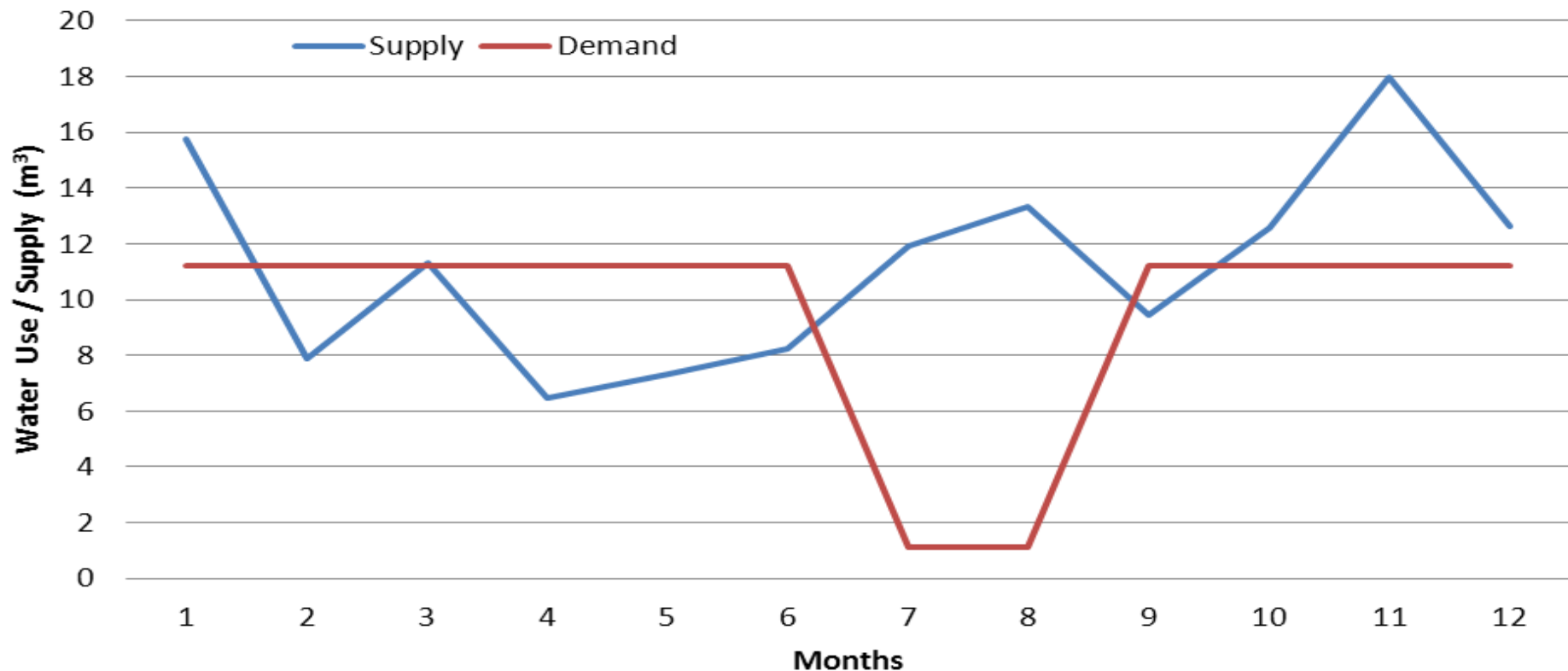


4. RWH MAINS WATER TOP UP





## Monthly Supply-vs-Monthly Demand



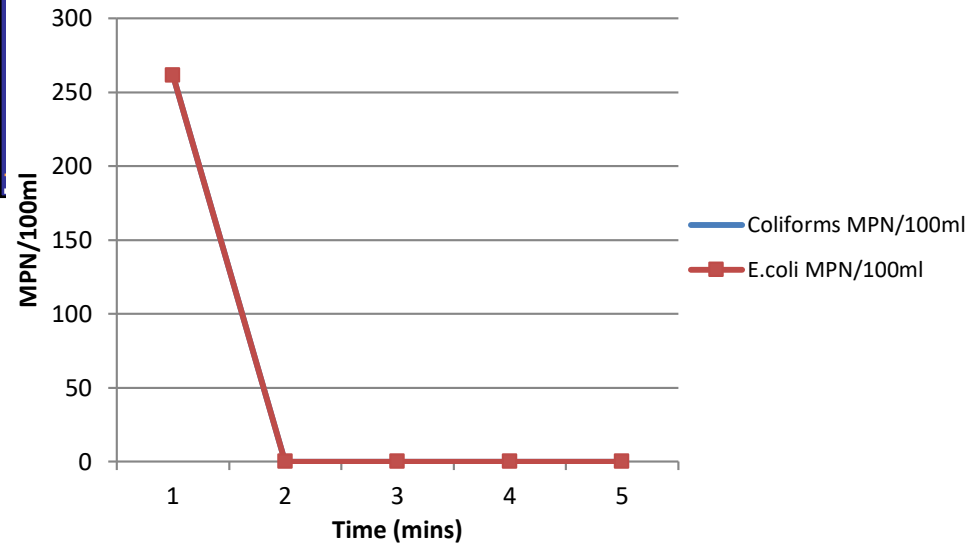
- Per capita consumption over the twenty one month period of the study was recorded as **2.81 m<sup>3</sup>/pupil/year**
- Non potable (WC) water use consisted of **1.49 m<sup>3</sup>/pupil/year.**
- RWH system - 52% of the total non potable (WC) water usage.
- Mains water top up provided 48%.

# Further Studies

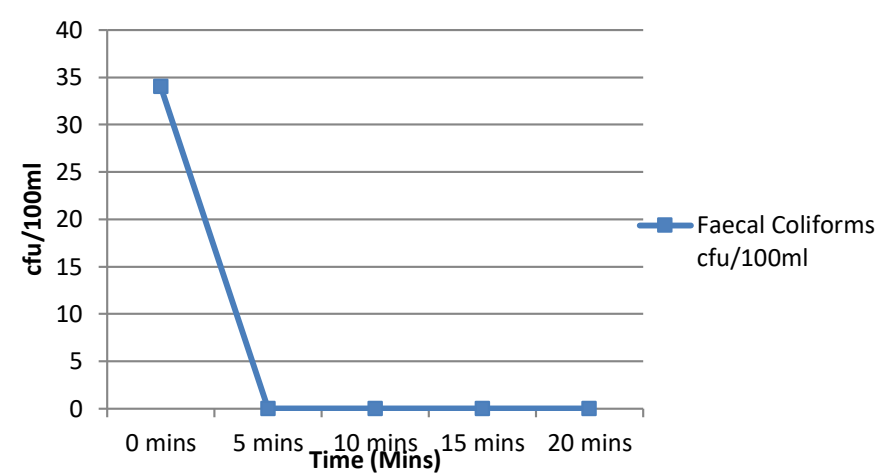


- **Thermal inactivation data for the range of bacteria relevant to health in hot water systems is rare although extensive work has been carried out in Australia in the last number of years.**
- **DIT Study – thermal inactivation rates at hot water temperatures of 55° and 60°**

**Thermal Inactivation Rates - Coliforms and E.coli at 60°C**

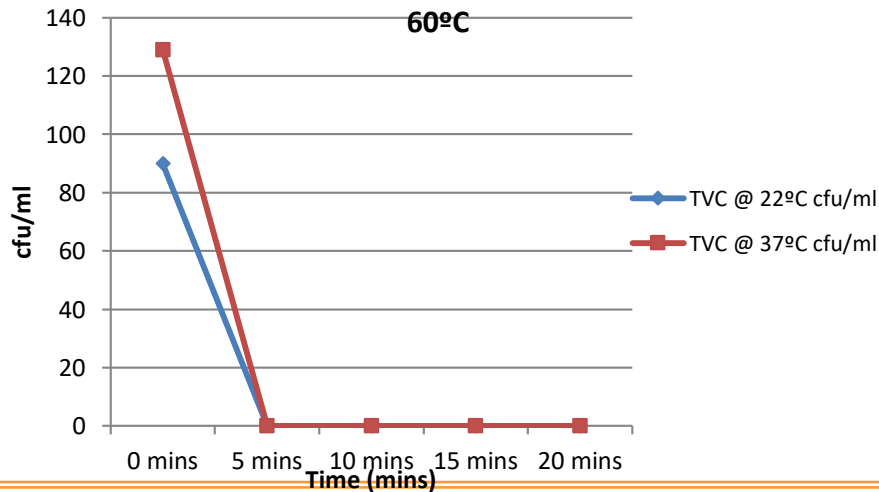


**Thermal Inactivation Rates - Faecal Coliforms at 60°C**

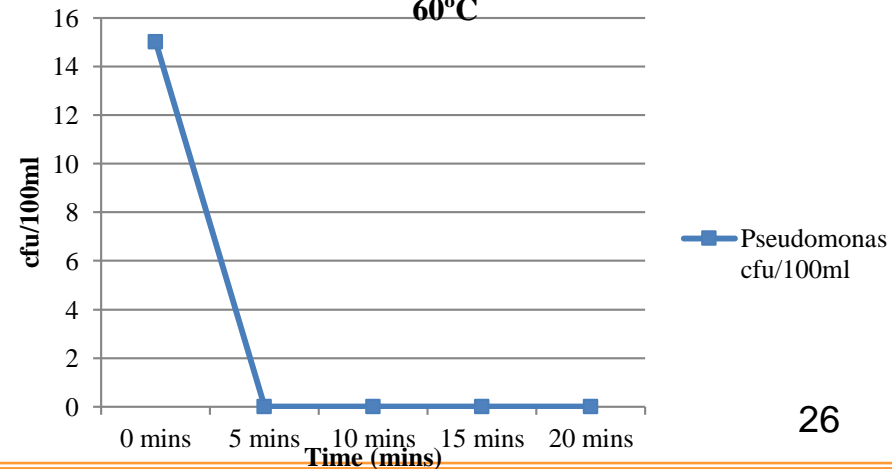


The aims of the thermal experiments were to determine the time required to reduce a bacterial population by 100% or 1 log reduction, for the potential waterborne pathogens mentioned, in a water medium at temperatures relevant for domestic hot water systems.

**Thermal Inactivation Rates - TVC 22°C and 37°C at 60°C**



**Thermal Inactivation Rates - Pseudomonas Spp at 60°C**



# EU - Major Policy Initiatives



## Germany

- Rain taxes collected for the amount of run off into the local storm sewer that is generated from the impervious surface cover of the property.



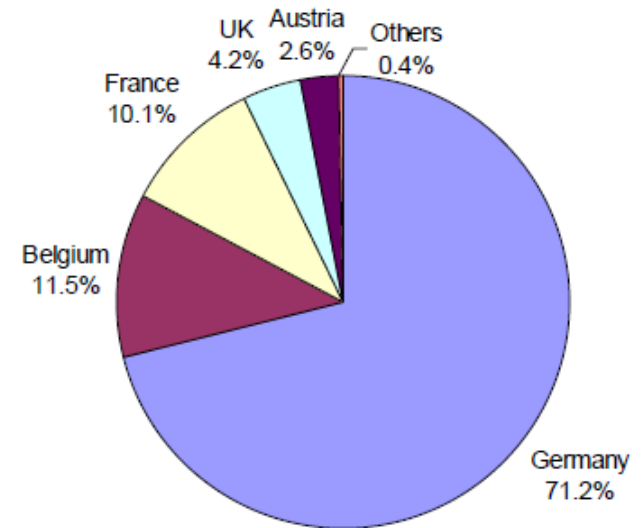
## France

- A tax rebate of 40 % up to a maximum of € 5000 is be provided to all RWH systems.



## Belgium

- National Legislation - all new constructions need to have RWH systems installed for the purpose of flushing toilets and external water uses.




**Germany** 

**Drivers**

- Rain Taxes
- Proactive Government
- High Water Taxes

**Restraints**

- Slow Construction Market
- Capital Cost

**France** 

**Drivers**

- Rising Water Tariffs
- Tax Rebates

**Restraints**

- Slow Construction Market

**European RWH Market Drivers and Restraints**


**Belgium** 

**Drivers**

- Eco Cheques
- Mandatory RWH

**Restraints**

- Slow Construction Market

**Ireland** 

**Drivers**

?

**Restraints**

- Planning Permission
- Lack of Government Policy
- No financial Incentives
- Lack of education
- Storage over designed leading to high capital costs

WE CANNOT SOLVE  
OUR PROBLEMS WITH  
THE SAME THINKING  
WE USED WHEN  
WE CREATED THEM

*~ Albert Einstein*



# Singapore – “Innovations in strategic vision leads to innovations in technology”



## Rainwater Harvesting

- collected from unprotected and protected catchments.

## Imported Water

- Malaysia

## NEWater

- Reclaimed water for non potable industry

## Desalination

- Reclaimed seawater (future)

**“Water dominated every Government policy”**

Prime Minister Lee Hsien Loong



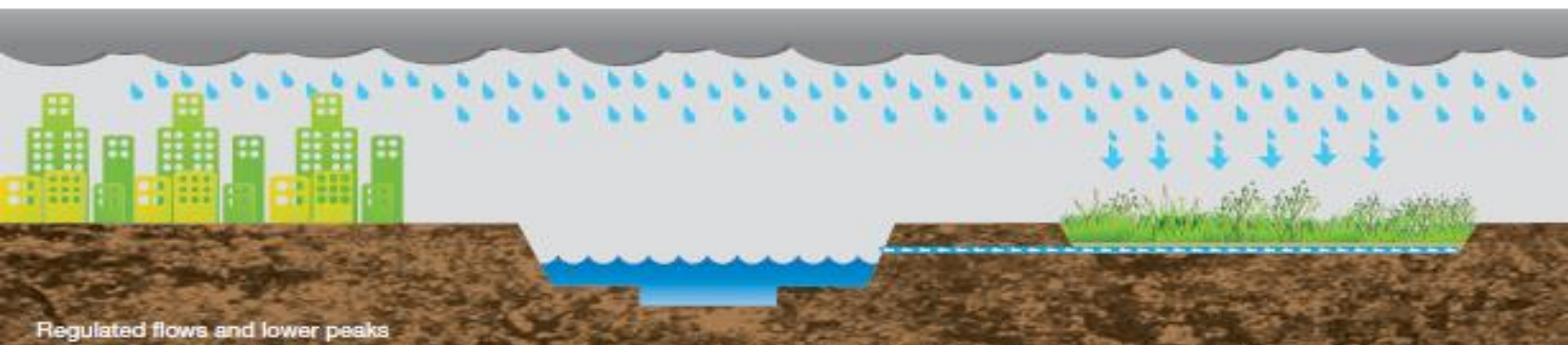


**Rainwater harvested on-site**

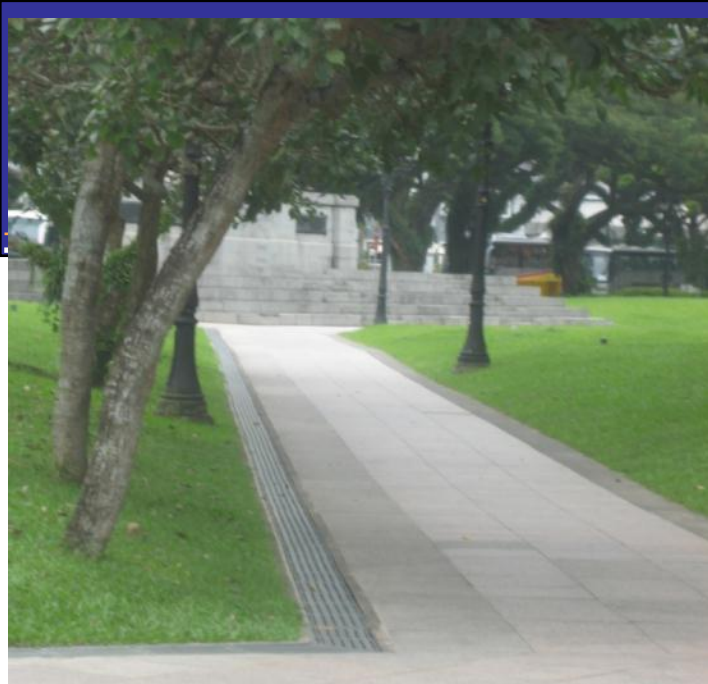
**Rainwater channelled to canals**

**Discharged to Reservoirs**

**“Two thirds of Singapore is already a water catchment”**



# “Singapore – Unprotected Urban Water Catchments”



# Marina Barrage



## Water Supply

Damming of the Marina Channel created a 10,000 hectare water catchment meeting 10% of Singapore Potable Water Supply Demand



## Flood Control

- High rainfall with low tide  $\equiv$  weir
- High rainfall with high tide,  $\equiv$ , rainwater pumped over barrier to sea-



## Lifestyle attraction

- “we used to keep people away from our water...now we want to attract them to the water as a resource, amenity”
- Active Beautiful, Clean (ABC)

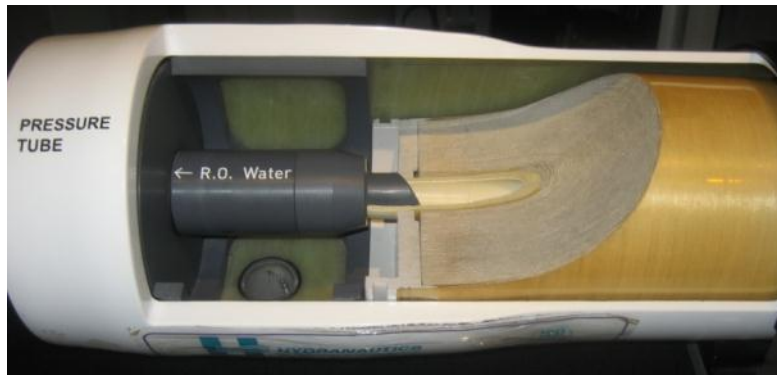
# Singapore – “wastewater is a resource”



## NEWater

High quality reclaimed wastewater for non potable industrial users

- Electronics industry
- Power generation
- Air conditioners



# *“A Zero Waste Approach to Water ”*



## **To develop an integrated water strategy for Ireland we need:**

- Innovative thinking
- Sustainable and resilient technologies
- Education curricula reform
- Co-ordinated Government and Community Action
- Appreciation of rainwater and wastewater as a valuable resource

# Innovation - not just technology !



- *“The Singapore example indicates that it is unrealistic to expect the existence of an efficient water management institution in a country, in the midst of other similar mediocre management institutions...*
- *Water management institutions in a country can only be as efficient as its management of other development sectors.”*

*(Tortajada, C, 2006)*