New technologies for mitigating risks of stormwater reuse

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CERES COMMUNITY ENVIRONMENT PARK

centre for water sensitive cities

Smart Water Fund

clearwater

Introduction.

* Urban stormwater and rainwater harvesting… multiple benefits to the community:
  * Reduces potable/mains water use

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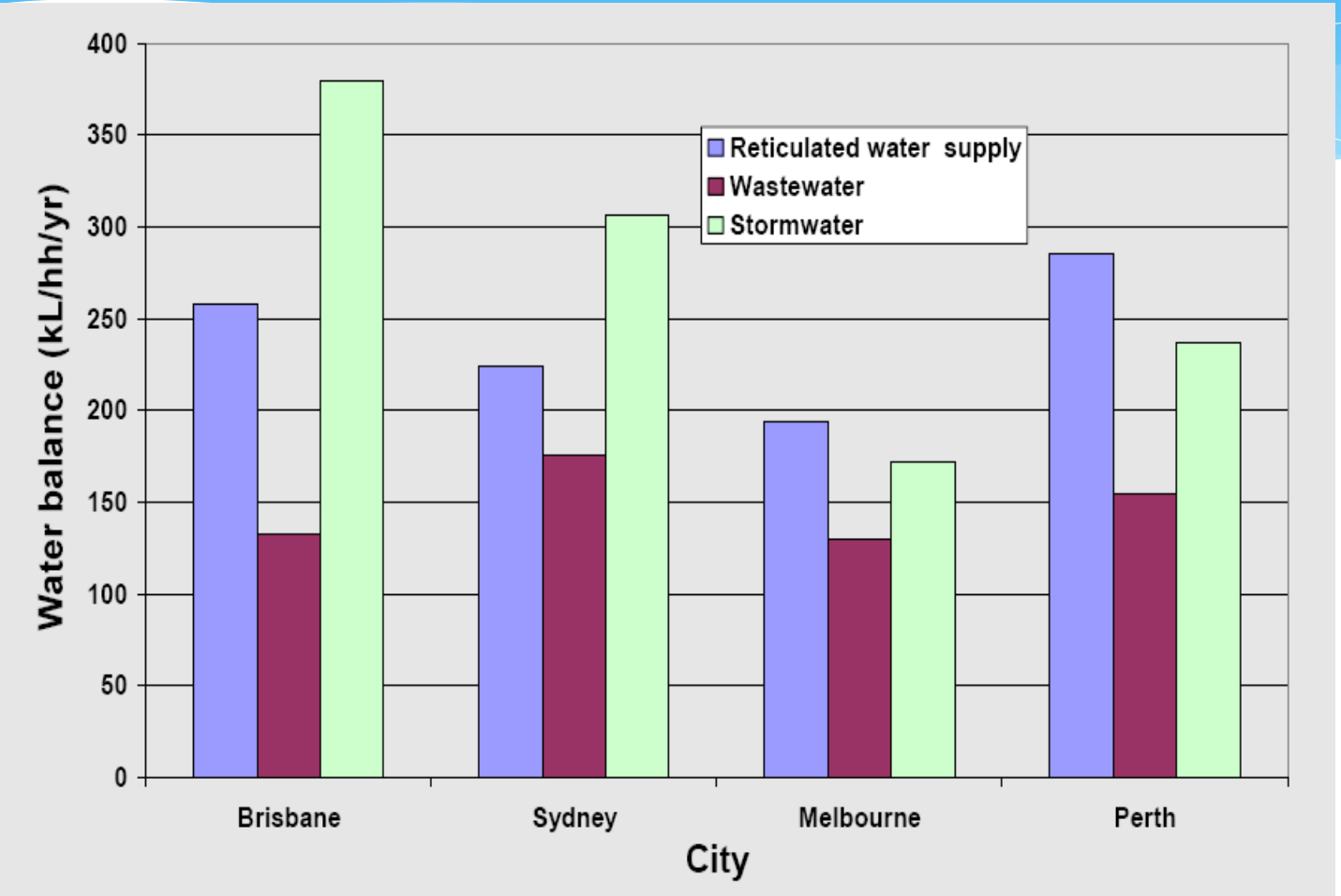

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  * Flood protection
  * Potential to improve microclimate -> making

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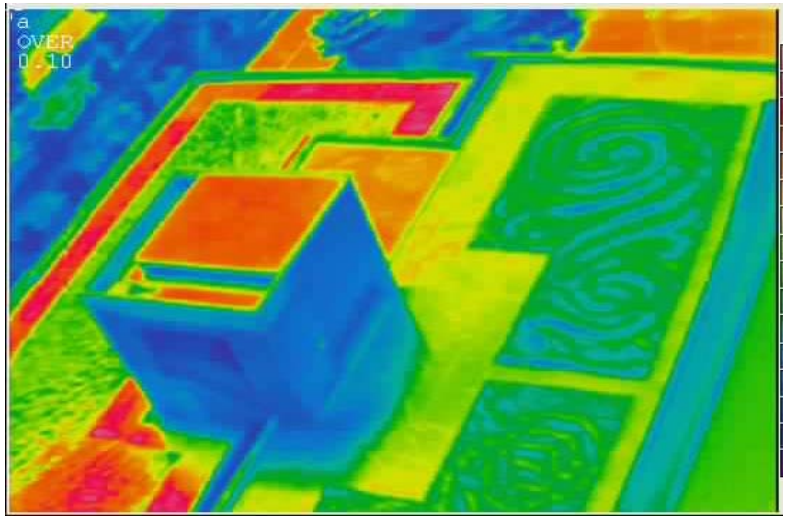

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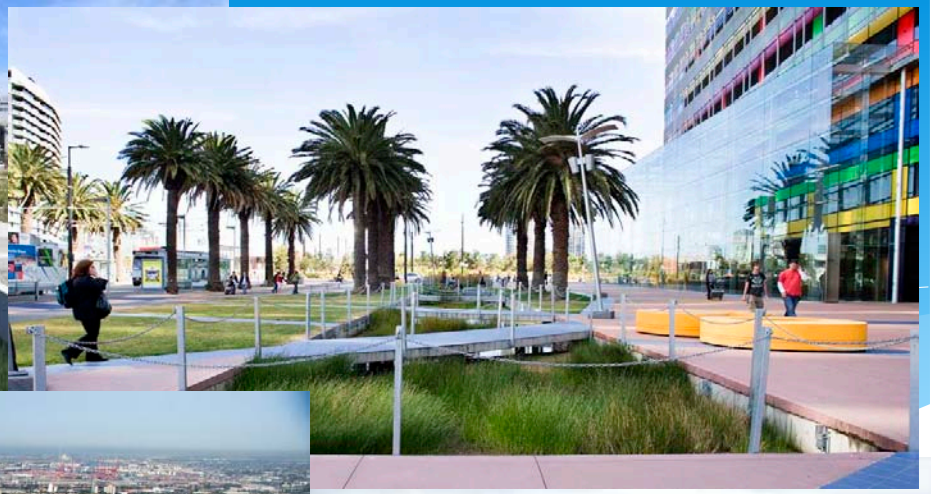
  * Aesthetics/amenity – household, streetscape, precinct









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  * and … urban food production…

* While rainwater is ***often*** of high quality, urban stormwater usually contains a number of pollutants which can cause harm to human health
  * Heavy metals, pathogens, micropollutants, etc
  * ->treatment is necessary before reuse…

Aims.

* The aim of this research project was

> *"to determine the performance of innovative stormwater recycling systems and to assess the risks of utilising harvested stormwater for crop irrigation"*

> *"to directly compare the water quality of treated and untreated roof runoff"*

Approach.

* Over a two year period, we monitored the efficiency of two systems at CERES environmental park
  1. **Roof runoff system** – comparing the risks of using untreated as compared to treated roof runoff
     * report online… tour…
  2. **Road Runoff System** – comparing the treatment performance of two stormwater treatment systems and to assess the short and long term impacts on human health of utilising recycled stormwater for crop irrigation

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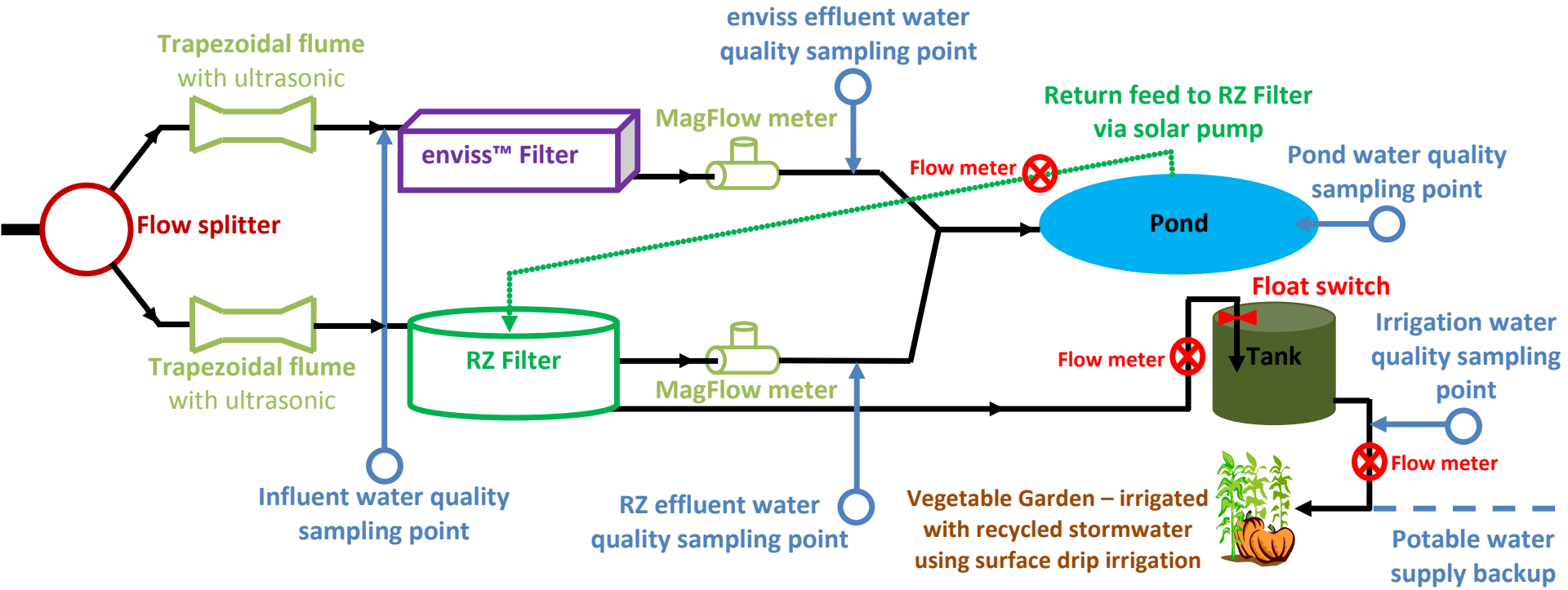

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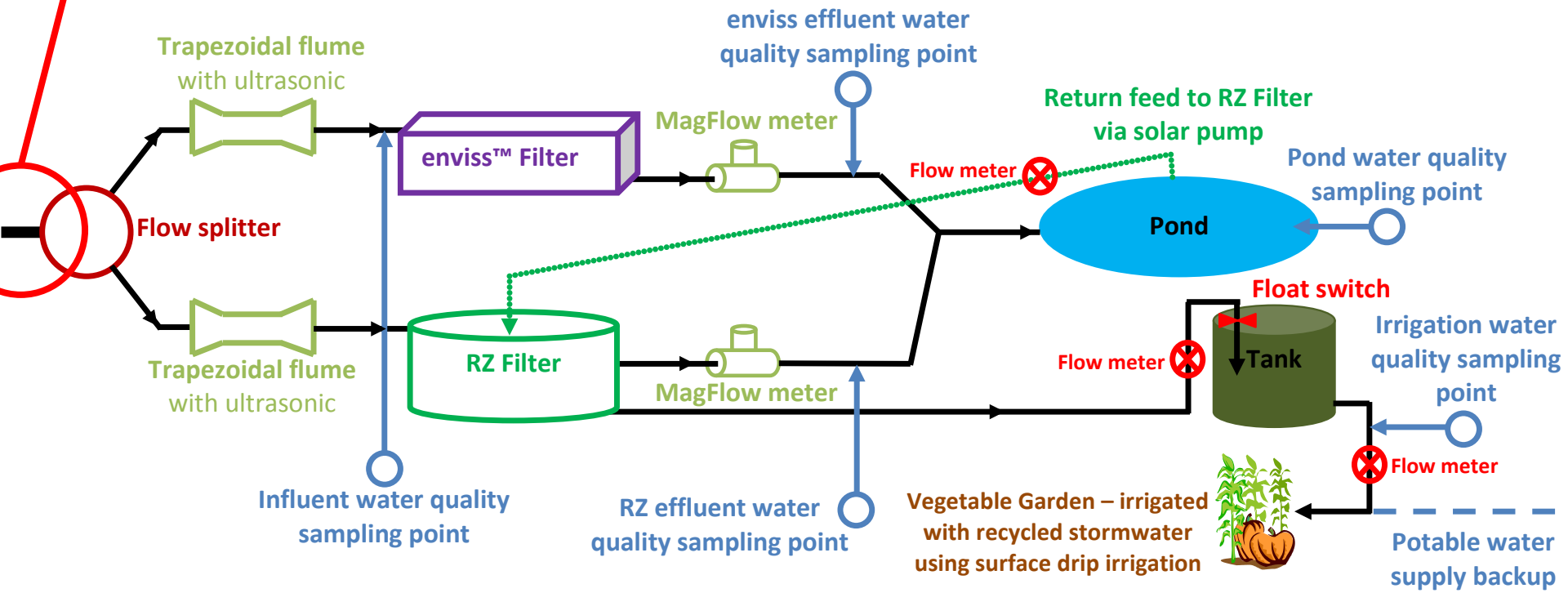

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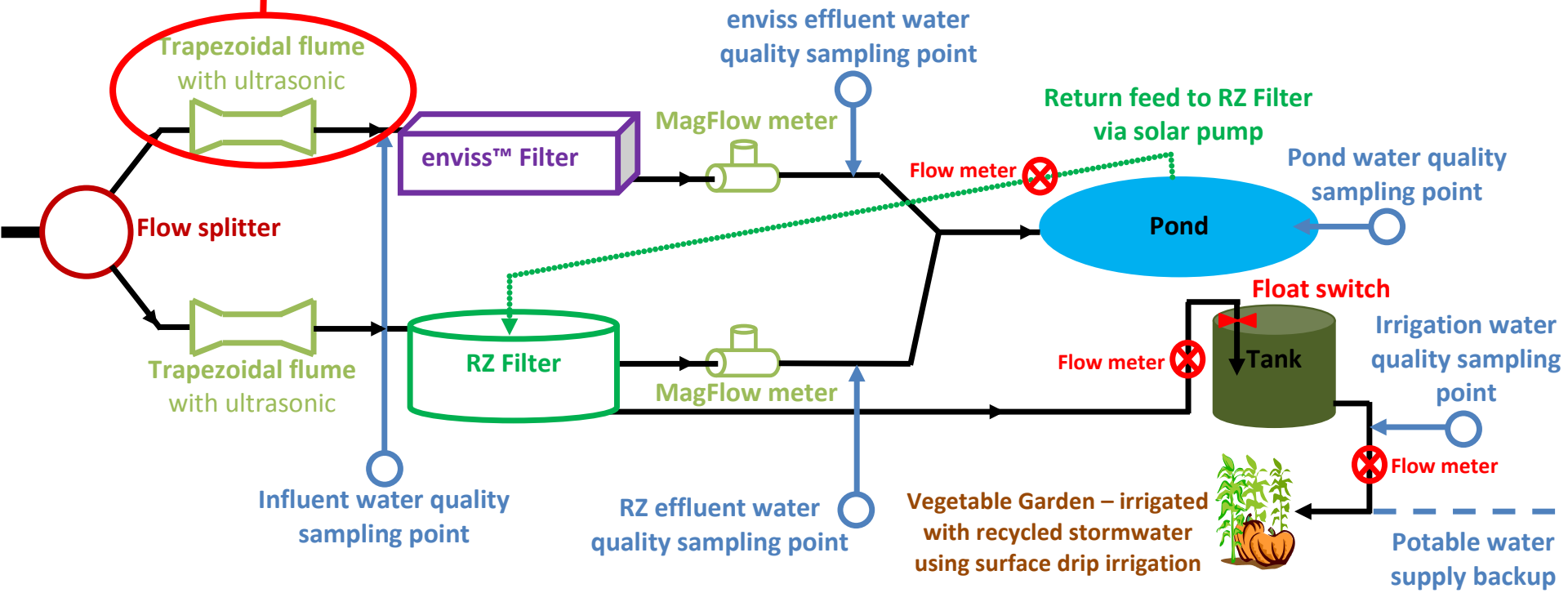

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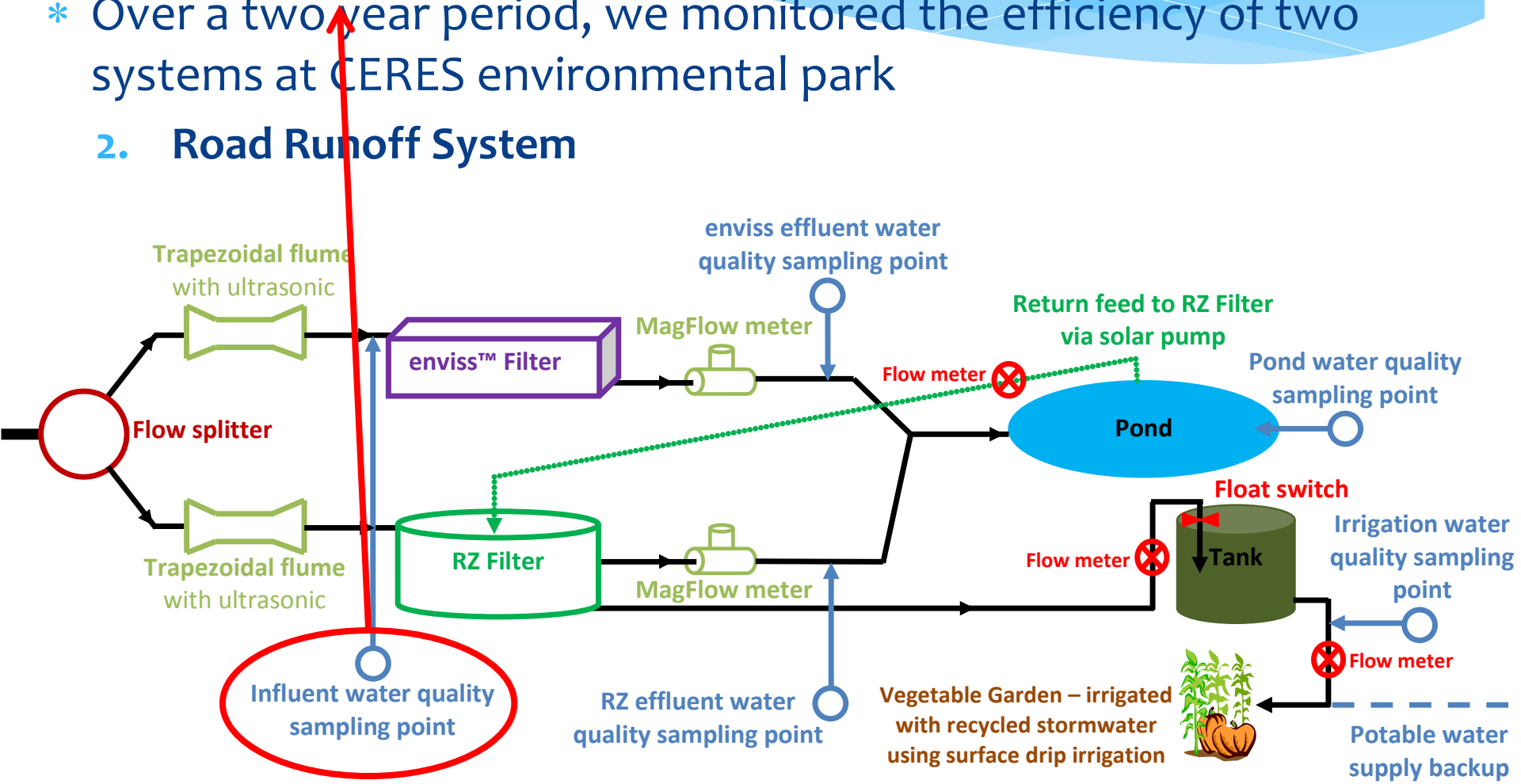

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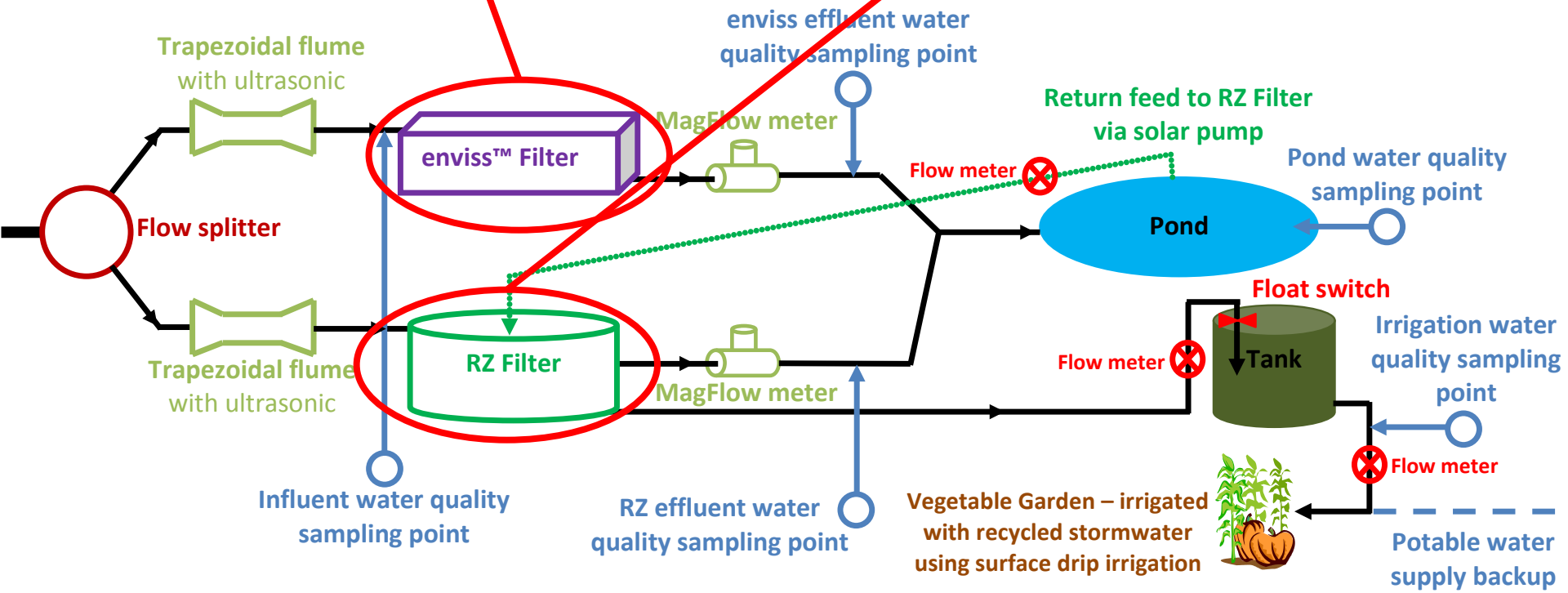

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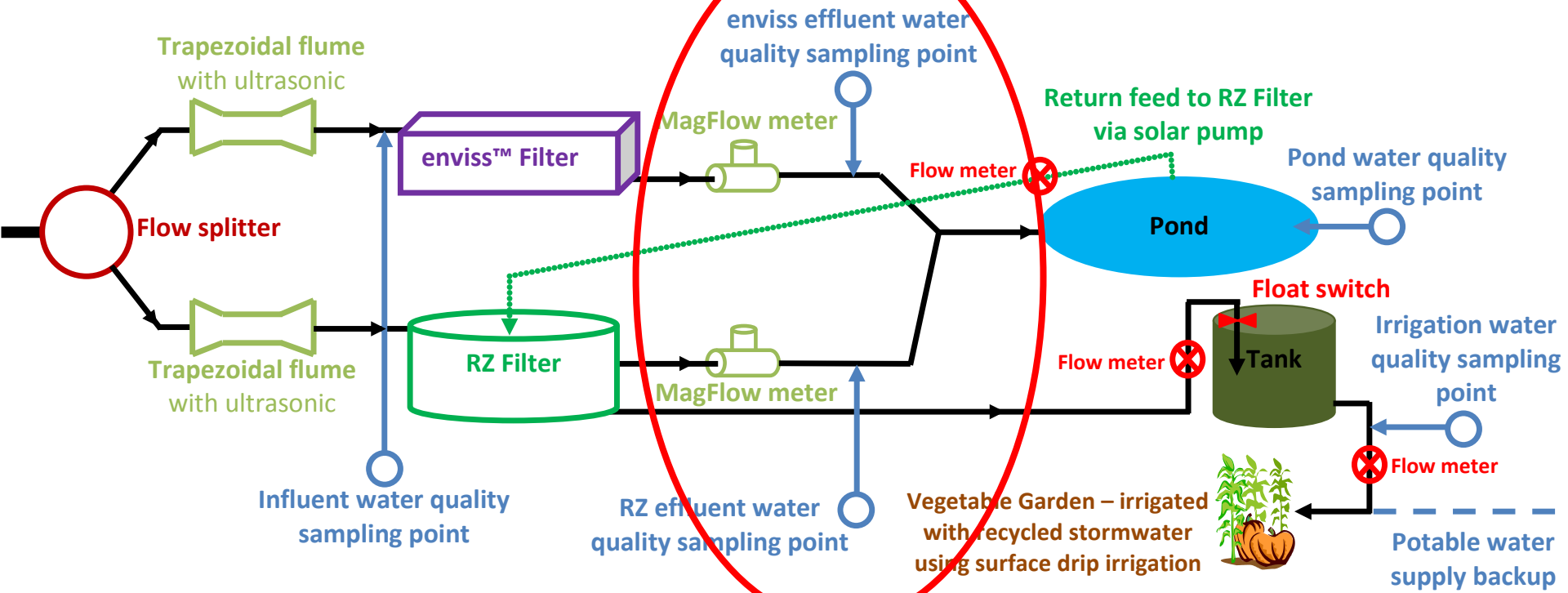

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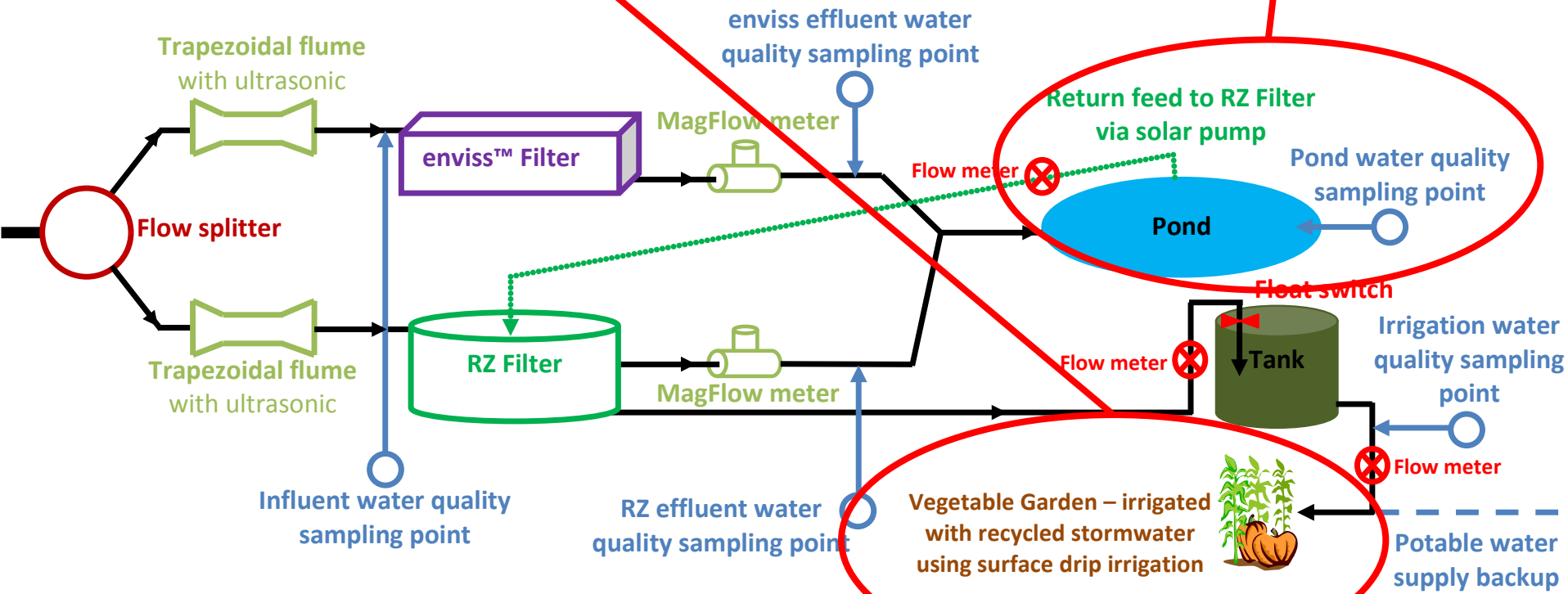

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2. **Road Runoff System**

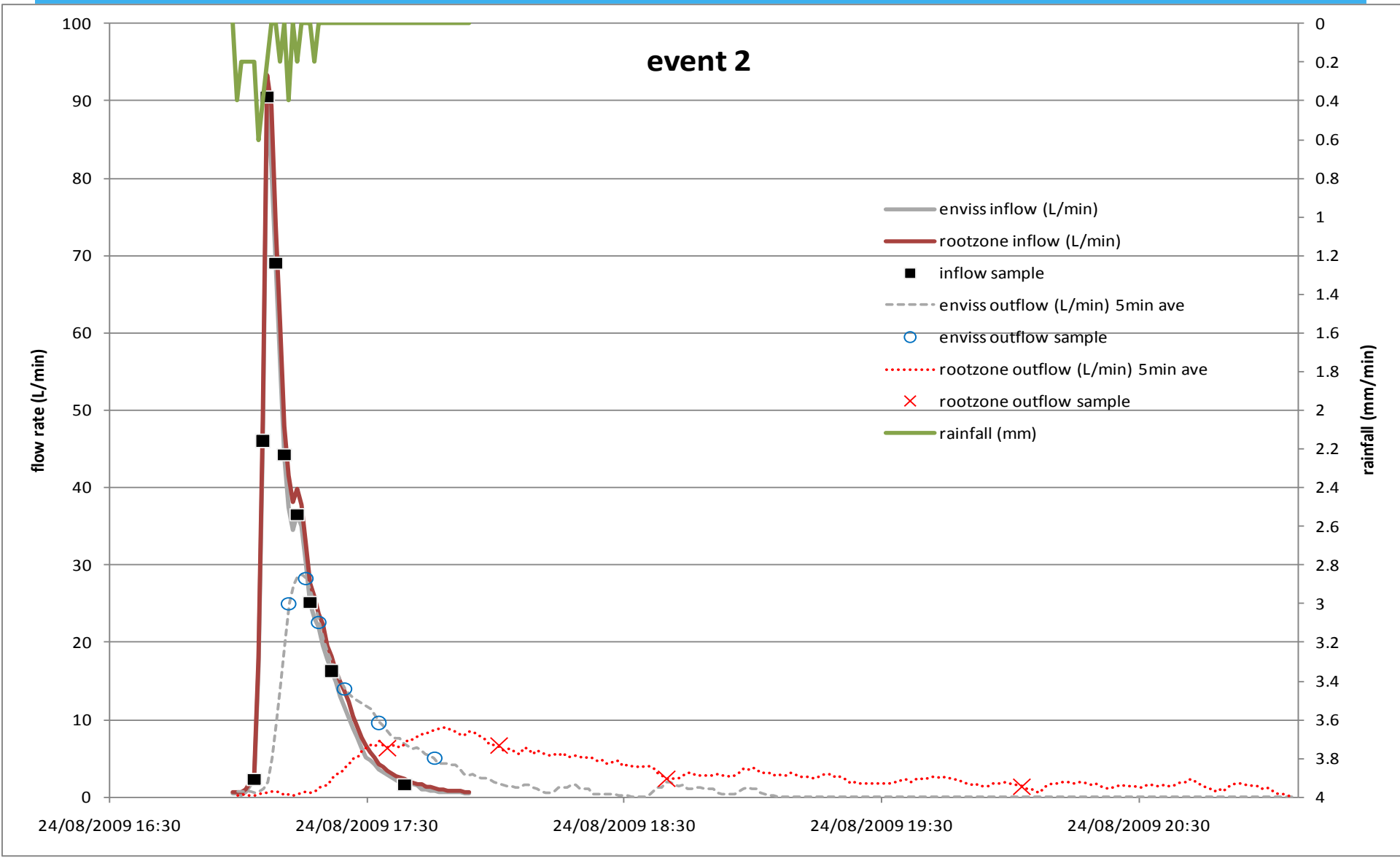
   - During 12 wet weather events, we sampled the inlet and outlet to each of the treatment systems – Event Mean Concentrations

   - On a fortnightly basis, samples were collected from the irrigation system (pond & tank effluent were sampled)

   - On a monthly basis, soil and vegetable samples (both leafy and root) were taken from the vegetable garden irrigated with stormwater

   - Less frequently, we also took soil and vegetable samples (both leafy and root) from the vegetable garden irrigated with mains water

Results. Road Runoff System



Results. **Road Runoff System**

* Treatment performance of the two treatment systems
  * In general, RootZone outperformed the enviss™ system for water quality treatment - % removal rates. Reasons…
    * RootZone was overdesigned, enviss™ designed OK
    * Filtration rate differences – enviss™ = >5 x Root Zone => contact time => different footprints
    * Pollutant levels were low => other than TP and TSS caused by mushy!

Results. Road Runoff System

- Treatment performance of the two treatment systems
  - Direct outflow concentrations from each system met guideline values
    - ADWG
      - Heavy metals - enviss™ ✓ RootZone ✓
      - *E. coli* - enviss™ ✗ RootZone ✗
    - Stormwater harvesting guidelines
      - Heavy metals (Fe) - enviss™ ✓ RootZone ✓
      - Nutrients (TP) - enviss™ ✓ RootZone ✓
      - *E. coli* (unrestricted & food crop) - enviss™ ✗ RootZone ✗
      - *E. coli* (restricted) - enviss™ ✓ RootZone ✓
    - Irrigation guidelines
      - Heavy metals - enviss™ ✓ RootZone ✓
      - Nutrients (TN & TP) - enviss™ ✓ RootZone ✓
      - *E. coli* (food crop) - enviss™ ✗ RootZone ✗
      - *E. coli* (other irrigation) - enviss™ ✓ RootZone ✓

Results. Road Runoff System

- Irrigation water quality
  - Second pass -> generally increased quality (not TN)
  - Nutrients – met all guidelines
  - Heavy metals – met all guidelines (ADWG, SWH, Irrigation)
  - Microorganisms
    - *E. coli* – 11 @ <1, 1 @ 4, 1 @ 10, 1 @ 15
      - 11/14 – met *E. coli* ADWG (ND)
      - 14/14 – met Irrigation guidelines
      - 13/14 – met Irrigation guidelines for irrigation of crops
      - 13/14 – SWH guidelines for U/R irrigation and irri of non food crops
      - 11/14 – SWH for indoor non-potable, food crops
    - *Salmonella* – 14/14 - ND

TP [mg/L P]	0.01
TN [mg/L N]	1
BOD5 [mg/L]	<2
Aluminium [mg/L]	0.56
Cadmium [mg/L]	<0.0002
Chromium [mg/L]	<0.001
Copper [mg/L]	0.006
Iron [mg/L]	<0.02
Lead [mg/L]	<0.001
Manganese [mg/L]	<0.001
Nickel [mg/L]	<0.001
Zinc [mg/L]	0.005
E. coli [MPN/100mL]	<1 [<1, 11]
C. perfringens [orgs/100mL]	<1 [<1, 8]
Somatic coliphages [pfu/100mL]	<2 [<2, 77]
Salmonella [Detect/ND]	ND

Results. Soil and vegetable quality

* **Soil quality** –
  * Soil from plots irrigated with mains water same as soil from plots irrigated with treated stormwater
  * Met all guideline values

	Stormwater	Mains water
Aluminium Dw [mg/kg]	5800	**6600**
Cadmium Dw [mg/kg]	**0.3**	0.2
Chromium Dw [mg/kg]	25	**26**
Copper Dw [mg/kg]	32	**40**
Iron Dw [mg/kg]	**14000**	13500
Lead Dw [mg/kg]	**42**	33
Manganese Dw [mg/kg]	300	**340**
Nickel Dw [mg/kg]	19	**20**
Zinc Dw [mg/kg]	145	145
E. coli [MPN/g]	**14**	5
Somatic coliphages [pfu/5g]	<1	<1
Salmonella [orgs/50g]	ND	ND

Results. Soil and vegetable quality

* **Leafy & root vegetable**
  * Leafy & root veggies from plots irrigated with mains water same as those from plots irrigated with treated stormwater
    * Transfer rates from soil from literature confirmed that these values can be due to soil/plant transfer
    * Unlikely to be atmospheric deposition => previous work

Leafy vegetables	Stormwater	Mains water
Aluminium Ww [mg/kg]	25	**32**
Cadmium Ww [mg/kg]	<0.02	**0.03**
Chromium Ww [mg/kg]	**0.13**	0.08
Copper Ww [mg/kg]	**0.93**	0.9
Iron Ww [mg/kg]	**32**	26
Lead Ww [mg/kg]	0.21	**0.25**
Manganese Ww [mg/kg]	**4.3**	2.2
Nickel Ww [mg/kg]	<0.1	**0.23**
Zinc Ww [mg/kg]	**9.6**	6.2
E. coli [MPN/g]	0.15	**0.36**
Somatic coliphages [pfu/5g]	**4**	<1
Salmonella [D/ND-25g]	ND	ND

Significant outcomes.

* **Roof water harvesting**
  * Site specific characteristics of the roof are very important, and can have a vast influence on pollutant levels in your tank – trees = possums…
  * Regular maintenance to ensure initial condition is maintained – trees grow…
  * enviss™ treatment system can help improve the quality of roof runoff, but not to drinking water levels

* **Stormwater harvesting** – & use for urban food production
  * Stormwater treatment using either RootZone or enviss™ systems can produce outflow concentrations which meet majority of guideline values
  * Stormwater harvesting system at Ceres produces irrigation water which meets all but a few microbiological guidelines – no *Salmonella* was detected
  * Using harvested stormwater did not significantly change the pollutant levels within the vegetables

Future work.

* Continue monitoring raw stormwater and treatment system performance
  * understand how these passive systems remove harmful pollutants -> understand processes
  * acknowledge that these systems do help remove harmful pollutants – need to provide credit to them -> validation of these systems

* Continue to monitor the heavy metal concentrations in vegetables irrigated with stormwater and mains water to validate these findings
  * Monitoring should continue at CERES
  * Laboratory work (specifically work will begin on using rain gardens for vegetable production)

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* Jo O'toole – initially for her help with selecting microbes to monitor

More information.

* Final reports:

Downloadable from

http://www.watersensitivecities.org.au/?page_id=2058

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