MOEEN GHOLAMI

GREEN WALLS: AN INNOVATIVE SOLUTION FOR TREATING GREYWATER IN AOTEAROA NEW ZEALAND

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GREYWATER GENERATION IN NZ

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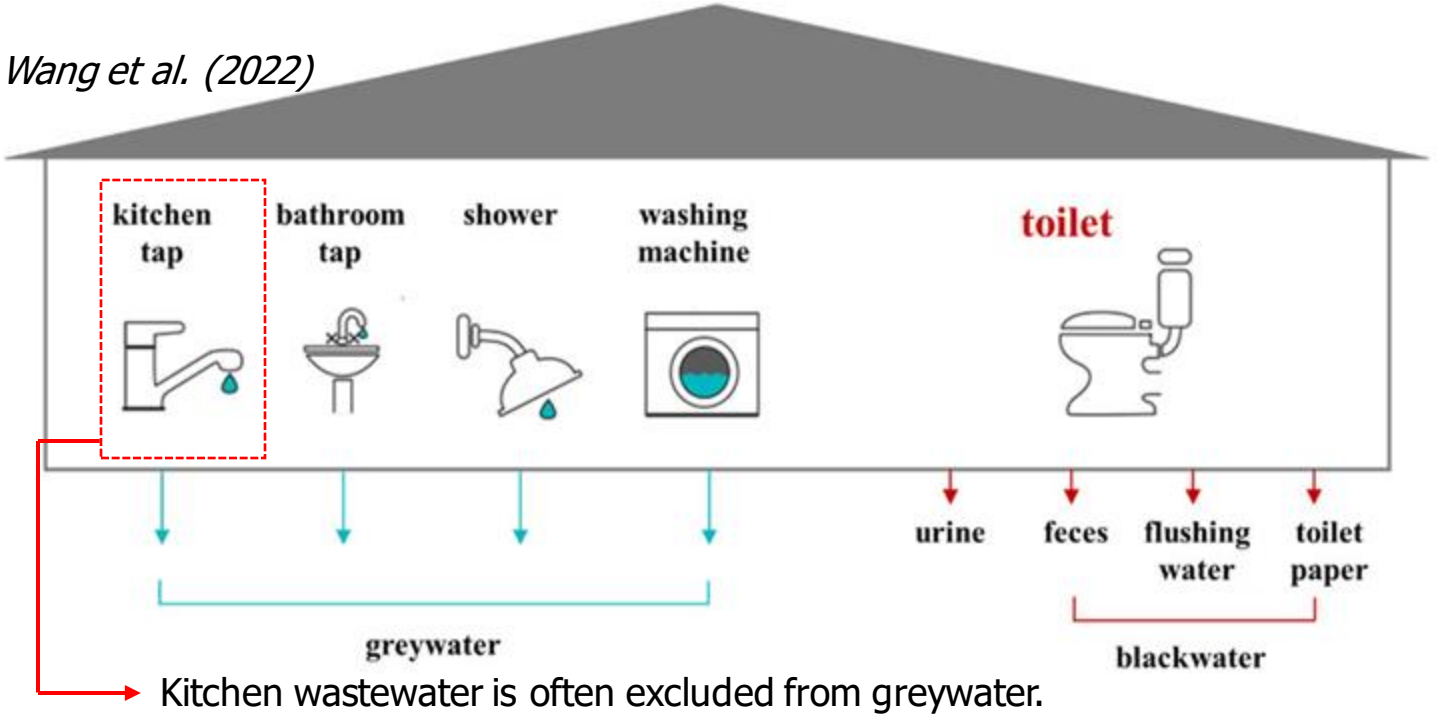
WHAT IS GREYWATER?

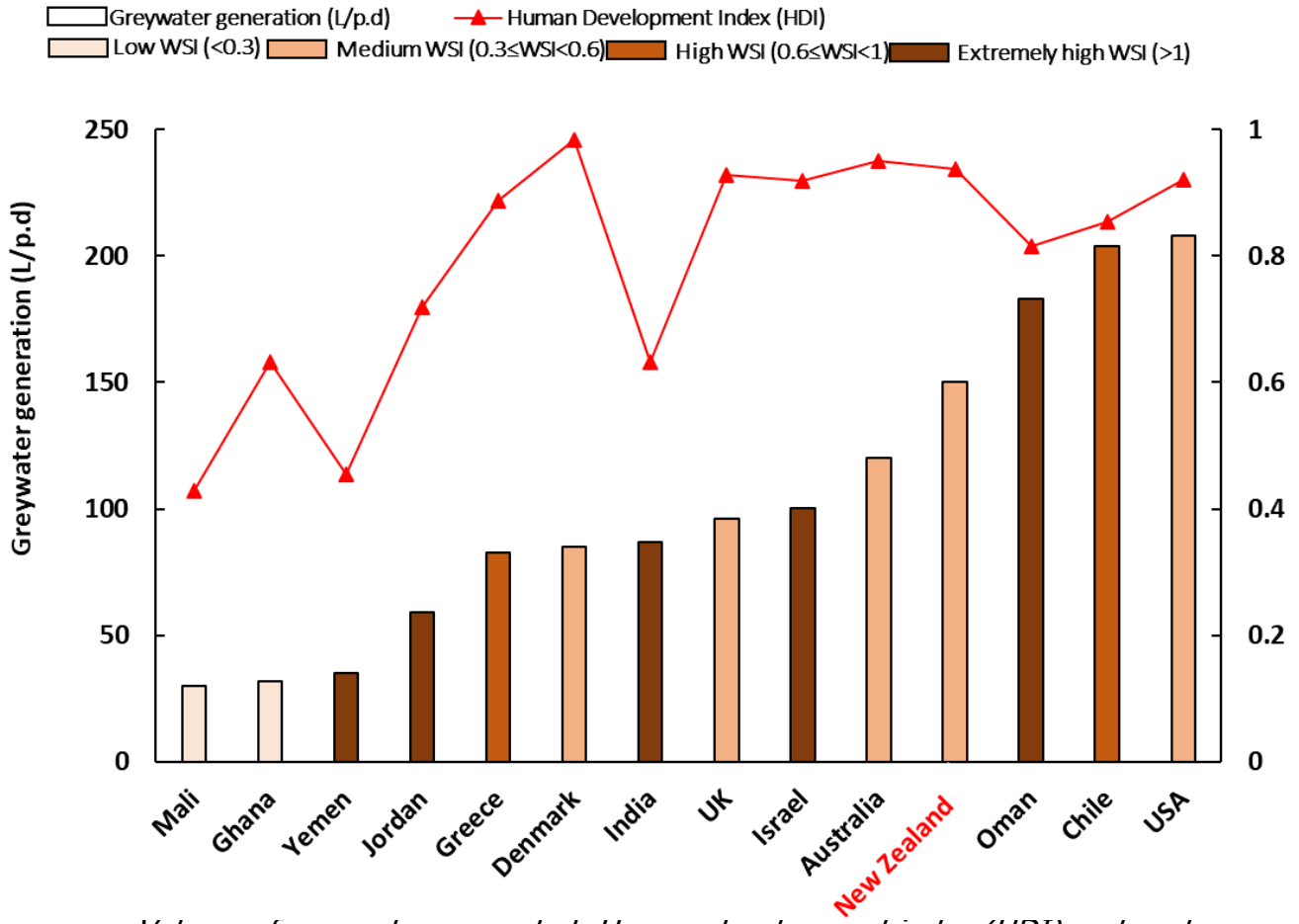
Wang et al. (2022)



- **Blackwater:** urine, toilet paper, and faecal (toilet) matter
- **Greywater:** soap, shampoo, toothpaste, shaving cream, laundry detergents, hair, lint, body oils, dirt, grease, fats, chemicals, etc.

- **Greywater** with low pathogen, nutrient and organic substances is favorable for **decentralized treatment systems**.

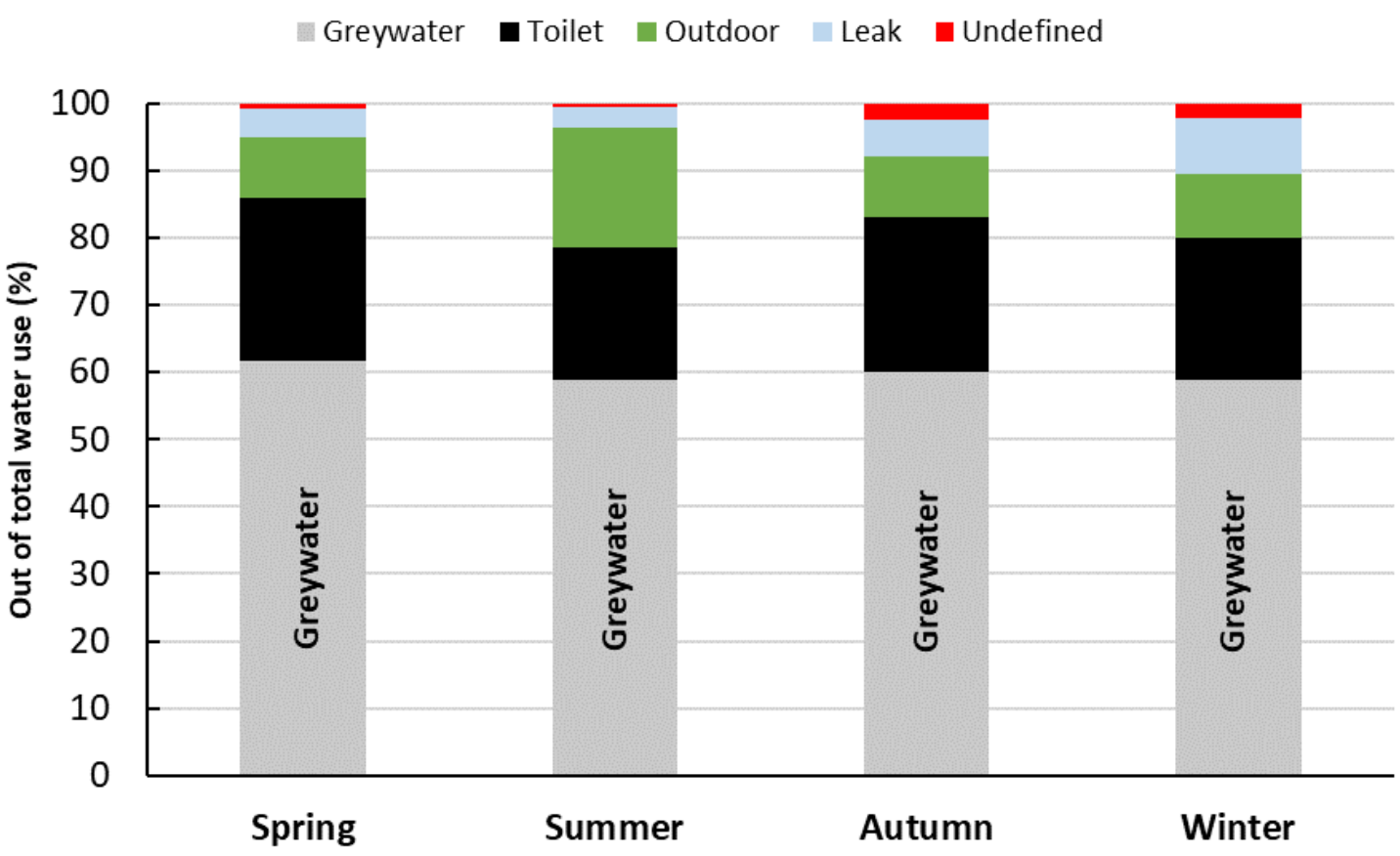
VOLUME OF GREYWATER GENERATED IN NZ

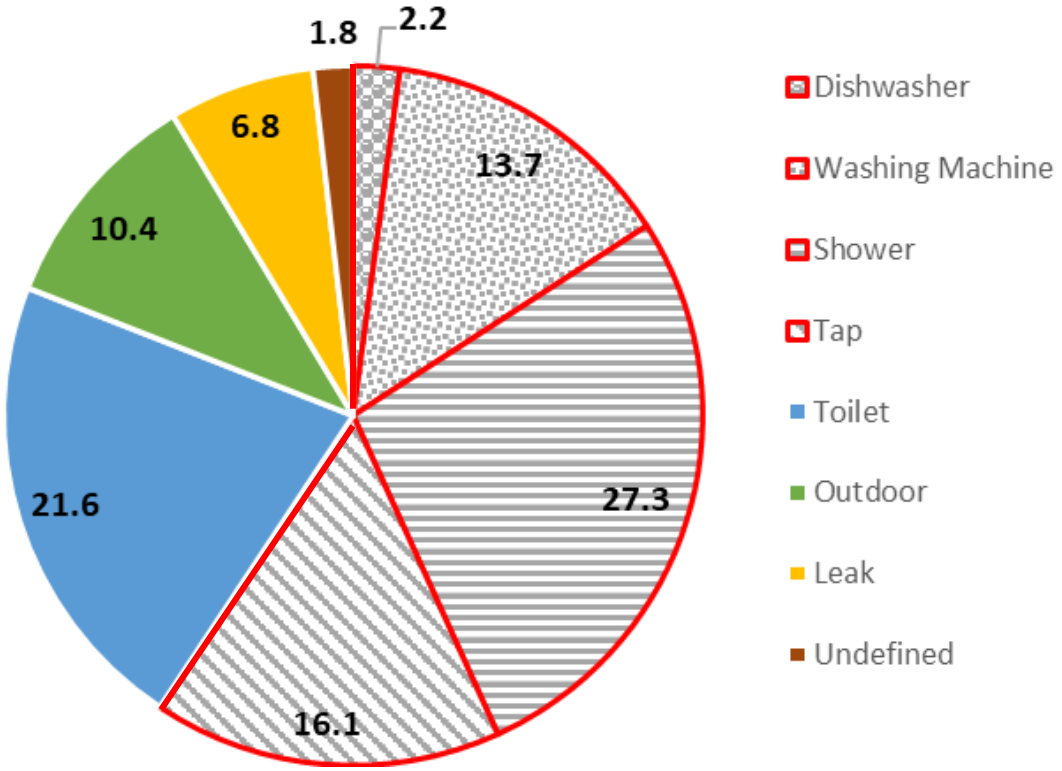


Volume of greywater generated, Human development index (HDI) and, water stress index (WSI) in different countries

The greywater generation in New Zealand is approximately 150 L/P/d

GREYWATER GENERATION IN NZ





Greywater generation in New Zealand (Whittaker et al. 2022)

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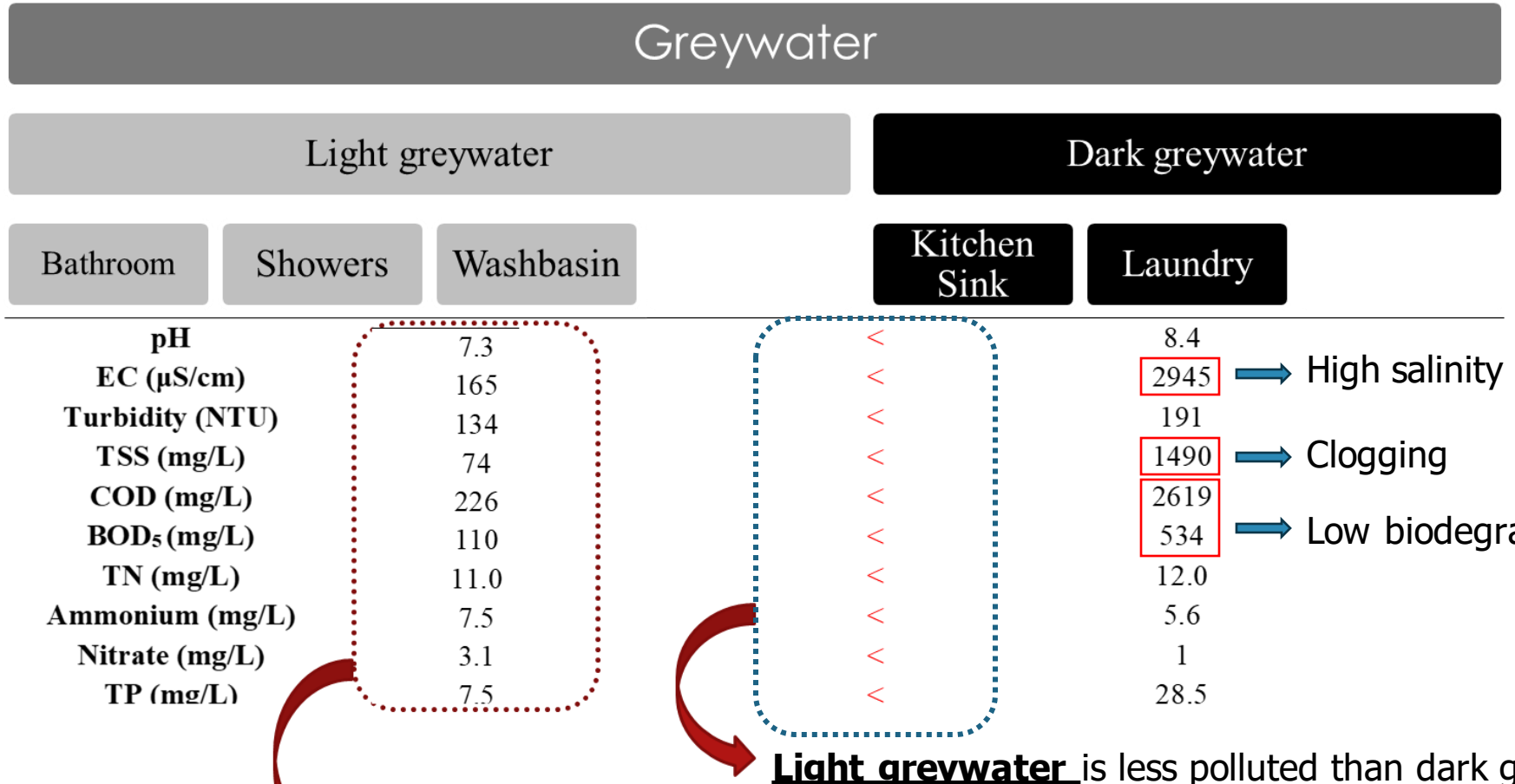
GW CHARACTERIZATION



	Light greywater			Dark greywater		
pH	7.3			8.4		
EC (µS/cm)	165			2945	→	High salinity
Turbidity (NTU)	134			191		
TSS (mg/L)	74			1490	→	Clogging
COD (mg/L)	226			2619		
BOD_5 (mg/L)	110			534	→	Low biodegradability (BOD5/COD <0.5)
TN (mg/L)	11.0			12.0		
Ammonium (mg/L)	7.5			5.6		
Nitrate (mg/L)	3.1			1		
TP (mg/L)	7.5			28.5		

Light greywater is less polluted than dark greywater.

Light greywater is suitable for irrigating green walls**.**

GREYWATER REUSE IN NZ

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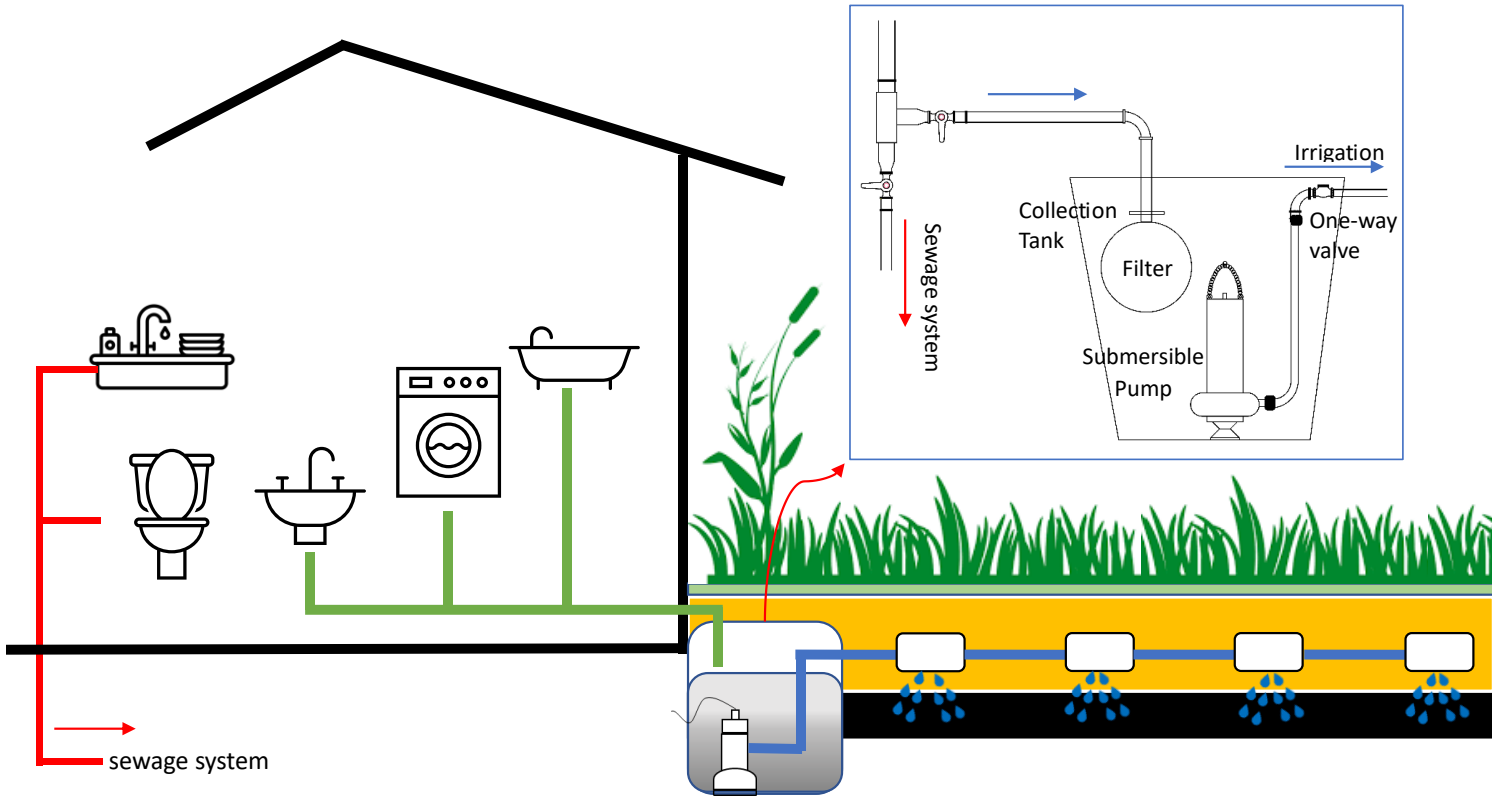
GREYWATER REUSE IN NZ

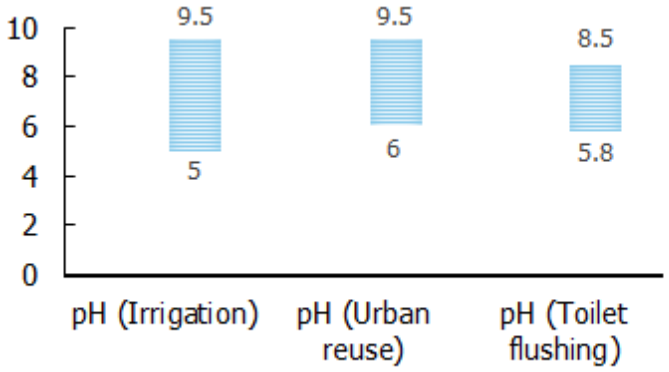
Nationally, a few local bodies are embracing water reuse:

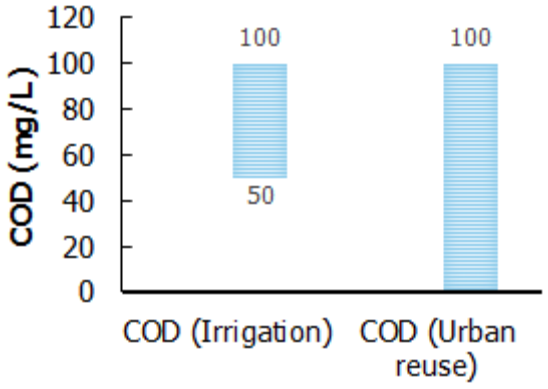
- Kāpiti Coast
- Auckland

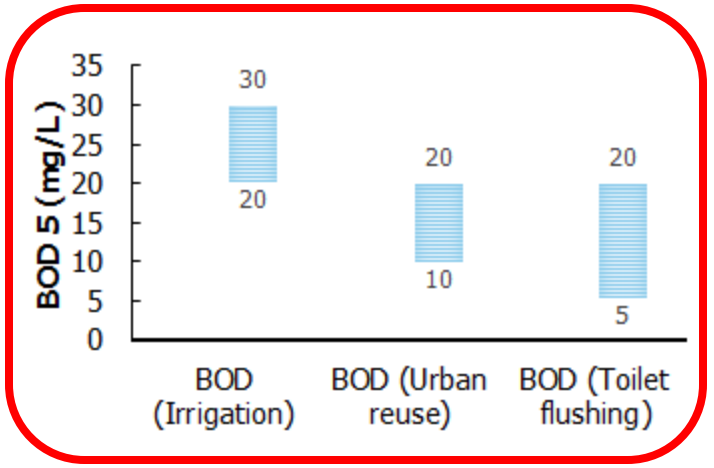


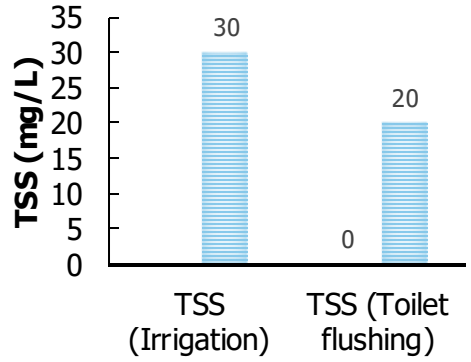
A schematic of greywater reuse for irrigation in Kāpiti Coast

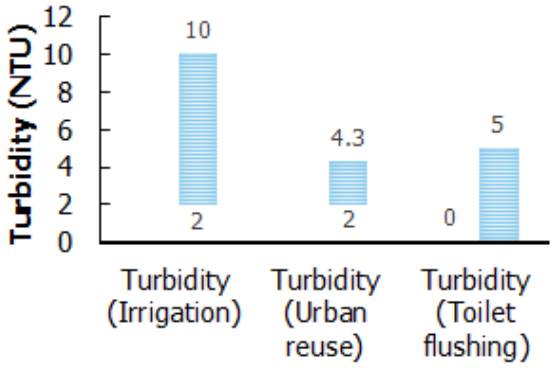
GREYWATER REUSE STANDARDS IN WORLD

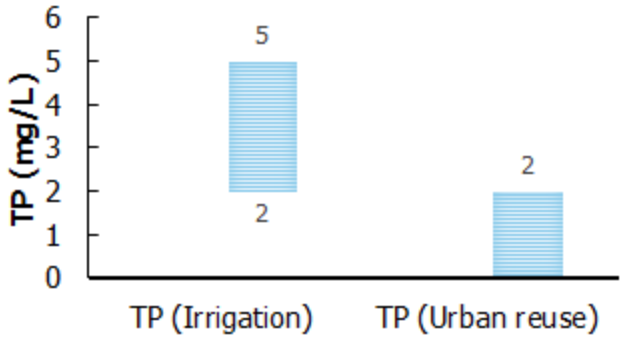


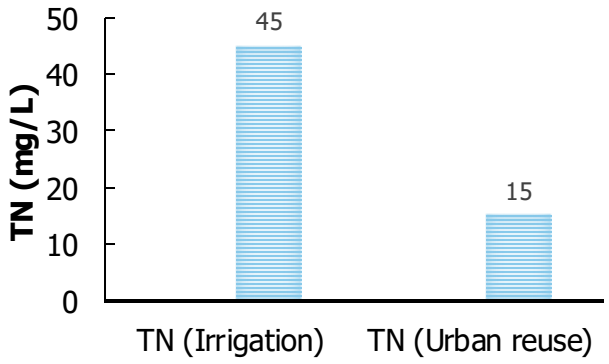


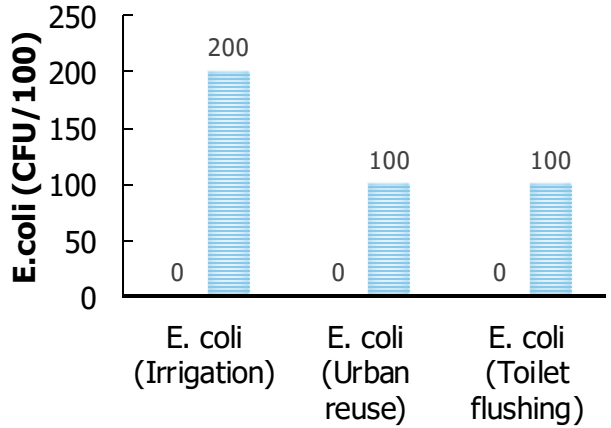




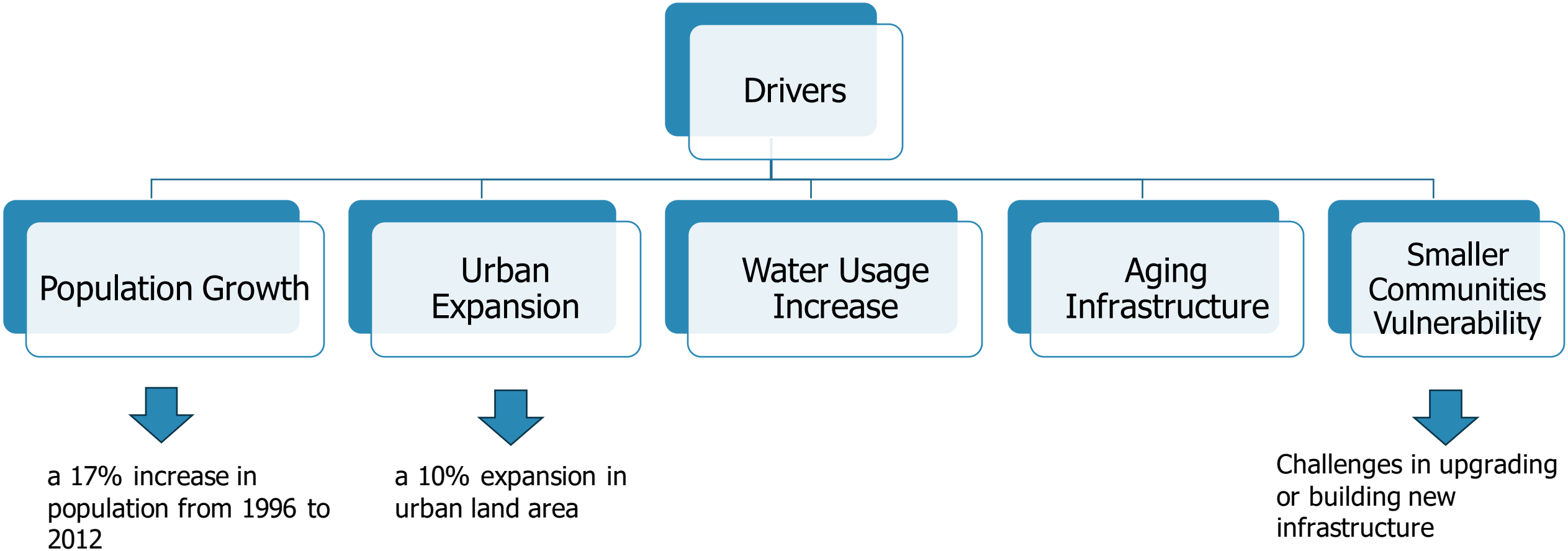








IMPORTANCE OF GREYWATER REUSE IN NZ



GREEN WALLS AS NUTRAL BASED SOLUTION FOR GREYWATER TREATMENT

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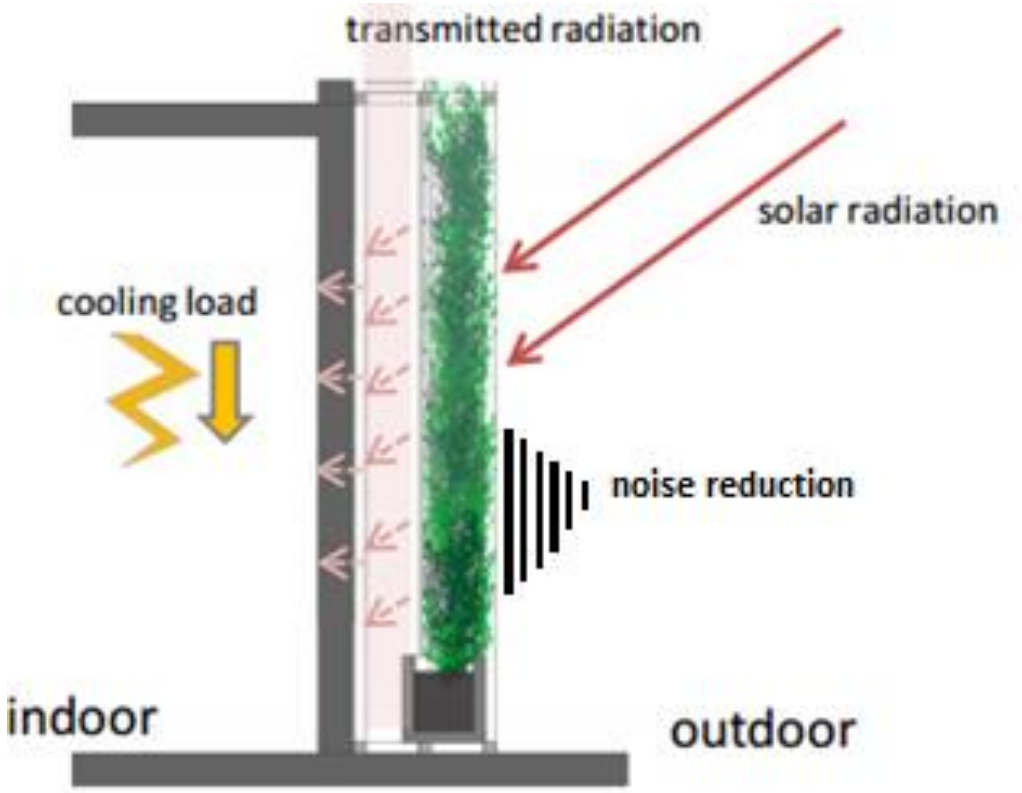
GREEN WALLS

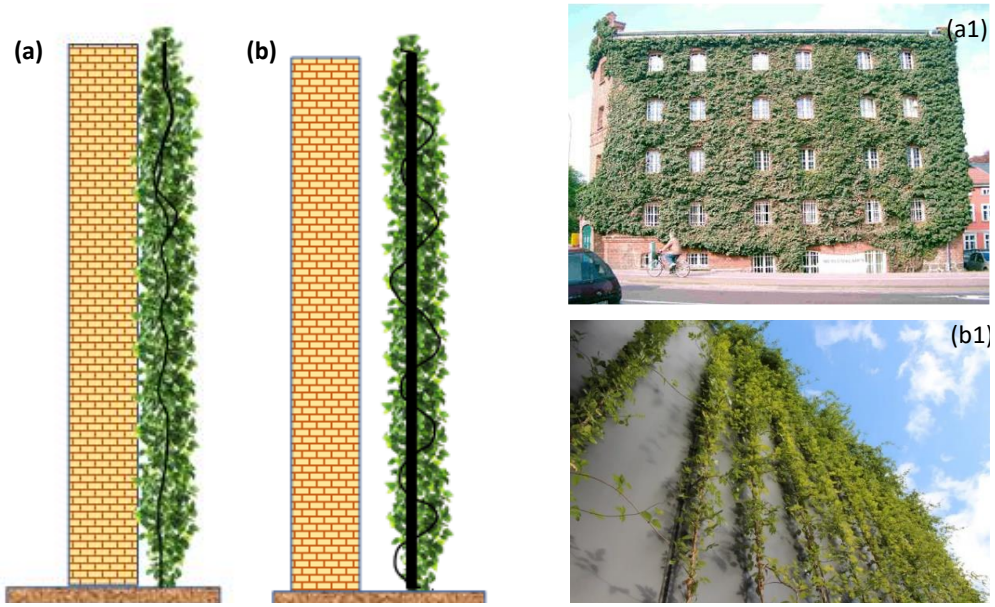
Green walls advantages:

- Aesthetic Enhancement
- Water Conservation
- Nutrient Recycling
- Noise Reduction
- Thermal Insulation
- Improved Air Quality
- Educational Tool



GREEN WALLS TYPES

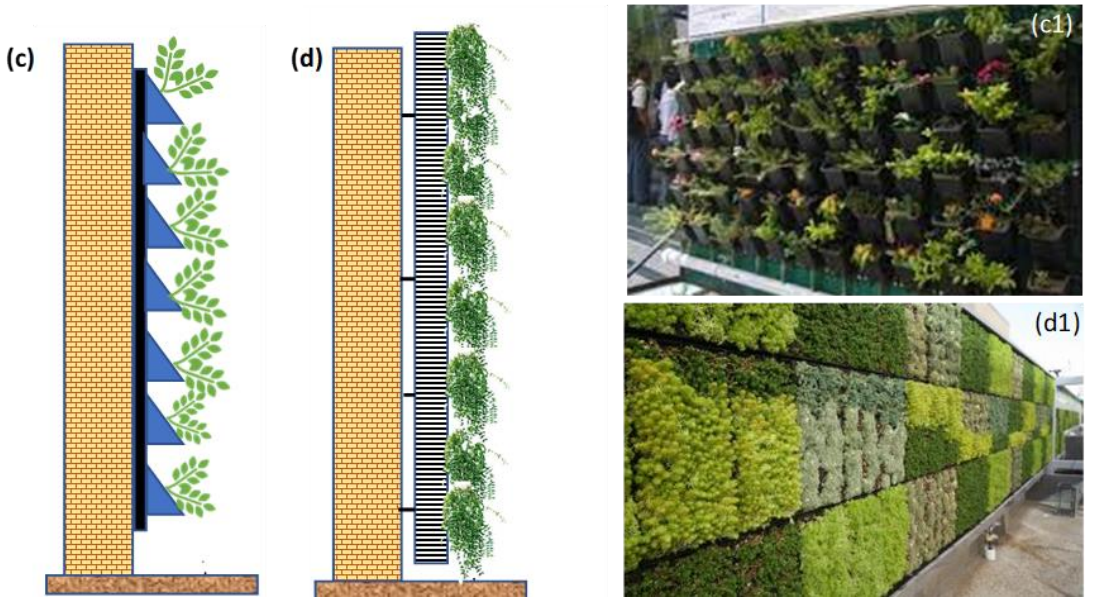
Green Façades



(a) Direct green façade (DGF)

(b) Indirect green façade (IGF)

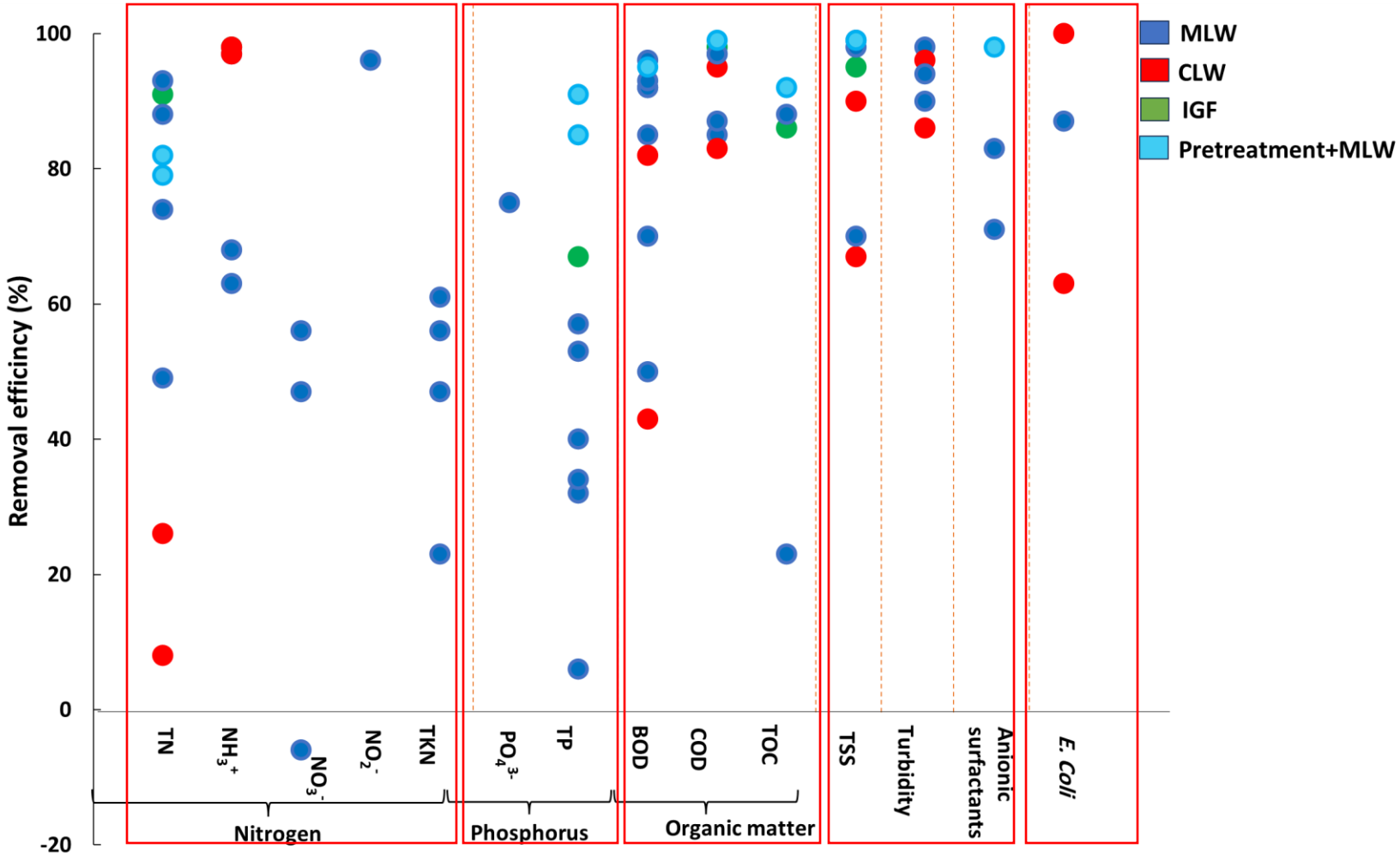
Living walls



(c) Modular living wall (MLW)

(d) Continuous living wall (CLW)

GREYWATER TREATMENT IN GREEN WALLS



GREEN WALLS FEATURES, OPERATING PARAMETERS, AND COSTS

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SUBSTRATE SELECTION

Crucial factors

- Lightness (BD: 0.6-1.2 (g/cm3))
- Particle size (< 0.5 mm)
- Surface area (BET > 1 m2/g)
- pH (6-8.5)
- Air filled porosity (AFP > 10%)
- Organic matter (10-20%)
- Water holding capacity (WHC: 35-65%)
- Porosity (> 75%)
- EC (> 3.5 µs/cm)

PLANT SELECTION

Crucial factors

- Robust capacity for nutrient removal
- Resilience to temperature and wind fluctuations
- Thrive in environments with elevated organic and nutrient concentrations
- Extensive root system
- Aesthetic appeal (evergreen, colourful)
- Lightness
- Low maintenance and longevity

Carex appressa

Cana lilies

Vitis vinifera

Pandorea jasminoides

OPERATING PARAMETERS

Hydraulic loading rate	• 50 to 60 mm/d.
Pollutant loading rate	• Species have different tolerance thresholds to higher nutrient loading rates.
Temperature and seasonal changes	• Cold temperatures hinder nutrient uptake rates and microbial activity.

GREEN WALL BIOFILTER DESIGN

Shape of biofilter effects

- Water distribution
- Vegetation support
- Resilience to plant-withering during extreme weather or low flow conditions

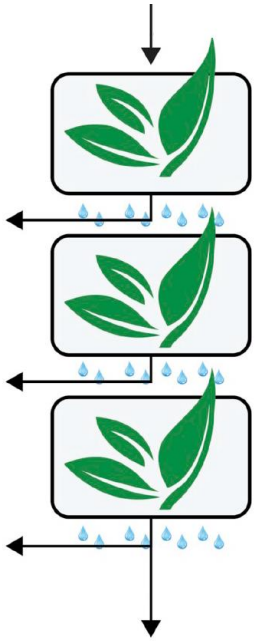
Biofilter size and depth effects

- Contact time with treatment agents and pollutants

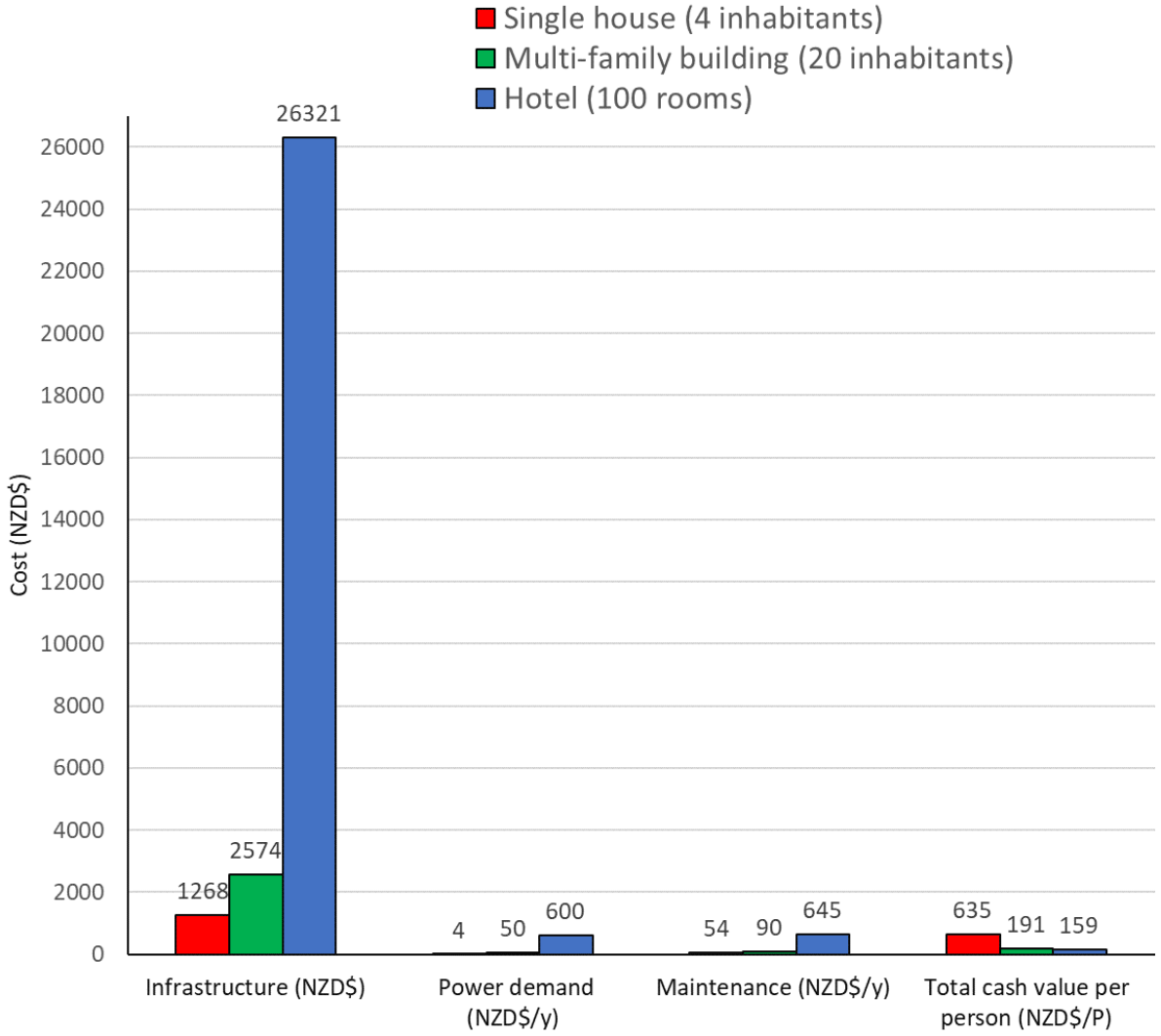
Use of excessive units

- Cost escalation
- Undesired colour in the effluent
- Poor growth of plants

Difference in development of N. obliterata across different levels of the green wall (Prodanovic 2019)



COST ESTIMATION OF GREEN WALLS



Vertical flow constructed wetland total costs (Kotsia et al. 2020)

- Standard green wall systems range from $NZD 640 to 2195 per square meter

Payback period (for toilet flushing):

- Hotels: 2.5 y
- Multifamily buildings: 4.7 y
- Single houses: 16.6 y

GREEN WALLS APPLICATION OPPORTUNITIES

Opportunities:

- Government Subsidies and Incentives
- Water Conservation Credits
- Urban Greening Initiatives
- Wastewater Reduction Targets
- Wastewater Treatment Integration
- Property Value Enhancement
- Public Awareness and Education Campaigns
- Research and Innovation Grants
- Water Recycling Programs
- Enhanced Building Sustainability Ratings

Thanks

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