IslandWater TECHNOLOGIES

Assessment of Wastewater Infrastructure and Go-forward Options for the Town of Canaries, St. Lucia

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Presentation Overview

1: Introductions – What is IWT

2: Energy-water nexus

3: Renewables and Decentralized wastewater treatment – advantages and disadvantages

4: Canaries – Consultancy Case Study

5: Canaries – Wastewater Infrastructure

6: Canaries – Decentralized Solutions

7: Summary

1: Introductions

What is Island Water Technologies

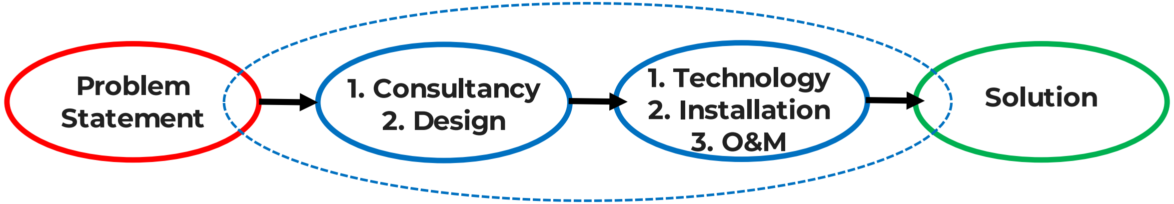
- **Founded with the goal of developing enabling technologies - self-powered, “smart”, self-operating wastewater treatment.**
- **Two year window of innovation – developed 3 products**
- **Consultancy services on diverse environmental and technical projects**

- **http://islandwatertech.com/about/**

ClearPod

REGEN™
Renewably Powered
Wastewater Treatment

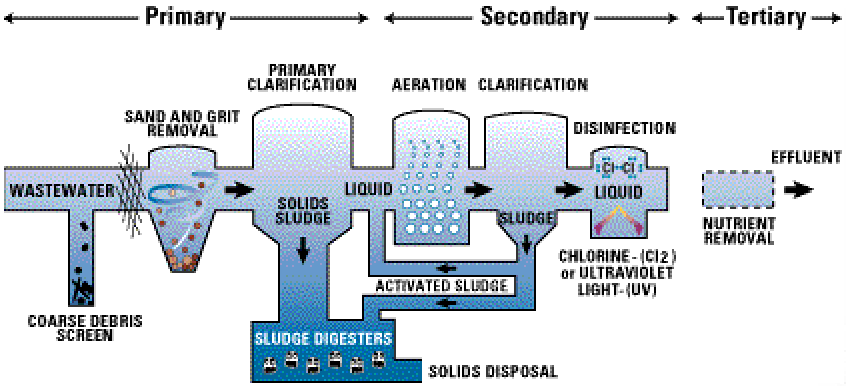
SENTRY-AD™



2: Energy-water nexus

3 – 4% of US electricity is spent on treating and transporting water and wastewater
86.4 million metric tons of CO_2

~ 80% of this is spent on transporting water



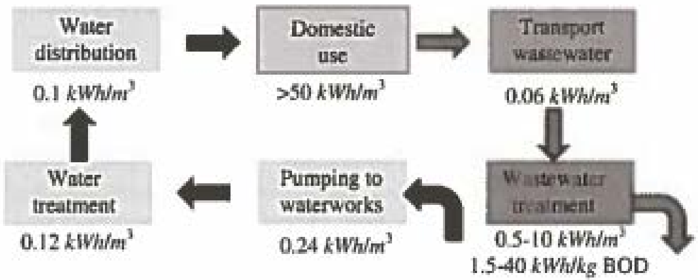
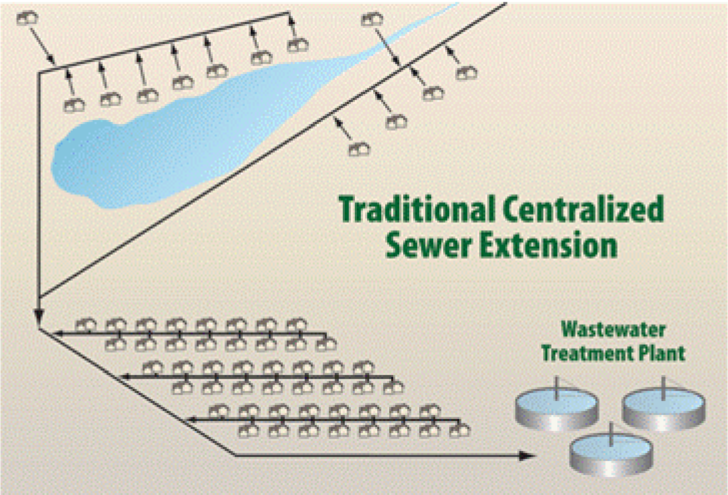


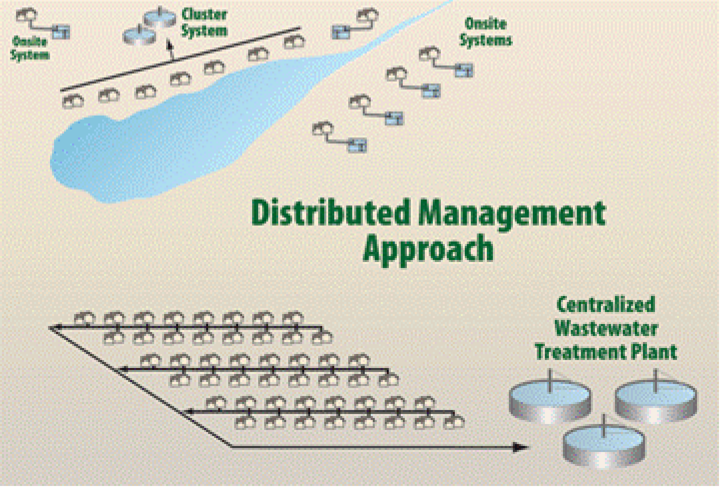
Figure 15.1 The urban water cycle and its energy footprint. *Source*: Swedish data from Lingsten *et al.* (2008).

Decentralized solutions hold inherent advantages over centralized

Saving costs / energy / infrastructure associated with moving waste water

3: Decentralized wastewater treatment





<u>Costing Components $$$$$</u>

<u>CapEx (Piping, wastewater treatment plant)</u>

<u>OpEx (Maintenance of installed infrastructure, energy)</u>

<u>CASE STUDY: Ontario Municipal Benchmarking Initiative (2013)</u>

Operating annual costs for collection of wastewater **<u>$10,013.50/ km</u>**

Total annual costs for collection of wastewater **<u>$17,435.04/ km</u>**

3: Decentralized wastewater treatment

CENTRALIZED

- High capital cost
- Energy cost associated with moving water
- Long, disruptive construction
- Highly trained operator needed
- Potential for catastrophic failure
- Lack of population awareness

DECENTRALIZED

- Lower capital costs?
- Low / no energy cost for moving water
- Short, less-disruptive construction
- Basic operation skills required
- Failure consequences felt in smaller area
- Local / homeowner awareness

3: Decentralized wastewater treatment

Benefits – Suitable application

- **Correct technology for the application:** Technology can be targeted to treat the specific WW to required local disposal levels
- **Utilize local resources:** Disposal using local soil complex, ocean, or surface water. Keeps water inside local ecosystem (no cross watershed transport)
- **Stimulate community economic growth, community independence, community choice (complexity, effluent quality, operator requirements, etc.):** Decisions made at the community level, can custom fit appropriate complexity with required performance
- **Easier to implement cutting edge and green technologies:** Lower risk, technologies implemented at appropriate scale, easier market entrance

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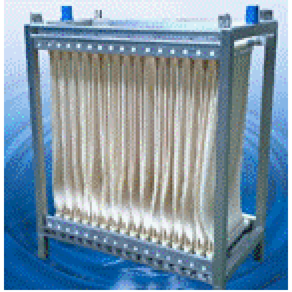
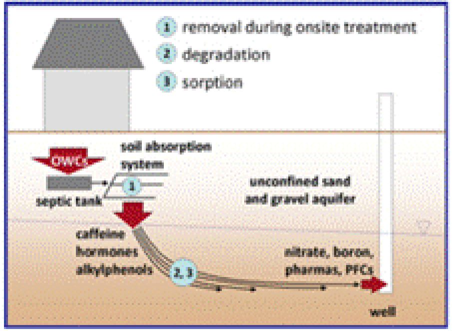
3: Decentralized wastewater treatment | Current Disadvantages

Decentralized WW treatment can pose advantageous over centralized solutions but standard technology is inadequate!!



Decentralized Disadvantages:

- **Higher energy** (technology dependent, economy of scale)
  - Examples: over aeration due to limited process control
  - Lack of aeration optimization (SOTE)
  - VFDs not really an option with small sized equipment
  - Design for worst day, as no daily operator



- **Variable effluent standards**

- **Legacy of poor performance** (technology dependent)
  - Mainly due to lack of proper maintenance/ care

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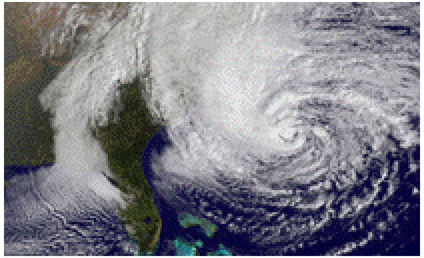
4: Solar powered decentralized wastewater treatment

Benefits – Cost and Reliability



- **Infrastructure resiliency:** Grid independence allows wastewater to be treated during grid outages/ fluctuations

Hurricane Sandy, 2012 - 11 billion gallons of untreated and partially treated sewage flowed into rivers, bays, canals. New Jersey wastewater treatment plant was pumping millions of gallons of untreated wastewater into the Newark Bay, because the plant had insufficient power to pump out tunnels inundated during the storm.

- **Lower capital costs:** Reduced requirement for electrical distribution system, no additional transformers / grid connections

- **Reduced GHG emissions:** Savings of 3 – 4% of electrical requirements (80% on transport)

4: Solar powered decentralized wastewater treatment

SUMMARY

Distributed management approach to wastewater treatment, that incorporates decentralized solutions results in reduced risk and significant economic and environmental benefits. Technology limitations have hindered adoption.

Self-powered, decentralized wastewater treatment solutions have the potential to drastically reduce energy utilization and costs (> 80%) associated with traditional centralized wastewater treatment

Next generation technology solutions should have the following features

- Low complexity
- Modular
- Low-energy
- High performance

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4: Canaries , St. Lucia - Case Study

CIF
CANARIES COMMUNITY IMPROVEMENT FOUNDATION
Working towards the sustainable development of Canaries

Canaries is located in a steep sided river valley on the West Coast of St. Lucia.

The existing wastewater infrastructure is inadequate.

Community interest in reducing health risk and improving tourism.

Open defecation and untreated wastewater discharged to open gutters – negatively impact tourism potential, pose significant health risks to the local population.

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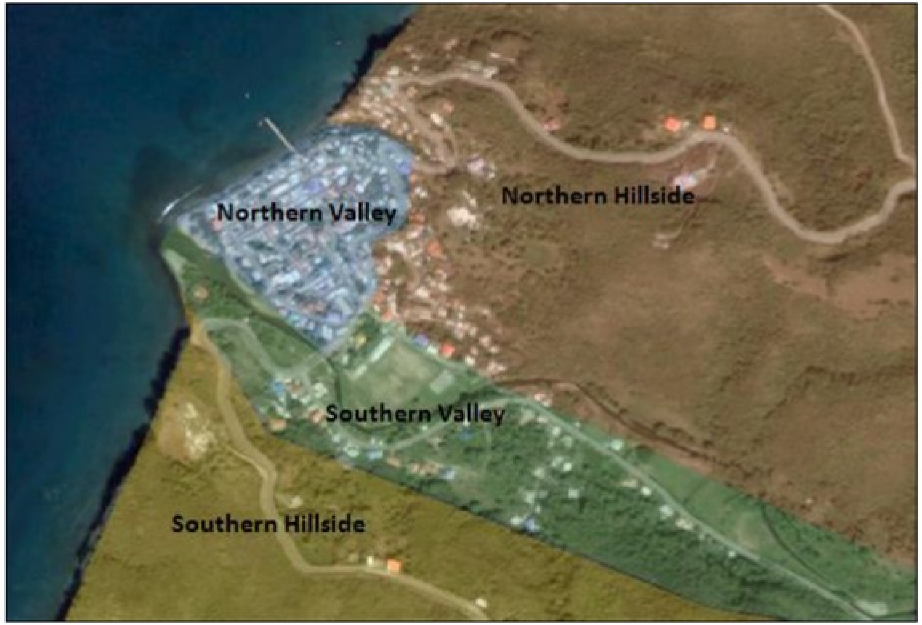
A go-forward strategy incorporating low-complexity, cost effective solutions for improved wastewater management have been suggested, that would drastically reduce the risk associated with fecal borne illness and allow for improved tourism based activities.

4.1: Problem Statement

The community of Canaries is located in a steep sided river valley on the west coast of St. Lucia, between Soufriere and Castries.

- The population is estimated at 2,044
- 780 households
- The community can be divided into 4 sections
- The Canaries River runs through the valley floor beside the village and discharges into Canaries Bay.
- A large concentration of the population resides within the northern valley (city center)



Canaries Community Improvement Foundation (CCIF)

A local community based organisation, the Canaries Community Improvement Foundation (CCIF) are currently working on a Ridge to Reef project.

Slope Stabilization:

Sewage Treatment:

Coral Nursery:

Small Business and Entrepreneurship Development:

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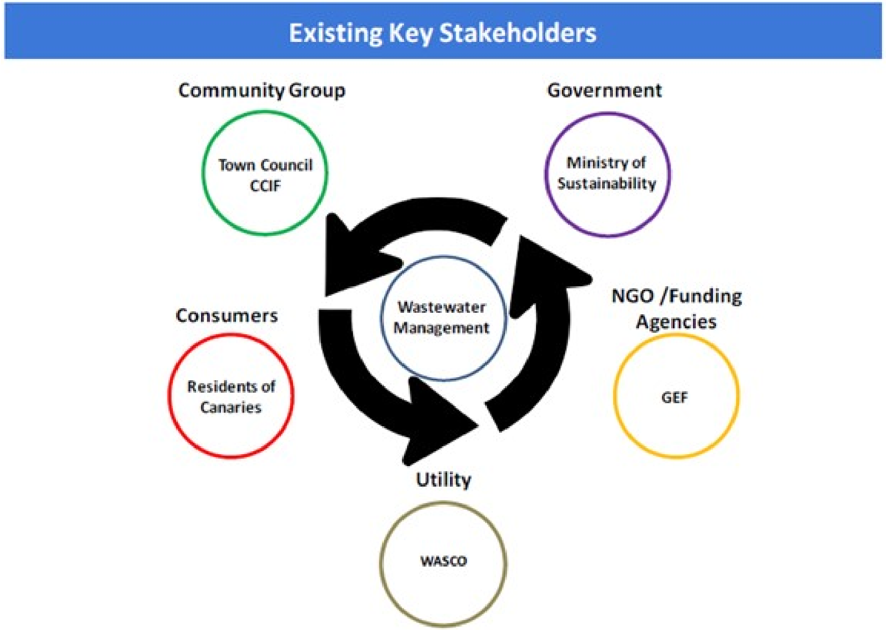
Working towards the sustainable development of Canaries

4.1: Problem Statement



Additional Environmental Concerns for Canaries

Climate Change

IWT used the online risk assessment and climate resilience decision tool, Caribbean Community Climate Change Centre (CCORAL).

Sediment Transfer

Additional environmental issues for Canaries include drinking water storage, flooding, and erosion. During a 2010 hurricane (Tomas) St. Lucia sustained an estimated $336.15 million USD worth of damage

Extensive flooding deposited large amounts of sand and silt into the riverbed (8-10 ft), as well as in the northern valley community. The riverbed is now at an equal height as many of the streets, causing frequent flooding

4.2: Objectives

- Review wastewater infrastructure and management practices in the village of Canaries.
- Suggest low-complexity, short-term and long-term solutions for reducing wastewater contamination in the village of Canaries.

5: Infrastructure Assessment

1: Understand the wastewater issues in Canaries

2: Record previous steps that had been taken

3: Outreach with key stakeholders; Local residents, CCIF, UNEP, WASCO, CCCCC, Ministry of Sustainable Development, Tourism Association etc.

4: Site visits to Canaries were performed by IWT

5: Tasks included locating, sizing, estimating flowrates and concentrations of existing wastewater, and wastewater infrastructure.

Several sources of pollution contribute to the poor water quality in Canaries Bay

- Primarily untreated domestic wastewater - discharged straight into the bay through storm drain network and open defecation on the beach
- Other sources include greywater and organic waste discharged to storm drains, phosphate detergents from washing laundry and cutlery, bathing in the river, and up-stream sedimentation from the river.
- Houses located above the ravine have either septic tanks with soakaways or directly drain into the ravine. The ravine is also used to dispose of garbage and drains directly to the bay

5: Infrastructure Assessment

Washroom #1 is on the oceanfront and is commonly flooded.

The primary school had a new septic tank installed within the last 2 years. It has not been pumped to date. It appears to discharge into the open gutters.

The secondary school is pumped every 2-3 years and is reported to have a soak-away which was not visible.

5: Infrastructure Assessment

Table 2: List of public holding/septic tanks in Canaries and estimated volume

	Estimated Volume (Liters)	Location
1st Washroom	36,000	Near shore in floodplain
2nd Washroom	15,000	Next to infant school
3rd Washroom	15,000	Up hill, near Floravilla
Secondary School Tank	16,000	Secondary School
Primary School Tank	16,000	Primary School
Old Church	4,900	Old Church
Health Center Tank 1	7,500	Health Center #1
Health Center Tank 2	7,500	Health Center #2
New Church	4,900	New Church
Total Public Use Tankage	66,000	
Estimated Max Available Tankage	123,000	

- 315 houses (15% were assumed to be abandoned or for commercial use).
- 2.6 people per house this equates to just under 700 people.
- Estimated total of total wastewater flowrate os 66,000 liters per day.

5: Infrastructure Assessment

- Public washrooms have a **<u>low capacity for the population</u>**
- **<u>Infrequent pumping</u>** of holding tanks, with solids clogging
- Washrooms are used by a large percentage of the population
- When full, residents resort back to **<u>using the beach area</u>**
- The tanks are not pumped frequently enough, this causes the tanks to be at **<u>capacity for a large percentage of the time</u>**
- Pumping of tanks is considered too expensive, and is not monitored
- During rain events, the effluent from certain washrooms overflows and drains to the ocean

The ravine is an area where garbage is dumped and eventually moves downstream and makes its way to Canaries Bay

5: Local / Site Specific Considerations

Cost:
The capital cost of implementing wastewater infrastructure in the Canaries typically relies upon grants and third party funding.

Lack of Local Expertise / Remote location
The local population does not have the training to maintain a treatment facility. WASCO believes it is too expensive for them to run any wastewater infrastructure day to day at this location.

Condensed Population and Infrastructure:
Canaries is located within a steep sided valley where most of the population is clustered. Houses are packed in, with no room for infrastructure improvements.

Energy Costs:
Residents in St. Lucia pay 0.34 $/kWh for power. Alternative sources of energy (solar powered solutions) will be considered to power or subsidize any energy costs. Low cost and low complexity technologies are also considered.

Standard of Living:
Most households within the valley do not have flushing toilets. There are no sewage lines installed in the community.

Flooding / Natural Disasters:
Flooding is a major issue in Canaries. Hurricane Tomas (2010) has changed the river bed which is now nearly level with many streets within the village. Part of the village regularly floods due to sustained rainfall events, and the geological location of the town.

4. Infrastructure Assessment Summary

The review of the wastewater infrastructure and management practices in the village of Canaries has identified the pathways for contamination of the river and bay.

The impact of contaminated water in the river and bay has been identified as a significant public health risk to the local community, as well as an ecological issue for the bay.

The public drinking water supply typically shuts down during storm events.

Of particular concern are the community residents in the northern valley region where a combination of regular flooding and open defecation or direct discharge of untreated wastewater could result in illness due to fecal borne contamination.

5: Potential Solutions

Goal:

Present short-term (immediate) solutions, including proper diligence, low-cost and easily implemented improvements, which are less reliant on a complete infrastructure and will incrementally assist with a more complete solution.

The short-term goals, given the proper funding, could be achieved in a 12-month period.

Followed by mid-term and long-term solutions that take a more complete view.

They would provide a long-term robust wastewater infrastructure. The longer term solutions could be implemented in a 1-5 year time period.

3: Objectives

1. Short-Term Solutions - Public Health Considerations, Increased Water Testing and Monitoring.

Public Health Awareness and Community Outreach:
Consistent Water Quality Testing/Monitoring: Canaries River Testing: Canaries Bay Testing:

Recommendation:
Recommends that water quality be assessed in the bay and river. Understand the pollutant load being transported to the bay, as well as allow the locals to understand its safe usage (fishing, swimming, etc.?). Sampling can be performed by local trained personnel.

Existing Infrastructure Auditing and Validation
Existing Holding Tank Testing, Modifications and Verification: Size/Year of Install: Pumping Frequency / Time to Fill: Liquid Discharge: Leak Detection:

Recommendation:
Recommends a complete audit of the existing wastewater infrastructure be performed, create a logging system that can translate to an appropriate estimation of usage/flowrate which can be subsequently used by decision makers to appropriately size and estimate the cost of new solutions going forward.

3: Objectives

1. Short-Term Solutions - Existing Infrastructure Preliminary Upgrades and Retrofit Considerations

- Reduced Flow Devices and Appliances:
- Extended Availability:
- Proper Operation and Maintenance of Existing Wastewater Tanks:
- Activating the Holding Tanks to Provide In-tank Treatment:

Recommendation:
Bathroom facilities hours be extended to 24-hour availability to help promote an environment to properly dispose of wastewater.
Reduced flow fixtures and appliances will be able to assist in a more complete situation (Public washrooms initially).
Adding drop-in treatment solutions to the tanks.

Properly operating and maintaining the existing wastewater tanks is the one of the few ways to greatly reduce the contaminant load into the bay.

The washroom facilities must be able to stay open and be pumped regularly to avoid this direct contamination. Additionally, alternative hauling companies should be investigated to try and see if a cheaper hauling company could be contracted for this work, or additional funding sources be secured.

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3: Objectives

2. Medium - Long-term solutions

- Storm-water Management
- Above Tank Decentralized, Packaged Treatment for Washroom Facilities
- Connection of the Holding Tanks to Form Centralized Wastewater Collection Network
- Review of Potential Centralized Wastewater Treatment Solutions

  Lagoon: Facultative Lagoons: Aerobic Lagoons: Extended Aeration Plant: Wetlands

- Disposal:

  Soak-aways, river, ocean discharge to bay, ocean discharge outside of bay

3: Decision Matrix and Implementation Pathway

Decision Matrix						
#	Options	Cost	Pollution Removal from Immediate Bay	Positive Effects on Human Health	Risk of Implementation	Prereqruisites
1	Water Quality Testing/Monitoring	minimum	medium	none	none	none
2	Existing Infrastructure Auditing and Upgrades	low	high	low	none	none
3	Activating Holding Tanks	low/medium	low/medium	low	minimum	2
4	Proper Operation and Maintenance of Existing Wastewater Tanks	medium	medium	medium	none	none
5	Stormwater Management Study	low	high	none	none	none
6	Stormwater Study Implementation	extreme	low	medium	low/medium	5
7	Above Tank Decentralized, Packaged Treatment	medium	medium	medium	low/medium	2
8	Connection of Holding tanks to Form Limited Collection Network	medium	low	none	low	2
9	Pumping Station Implementation	medium	low	none	low	6,8
10	Centralized Treatment Option	high/extreme	high	high	low	9
11	Discharge to River	low	low	low	high	10
12	Centralized Treatment and Discharge to Ocean	extreme	high	high	medium	10
13	Primary Treatment and Discharge to Ocean	extreme	medium	high	medium	8,9, additional solids separation capacity

Depending on available funding;

IWT recommends one of the following four cost options to provide **maximum health and environmental impact** with the available funds.

A: Minimal Cost: #1, #2, #4

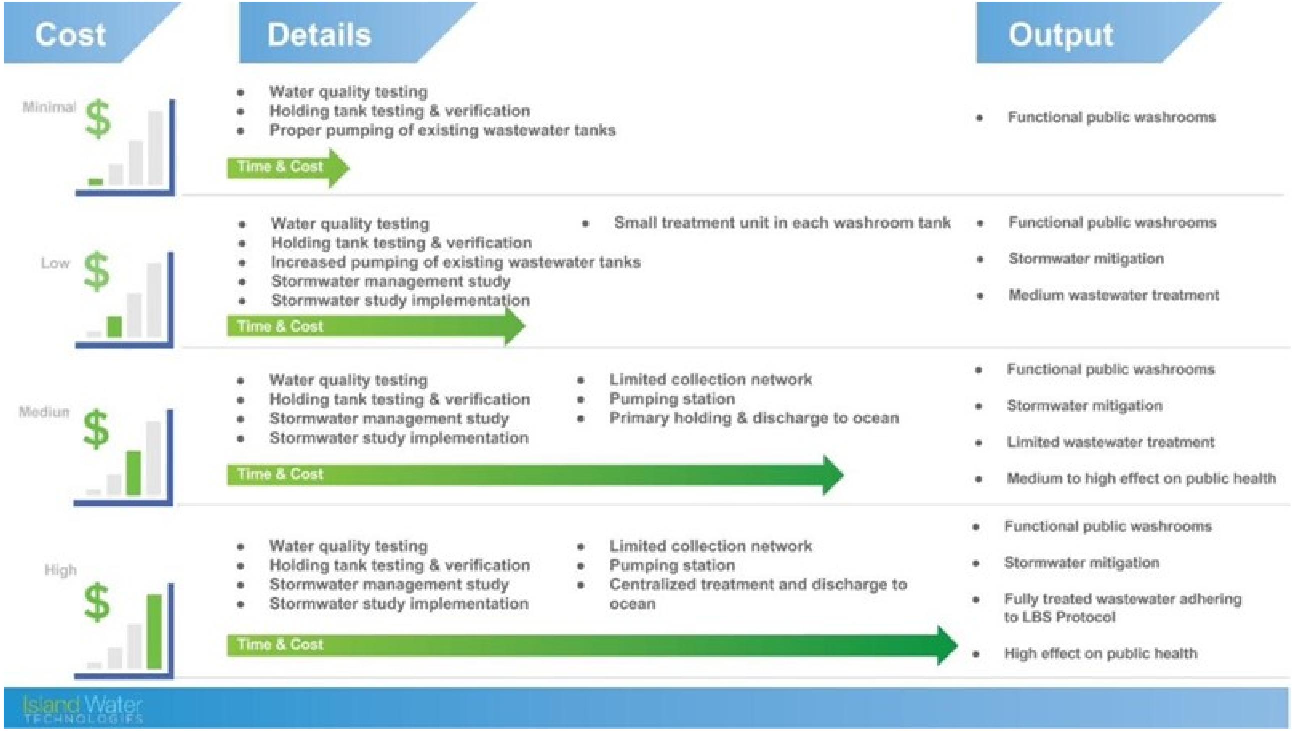
B: Low Cost: #1, #2, #3, #4 (50%) #5, #6

C: Medium Cost: #1, #2, #5, #6, #8, #9, #13

D: High Cost: #1, #2, #5, #6, #8, #9, #10, #12

3: Decision Matrix and Implementation Pathway

http://islandwatertech.com/wp-content/uploads/2016/07/Canaries-Wastewater-Report-2016.pdf



Acknowledgments

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- **James Crockett** (Community Consultant - CCIF)
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Thank you

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5: REGEN Commercial Applications

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Product Description	ClearPod	REGEN™ 20	REGEN™ 40	REGEN™ 20 plus+	REGEN™ 40 plus+
	Drop-in solution for enhanced on-site performance	Containerized, low-energy, packaged wastewater treatment plant.	Containerized, low-energy, packaged wastewater treatment plant.	Containerized, low-energy, packaged wastewater treatment plant.	Containerized, low-energy, packaged wastewater treatment plant.
Dimensions	18" x 18" x 34"	20' x 8' x 8'	40' x 8' x 8'	20' x 8' x 8'	40' x 8' x 8'
Flow Capacity (L/day)	1,250 (per unit)	12,500	25,000	37,500	75,000
Person Equivalent (PE)	4-6	50	100	150	300
Aeration Energy Usage (kWh/m3 wastewater)	0.5	0.5	0.5	0.5	0.5
Routine Operation and Manitenance Requirements	Annual 2-hr check up	Monthly 2-hr check up	Monthly 2-hr check up	Bi-weekly	Bi-weekly
Standard Effluent (BOD/TSS)	25/25	15/15	15/15	15/15	15/15

BCIP REGEN Video:
https://www.youtube.com/watch?v=1C-jGqb-6NQ

Other milestones in commercial solar powered wastewater treatment worldwide

- City of Auburn, WA, U.S. (2013) = Centralized WW plant = 100% solar powered, 680 kW PV
- Sydney, Australia = Centralized, floating solar

- Ventura County, California, US = 1.1 MW solar plant, 75% of electrical requirements
- City of Homer, Alaska = Solar powered aeration of lagoons

5: REGEN Technology development

REGEN Demonstration System		
Parameter	**Value**	**Unit**
Flow	1500-1800	GPD
PE	20-25	people
HRT	1.1-1.3	days
Aeration Energy	0.4-0.5	kWh/m3
BOD removal	85	%
TSS removal	80	%
Solar Panel Maximum Capacity	2.64	kW

Typical Effluent Standard = 15 mg/ L BOD / TSS