Evaluating Approaches To Decentralized Wastewater Treatment And Management For Diverse Coastal And Island Environments

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FINDINGS FROM THE PACIFIC WASTEWATER TECHNOLOGY RECOMMENDATIONS CONSULTANCY FOR THE NATURE CONSERVANCY

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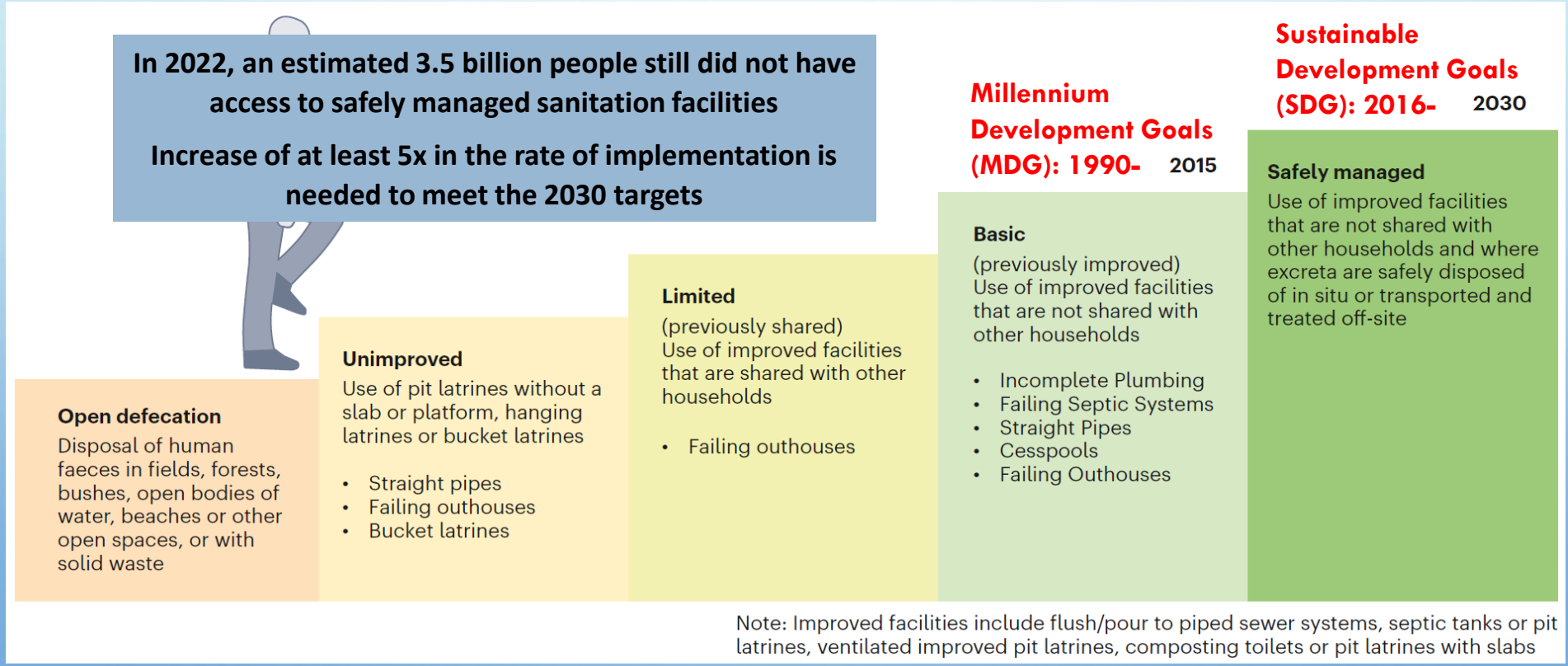
SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Joint Monitoring Programme (JMP) Service Ladder for Global Monitoring of Sanitation in Households



Maxcy-Brown, J., D. Capone, and M. A. Elliott. 2023. "Characterizing the nature and extent of access to unsafely managed sanitation in the United States." *Nat. Water*, 1 (11): 915–928. Nature Publishing Group. https://doi.org/10.1038/s44221-023-00157-7.

Existing Sanitation Guides

- Most lack specific guidance suited for pacific island countries and territories (PICTs)
  - Unique climate and geological conditions
  - High island, high rainfall settings and low, coral islands
  - Impacts on coastal and freshwater ecosystems
  - Diverse subsurface transport with very high and very low porosity
  - Unique supply chain contexts
  - Highly variant population densities across the islands
  - Highly vulnerable to the ongoing natural impacts (e.g. cyclones, droughts, earthquakes, tsunamis)
  - Increasing human impacts (e.g. Population changes, demands on natural resources, freshwater scarcity)

Study Objectives

Determine

key factors for effective decentralized wastewater treatment in PICTs

- for both ecosystem and public health protection
- for high island, high rainfall and low, coral island settings

Examine

case studies of successful technology and management practices applicable to PICTs

Propose

practical guidance for community-scale wastewater treatment projects

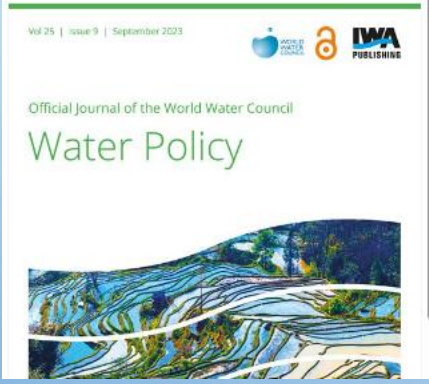
Estimated Number of Residents Relying on Each Sanitation Access Levels for U.S.-Associated Pacific Island Countries

Location	Data Year	Open Defecation	Unimproved	Limited	Basic	Safely Managed
Hawai'i	2022	0.1% (1,394)	0% (0)	0.0% (628)	17.8% (256,668)	82.0% (1,180,709)
American Samoa	2022	0% (0)	1.5% (678)	44.3% (19,623)	17.2% (7,593)	37.0% (16,378)
Guam	2022	0% (0)	0.8% (1,377)	8.8% (15,153)	90.4% (155,243)*	
Northern Mariana Islands	2022	0.2% (79)	0.4% (203)	19.1% (9,466)	80.3% (39.803)*	
Federated States of Micronesia	2020	0% (0)	9.5% (10,702)	0% (0)	90.5% (101,404)*	
Republic of the Marshall Islands	2022	8.7% (3,608)	3.3% (1,384)	6.5% (2,715)	81.5% (33,862)*	
Republic of Palau	2022	0% (0)	1.0% (177)	0% (0)	99.0% (17,878)*	

Data Sources: (Ka Mana O Na Helu 2023; State of Hawai'i Department of Health 2018; WHO and UNICEF 2022)

Wastewater Data Limitations In U.S.

Volume 25, Issue 9
1 September 2023



RESEARCH ARTICLE | SEPTEMBER 16 2023

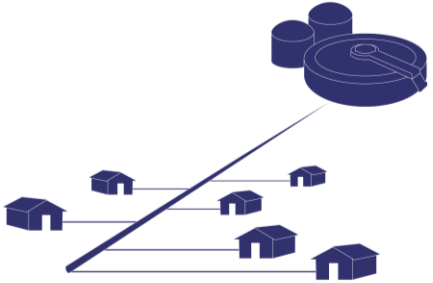
Household level wastewater management and disposal data collection in the U.S.: the history, shortcomings, and future policy implications

Jillian Maxcy-Brown; Mark A. Elliott; Bennett Bearden

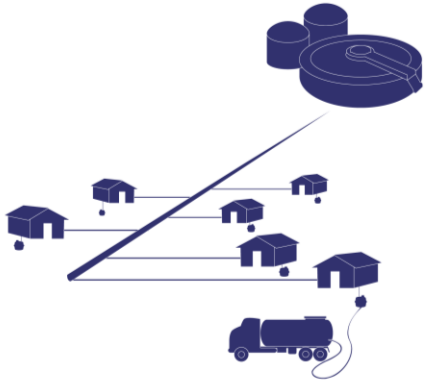
Water Policy (2023) 25 (9): 927–947.
https://doi.org/10.2166/wp.2023.147 **Article history**

Four Broad Network Typologies

(a) Conventional sewer system:
Solids and liquids are transported to an off-site wastewater treatment plant

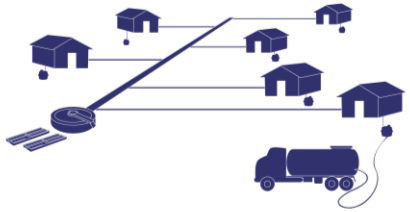


(b) Hybrid sewer system:
Liquids are transported to an off-site wastewater treatment plant while solids are retained on-site



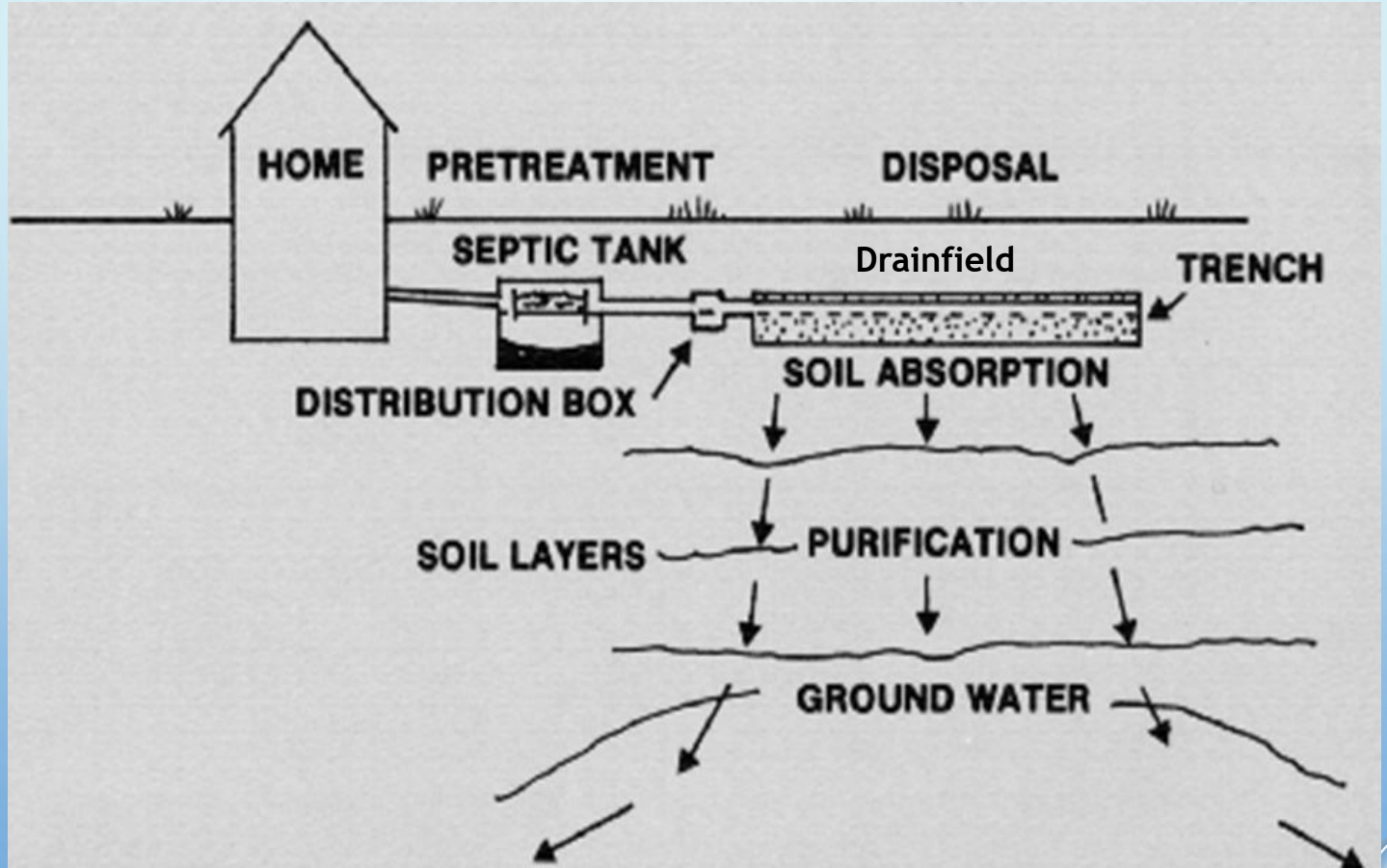
(c) On-site wastewater treatment systems:
Retention and/or treatment of all solids and liquids with disposal on-site (e.g., a septic tank and drainfield)

(d) Hybrid sewer system:
Liquids are transported to a local liquid-only treatment facility while solids are retained on-site



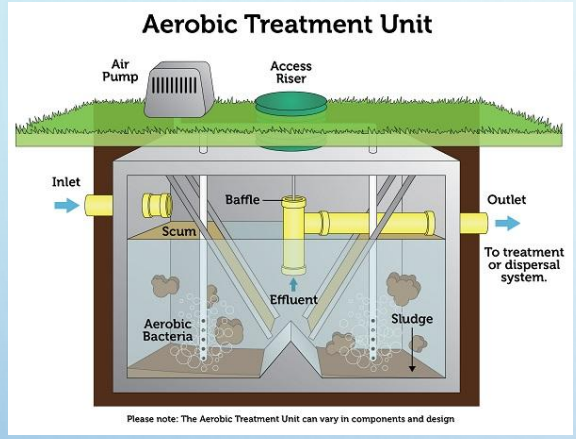
Options (b), (c), and (d) require periodic pumping of solids from the tank that retains solids on-site.

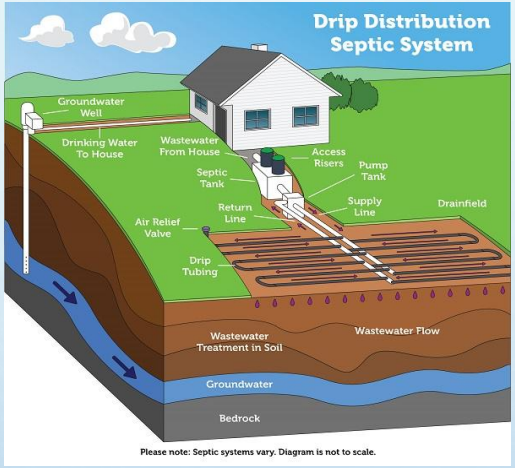
Conventional Septic Tank System

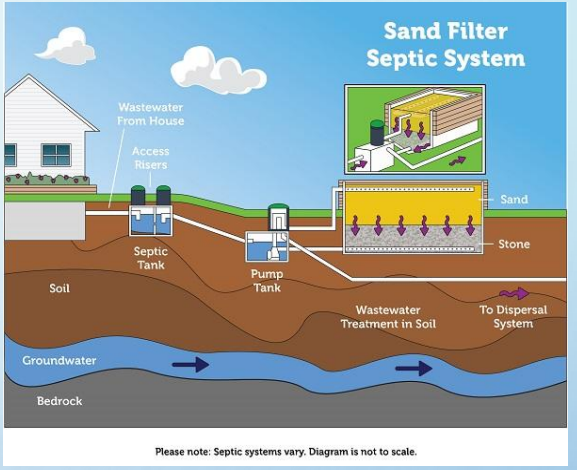


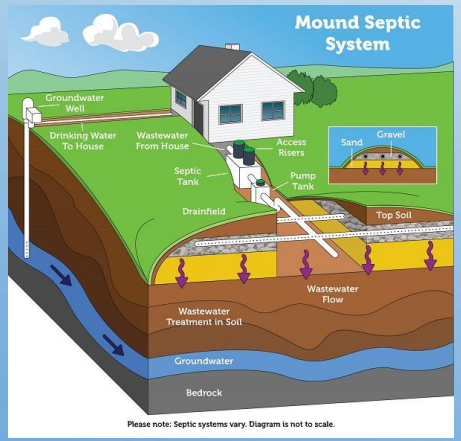
Source: Purdue Univ. Extension Service (Jones et al., 1990)

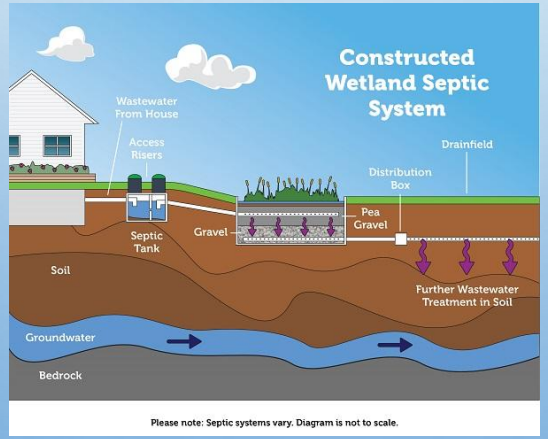
Advanced Onsite Wastewater Treatment

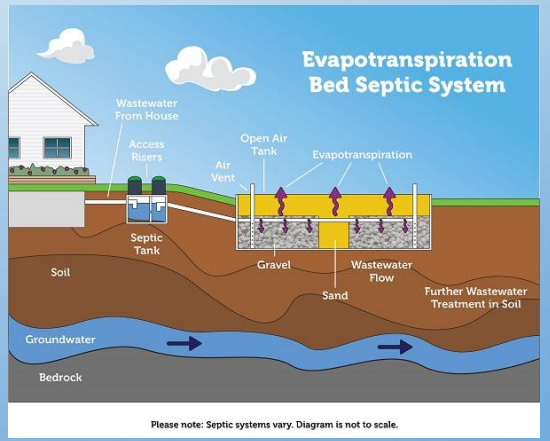




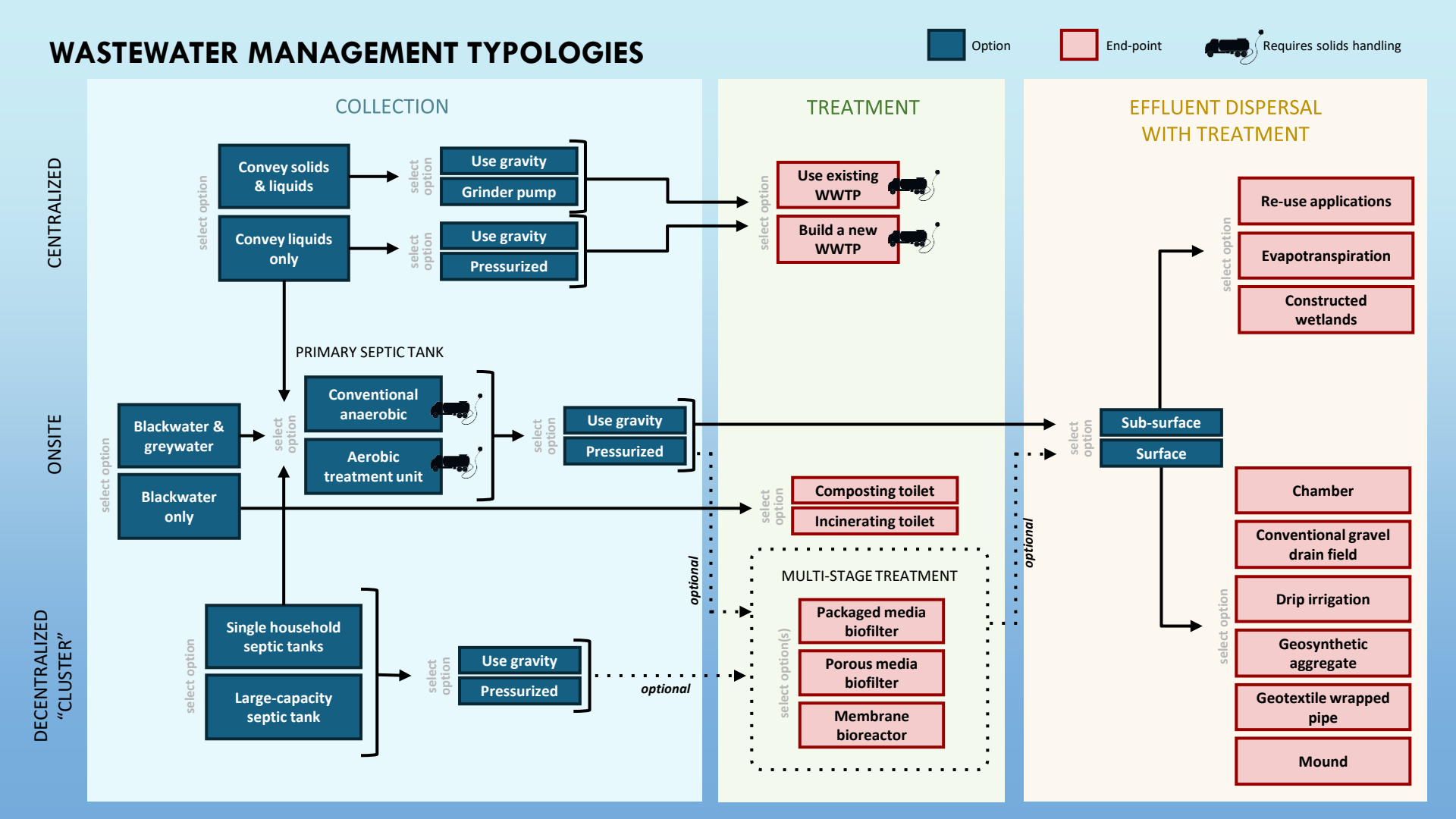




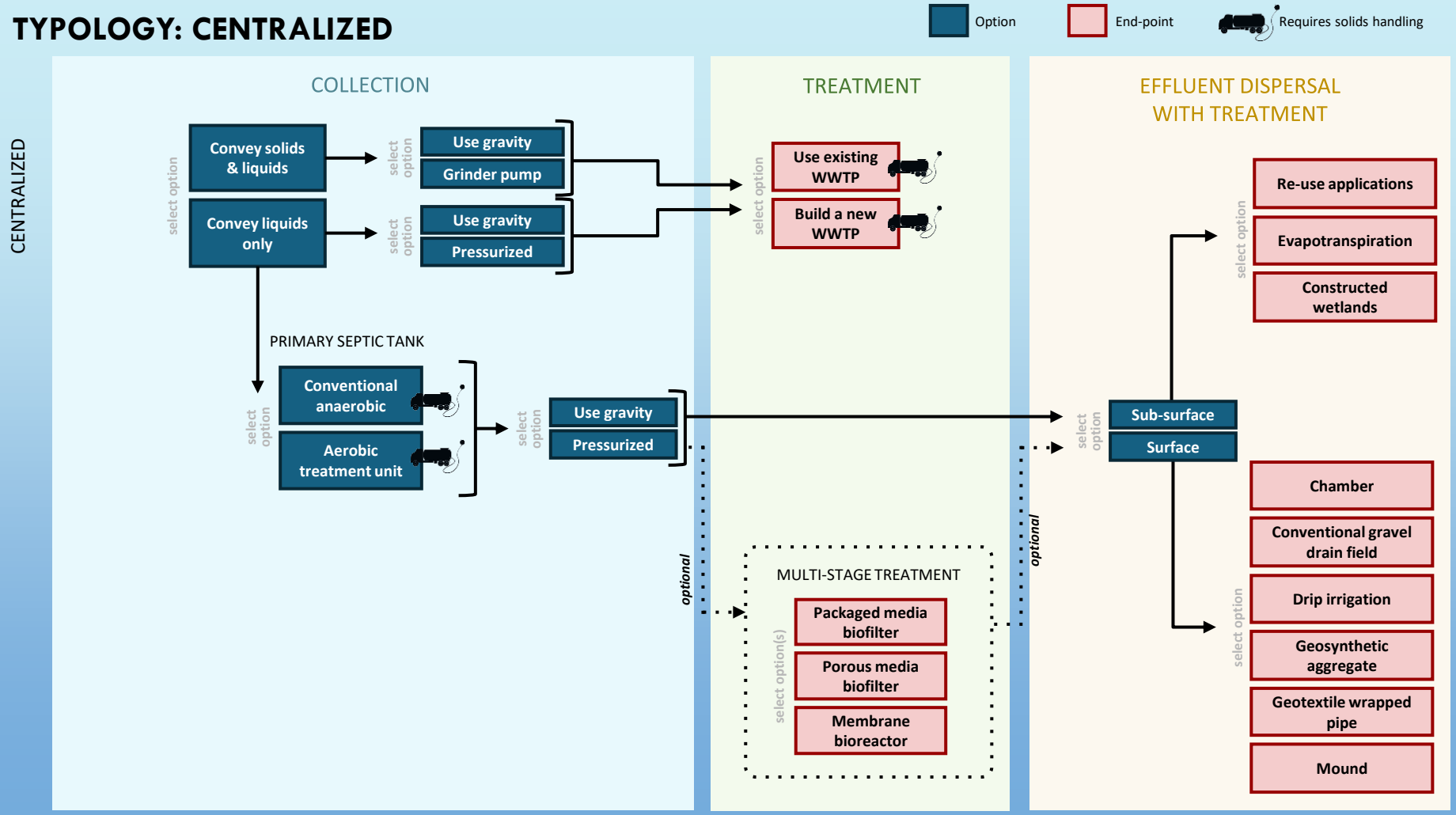




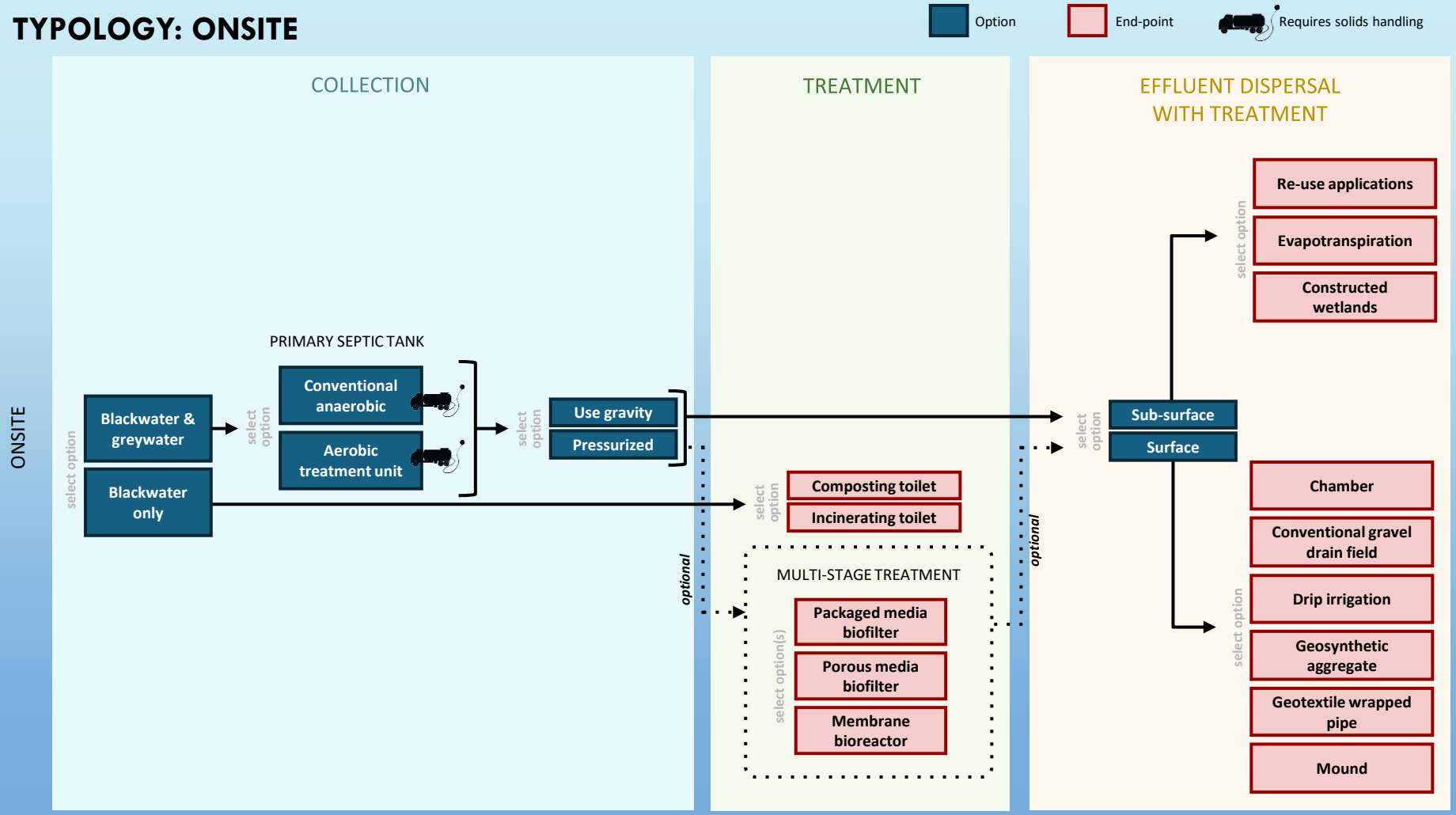
WASTEWATER MANAGEMENT TYPOLOGIES



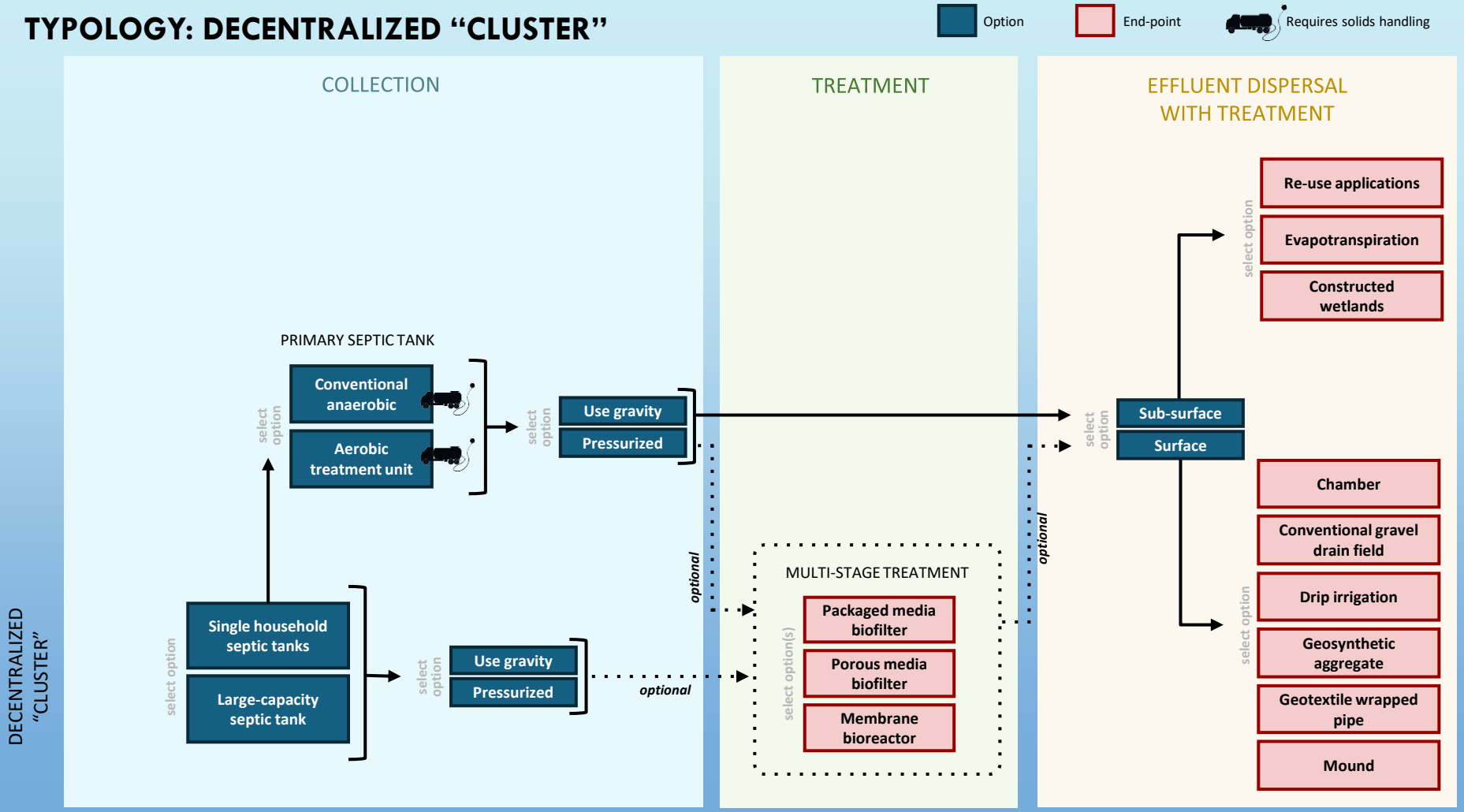
TYPOLOGY: CENTRALIZED



TYPOLOGY: ONSITE



TYPOLOGY: DECENTRALIZED "CLUSTER"



QUESTIONS FOR COMMUNITY ADVOCATES, STAKEHOLDERS, AND DECISION MAKERS

Existing Infrastructure

- Is there an existing centralized wastewater collection system and treatment plant on the island? If so, how far from the community?
- Do the buildings already have septic tanks?

Service Population Size

- Does the community have enough households to support a decentralized cluster or is the community better suited for individual systems for each household?

Service Geographical Size

- What is the total length of sewer main and maximum distance between a building and the treatment unit that would be included in the project?

Local Geology

- Topography: Could effluent be conveyed downhill? If not, is the terrain relatively flat?
- Land area: Is land available for a community treatment system or drainfield? Do parcels have sufficient area for OWTS?
- Soil: Is the soil appropriate for subsurface infiltration?
- Groundwater: Is there sufficient soil depth above the water table for soil-based wastewater treatment? Does the groundwater level fluctuate?

Desired Level of Nutrient Removal

- Is the community adjacent to a sensitive water body?

Local Regulations

- Do the local regulations require advanced treatment systems?
- Do the local regulations allow for surface discharge of treated effluent?

QUESTIONS FOR COMMUNITY ADVOCATES, STAKEHOLDERS, AND DECISION MAKERS

Management Entities

- Are there existing responsible management entities (e.g., local sewer utility/board) for wastewater?
- Is there local capacity to develop a new responsible management entity or partner with an existing drinking water utility?

Operation and Maintenance

- Does the system require an operator?
- Does the system have high costs or demands associated with long-term operations and maintenance?

Supply Chain

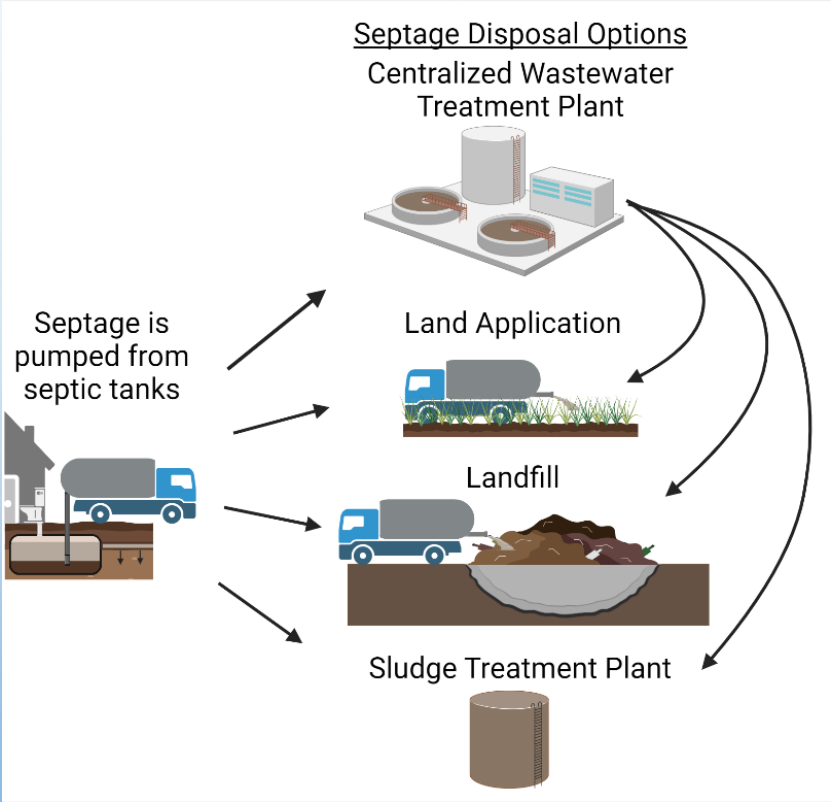
- Is it feasible to procure the necessary installation and care supplies and equipment locally/affordably?
- How do the procurement costs for this technology compare to another option?

Solids Management

- Does the island have an appropriate management system for septage (solids periodically pumped from septic tanks)?

Biosolids & Septage Management Options

- Especially critical in coastal areas due to the proximity of the water body and impending climate change impacts
- These coastal areas have sensitive ecosystems and may be a source of seafood
- Improved management of septage and biosolids will yield major improvements to surface water quality and groundwater quality
- Regulatory changes for solids handling will have major implications in coastal regions



CENTRALIZED

- Communities located within or near existing sewer service areas
- If there is need for many expensive lift stations, consider liquid-only sewer with septic tanks
- If these systems fail, they would be discharging larger, concentrated volumes of untreated or partially treated wastewater

ONSITE

- Must have advanced treatment
- ATUs with solar panels
- Multi-stage tank treatment system
  - Constructed wetlands (if sufficient land area)
  - Packaged media biofilters (if procured in large quantities)
  - Sand filters and membrane bioreactors (in affluent areas with management entity)
- Effluent discharge depends on regulations, geological conditions, and proximity to ground/surface waters

DECENTRALIZED "CLUSTERS"

- Low-density housing in areas where conventional septic systems are not suitable
- Lower cost than centralized
- Requires a responsible management entity

Table 2: Overview of Wastewater Management Typologies including benefits & limitations

QUESTIONS?

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