Engineering Field Testing Platform in eThekwini: Lessons Learned

Testing innovative non-sewered sanitation systems

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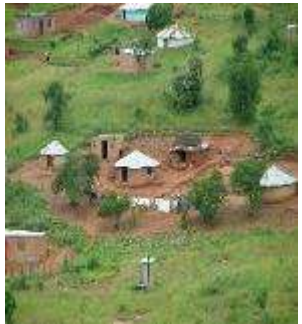
eThekwini Water and Sanitation, Khanyisa Projects,
Pollution Research Group - University of KwaZulu-Natal

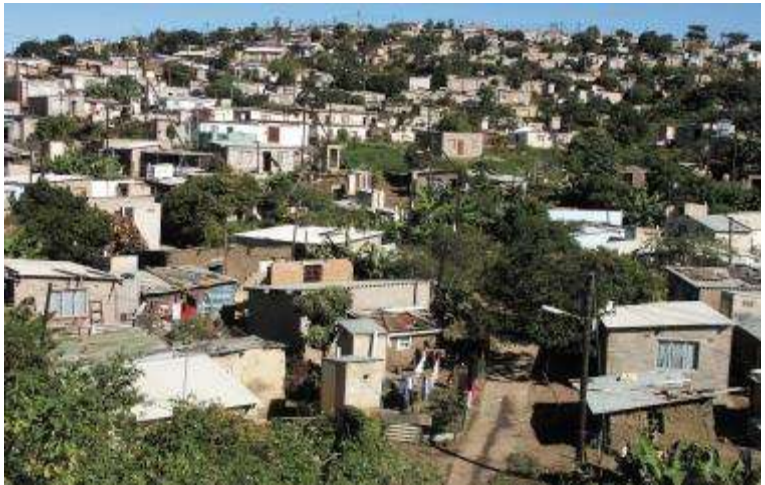
eThekwini Municipality

- 2,297 km2
- Mostly hilly topology
- 3.6 million people
- 53% in formal housing
- 32% in informal settlements
- 15% in peri-urban & rural areas
- 23% unemployment (Jan – Mar 2019)



Sanitation challenges in eThekwini

- Water shortages, drought area
- Historically unequal service provision, particularly in rural homeland areas
- Proliferation of informal settlements
- Perception of ‘inferior technology’ being provided to certain areas
- Flush toilet = gold standard
- Hilly topography, low rural population density
- Wastewater treatment works at capacity

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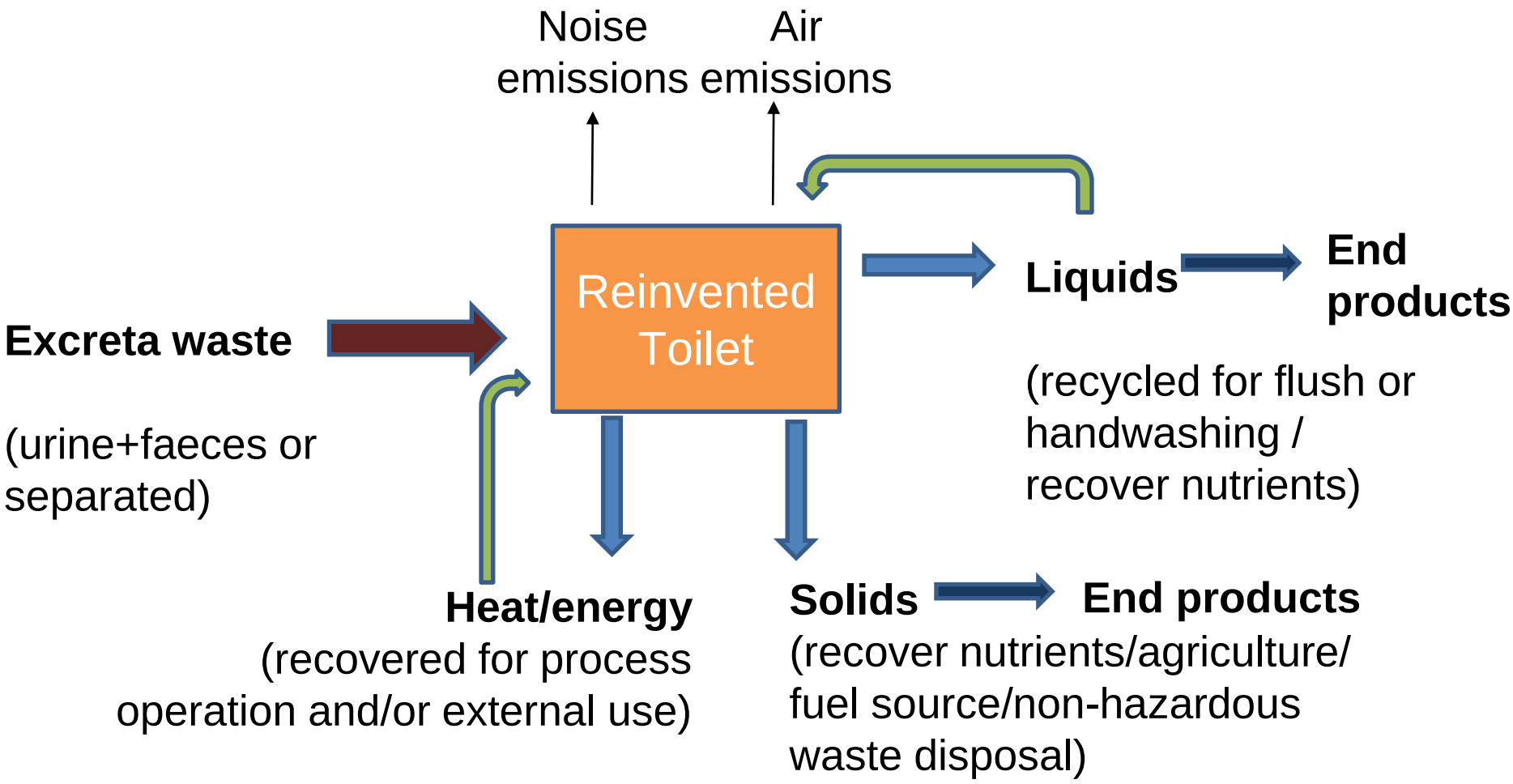
Non-sewered sanitation (NSS) solutions

- Non-sewered sanitation recognised as critical for the future **by International Water Association (IWA)** and **World Toilet Board**
- Do not require connection to sewer
- Can offer the **same level of user experience as a regular flush toilet**
- Can be **desirable, aspirational products**
- High tech systems, produced at scale, at an affordable price
- Innovative – the ‘Reinvented Toilet’
- Contribute to the **circular economy**

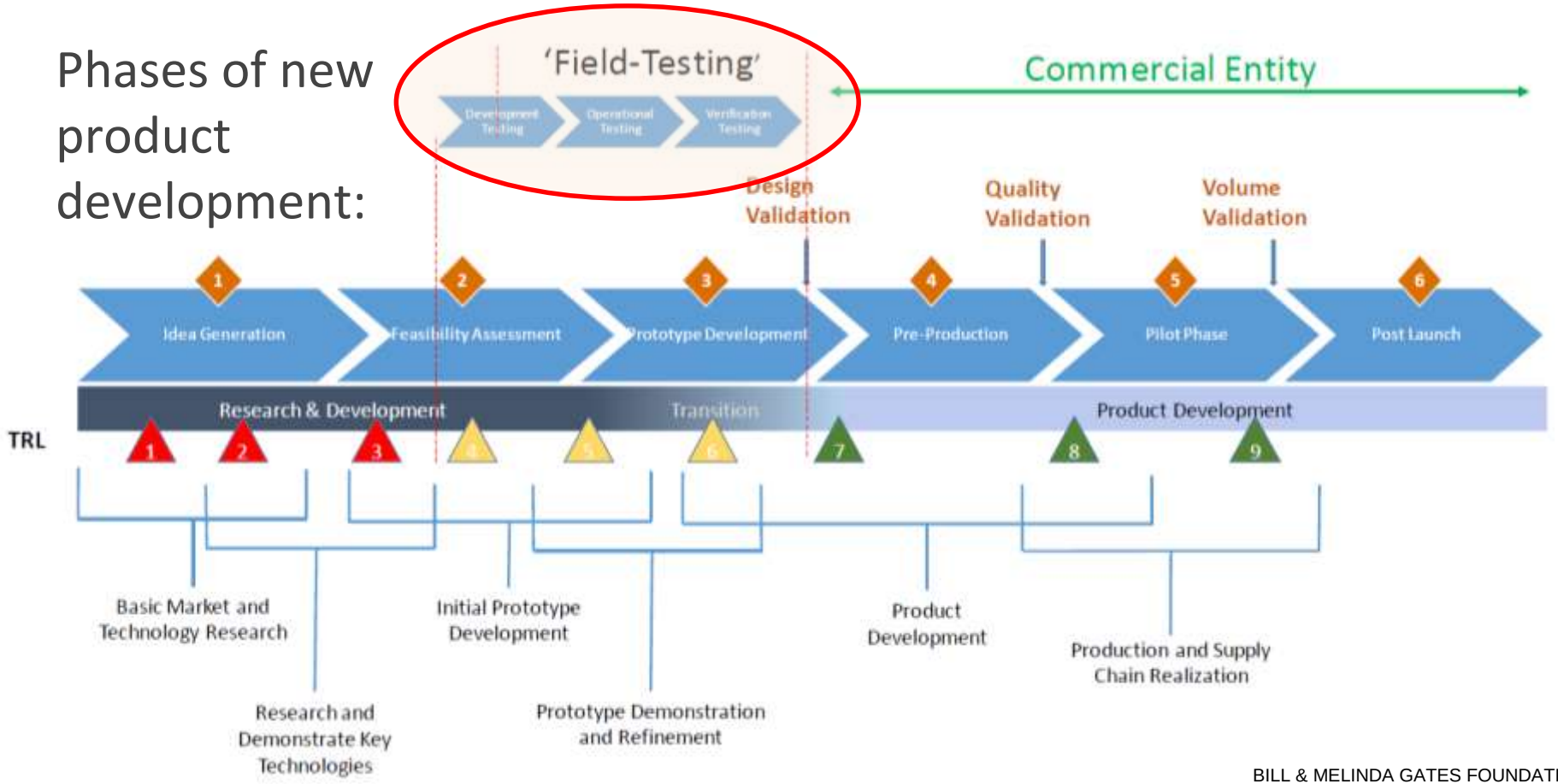
Why a sanitation testing platform in eThekwini?

- eThekwini needs viable **alternatives to conventional waterborne sewerage**
- Technology developers need to **test new NSS systems in the real world**


Noise emissions
Air emissions
Reinvented Toilet
Excreta waste
(urine+faeces or separated)
Liquids
End products
(recycled for flush or handwashing / recover nutrients)
Heat/energy
(recovered for process operation and/or external use)
Solids
End products
(recover nutrients/agriculture/ fuel source/non-hazardous waste disposal)

The EFT platform and product development

Phases of new product development:



Field Testing phase

The Engineering Field Testing Platform (EFTP) in eThekwini:

- **Real world** testing**, many users**
- Evaluates performance over an **extended period**
- **Feedback from community** on suitability and impact
- Uses the information and data generated to **improve sanitation for all**

WATER RESEARCH COMMISSION

ETHEKWINI MUNICIPALITY

Khanyisa PROJECTS

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATA

PRG

How the EFT platform works:

SITE SELECTION

COMMUNITY ENGAGEMENT

SITE PREPARATION

INSTALL & COMMISSION

TESTING

DECOMMISSION

SHIPPING

TECHNOLOGY CONSTRUCTION

FEEDBACK AT ALL STAGES TO:

- TECHNOLOGY DEVELOPERS
- DURBAN EFTP TEAM
- FUNDERS

SITE SELECTION

COMMUNITY ENGAGEMENT

SITE PREPARATION

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TESTING

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DUKE UNIVERSITY CENTER FOR WaSH-AID

SITE SELECTION

COMMUNITY ENGAGEMENT

SITE PREPARATION

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TESTING

DECOMMISSION

Testing on the Durban EFT platform:

2017 – 2019, currently testing or confirmed for testing

11

TECHNOLOGY DEVELOPERS

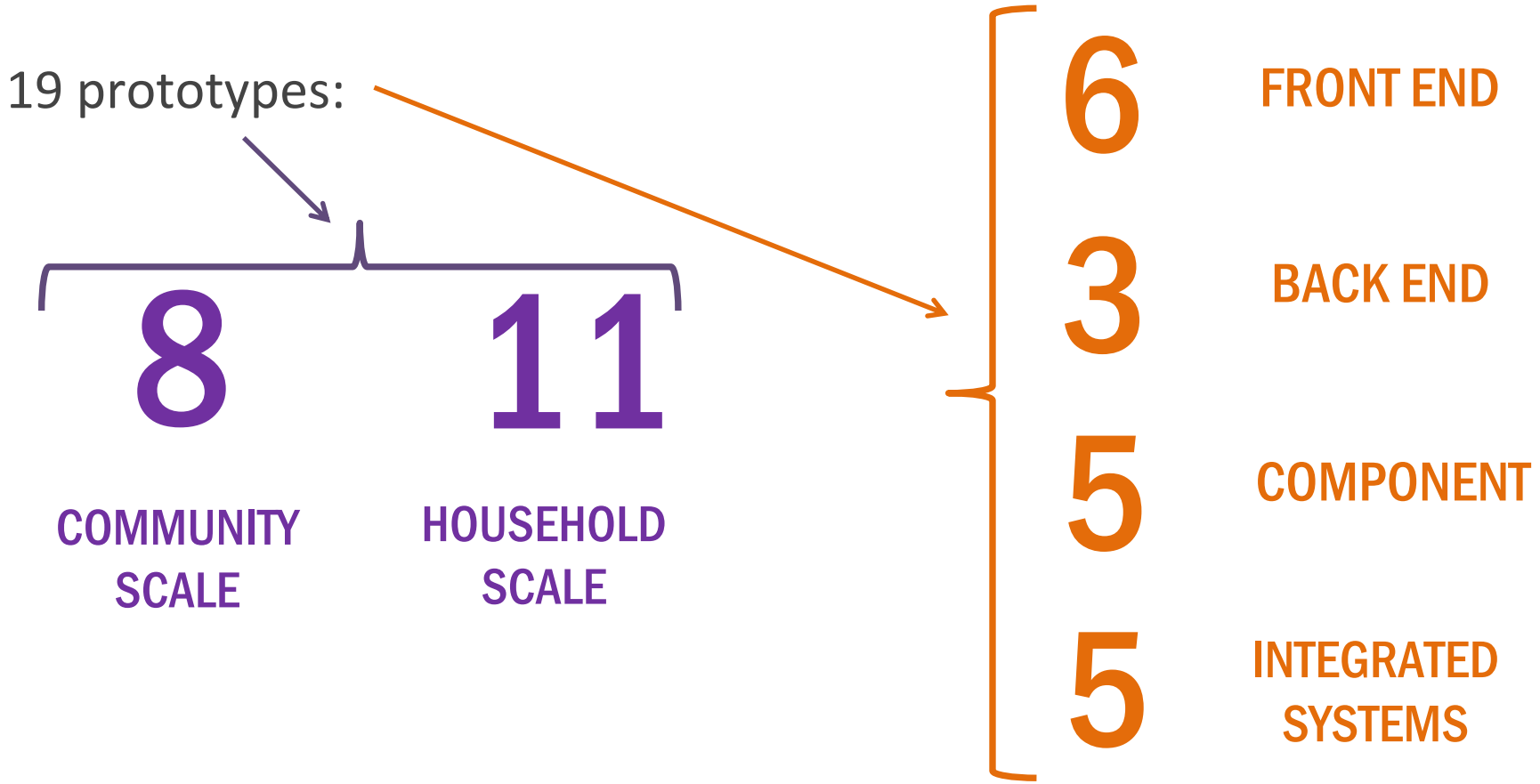
19

PROTOTYPES

20

TESTING SITES

Testing on the Durban EFT platform:



Lessons learned: operating the EFTP

Testing on a platform = greater benefits than individual field tests

REGULATOR SEES PERFORMANCE UNDER LOCAL CONDITIONS

KNOWLEDGE SHARING

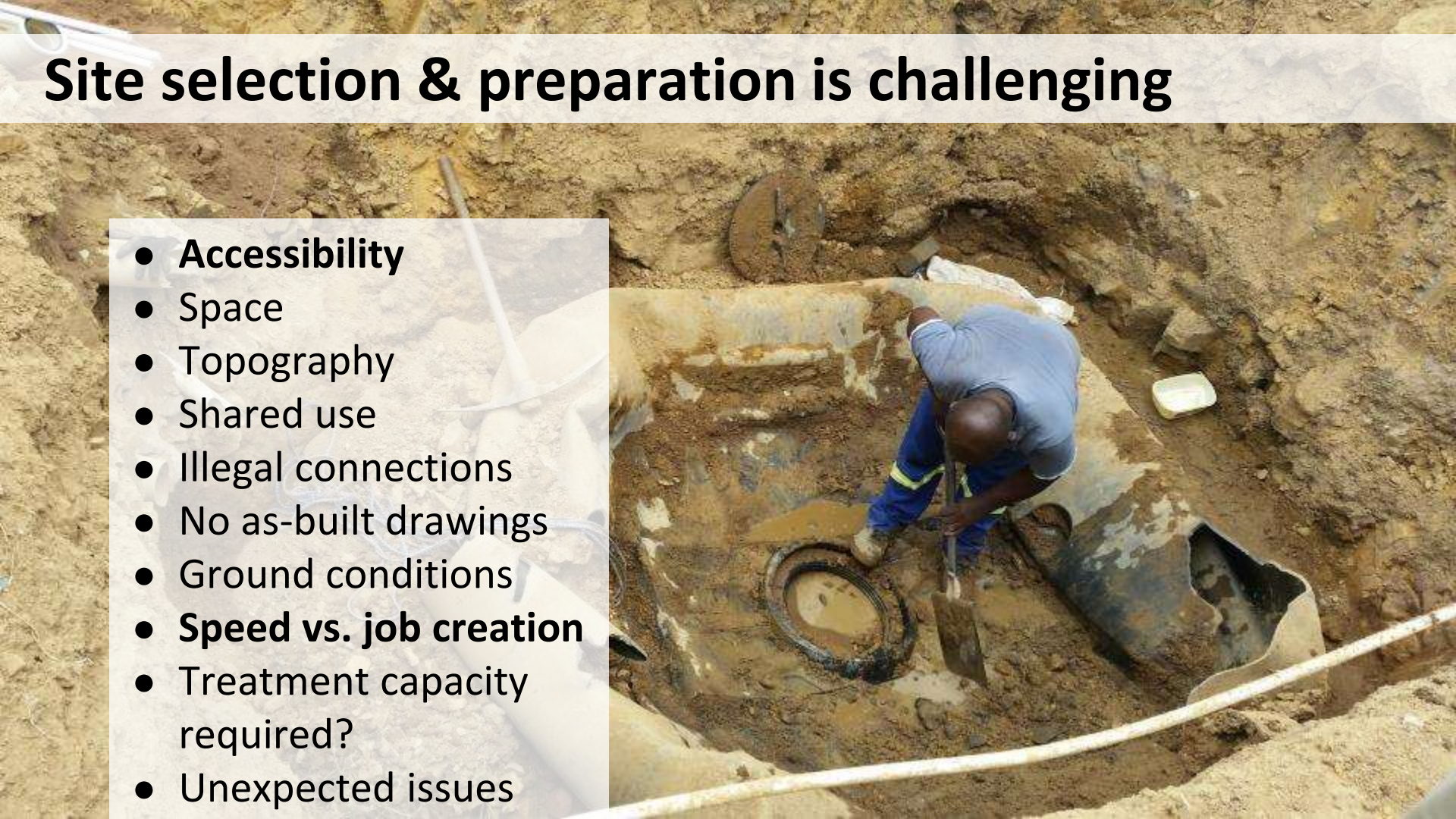
TECH DEVELOPERS CAN FOCUS MORE ON TECHNOLOGY, LESS ON LOGISTICS

COMBINE TECHNOLOGIES

FASTER ESTABLISHMENT

SHARED INFRASTRUCTURE

Site selection & preparation is challenging



- **Accessibility**
- Space
- Topography
- Shared use
- Illegal connections
- No as-built drawings
- Ground conditions
- **Speed vs. job creation**
- Treatment capacity required?
- Unexpected issues

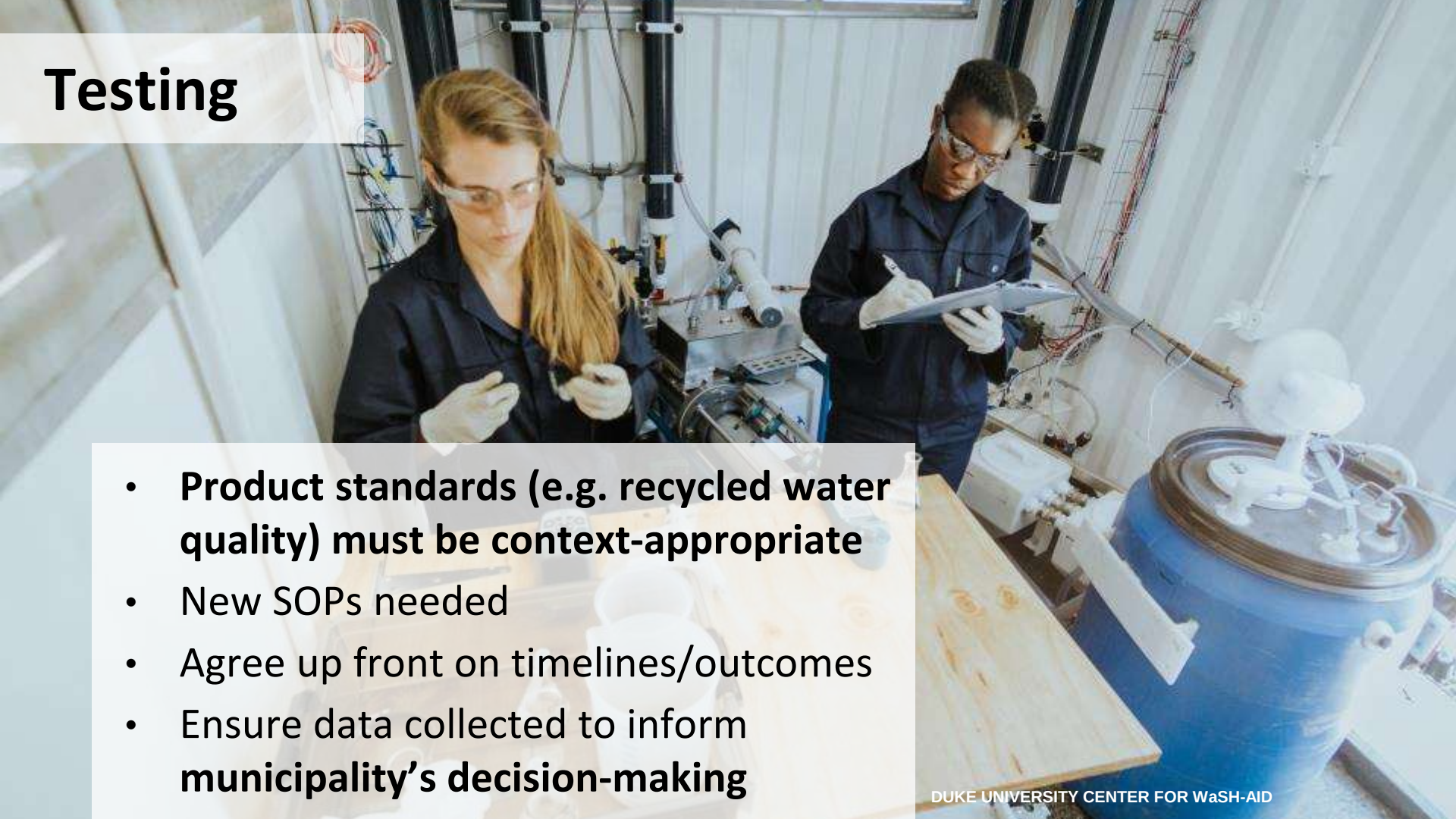
Community support more important than technical suitability

- **Political tensions**
- Security
- Community Liaison Officers
- Community can stop the project
- **Good community engagement is key to success of EFTP**

Managing expectations

- **Setting precedents**
- Testing has an end
- **Local employment**
- EFT can’t solve all problems
- Timelines change a lot
- Working hours

Testing



- **Product standards (e.g. recycled water quality) must be context-appropriate**
- New SOPs needed
- Agree up front on timelines/outcomes
- Ensure data collected to inform **municipality's decision-making**

Decommissioning

- **Exit strategy** must be developed **before technology installed on site**
- Decommissioning possible without technology developer present, but more difficult

What does it cost – (1) Direct costs (indicative)

SITE PREPARATION & ESTABLISHMENT

Community site
US$ 20,000

Household site
US$ 1,800

TESTING

US$ 35,000 to US$ 100,00, dependent on analyses required

DECOMMISSIONING

US$ 2,500

What does it cost – (2) Personnel

MUNICIPALITY

- US$ 160,000/year in-kind contributions
- Management, engineering, community engagement lead, O&M, consumables

ENGINEERING & PROJECT MANAGEMENT COMPANY

- Management inputs
- Project manager
- Project engineer
- Plumber/field assistant
- Community engagement inputs
- Community liaison officers
- Admin/finance

UNIVERSITY

- Principal investigator
- Project manager
- Ops manager
- 6 platform engineers
- Lab manager
- 4 Lab technicians
- Social research lead
- 4 social researchers
- Field workers
- Workshop manager
- 2 workshop staff
- Admin/finance
- 9 Masters & 4 PhD students

Typical timelines

SITE PREPARATION & ESTABLISHMENT

Community site
2 to 5 months

Household site
1 to 3 months

Note: community engagement, ethics, contracts & utilities can be lengthy!

COMMISSIONING & TESTING

Variable **– a few months to one year**

DECOMMISSIONING

1 to 2 months

Lessons learned: selection of technologies tested on the EFTP

Yixing Eco-sanitary Manufacture Co.,Ltd

Eco-san: off-grid blackwater recycling

- Toilet block + wastewater treatment system
- Treats toilet wastewater only and recycles for toilet flushing
- Serves 250 people/day
- Biological pre-treatment + electrochemical oxidation
- Solar powered
- **Has operated in recycling mode in SA**
- **Some modifications needed to make it more suitable for South African context**
- Currently operating at informal settlement & school
- **School wastewater profile challenging**

University of South Florida (USF)

NEWgenerator: off-grid wastewater recycling

- Informal settlement
- Treats toilet wastewater + greywater from one community ablution block
- Serves 100 people/day
- Anaerobic membrane bioreactor (AnMBR) + electrochemical disinfection
- Solar powered
- Can produce **two types of treated water**, to be recycled for:
  1. Toilet flushing
  2. Irrigation (nutrient rich)
- **Near commercial-ready, but some O&M issues still being addressed through EFTP**

EAWAG

Autarky: household flush toilet + handwashing with recycling

- **Household toilet and handwashing facility with integrated wastewater treatment**
- Recycles treated wastewater for toilet flushing & handwashing
- Serves 1 household (5 to 10 people)
- Process summary: urine separation toilet, urine dehydration, solids/flushwater separation, liquid treatment (gravity driven membrane filtration + electrolysis)
- **Liquid treatment & recycling functioned well**
- Solids treatment still under development – therefore system **not commercial-ready**
- Currently **grid-powered**
- Operated successfully for three months at a rural household, **high social acceptance**

University of the West of England (UWE)

PEE POWER: electricity from urine via microbial fuel cell

- Community ablution block urinals feed a stack of microbial fuel cells
- Generates electricity from urine
- Serves 1 community ablution block (around 100 people/day)
- System powers LED lights in the ablution block
- **Operating well but some issues including greywater disposal to urinals causing dilution of urine and blockages caused by precipitates/dead flies**

Recommendations

…for **technology developers**

- Don’t test on the EFTP too early
- **Decide on primary aim: testing technology or testing suitability for Durban/South Africa**
- Community engagement can make or break project
- Communicate early about design **(visits both directions are valuable)**
  - Flexibility
  - Local regulations
  - Security/vandalism
  - Local procurement
- Align expectations early (timeline, working hours, staffing, costs…)
- Exit strategy

Recommendations

…for **setting up an Engineering Field Testing Platform**

- Strength of municipality – private company – university partnership
- State minimum readiness level for technologies
- Resource planning is difficult when testing multiple technologies
- Personnel requirements are significant
- Get communication right (internal + external)
- Who is driving the programme/outcomes?
- **Establish how EFTP host city will benefit:**
  - Monitoring requirements
  - Structured knowledge sharing
  - Partner with local technologies

Acknowledgements

EFT platform funders & partners:

- Technology developers
- The communities, households, schools and other sites hosting the field tests
- Bill & Melinda Gates Foundation
- South African Water Research Commission
- South African Department of Science and Innovation

Thank you!

Second presentation on EFTP this afternoon (Session 21 IPRDP) – municipal perspective

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Case study video of EFTP available; also see publicity from China Reinvented Toilet Expo