

Reduction of Unintentionally Produced Persistent Organic Pollutants (UPOPs) emissions by improving waste management practices at landfills

Road map to resilient landfill management

GEF Project ID: 5558 – Component 2 - Development and Implementation of a Sustainable Management Mechanism for POPs in the Caribbean

7 Oct 2021



Measures for improved operational resilience and UPOPs mitigation

Operational Resilience:

The ability to:

- Prevent,
- Adapt to,
- Respond to,
- Recover from, and
- Learn from

Operational disruptions. (ISO 22316)

ISO 22301:2019, *Security and resilience – Business continuity management systems – Requirements*

Highly recommended framework to adopt.

Business Continuity management systems

Plan, establish, implement, operate, monitor, review, maintain and continually improve

your management system to

protect against, reduce the likelihood of occurrence, prepare for, respond to, and recover from

disruptive incidents when they arise.

ISO 22301:2019, Security and resilience – Business continuity management systems – Requirements

Highly recommended framework to adopt.

Operational Resilience

Key components to developing Operational Resilience:

1. **Identify important business services** that if disrupted could cause harm to your customers or your reputation, threaten the viability of the service or cause instability in the local economy and environment;
2. **Identify and document** the people, processes, technology, facilities and information that support your important business services; and
3. **Take actions to be able to ensure business continuity** through a range of severe but plausible disruption scenarios by incrementally addressing vulnerabilities.

1

Identify important business services



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Operational Resilience

Key components to developing Operational Resilience:

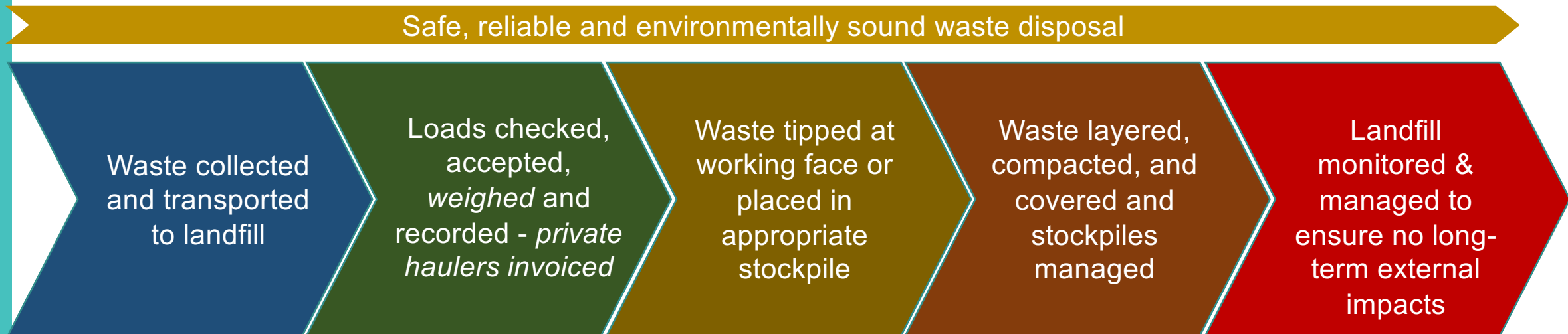
1. **Identify important business services** that if disrupted could cause harm to your customers or your reputation, threaten the viability of the service or cause instability in the local economy and environment;
2. **Identify and document** the people, processes, technology, facilities and information that support your important business services; and
3. **Take actions to be able to ensure business continuity** through a range of severe but plausible disruption scenarios by incrementally addressing vulnerabilities.



Identify important business services

Use results from identifying important business services outlined in presentation “Landfill practices that impact operational resilience”.

Understand how each business service is delivered by mapping the key process steps and defining which resources enable it to be delivered.



2

Identify and map services and resources



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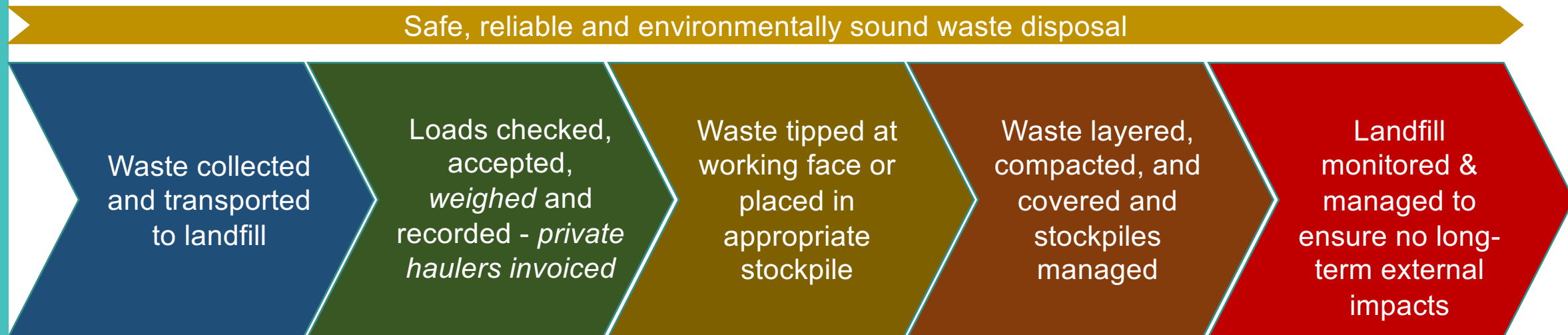


Identification and mapping of resources

1. Map the baseline conditions, what resources are allocated and available now to deliver each key process step required to deliver the business services.
2. Identify the vulnerabilities in the system that exist within those resource allocations.
3. Identify the vulnerabilities in the system and identify options to mitigate the vulnerabilities, and re-map the resources with the additional / removed resources required to implement the mitigation plan.

Map resources required to deliver service

For each important business service, considering the vulnerabilities (1st & 2nd tier causes) identified in the trigger, cause and root cause exercise in impact on operational resilience presentation, identify the resources required to ensure Business Continuity and deliver the service (incl. monitoring and learning from performance and impact), highlighting those that exist and those that are lacking:



Resources required to deliver service

In mapping the business services, identify the resources that enable you to deliver the service and monitor performance and impact, which may include (consider what is there and what is required):

Technology:	<ul style="list-style-type: none"> • Weighing and billing system (IT) 	<ul style="list-style-type: none"> • Compaction equipment
People:	<ul style="list-style-type: none"> • Maintenance crew • Equipment operators • Engineers / technicians 	<ul style="list-style-type: none"> • Weighbridge attendants • Landfill supervisors • Litter wardens
Facilities:	<ul style="list-style-type: none"> • Landfill cells (Lined) • Weighbridge • Leachate treatment facility 	<ul style="list-style-type: none"> • Landfill site office • Managed stockpiles
Material:	<ul style="list-style-type: none"> • Cover material 	<ul style="list-style-type: none"> • Fire fighting equipment
Finance:	<ul style="list-style-type: none"> • Landfill operational budget • Cost recovery pricing 	<ul style="list-style-type: none"> • Landfill capital budget • Segregated material management finance
Information:	<ul style="list-style-type: none"> • Waste volume and composition predictions 	<ul style="list-style-type: none"> • Private hauler registration • Weather forecasts
Third parties:	<ul style="list-style-type: none"> • Maintenance contractor firms • Equipment / spare part suppliers • Civil engineering support • Stockpile reclamation contractors • Private recyclers / Waste brokers and composters 	<ul style="list-style-type: none"> • Environmental monitoring services • Enforcement mechanisms (i.e. police enforcement of anti-dumping)

RASCI Matrix (from previous presentation)

Consider also the results of the stakeholder mapping exercise from stakeholder presentation

R	Responsible	The organisation, people (or person) who are expected to actively address this root cause
		Person working to mitigate this root cause
		"the doer"
A	Accountable	The organisation, person who is ultimately accountable for ensuring the root cause is mitigated
		Position with Yes/No authority
		"Approver"
S	Support	People to support the responsible organisation / person (help with collecting and compiling the data) - not used all the time
		Position that is helping out at the direction of responsible person
		"Helper"
C	Consult	People who have a particular expertise that they can contribute to specific decisions
		Position involved prior to decision or action (e.g. approving data)
		"in the loop"
I	Inform	People who are affected by the activity/decision and therefore need to be kept informed,
		Position that needs to know of the decision or action
		"Tell me after" "Notify me"

Data needs to inform decision making

Measures of direct impact of operational disruption: Determine baseline to then set maximum tolerable level of disruption (**impact tolerance**) including the maximum tolerable duration of a disruption

1. Number of consecutive days landfill closed (days)
 - How many days can the landfill be closed before consequences exceed a tolerable level
2. Total stockpile capacity remaining (days).
 - How many more days can waste stream keep being accepted before stockpiles are full
3. Waste compactor / bulldozer operational time (hours/week)
 - How many hours can waste be received without layering and compaction before landfill integrity / accessibility is affected
4. Environmental monitoring and parameter limit for air, water and soil quality (parameter specific)
 - What concentrations of pollutants can receiving bodies accept before intolerable harm caused / regulatory fine issued.
5. Total revenue collected from gate fees (where applicable) and other sources (Dollar / month)
 - What financial loss can the corporation sustain before financing to maintain minimum operational level is affected

Mapping resources to deliver service



	Existing / have	Challenges / Vulnerabilities
Technology:	<ul style="list-style-type: none">• ...	
People:	<ul style="list-style-type: none">• ...	
Facilities:	<ul style="list-style-type: none">• ...	
Material:	<ul style="list-style-type: none">• ...	
Finance:	<ul style="list-style-type: none">• ...	
Information:	<ul style="list-style-type: none">• ...	
Third parties:	<ul style="list-style-type: none">• ...	

Mapping resources to deliver service

Loads checked,
accepted,
weighed and
recorded - *private
haulers invoiced*

	Existing / have	Challenges / Vulnerabilities
Technology:	<ul style="list-style-type: none">• ...	
People:	<ul style="list-style-type: none">• ...	
Facilities:	<ul style="list-style-type: none">• ...	
Material:	<ul style="list-style-type: none">• ...	
Finance:	<ul style="list-style-type: none">• ...	
Information:	<ul style="list-style-type: none">• ...	
Third parties:	<ul style="list-style-type: none">• ...	

Mapping resources to deliver service

Waste tipped at working face or placed in appropriate stockpile

	Existing / have	Challenges / Vulnerabilities
Technology:	<ul style="list-style-type: none">• ...	
People:	<ul style="list-style-type: none">• ...	
Facilities:	<ul style="list-style-type: none">• ...	
Material:	<ul style="list-style-type: none">• ...	
Finance:	<ul style="list-style-type: none">• ...	
Information:	<ul style="list-style-type: none">• ...	
Third parties:	<ul style="list-style-type: none">• ...	

Mapping resources to deliver service

Waste layered,
compacted, and
covered and
stockpiles
managed

	Existing / have	Challenges / Vulnerabilities
Technology:	<ul style="list-style-type: none">• ...	
People:	<ul style="list-style-type: none">• ...	
Facilities:	<ul style="list-style-type: none">• ...	
Material:	<ul style="list-style-type: none">• ...	
Finance:	<ul style="list-style-type: none">• ...	
Information:	<ul style="list-style-type: none">• ...	
Third parties:	<ul style="list-style-type: none">• ...	

Mapping resources to deliver service

Landfill monitored & managed to ensure no long-term external impacts

	Existing / have	Challenges / Vulnerabilities
Technology:	<ul style="list-style-type: none">• ...	
People:	<ul style="list-style-type: none">• ...	
Facilities:	<ul style="list-style-type: none">• ...	
Material:	<ul style="list-style-type: none">• ...	
Finance:	<ul style="list-style-type: none">• ...	
Information:	<ul style="list-style-type: none">• ...	
Third parties:	<ul style="list-style-type: none">• ...	

3

Take actions to be able to ensure business continuity - Addressing vulnerabilities



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Operational Resilience

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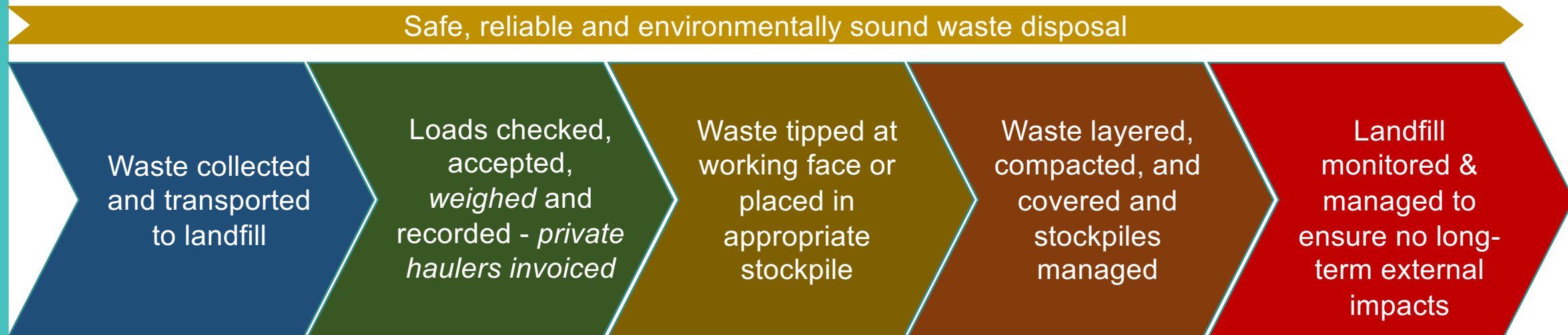


Identification and mapping of resources

1. Map the baseline conditions, what resources are allocated and available now to deliver each key process step required to deliver the business services.
2. Identify the vulnerabilities in the system that exist within those resource allocations.
3. **Identify the vulnerabilities in the system and identify options to mitigate the vulnerabilities, and re-map the resources with the additional / removed resources required to implement the mitigation plan.**

Identify Resources required to deliver (improved) service

For each important business service, considering the vulnerabilities (1st & 2nd tier causes) identified in the trigger, cause and root cause exercise, identify the resources required to ensure Business Continuity and deliver the service (incl. monitor and learning from performance and impact), highlighting those that exist and those that are lacking:



How to mitigate the root cause

1. Further detail the cascading trigger factor, cause and root cause.
2. Categorise the causes into those that are (focus on one category if time is tight):
 - A. Landfill Operations
 - B. Waste segregation (behavioural)
 - C. Finance / Policy framework
3. Identify tasks to address mitigate the root cause and identify resource needs for the intervention
 - i. Technology:
 - ii. People:
 - iii. Facilities:
 - iv. Material:
 - v. Finance:
 - vi. Information:
 - vii. Third parties:

Grouping causes and consequences

Trigger factors, causes and root causes groups

1. Landfill Operations (directly controllable by CWSA/SWMU)
2. Waste segregation (consumer / producer behaviour and collection operators)
3. Finance / Policy framework (national level)

Consequence chain of events / cascading effects groups

1. Harm to general population (health, safety and environment)
2. Risk to landfill safety and soundness (operational integrity, includes financing operations)
3. Risk to national economic stability and governance

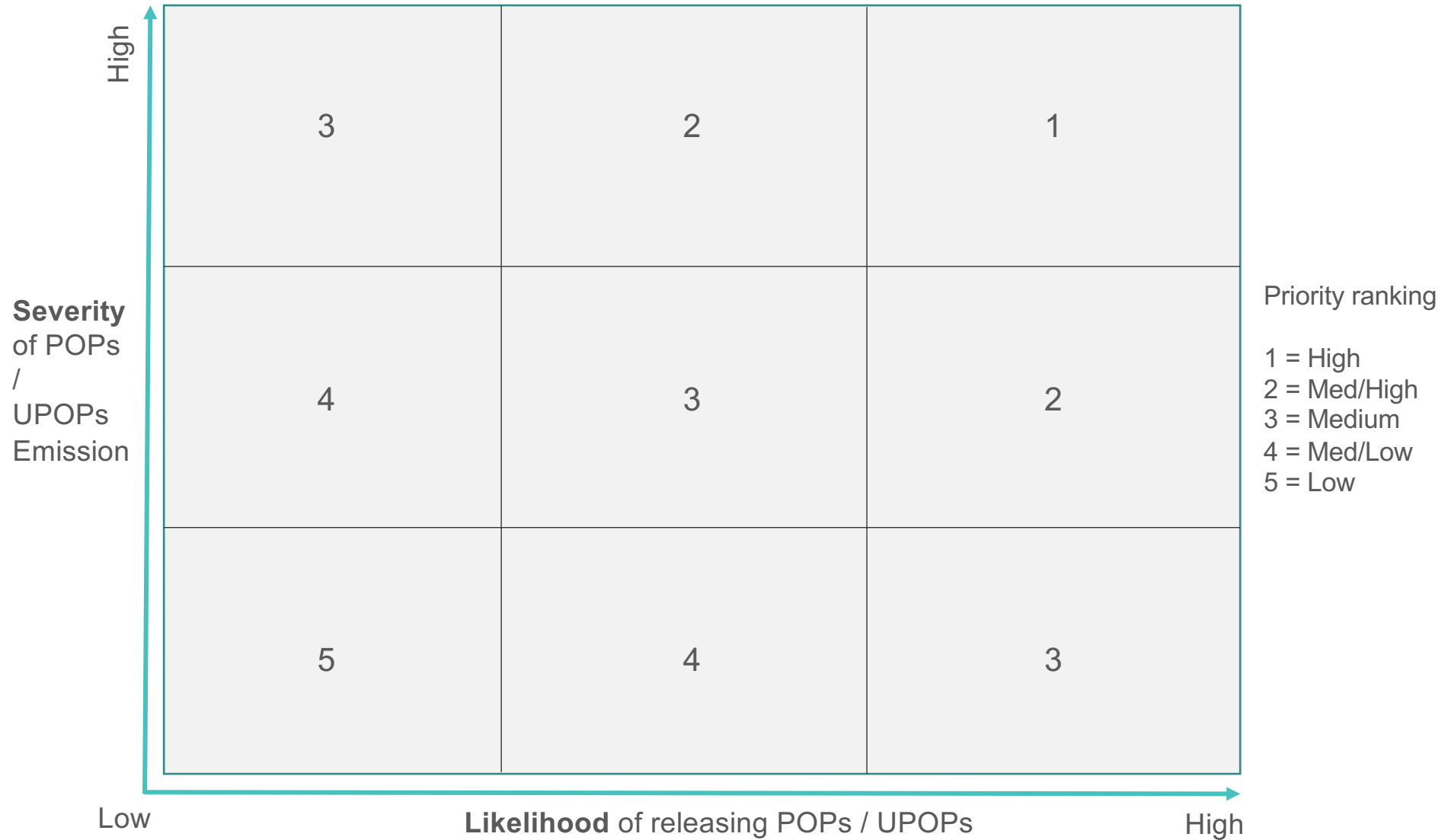
These groups enable us to identify key stakeholders to make responsible and accountable for interventions

Tyre / white good levy finance not ringfenced for tyre recycling	No resources allocated to recovery or recycling	
No management strategy for tyres / white goods		Unmanaged tyre stockpiles at risk of ignition
Increasing number of vehicles and associated waste tyres	No proper management of bulky waste, white good, tyre stockpiles	
Insufficient budget allocated to machinery	Lack of / inappropriate machinery	
Unqualified award of equipment contracts	Operators insufficiently trained	Insufficient waste compaction and cover
Poor enabling environment to attract investment in alternate waste treatment tech	Insufficient alternatives to landfill	
Waste not segregated at source	Lithium batteries in waste crushed by compactor and ignite waste mass	Flammable material ignites working face
No site security	Waste pickers active on site	Open burning to recover metals
No enforced ban on purchasing burnt wire	Recyclers pay more for wire without plastic	
No plan for fire breaks	De-bushing not conducted around landfill site	No fire breaks maintained fire enters landfill / stockpiles
No tools to cut bush regularly	Fire on neighbouring plot	
Green waste and cardboard bulky and consuming void space	No alternate option for treating green waste and card	Open burning on site as a management practice

Fire on landfill



Ranking vulnerabilities



intervention points - addressing vulnerabilities

1. Important Business Service identified
2. Key resources required to deliver service identified
3. Trigger factors, causes and root causes of a disruptive event (fire) mapped
4. Consequence chain of events / cascading effects of a disruptive event (fire) mapped

Availability of Resources

ISO 22316 – Section 5.7

Develop and allocate resources, including people, premises, technology, finance and information, **to address vulnerabilities**, providing the ability to adapt to changing circumstances (in our example, fire, but any change).

The organization should prioritize and resource activities that:

- a) Avoid **single points of failure** and respond to incidents and change, so that core services are maintained at an acceptable, pre-determined level;
- b) Recruit and develop employees with a diverse set of skills, knowledge and behaviour that can contribute to the organization's ability to respond and adapt to change;



- a) Plan resourcing and capacity, diversification, replication and redundancy to **avoid single points of failure and respond to incidents and change, so that core services are maintained at an acceptable, pre-determined level;**
- b) select and develop employees with a diverse set of skills, knowledge and behaviour that can contribute to the organization's ability to respond and adapt to change;

Take actions to be able to ensure business continuity



Create an inventory all infrastructure, mobile equipment, and static equipment



Create preventative maintenance procedures – obtain maintenance manuals for all equipment, identify tasks required and assign them to specific staff with work schedules, including daily, weekly, monthly, annual and by running hours/distance.



Create preventative maintenance schedule (calendar) of routine maintenance inspections and tasks to be undertaken at specific intervals.



Provide specific training on preventive maintenance for equipment to staff



Analyse – Adjust - Improve

Take actions to be able to ensure business continuity

- Focus on preventative maintenance and not reactive
- Ensure redundancy in system to provide immediate back up in times of need.
- Fire risks and control – preventing and managing fires
- Controlling waste pickers
- EHS measures implemented in accordance with professional risk assessment and operating plan
- Environmental monitoring system in place with annual reporting capability

Fire control action / contingency planning

- Defensive Planning
 - Proper compaction and cover materials
 - Properly sized, spaced and banded stockpiles
 - Bulldozers / earth movers on standby
 - Hazardous / low flashpoint wastes diversion
 - Regular Maintenance checks on equipment and vehicles
 - Minimum distances observed
- Notification procedures
 - Stakeholders (roles and responsibilities regarding fire)
 - Response times and preparations
- Fire fighting procedures
 - Equipment
 - Techniques
 - Training (incl. SOPs, fire drills, etc)



Fire extinguisher trolleys at working face
Fixed extinguisher points on vehicles, at buildings and at stockpiles

Regular compliance monitoring and reporting








For each disposal site, overall summary evaluation covered:

Landfill component	Evaluation Criteria
Landfill site overview	Available and adequacy of Infrastructure
	Available and adequacy of equipment
	Site layout and fill planning
	Environmental monitoring
Waste inspection and acceptance	Acceptance criteria
	Weighbridge records
Diversion of waste at the landfill	Hazardous waste
	Tyres
	Oils, oily waters and greases
	ELV and white goods
	WEEE
Cell Structure and Operations	Green waste
	Layout and cell development
	Compaction
	Cover material
Fire control/ contingency plan	Operations health and safety
	Notification procedures
	Firefighting procedures
Informal activities at the landfill	Fire risk on site
	Presence and controlling of waste pickers

- - adequate
- - room for improvement
- - non-adequate

Impact on UPOPs generation:
Direct / Indirect

Findings Summary – Enabling Environment

Enabling Aspect	Improvement		
Legislation	Fair		Strong
Policy	Fair		Strong
Standards and Guidance	Weak		Strong
Defined roles and Responsibilities	Fair		Strong
Planning and monitoring (data collection, analysis, options appraisal and informed decision making)	Weak		Strong
Public sector stakeholders (coordination and ability to publicly administer sector coordination, monitoring and service provision)	Fair		Strong
Private sector stakeholders (integration into ISWM within enabling environment)	Weak		Strong

ROOT CAUSES FACTORS

FINANCE / POLICY FRAMEWORK

- National policy and strategic direction with appropriate financing mechanisms and cost recovery.
- Strategic management plans for all main waste streams
- Clearly defined roles and responsibilities with clear accountability
- Ensuring fair and well resourced permitting and enforcement mechanisms
- Ensuring data collection and full cost accounting with cost recovery so that landfill is not a low financial cost dumping option but an increasing full economic cost making alternatives to landfill financially attractive

CAUSES

SEGREGATED MANAGEMENT

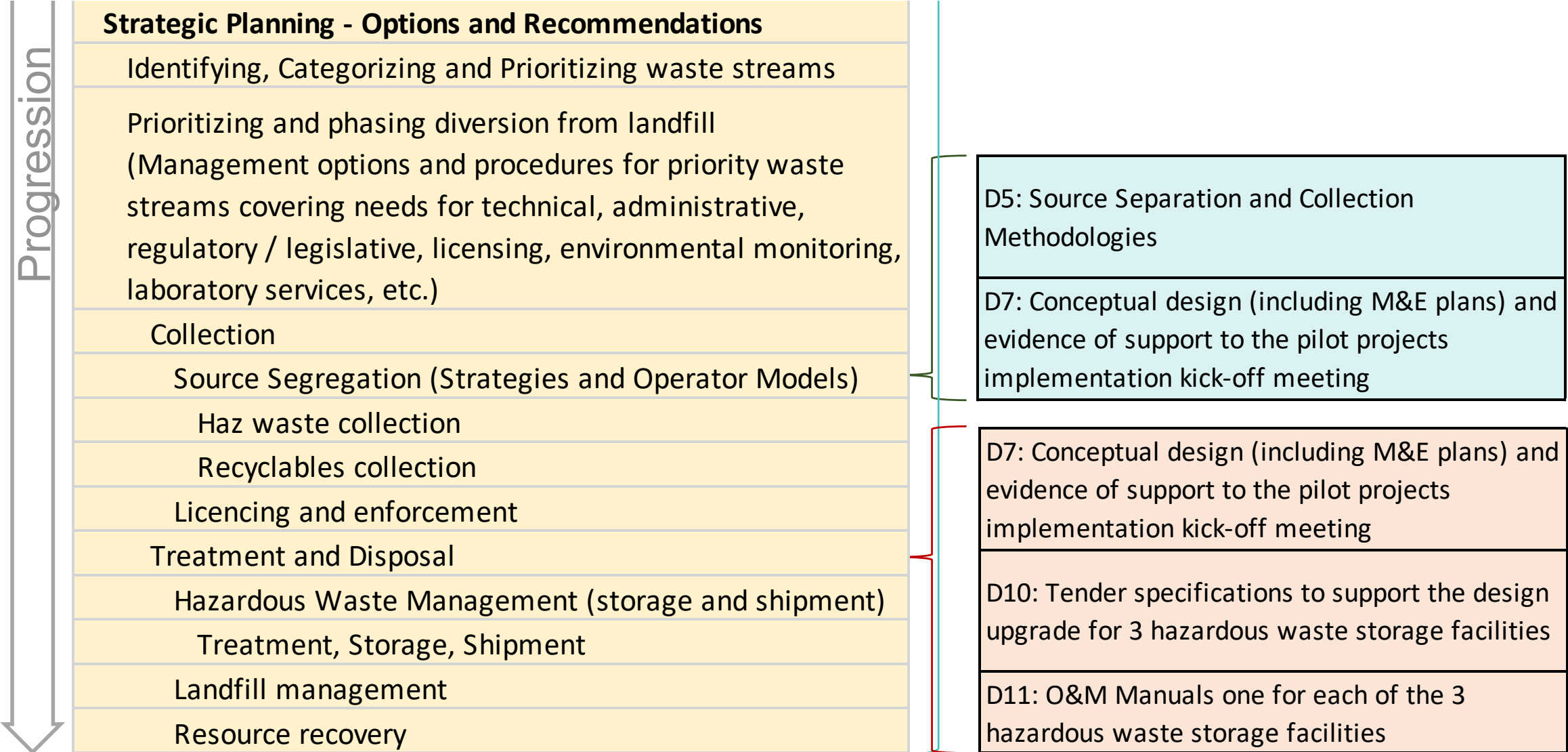
- Ensuring appropriate management option exists for all waste streams – incrementally developing alternatives from landfill based on evidence based priorities
- Ensuring public engagement, participation, education and system transparency as an essential component of operational resilience.
- Out source and encourage private sector to conduct non-landfill waste management activities by creating the enabling conditions that make it a viable business (the authority can not, and should not do it all) – ensure permitting and enforcement to prevent unscrupulous companies undercutting legitimate actors.

TRIGGER

LANDFILL OPERATION

- Ensuring landfill operational planning and associated staff competency trainings
- Ensuring appropriate resourcing with redundancy capacities
- Perform regular site inspection check lists and ensure collection of data on materials entering landfill, environmental monitoring and all environmental controls are performed according to evidence based decision making.
- Perform regular risk assessments and emergency response planning to minimise risks.
- Plan, Do, Check, Act, Repeat!

Strategic Planning for Resilient System



Steps and resources for implementation

Recognising current financial realities of the system

Steps for implementation	What can be achieved with current resources?	Additional resources needed for successful implementation
....		
...		