

# **Strategic Aspects on Waste Management in Decommissioning**

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# Background

- O1/O2 early retirement due to current market situation
- OKG decided to perform a waste management strategy investigation (2016)
- A decision base for the global strategy
- The investigation includes all material and waste from decommissioning, based on the decommissioning studies of O1 and O2.

# Waste Led Decommissioning

## Important principles

Do not  
bottleneck the  
waste routes!

Prior to dismantling  
and demolition  
–  
mandatory with a plan for  
materials and waste  
arising

Zero tolerance for waste  
streams without  
defined and accepted  
disposition route

All radioactive and  
potentially radioactive  
materials  
must be registered in  
accordance with a  
defined procedure

Data shall immediately be  
registered and quality  
assured.

Traceability throughout  
the process up to  
disposition  
(confirmed end-state)

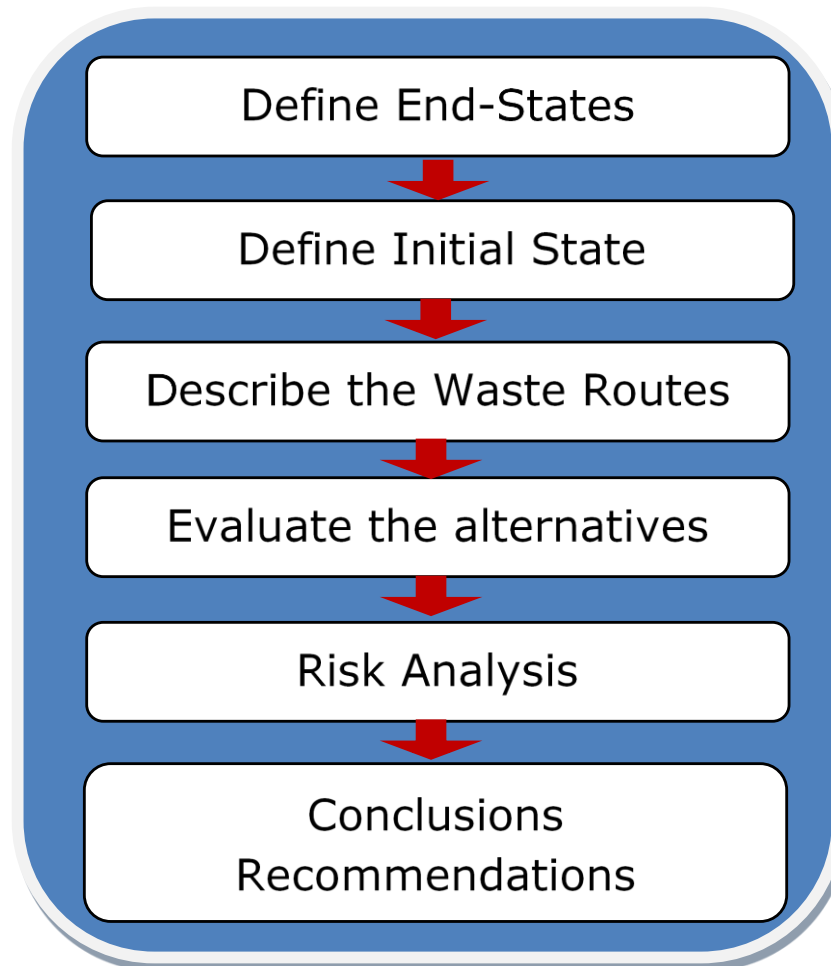
The Material and Waste  
Management should not  
be  
a limiting factor during  
dismantling and  
demolition.

# Waste Led Decommissioning

- The cost for management of radioactive waste is not proportional against the radioactivity content
  - “Extremely Low Risk” is very low cost (material value)
  - “Low Risk” is low cost
  - “Risk” can be low cost
  - LLW is expensive due to large volumes
  - ILW is expensive due to high handling costs
- A weak waste management process drives “hidden costs”
- Frequent and fast removal of material and waste will increase the performance in the decommissioning project
- Reconditioning is expensive – make it right the first time

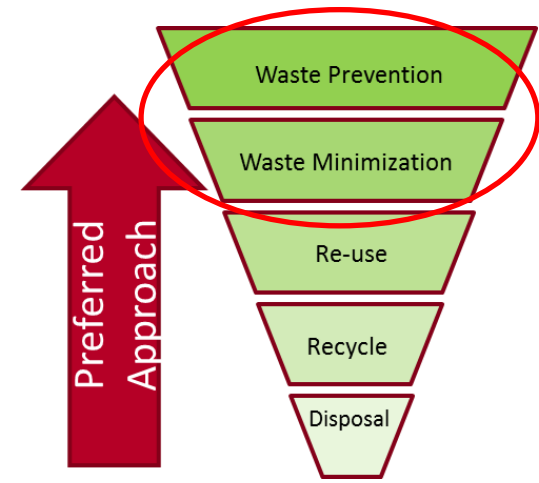
# Decommissioning Waste Strategy

## Process overview



# Step 1: Available End-States

- **General clearance**
  - Reuse
  - Recycling
  - Disposal as conventional waste
- **Conditional clearance**
  - Reuse, recycling or disposal with conditions
  - Significantly higher clearance levels
- **Disposal in VLLW repository (Landfill)**
- **Disposal in the geological repository**



# Step 2: Initial State

- Take benefit of **operational history** and the available **characterisation information**.  
The more you **know** – the better
- **Categorisation** of material and waste based on **radiological and non-radiological** properties
- Strategic decisions on **large components**
- Quantify **volumes and masses**

May have to be revisited  
several times throughout  
the strategy process

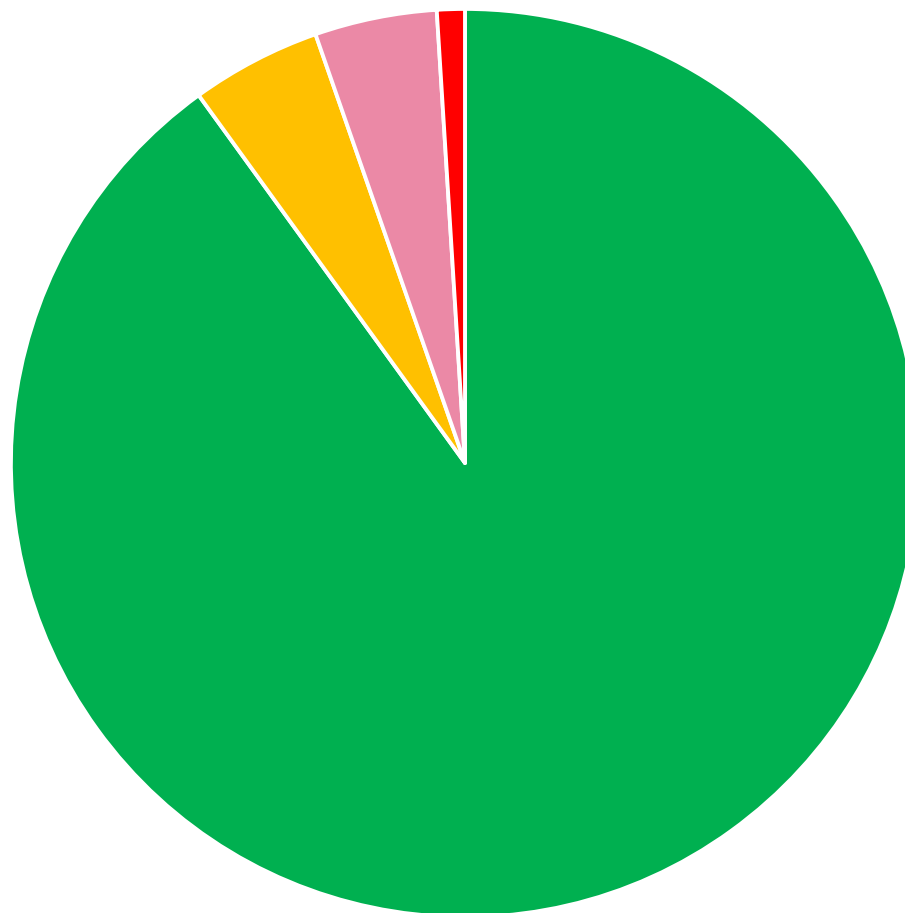
# Waste Categories

Waste Category	Specific activity [Bq/g Co-60]
Extremely Low Risk	Contamination <b>cannot</b> occur
Low Risk	Contamination of significance for clearance <b>should not</b> occur
Risk	< 0,1
LLW-1	0,1 – 1
LLW-2	1 – 20
LLW-3	20 – 100
LLW-4	100 – 1 000
ILW	> 1 000



# Amounts of Materials and Waste

Waste category	Total [Mg]
Extremely low risk	221 400
Low risk	Not quantified
Risk	11 400
LLW-1	6 540
LLW-2	1 350
LLW-3	997
LLW-4	1 805
ILW	2 440



■ Extremely low risk + low risk   ■ Risk   ■ LLW 1-4   ■ ILW

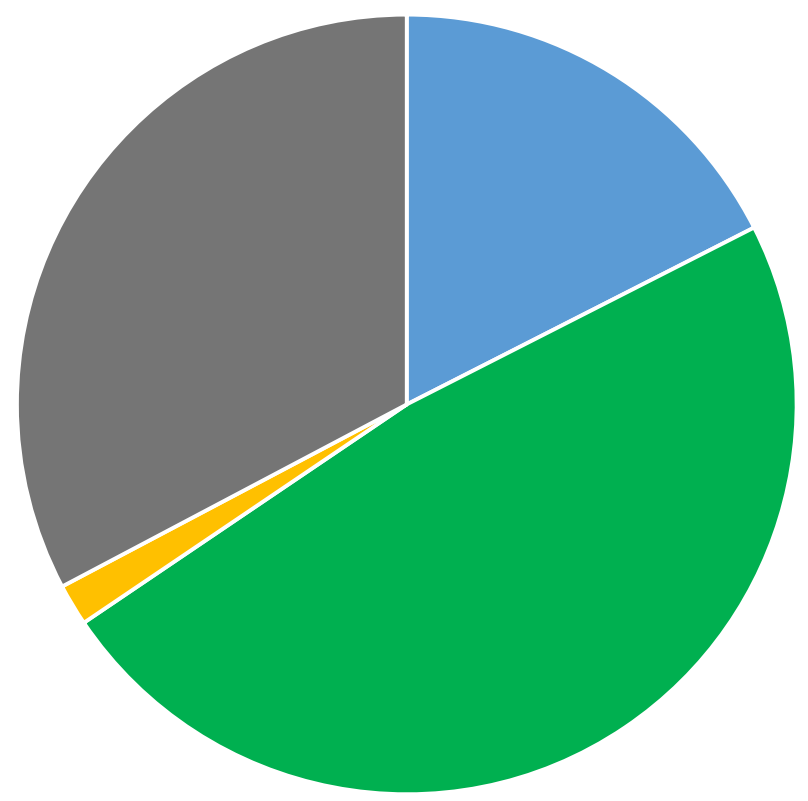
# Low Level Waste

## Activity distribution



■ LLW-1 ■ LLW-2 ■ LLW-3 ■ LLW-4

## Waste type



■ Large components ■ Other metal  
 ■ Incinerables ■ Other

# Step 3: Alternative Waste Routes

- Dispose waste as is after dismantling  
i.e. **no treatment**
- On-site waste treatment centre  
**inside facility**
- On-site waste treatment centre  
**outside facility but on site**
- Ship to dedicated **external waste treatment facility**

Large waste volumes  
for disposal

Logistical challenge  
Low investment

High investment  
Minimum impact on  
dismantling process

Transfer of risk  
Less volume for  
disposal

# Step 4: Evaluate the Alternatives

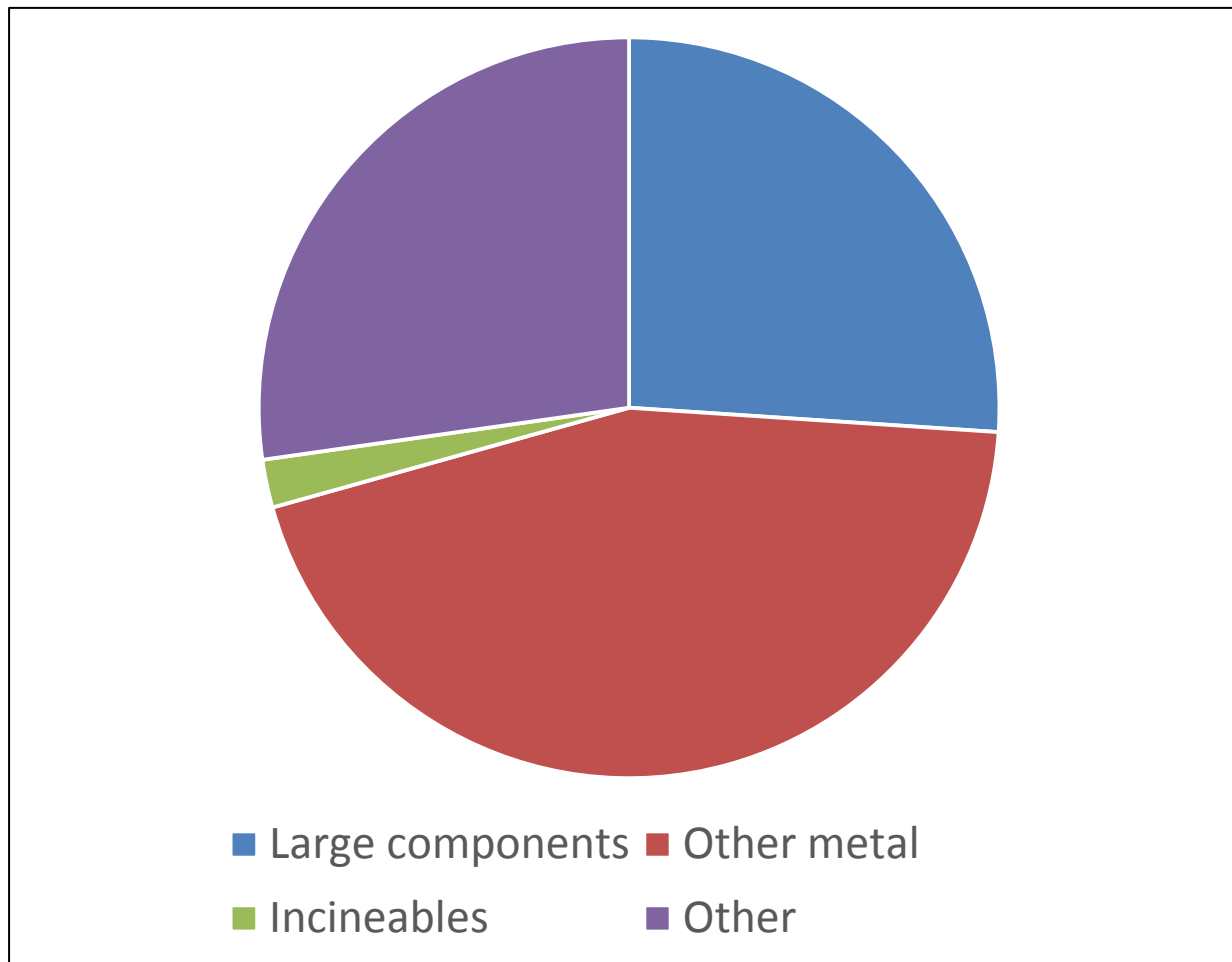
## Quantify

- Direct costs
- Indirect costs (including estimate of hidden costs)
- Investments in facilities and equipment
- Investments in competence
  
- Utilisation of organisation over time
- Utilisation of available disposal volume
  
- Impact on project performance (schedule)

The major cost driver in a D&D project

## ➤ Evaluate and compare

# Distribution of costs for Low Level Waste



# Step 5: Risks - Risk analysis

- **Uncertainties**

- Known Knowns (low uncertainty)
- Known Unknowns (possible to estimate)
- Unknown Unknowns (impossible to quantify)

Plan - Mitigate

We may have a problem...

Oh no - It can't be true...

- *Reduced by additional characterisation activities of Known Unknowns*
- *Mitigated by wider acceptance window for treatment/disposition*

- **Practical considerations**

- Availability of waste routes and disposition alternatives
- Efficiency in processes
- Where and how to recondition prior to future disposal, if needed

- *Reduce risks by keeping at least two waste routes and disposition alternatives open for each waste category*

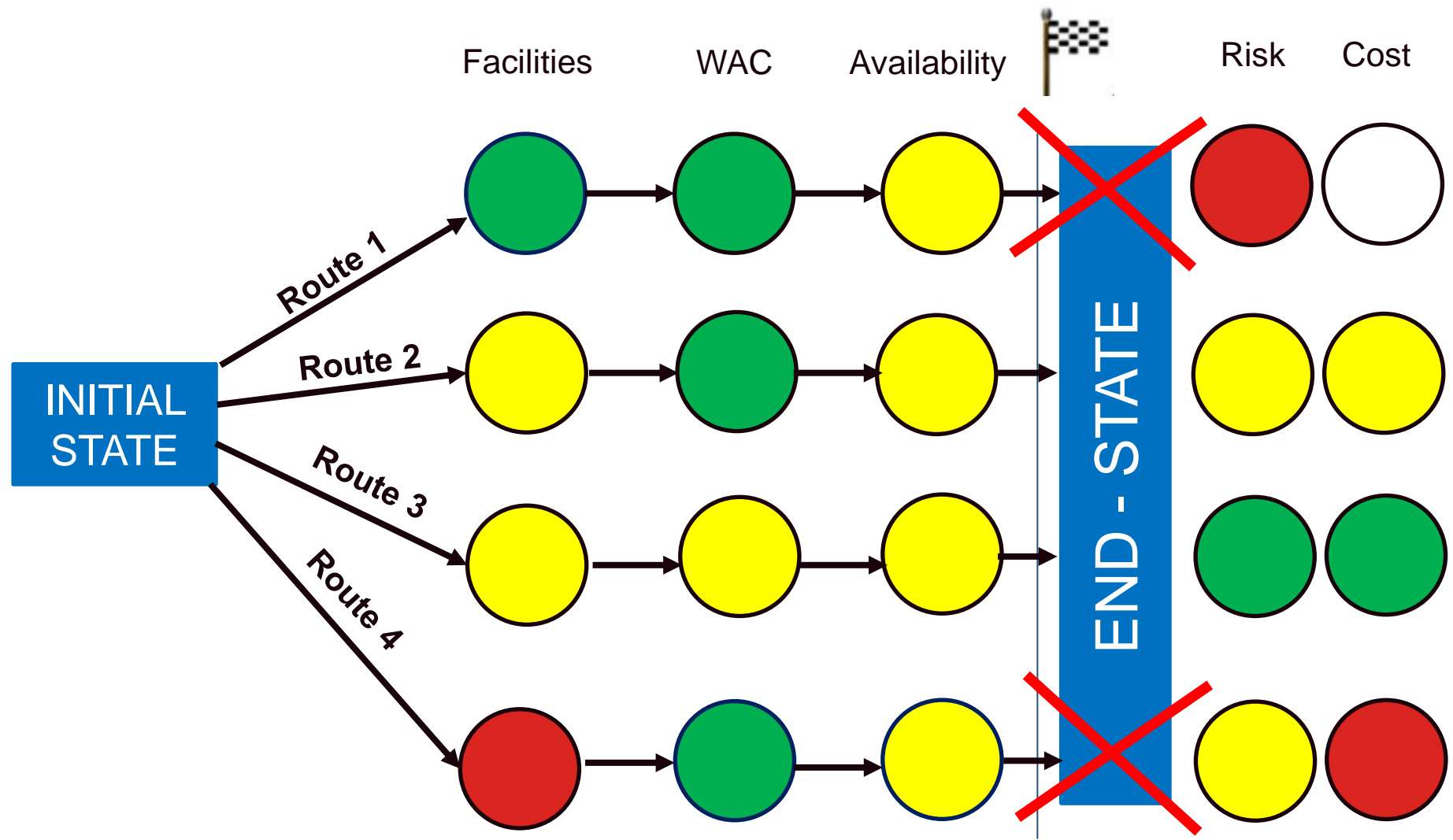
# Risk analysis (excerpt)

Risk description	Probability	Consequence	Cost impact	Mitigation to reduce risk
Poor characterisation/ categorisation of radiological and non- radiological properties	U-L	Additional efforts which delays the project	L-H	Robust processes, Record management, Quality assurance
Non-clearable waste to clearance station	E	Re-routing of waste. Failure investigation	L	Education, Eng. barriers Quality assurance
New requirements for final disposal of waste	L	Opening of waste packages, Additional sampling Reconditioning	L-M  M-H	Reversibility, Precaution measures, Record management, Dialogue with repository owner

Unlikely – Likely - Expected

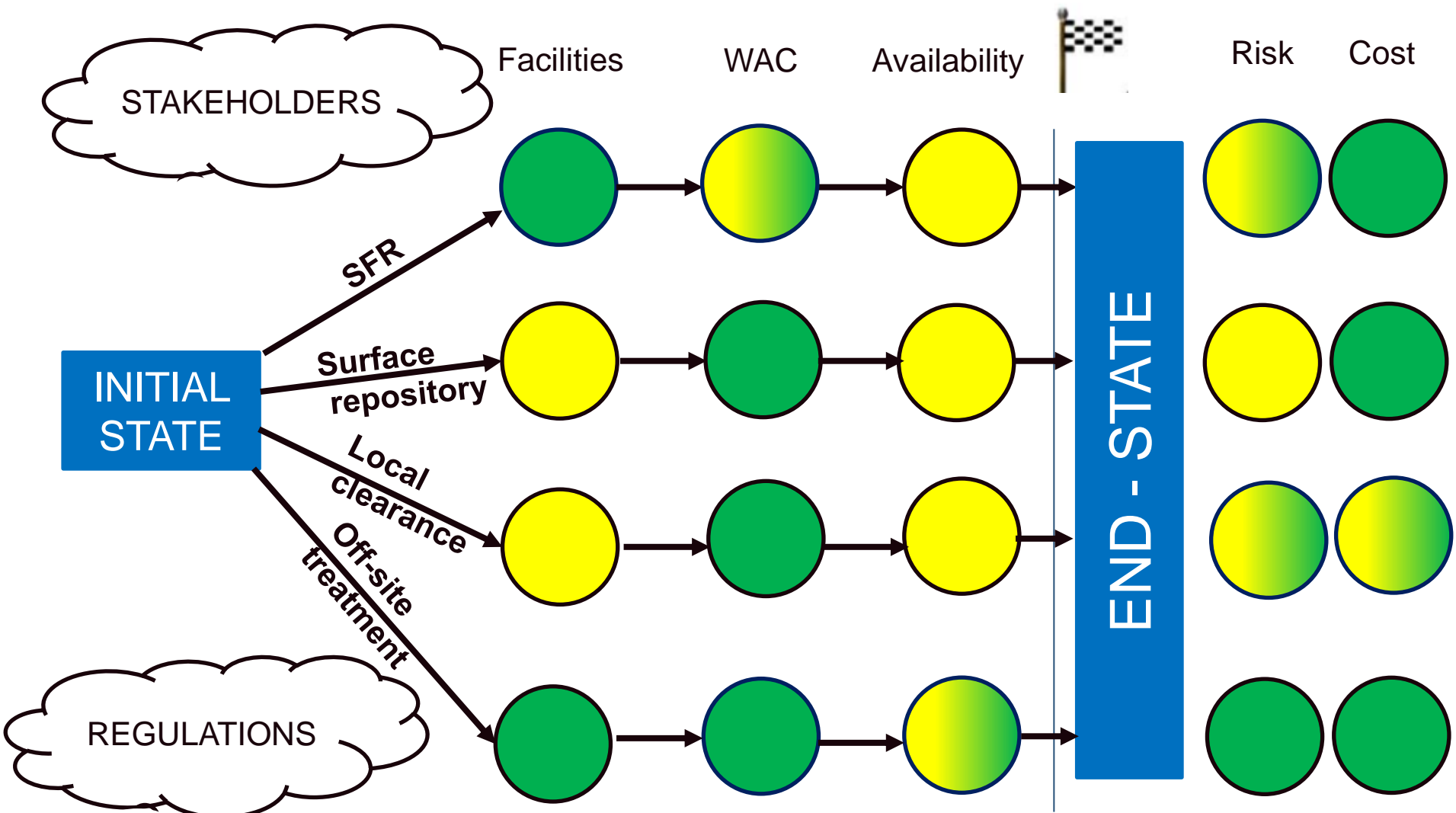
Low – Medium - High

# Conclusions - Example





# Conclusions – Specific 01/02



# Summary

Secure  
End-states  
and  
understand  
Initial state

Characterisation  
Characterisation  
Characterisation

Minimize  
“Known  
Unknowns”

Do not  
bottleneck  
Waste Routes

More than one  
waste route -  
where  
possible

Implementation of Waste Led Decommissioning –  
**a way to success**

Thank you for your Attention!