Rijkswaterstaat
Ministry of Infrastructure
and Water Management

Maeslant Barrier
History, Present & Future

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Maeslant Barrier . . . .
more in detail

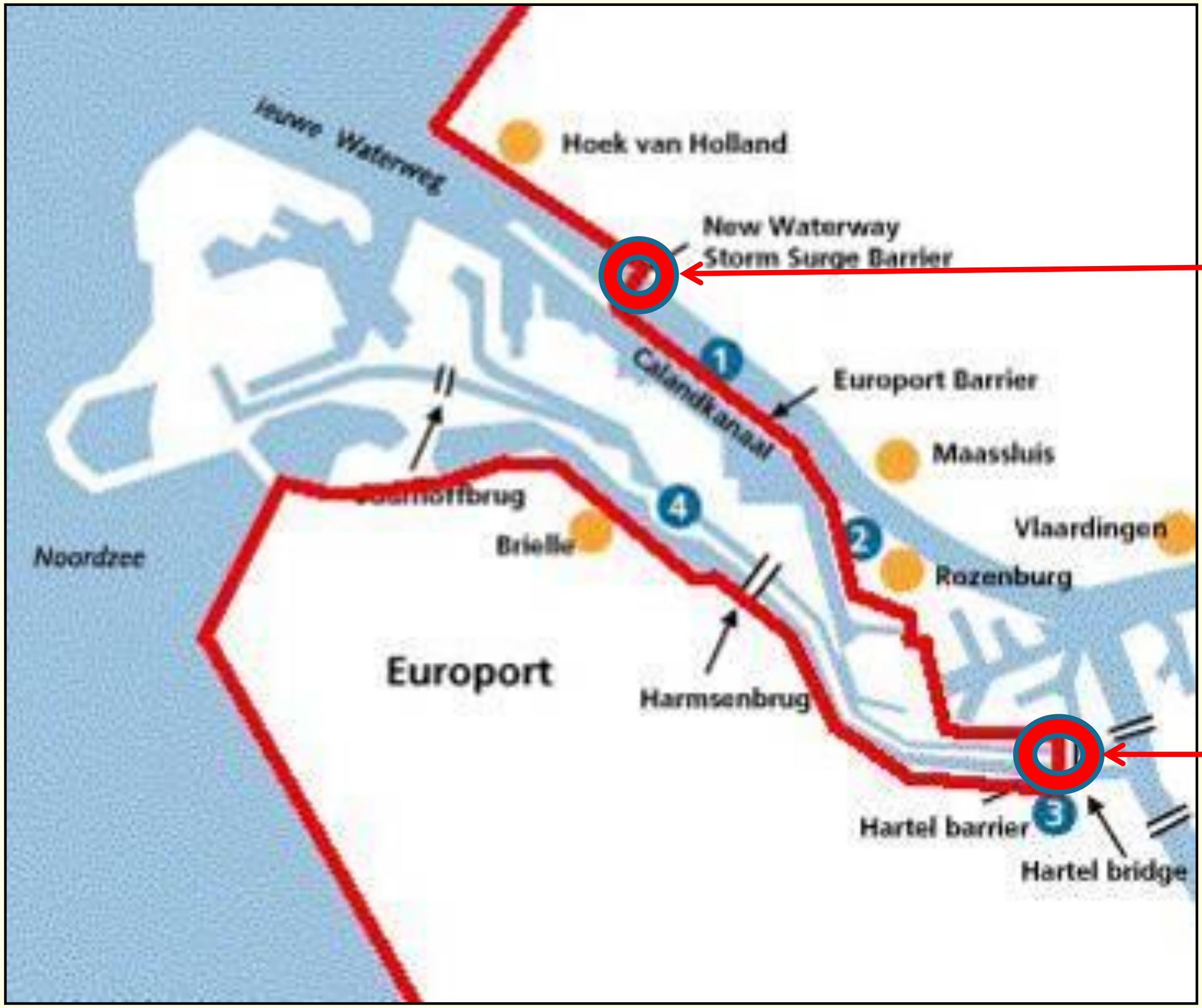
Maeslant Barrier

- 1997
- 2 gates
- no sluice

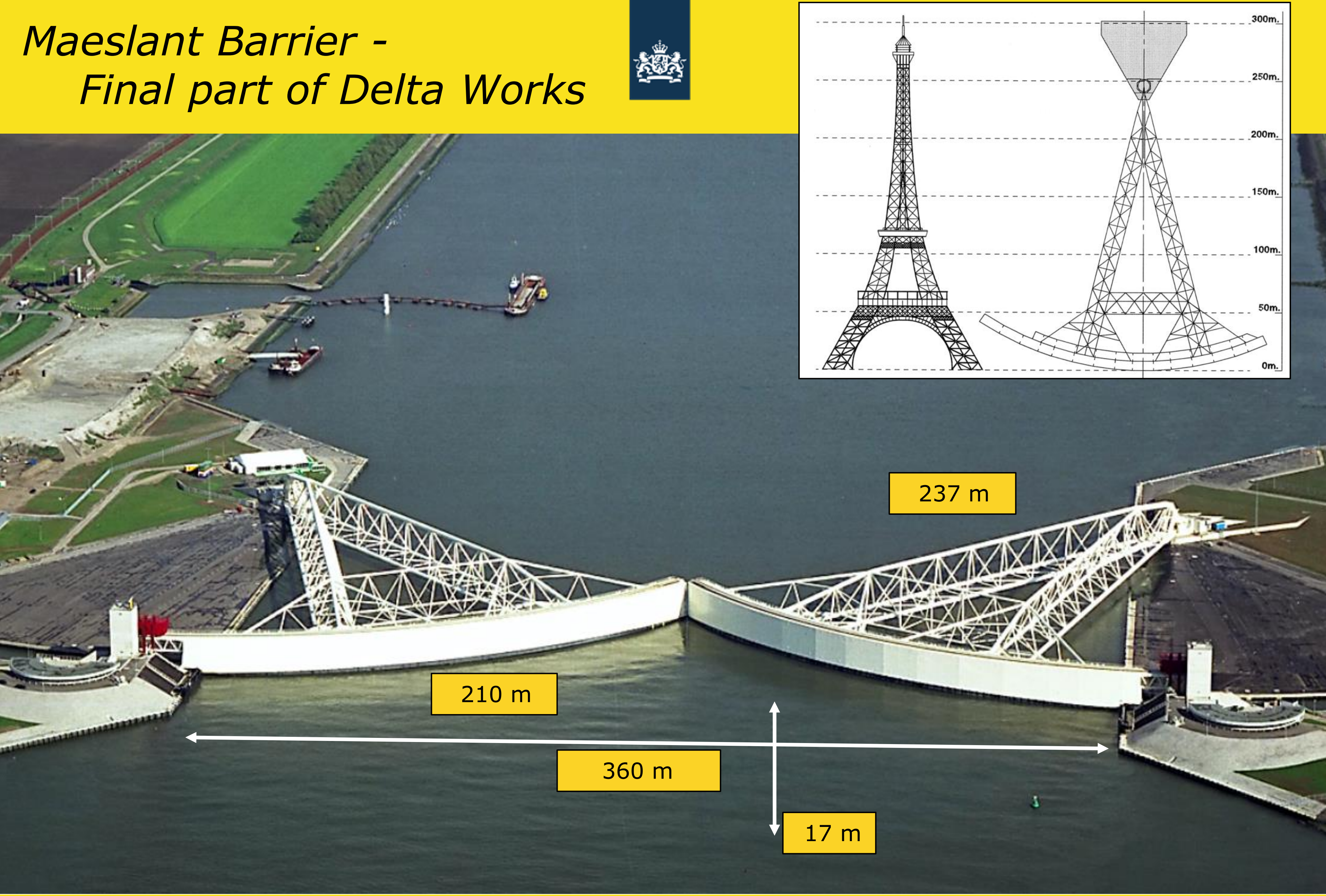
Maeslant Barrier - Final part of Delta Works

- Preparation started in 1987
- Competition
- 6 alternative designs
- Design, construct and maintenance

Maeslant Barrier -
Final part of Delta Works

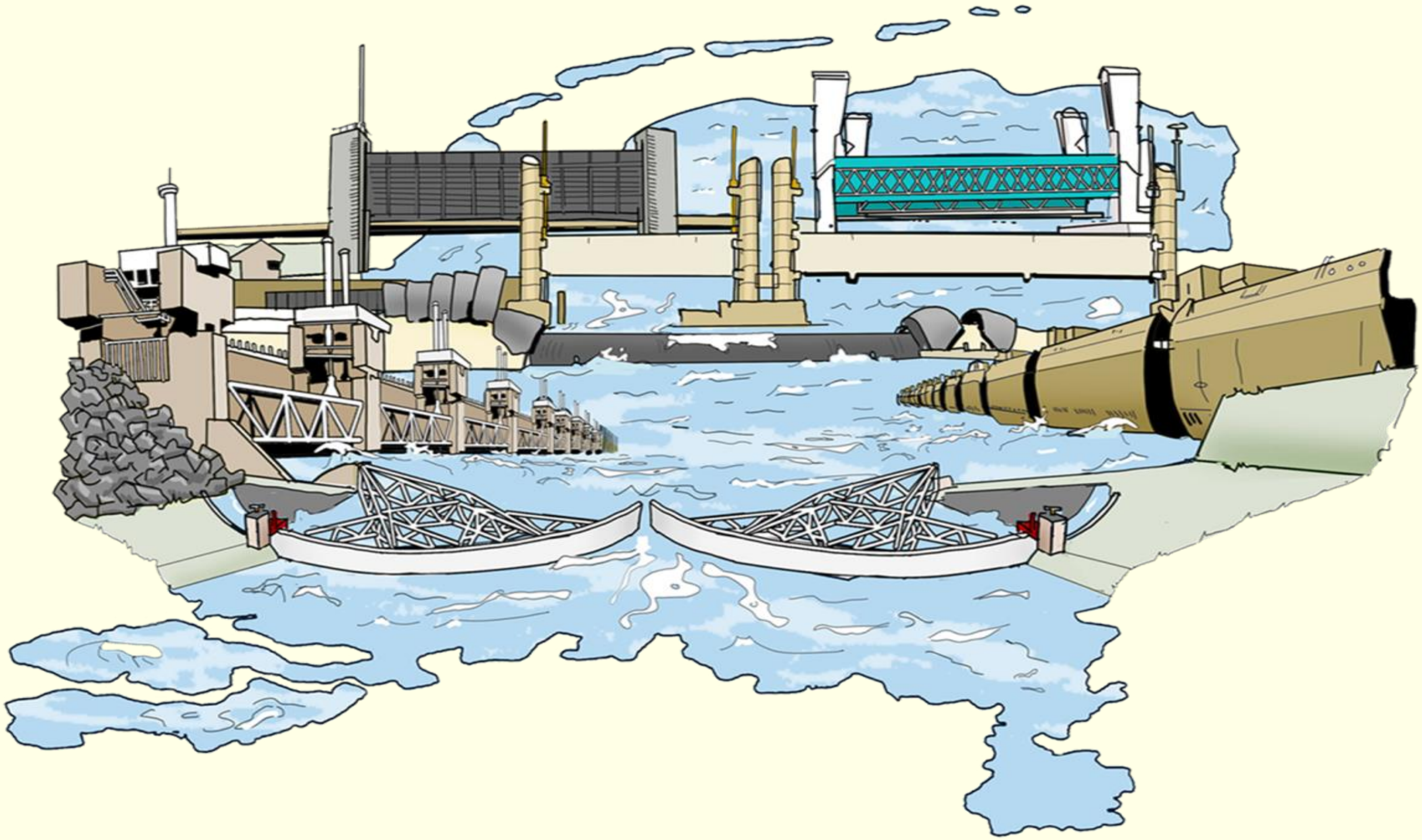


Maeslant Barrier - Final part of Delta Works



Maeslant Barrier

Construction of the Maeslant Barrier



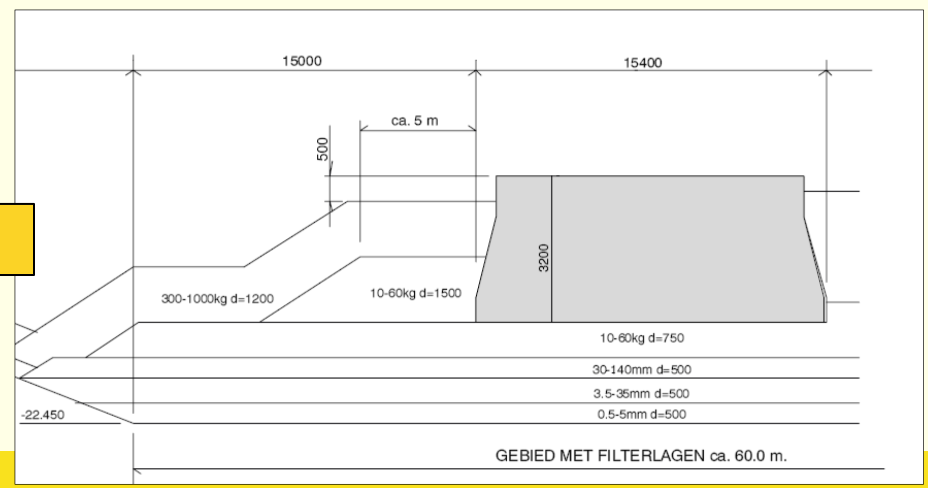
Maeslant Barrier - Sill

Filterbed, sand, gravel, big stones

15 x 5 x 3 m each

630 tons each

64 threshold parts, submerged



Maeslant Barrier - Ball joint

revision in 2003/04

10 m diameter

680 tons

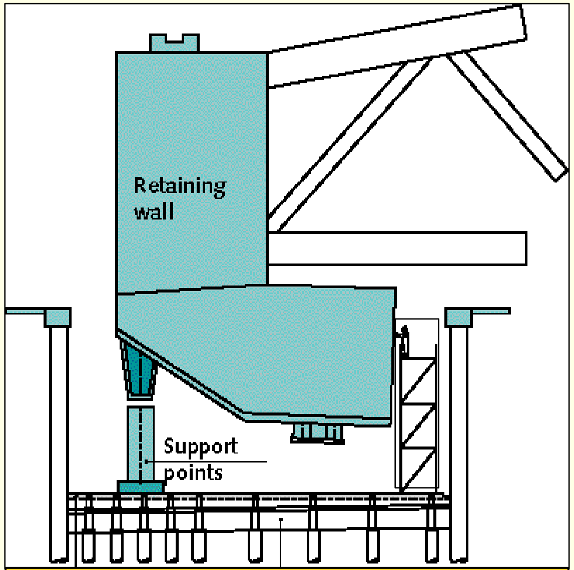
3 directions of movement

52.000 tons foundation

Maeslant Barrier - Retaining Wall

210 m wide

22 m high



26 valves &
30 pumps per wall

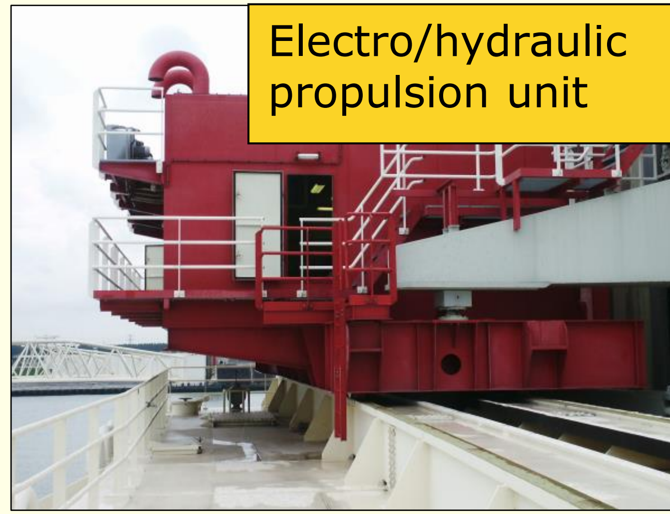
13 compartments

depth 17 m

Maeslant Barrier - Locomobile

6 engines

Electro/hydraulic propulsion unit



6,000 kN pulling force

Rack and pinion

For horizontal movement and fixation

Maeslant Barrier - Trusses

Maeslant Barrier - Trusses

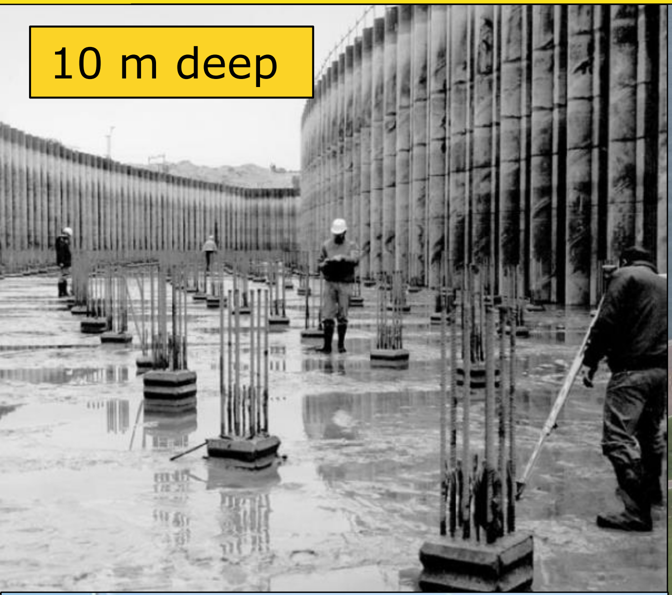
20 m high

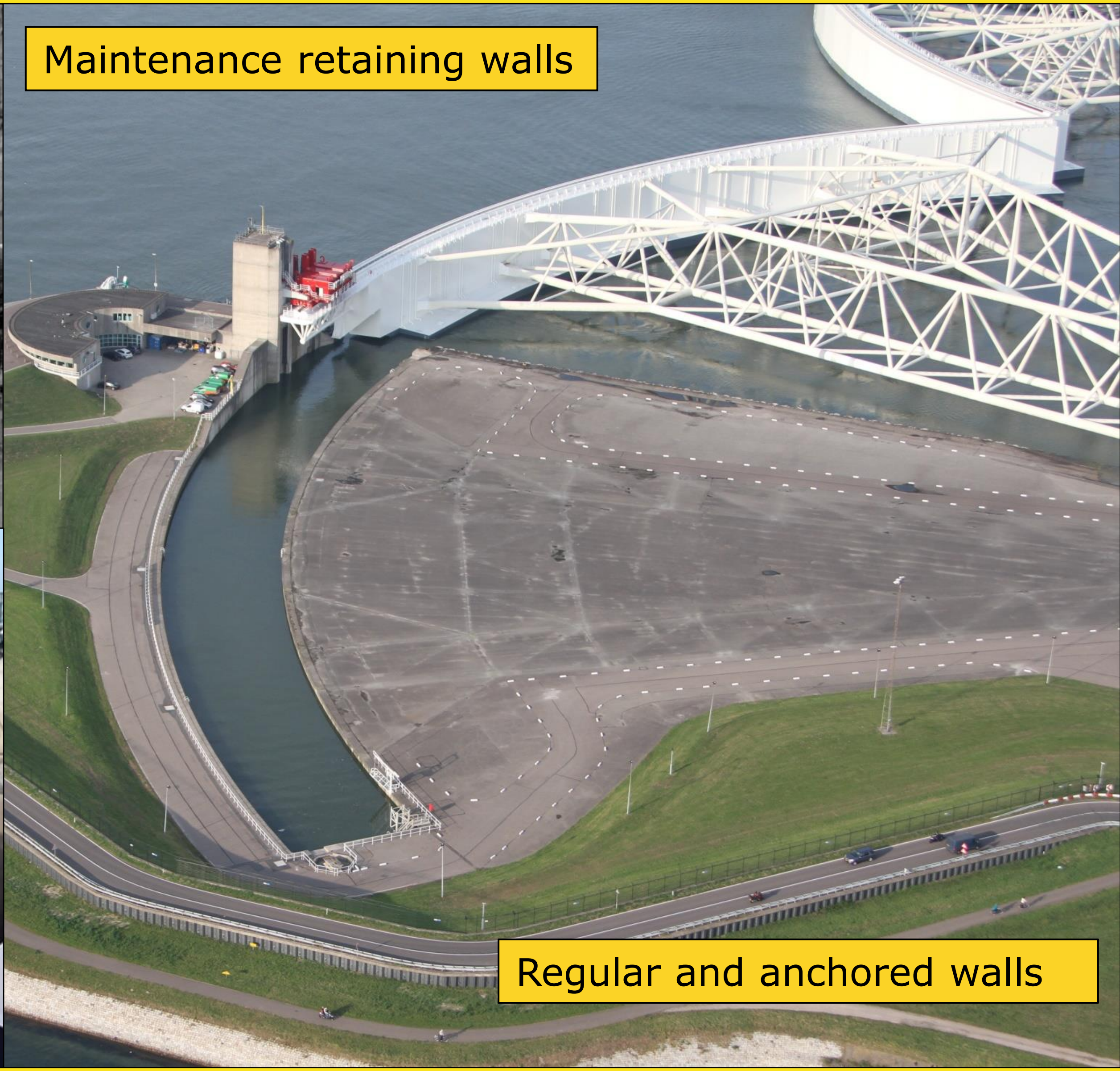
90 mm thickness

1.80 m diameter

237 m long

Maeslant Barrier - Dock and Dock Doors





Maeslant Barrier - Support and Control Systems

Hydro meteo forecast

BOS

BES

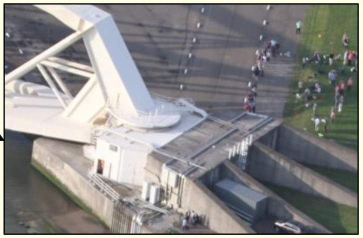
Decision support system

Control systems

Dock

Locomobile

Retaining Wall

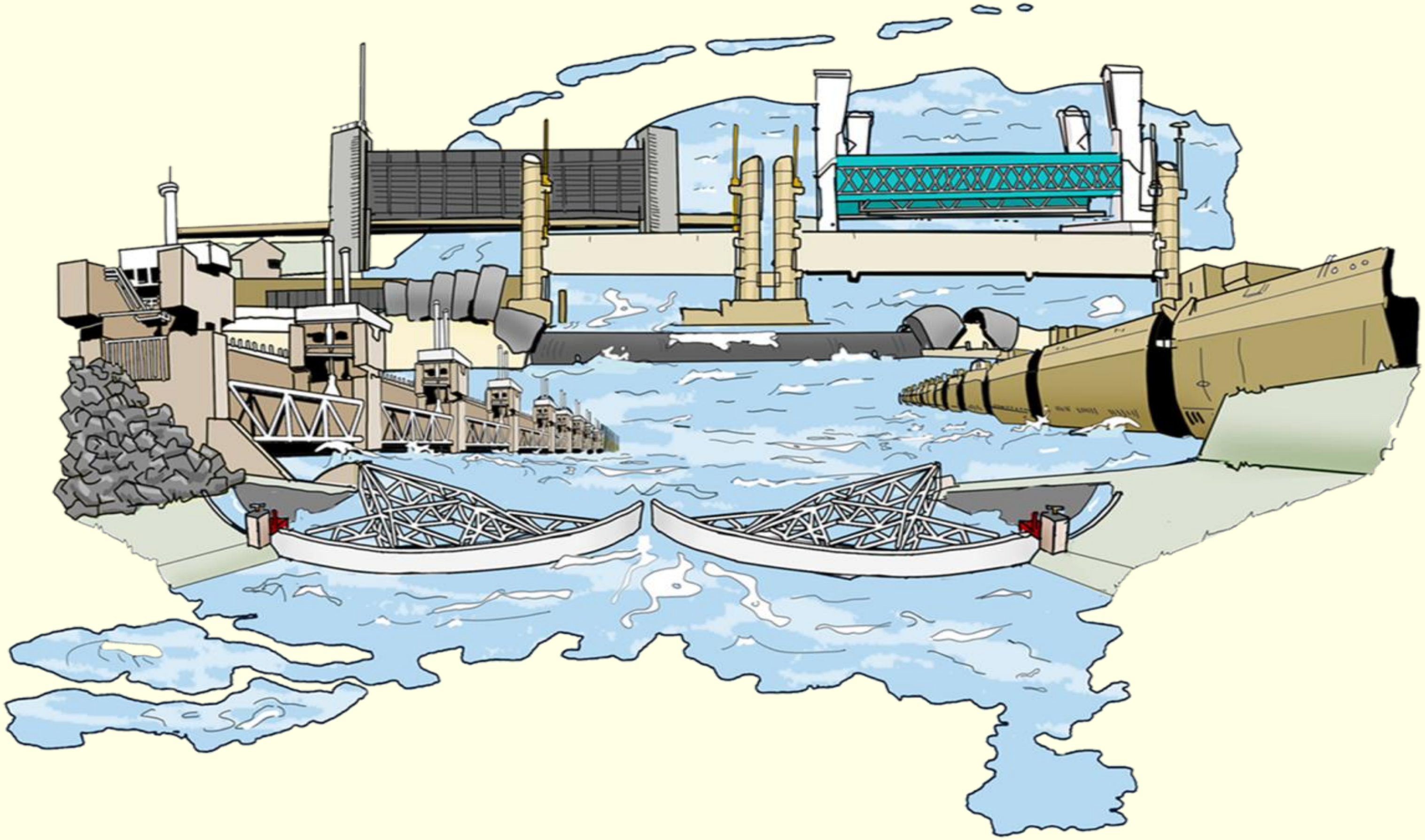


Ball Joint

Utilities

Impression of closure

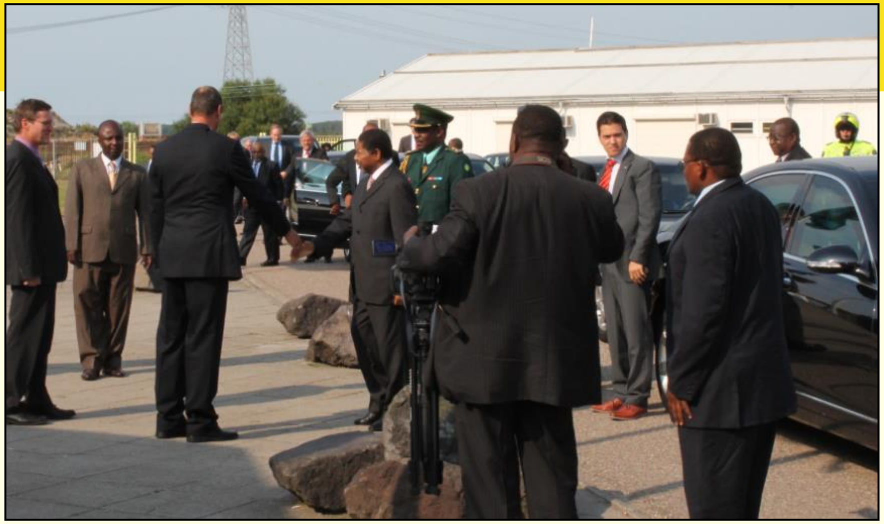
Information Center



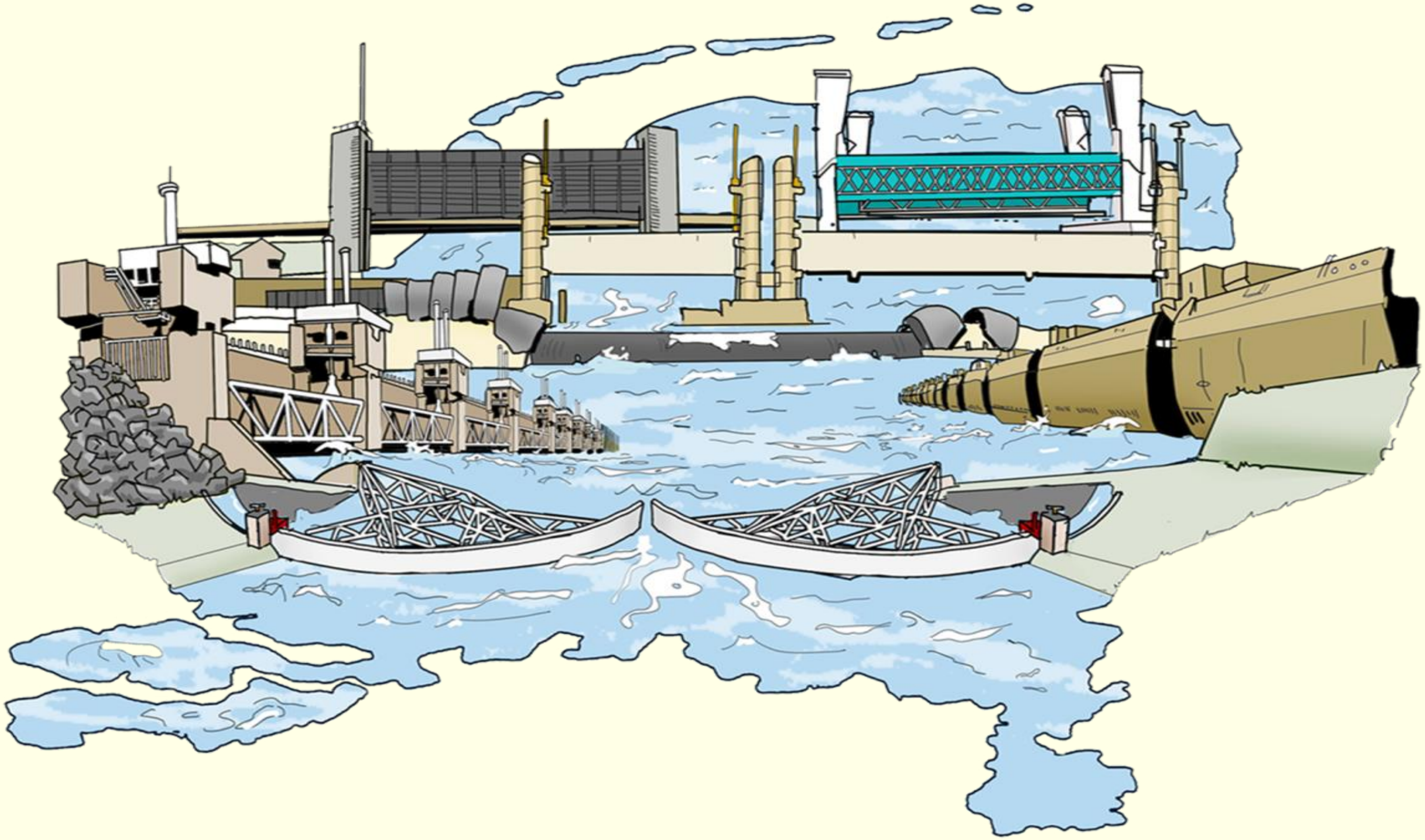
Information center

Various groups of visitors

. . . and high officials



Introduction to Risk Based Asset Management

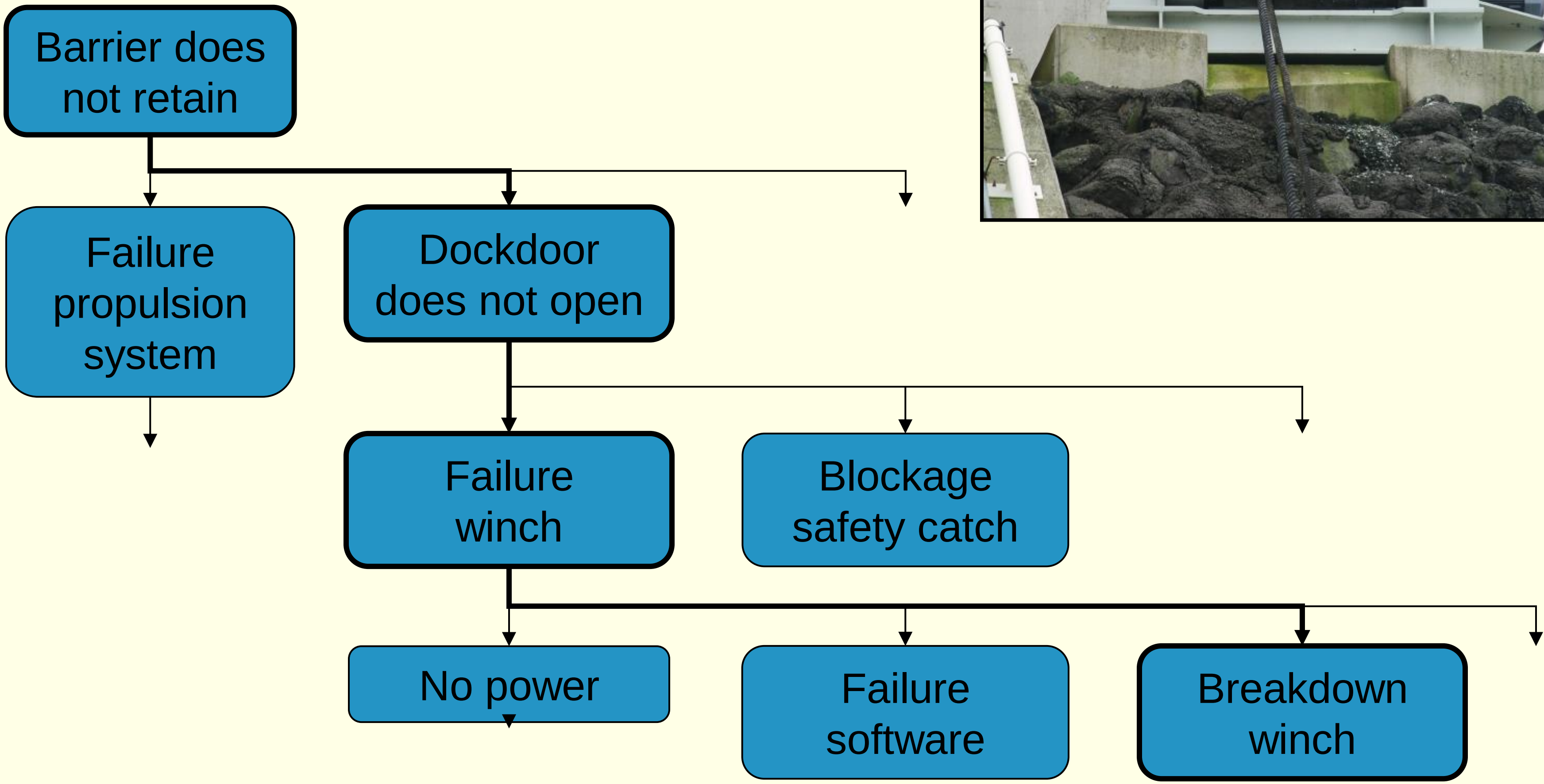


Frontpage news

Changes in Maintenance and Operations from three new perspectives

1. **Focus on reliability related issues and operational use**
2. **Trained Staff contributes to reliability**
   - Technical expertise and safety awareness
   - Training and exercize
   - Procedures and instructions (to prevent failures)
   - Tests and exams
3. **Probabilistic maintenance and operations**
   - Corrective maintenance
     failure? → repair
   - Preventive maintenance
     example: Exceeded mileage? → replace
   - Predictive maintenance
     example: maintain only when failure may occur
   - Choice of strategy depends on risk analysis and type and contribution of component to the operational use of the barrier

Reliability dock door
Fault tree analysis - example



. . . down to maintenance level

2 Flood defense walls
13 compartments
Total 60 pumps

<u>Pump characteristics</u>

- Failure probability (demand): $8{,}6 * 10^{-6}$ / each time
- Failure probability (mission): $3{,}0 * 10^{-6}$ / hr
- Mission duration: 8 hours

<u>Maintenance characteristics</u>

- Test frequency: 1 / month
- Inspection frequency: 1 / year
- Replacement interval: 30 years
- Maximum repair time: 48 hours

Spare parts on site

Fault tree includes

- Redundancy
- Software and hardware failure
- Absence of data on water levels

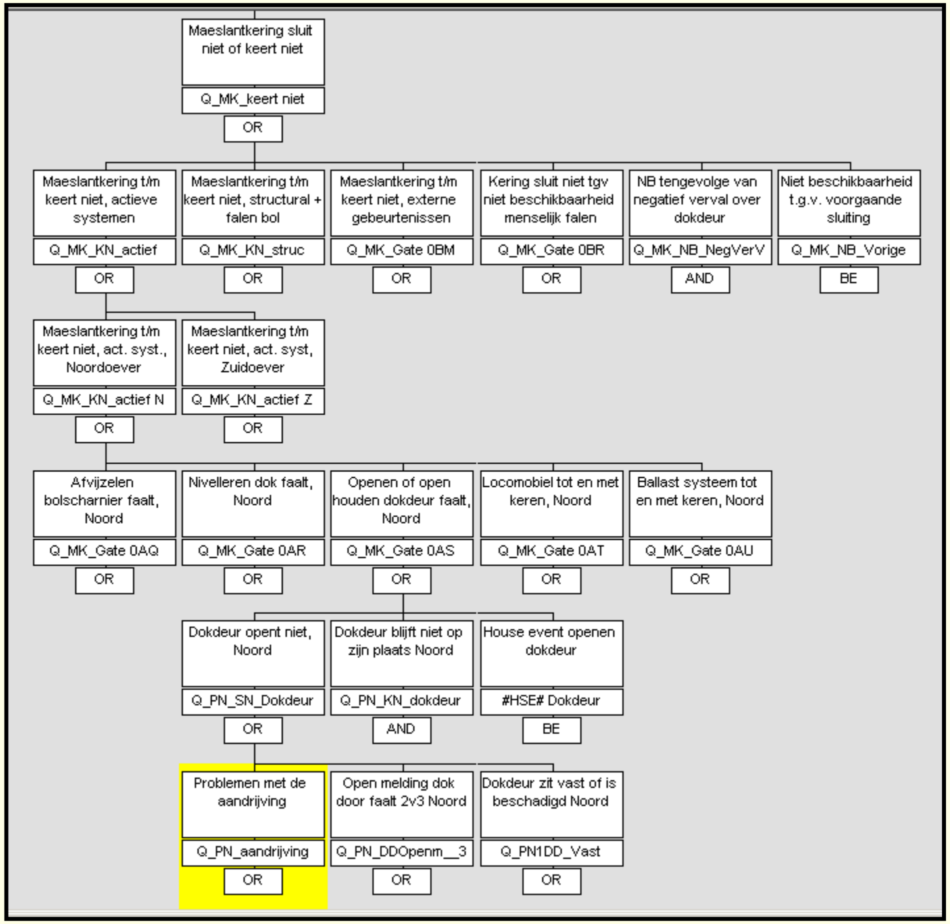
- Level of training and expertise
- Human error and human corrective capabilities

- External influences (lightning, collision, wind mills)

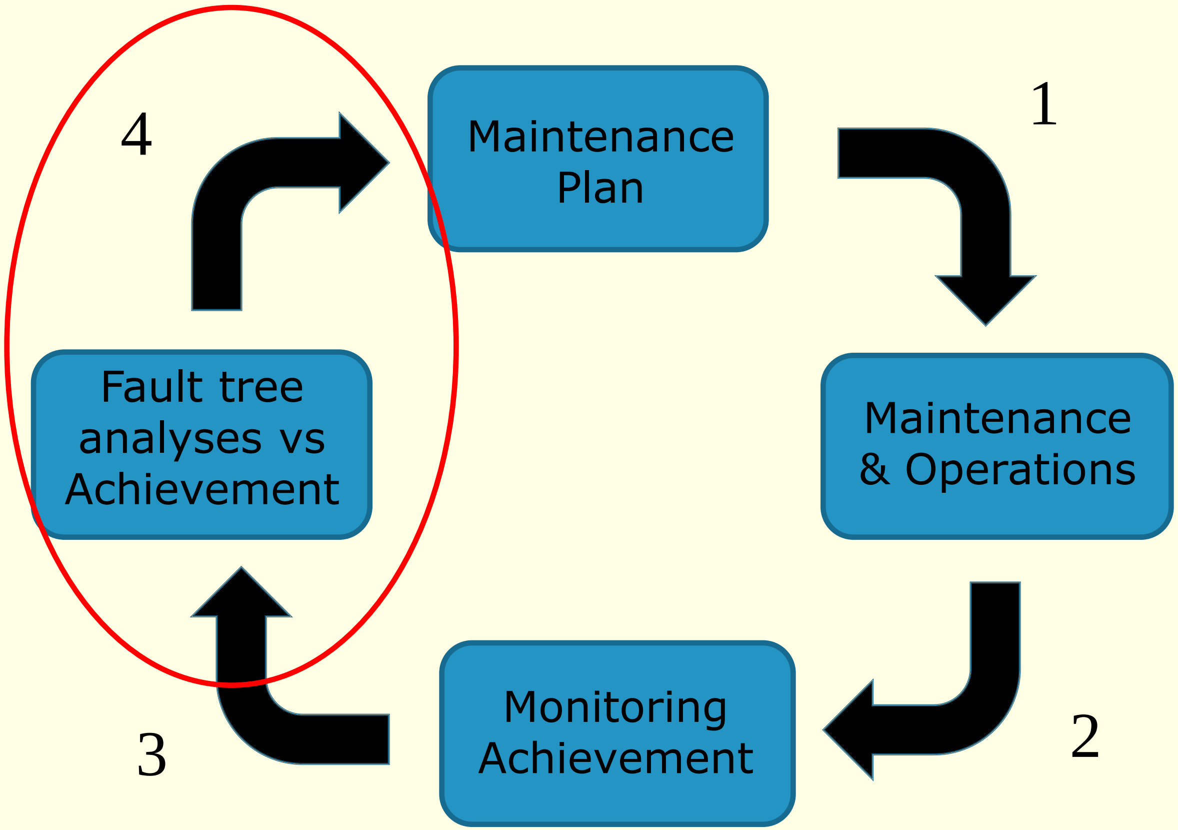
<u>Approach</u>

- Regular updates (monthly/annualy)
- Measures to be taken if actual failure rate is worse than required failure rate

Fault tree Maeslant barrier



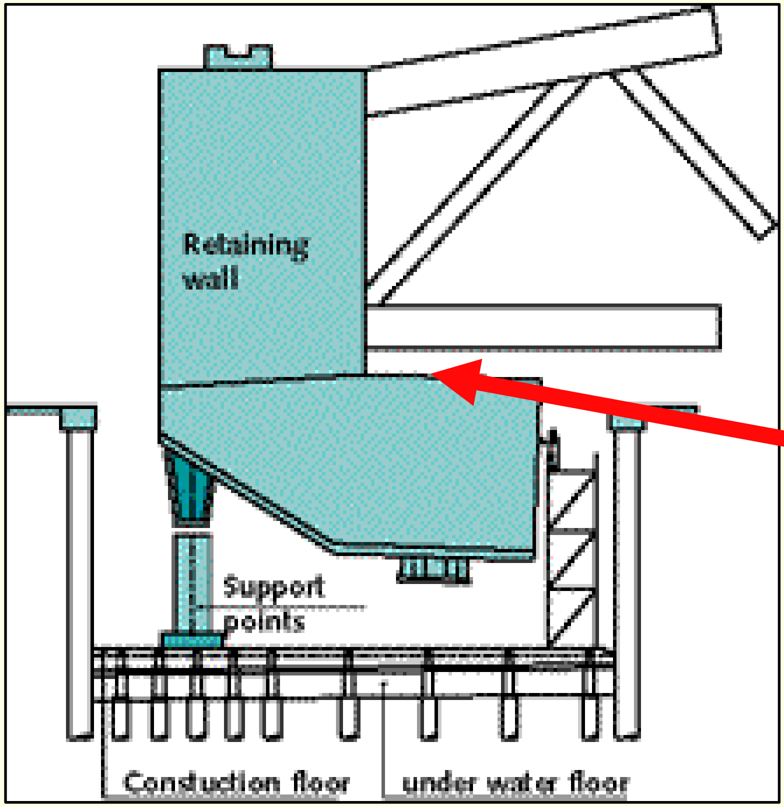
- 9,000 Basic Events
  - 5,000 related to components
  - 4,000 modeling events (e.g. fraction of time leading to failure)
- 210 maintenance groups (clustering of similar components)
- 3 top events:
  - Failure to close
  - Failure to retain water
  - Failure to re-open
- Roughly 1,600 * A4
- Updated twice a year

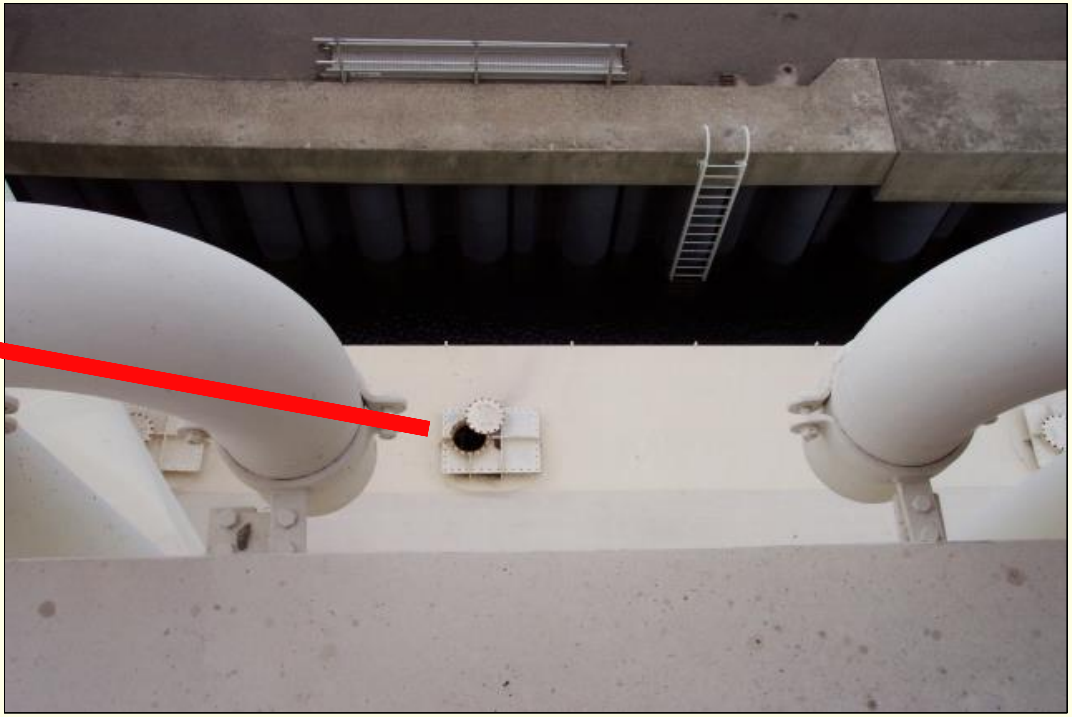


Safety levels stated in Dutch Flood Defence Act

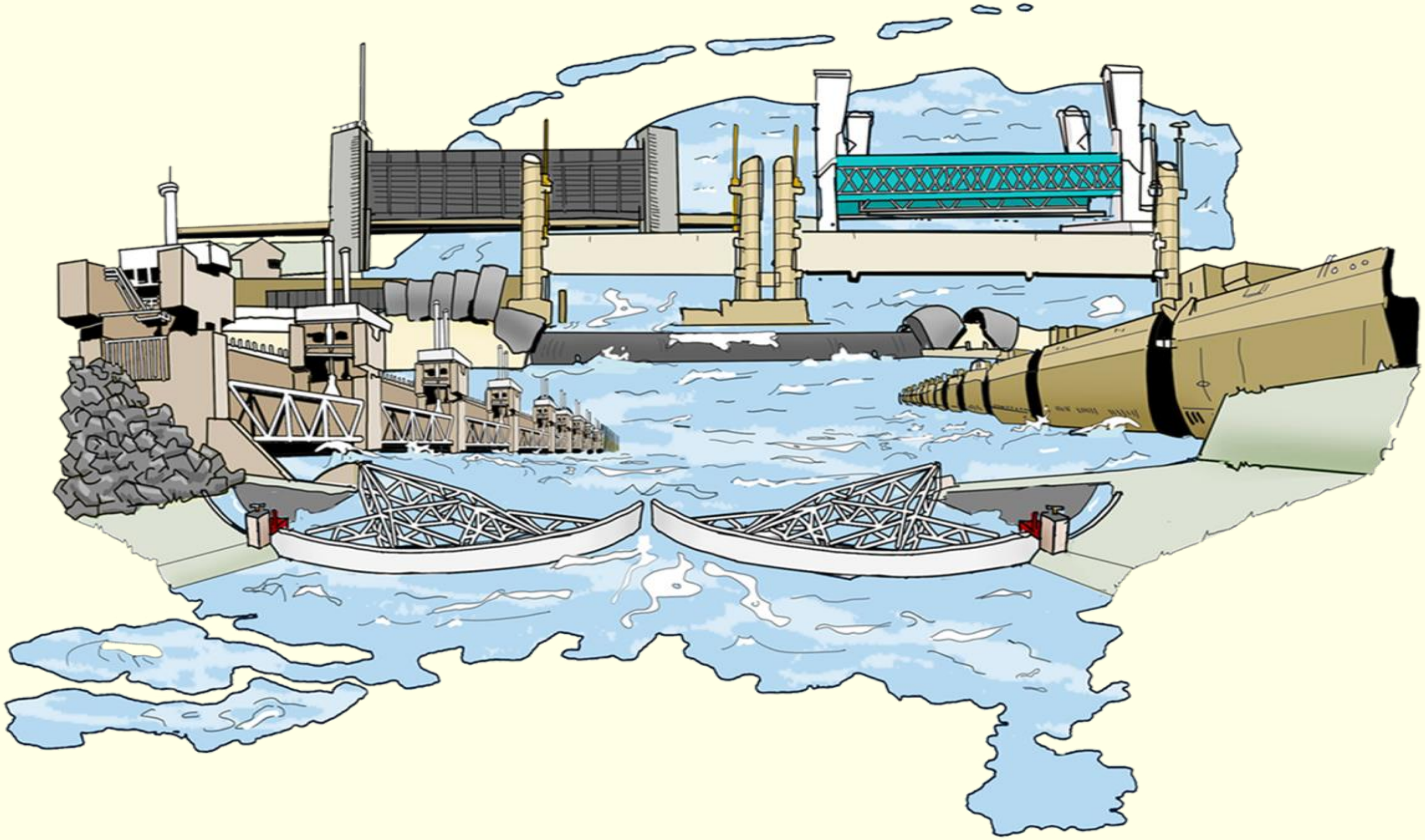
Reality can be hard to model: Human error

- All bolts tightened too hard

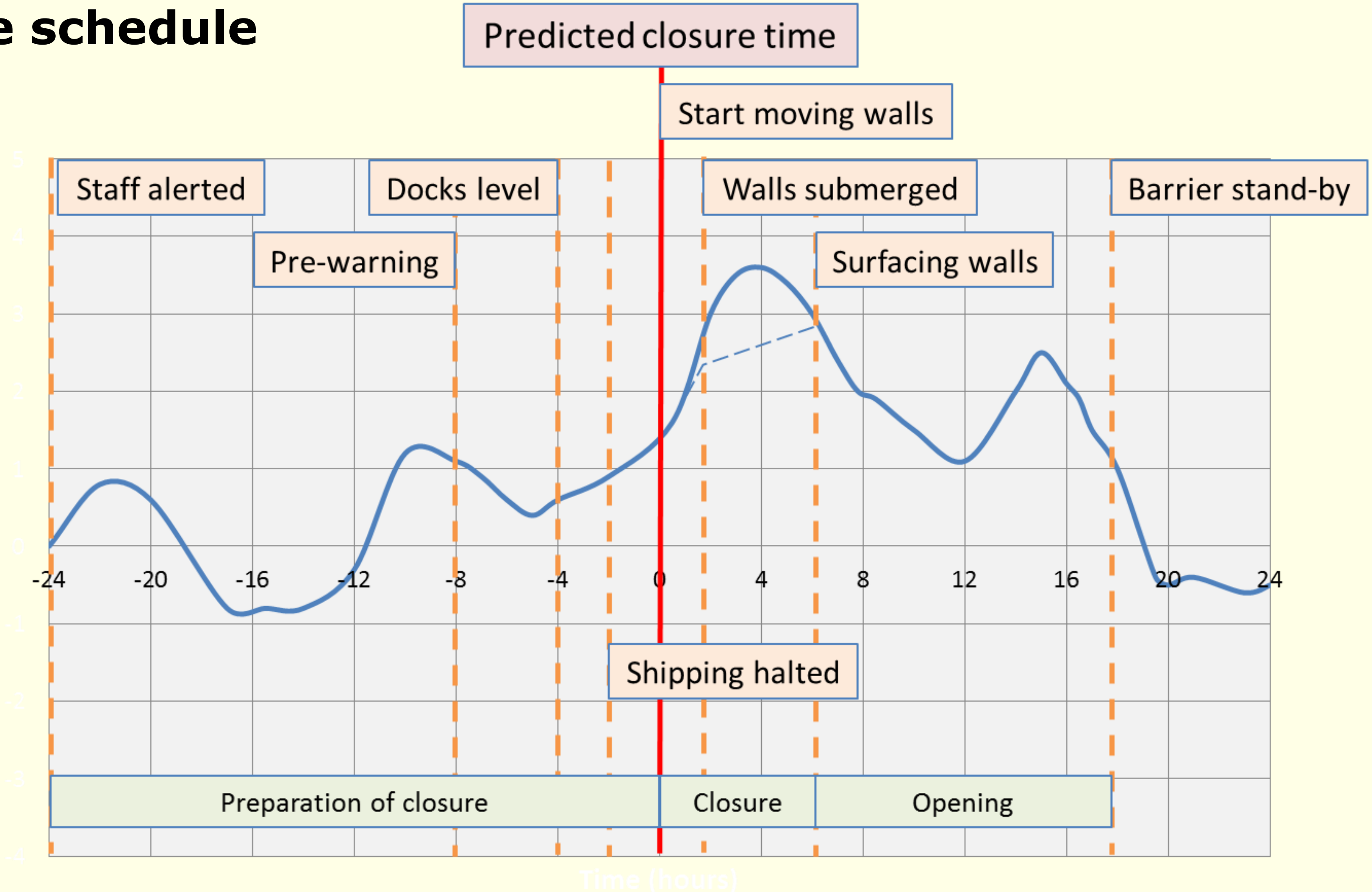




Introduction to Operational Team



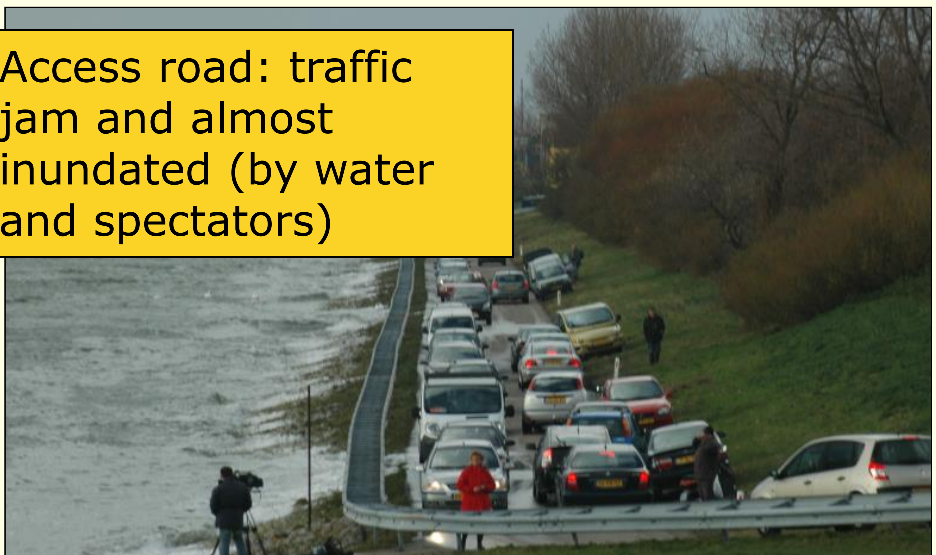
Closure schedule



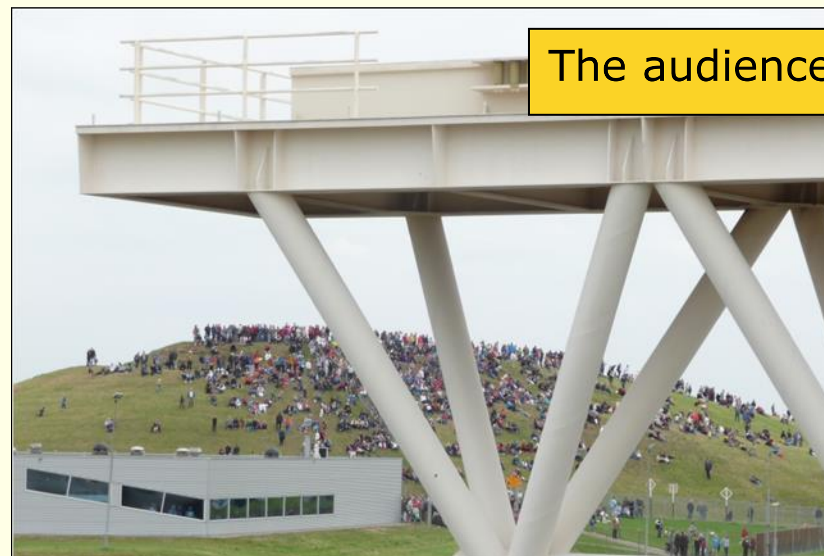
Introduction to Operational Proces

Press and camera crew

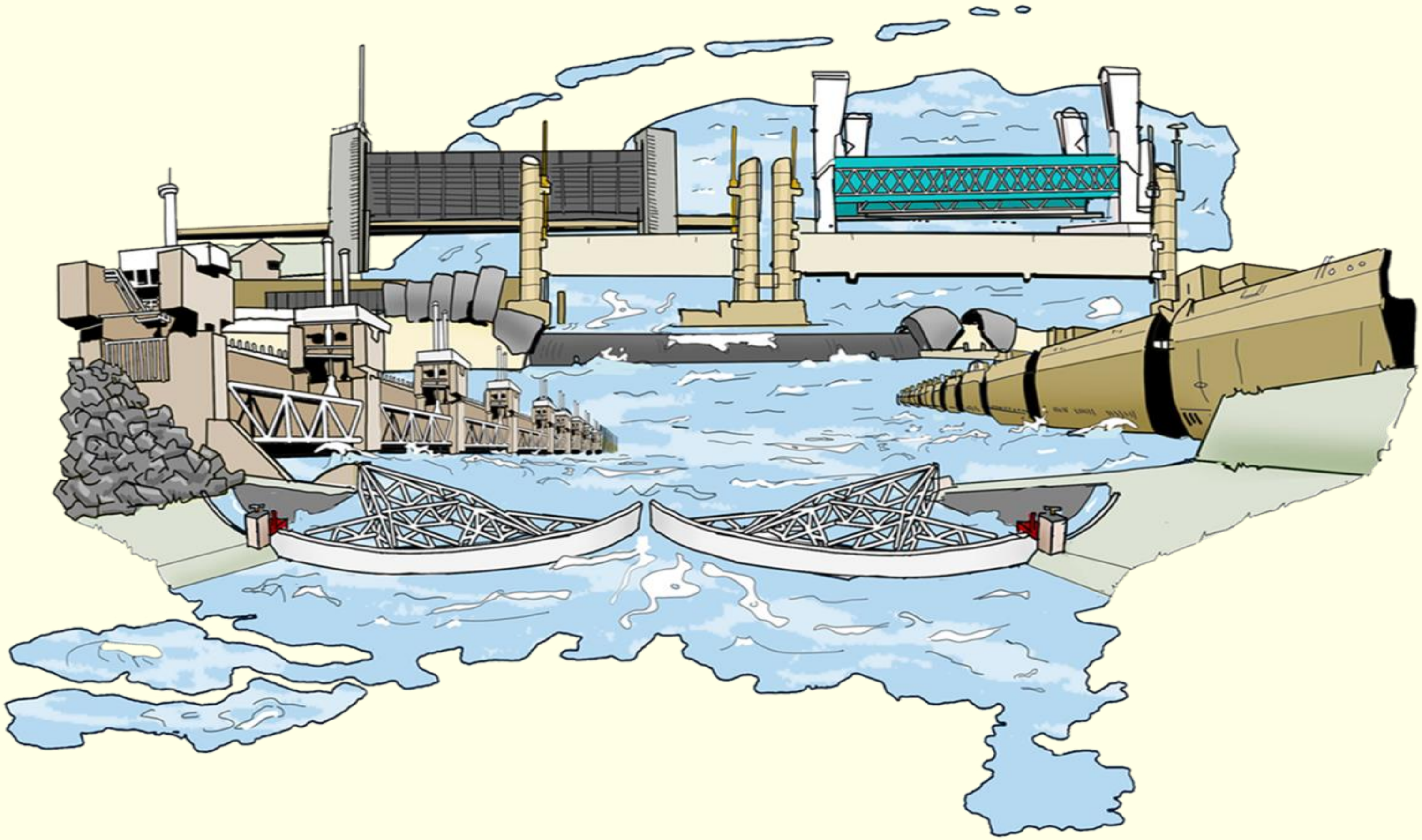
VIP Program



Access road: traffic jam and almost inundated (by water and spectators)



The audience



Introduction to Knowledge Management

- Necessary knowledge and expertise is scarce
- Can often only be gained through active involvement in operational work.
- Every SSB has his own specific characteristics
- SSB may be subject to inadequate attention to knowledge development and knowledge retention
- Risks could lead to high costs and reputational damage (political governance) and pressure on the flood barriers.

➔ **This requires a robust strategy of what knowledge where and how to secure**

Knowledge Strategy

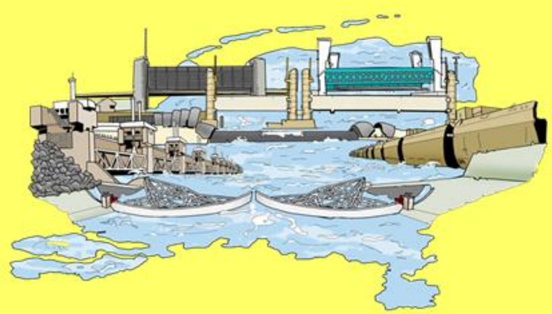
Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

RWS BEDRIJFSINFORMATIE

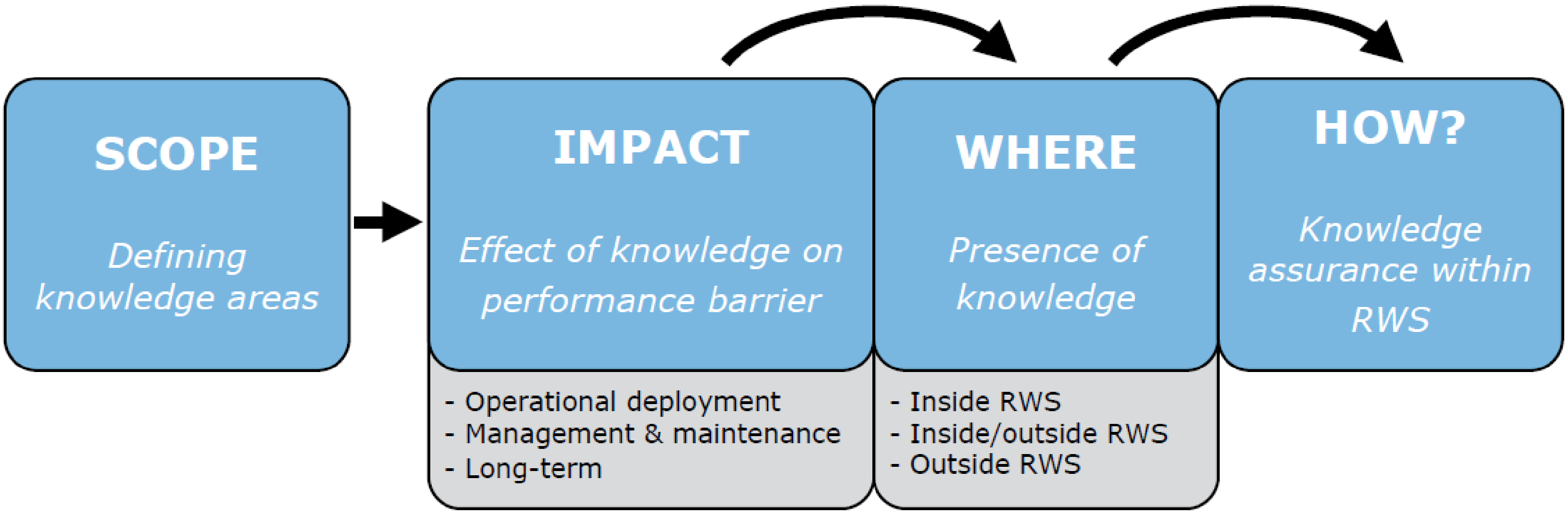
Knowledge Strategy Storm Surge Barriers

Knowledge development and retention for Storm Surge Barriers

Date	April 2018
Status	Final
Version	1.0



Knowledge Strategy Approach



Knowledge Strategy Examples

Games

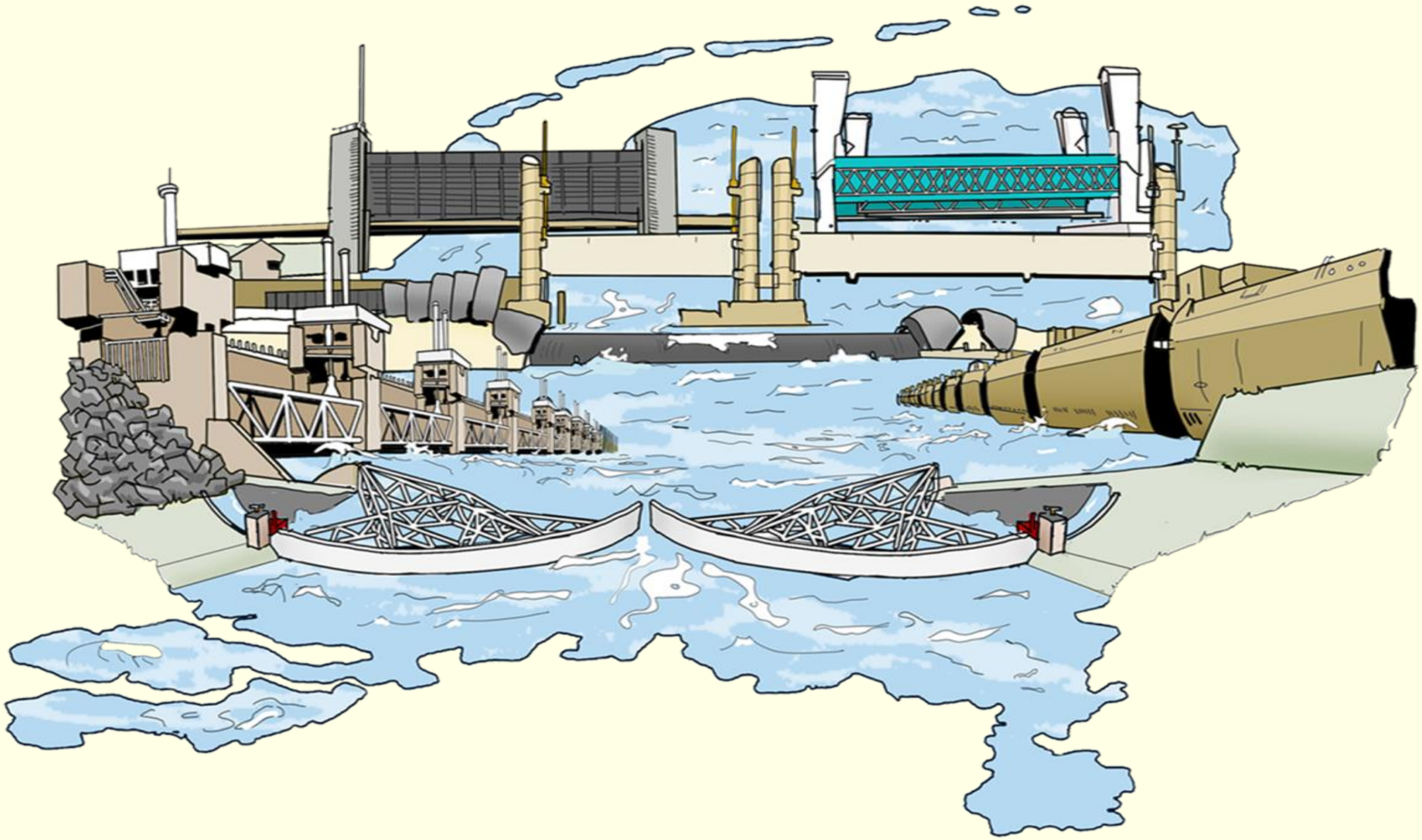
Knowledge Scan

Hoofdkennisveld	Vraag	Ant 0	1	2	3	4	#	KW	0	1	2	3	4	KW	0	1	2	3	4	Kenniswaarde
Risicogestuurd beheer en or	Faalkans beheer	2	5	3	2		12	17	1	3	4	2	2	25	-1	-2	1	0	2	8
Risicogestuurd beheer en or	Onderhoudsmanagement	2	3	4	1	2	12	22	1	3	2	3	2	24	-1	0	-2	2	0	2
Risicogestuurd beheer en or	Inkoop/contractmanagement	2	3	5	2		12	19	1	3	5	2		19	-1	0	0	0	0	0
Risicogestuurd beheer en or	Integrale veiligheid		4	2	6		12	26		3	2	5	1	26	0	-1	0	-1	1	0
Objectkennis	Integrale techniek en ontwerp	1	2	4	4	1	12	26	1		3	5	2	29	0	-2	-1	1	1	3
Objectkennis	Organisatie en werkwijze: Operationele inzet (slu	1	4	3	3	1	12	23		3	3	3	2	26	-1	-1	0	0	1	3
Objectkennis	Organisatie en werkwijze: Beheer en onderhoud		4	4	4		12	24		2	2	7		27	0	-2	-2	3	0	3
Objectkennis	Watersysteem in relatie tot Object	3	2	6		1	12	18	1	2	3	4	1	24	-2	0	-3	4	0	6
D: Installatie technologie	Elektrische installaties	2	3	3	4		12	21	2		2	5	2	27	0	-3	-1	1	2	6
D: Installatie technologie	Sensoren, bekabeling	3	2	3	4		12	20	2	1	2	3	3	26	-1	-1	-1	-1	3	6
D: Installatie technologie	Energievoorziening	3	3	4	2		12	17	2	2	4	1	2	21	-1	-1	0	-1	2	4
D: Informatie technologie	Basis IV-systemen (ondersteunend aan basisinfor	1	5	3	3		12	20		2	5	3	1	25	-1	-3	2	0	1	5
D: Informatie technologie	Functionele IV-systemen (ondersteunend aan de	3	2	5	1	1	12	19	1	2	4	3	1	23	-2	0	-1	2	0	4
D: Informatie technologie	IA (Besturingssystemen - direct gekoppeld aan en	4	3	2	3		12	16	1	3	2	5		22	-3	0	0	2	0	6
D: Werktuigbouw	WTB Mechanisch en Pneumatisch	2	3	3	3	1	12	22	2	1	3	3	2	24	0	-2	0	0	1	2
D: Werktuigbouw	WTB Hydrauliek	2	3	5	2		12	19	2	2	4	1	2	21	0	-1	-1	-1	2	2
D: Civiele techniek	Civiel Droog, Staal en conservering	1	5	5	1		12	18	1	2	5	3		21	0	-3	0	2	0	3
D: Civiele techniek	Waterbouw	1	4	6	1		12	19	1	2	5	3		21	0	-2	-1	2	0	2
D: Hydraulica	Watersystemen	4	5	2		1	12	13	3	1	6		1	17	-1	-4	4	0	0	4
D: Hydraulica	Waterloopkundige modellen	5	6		1		12	9	3	5	2	1		12	-2	-1	2	0	0	3
Ontwikkeling methodische k	1. Leidraad ProBO	1	6	4	1		12	17	1	4	3	3		19	0	-2	-1	2	0	2
Ontwikkeling methodische k	2. Integrale veiligheid	1	4	5	2		12	20	1	3	2	5		22	0	-1	-3	3	0	2
Ontwikkeling methodische k	3. Cyber Security richtlijnen	1	5	5	1		12	18	1	2	4	3	1	23	0	-3	-1	2	1	5
Ontwikkeling methodische k	4. Supplement inkoopstrategie	5	2	4	1		12	13	4	2	3	2		14	-1	0	-1	1	0	1
Ontwikkeling methodische k	5. Systeem gerichte contractbeheersing	1	9	1	1		12	14	1	4	5		1	18	0	-5	4	-1	1	4
		51	97	91	53	8	300	470	33	57	85	75	26	556	-18	-40	-6	22	18	86

Classes

New tools

Future



Future

Recent studies suggest that the Antarctic ice sheet is much less stable than scientists once thought.

CLIMATE

Trigger seen for Antarctic collapse

Continued growth of greenhouse-gas emissions this century could raise sea levels more than 15 metres by 2500.

Nature, March 2016

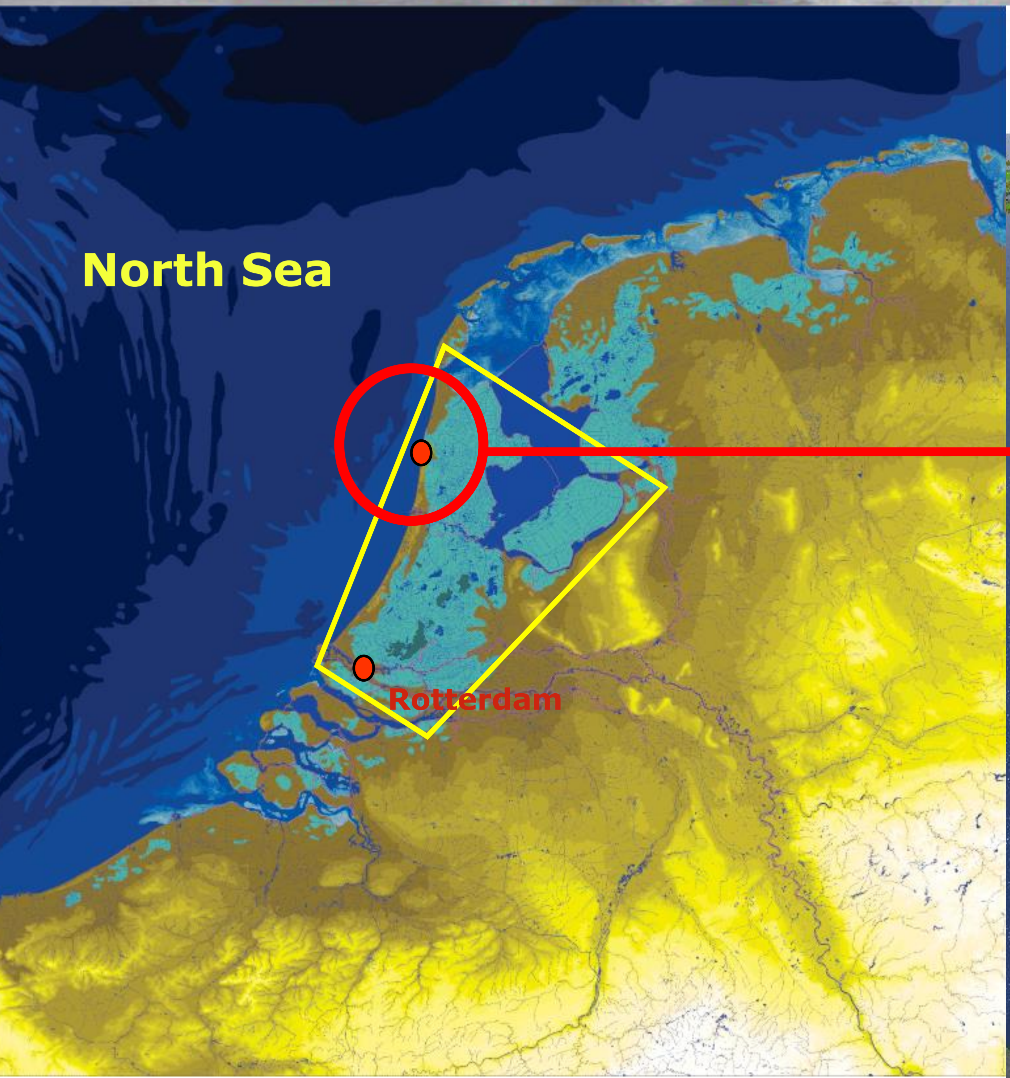
Antarctic model raises prospect of unstoppable ice collapse

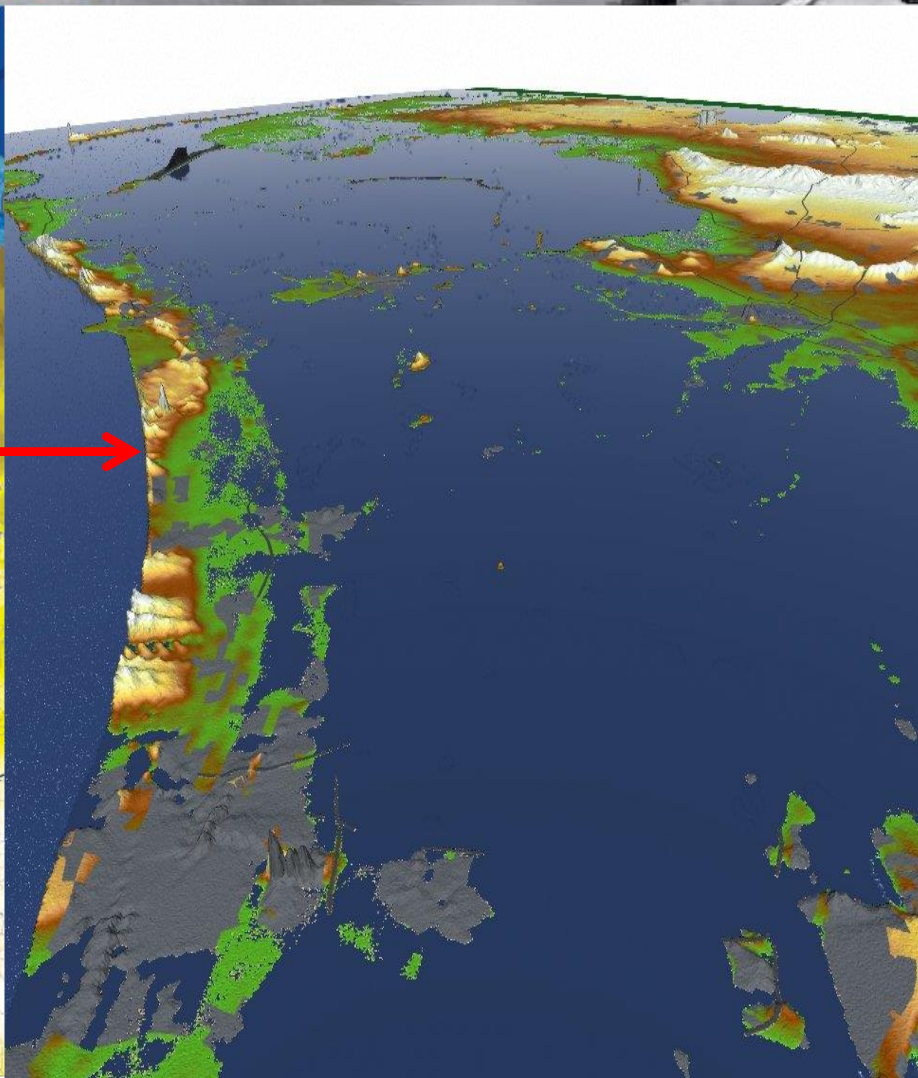
Sea levels could rise by more than 15 meters by **2500** if greenhouse-gas emissions continue to grow.

Pollard, D. & DeConto, R. M. *Nature* http://dx.doi.org/10.1038/ nature17145 (2016).

Overstroming Petten in Google Earth.avi

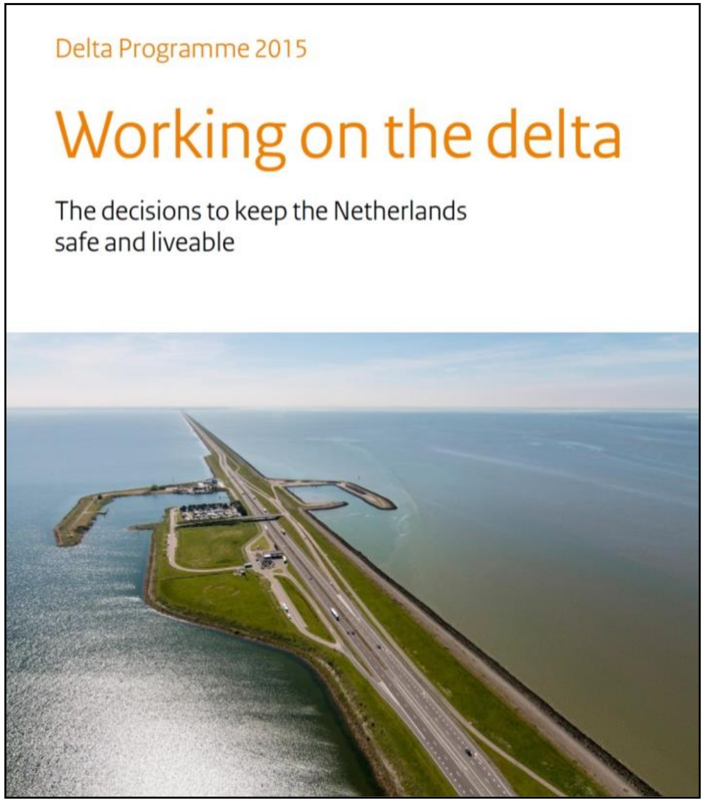
If we do nothing......



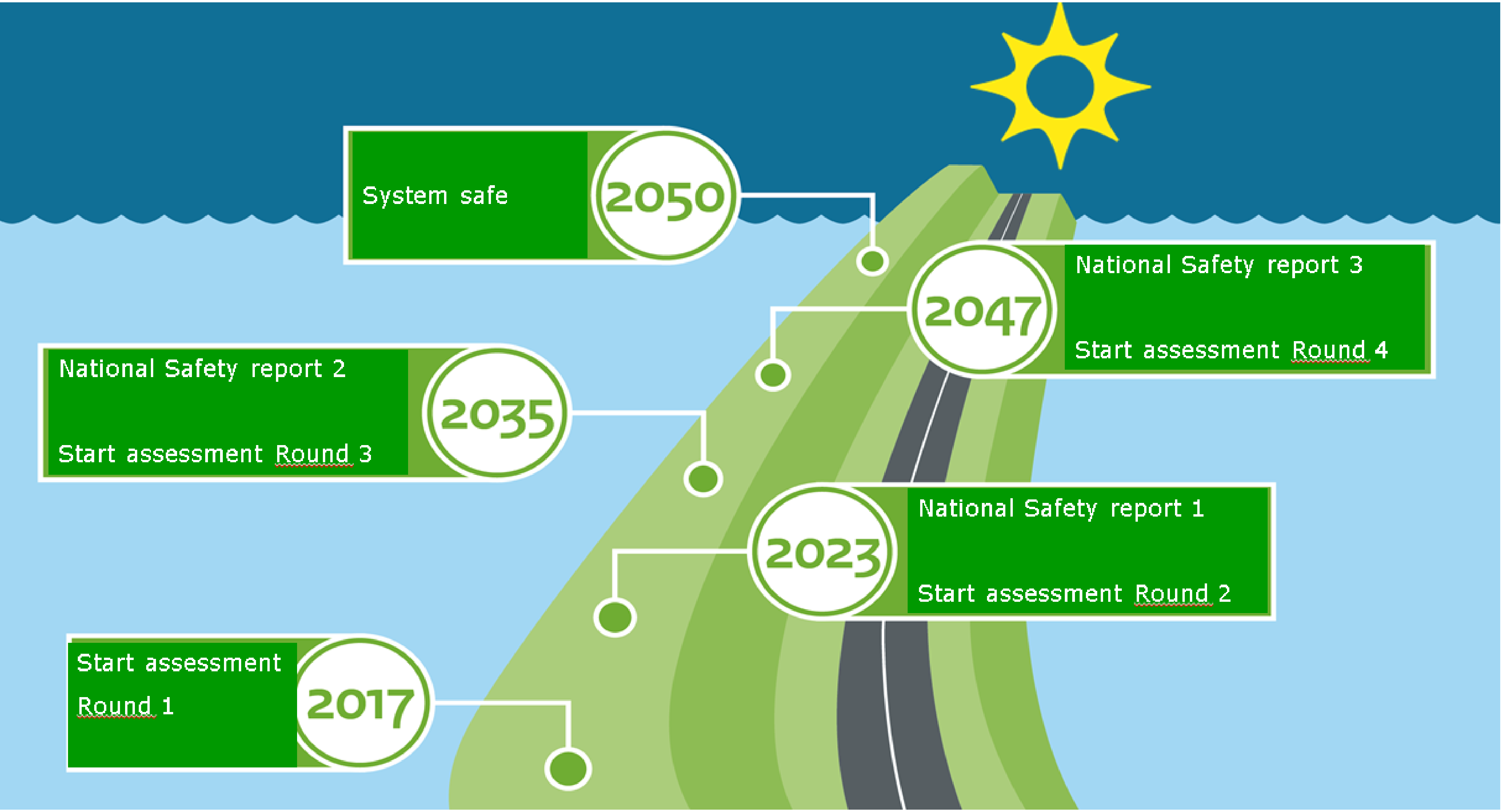


New policy principles on flood safety since 1995

- Rivers area: Room for the River
- Coastal zone: nature based solutions
- National policy document spatial planning:
  - Spatial planning based on water
- Flood safety act (1996):
  + Regular assessment of levees
  + flood protection program
  + funding
- Water management 21st Century
  - Retain – store – discharge
- National policy document on Water
  - Multi-layer safety
- Delta programme
  - Risk based Flood safety standards

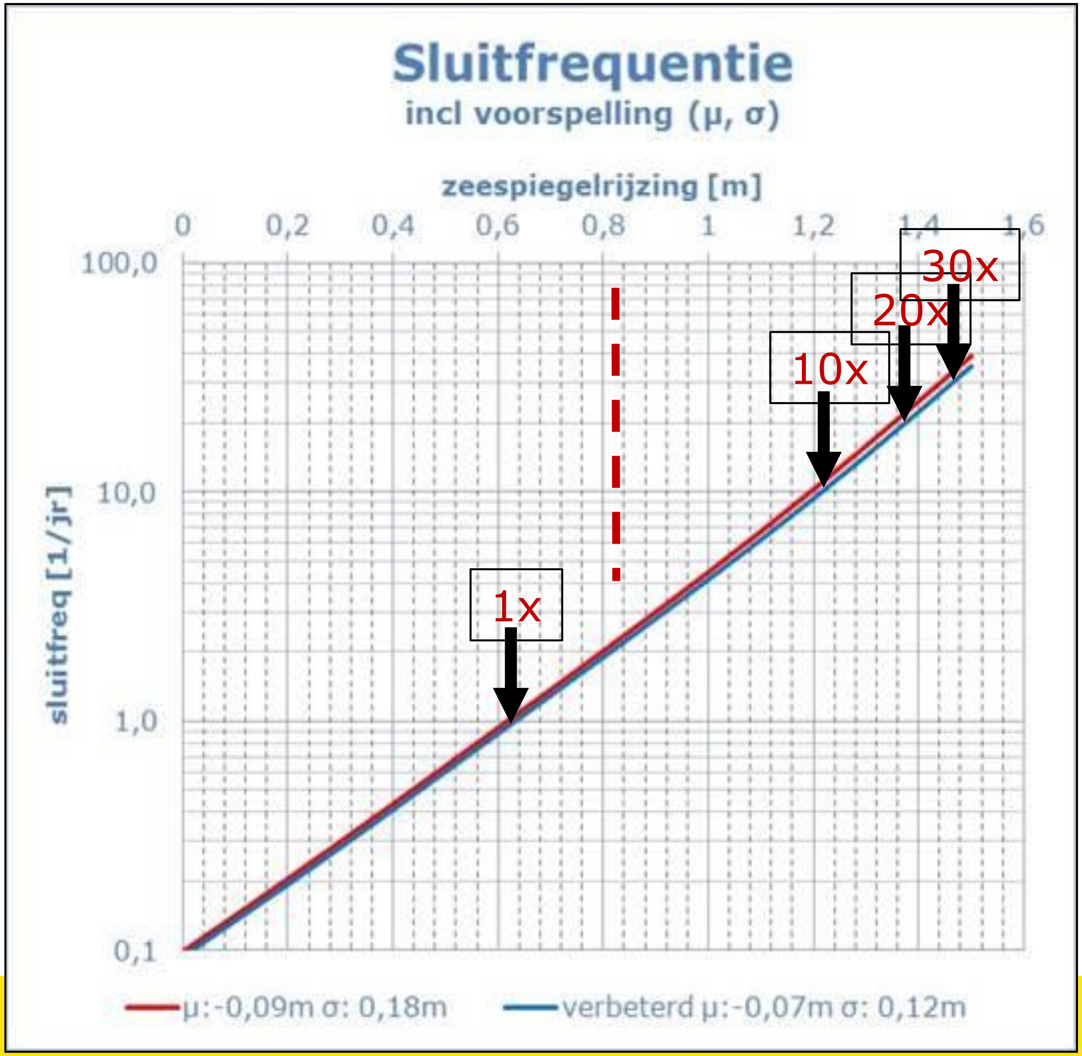


The road to flood safety 2050



Future impact on Maeslant Barrier

Closing frequency Maeslant Barrier



Future studies have been started

Thank you
Any questions?