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Introduction to Sustainable Management of POPs Contaminated Sites

Best Available Techniques and Best Environmental Practices

26 January 2023

Boudewijn Fokke
Soil Consultancy

TÜRKİYE CUMHURİYETİ ÇEVRE, ŞEHİRCİLİK VE İKLİM DEĞİŞİKLİĞİ BAKANLIĞI

Çevre ve İklim Eylemi Sektör Operasyonel Programı

Kalıcı Organik Kirleticiler

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Content

Bu proje Avrupa Birliği ve Türkiye Cumhuriyeti tarafından finanse edilmektedir.

(1) POPs contaminated sites

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(1) POPs contaminated sites

Per-fluoro-octane sulfonic acid, its salts or PFAS and per-fluoro-octane sulfonyl fluoride or PFOS

- Widespread used
  - ✓ Electric and electronic parts
  - ✓ Fire-fighting foam
  - ✓ Photo imaging
  - ✓ Hydraulic fluids
  - ✓ Textiles
- Fulfils the toxicity criteria of the Stockholm Convention
- Extremely persistent
- Bioaccumulations and biomagnifying properties
- Binds to proteins most notably in the blood and the liver
- Long-range transport
- Water soluble very challenging to remediate in groundwater, soils, sediments
- Complex fate and transport profile
- High potential for offsite migration of contaminants in groundwater plumes
- Destruction of PFOS and other PFAS is proving difficult and is often incomplete with standard POPs destruction techniques
- Research in the area is intense and new treatment methods are under development

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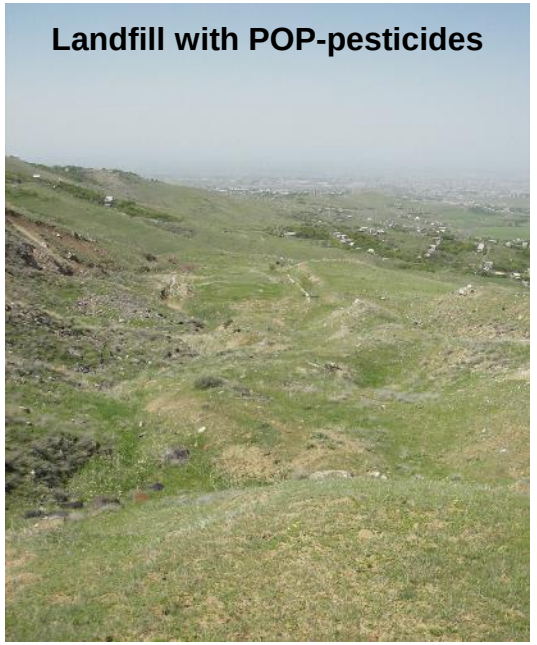
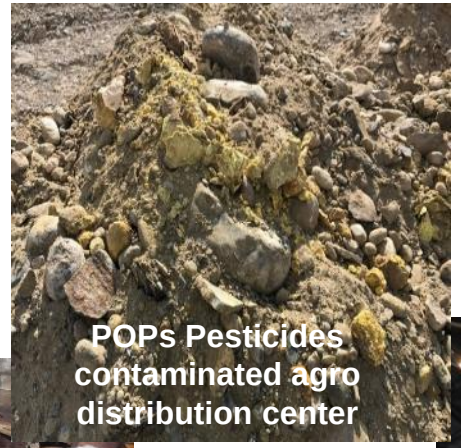
(1) POPs pesticides contaminated sites


Landfill with POP-pesticides


POPs Pesticides contaminated agro distribution center


Sarcophagi/ bunker with POPs pesticides


Former POP pesticides store


Storage POPs pesticides (lindane) production waste


DDT contaminated site Viet Nam

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(1) The objectives of this presentation

- **Introduce**
  - ✓ Stockholm Convention BAT & BEP guidance on the sustainable management of POPs contaminated sites
- **Explain**
  - ✓ The five phases of the sustainable management of contaminated sites
  - ✓ The use of a CSM when managing contaminated sites

BAT = Best Available Techniques
BEP = Best Environmental Practice

CSM = Conceptual Site Model
The CSM is <u>the</u> tool to sustainable manage contaminated sites

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(1) Objectives sustainable management contaminated sites

- **Protect human from contact with contaminants**
  - ✓ Direct contact: dermal contact, swallowing and inhalation
  - ✓ Indirect contact: through food & water
- **Protect ecosystem**
  - ✓ Protect soil and groundwater from getting contaminated
  - ✓ Protect drinking water resources from getting contaminated
  - ✓ Protect surface water from getting contaminated
- **Prevent migration of contaminants**
  - ✓ Prevent contaminants to become airborne
  - ✓ Prevent contaminants to run-off
  - ✓ Prevent contaminants to leach into soil & groundwater

Environmental risks are:
- *Human health risks*
- *Risks for the ecosystem*
- *Risks for migration of contaminants*

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(1) Dealing with contaminated sites

When you have a wide scientific knowledge concerning contaminant fate and transport processes in soil and groundwater, site characterization, Human Health Risk Assessment, Ecological Risk Assessment and Groundwater-related Risk Assessment, AND have experience with designing cost-efficient Risk Management solutions AND have a creative personality AND have good communication qualities AND are in a position to take policy decisions: Go ahead. Otherwise: Build a team.

Frank Swartjes
Dealing with Contaminated Sites
From Theory Towards Practical Application
National Institute of Public Health and the Environment (RIVM), Bilthoven, The Netherlands

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(2) Conceptual Site Model

Definition

- A model of a contaminated site that describes the distribution, release mechanisms, exposure pathways and migration routes and potential receptors of the contaminants of concern
- ‘Visually oriented, comprehensible representation of what is already known about a site’

Goal/aim

- CSM organizes all available historical and current information and facilitates the identification of information gaps
- Tool to support decision making process by reducing and managing contaminated site-related uncertainties
- Basis for optimized site-related decisions

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(2) We use the following types of CSM

- Initial Conceptual Site Model
  - Is made with available data
  - Is made by experienced expert, expert judgement is crucial
  - Is made after a site visit
  - Should not be costly and time consuming to make
- Improved Conceptual Site Model
  - Initial CSM is the input
  - Improved with on-site field data, chemical & physical sample analyses
  - Is made by a multidisciplinary team
  - Is made in an iterative way with data collected in various campaigns
  - Is costly and time consuming to make
- Updated Conceptual Site Model
  - Improved CSM is the input
  - Is made when on-site situation is changed
  - Should be after the site remediation measures are implemented
  - Should be made when the remediation is completed

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(2) The pieces of the puzzle / the Conceptual Site Model

- Site history
- Past and current site lay-out above and below ground
- Current and future land-use
- Site and surrounding geology
- Site soil type(s), structure and heterogeneity
- Site and surrounding hydrology
- Site groundwater depth aquifer(s) and aquitard(s)
- Groundwater and flow direction
- Etc.

- Source(s) of the contaminants
- Contaminant(s) types and properties
- Soil Contamination(s): load, location, state, extent horizontal &vertical
- Groundwater contamination(s): load, location, state, extent horizontal & vertical
- Contaminant(s) fate, transport & migration
- Geochemistry & redox conditions
- Natural attenuation potential
- Etc.

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(2) Conceptual Site Model always reveal

The initial CSM is input for a tier 1 risk assessment
A CSM is the input for a tier 2 and tier 3 risk assessment

- Source(s) of contamination(s)
- Source – receptor pathways / exposure pathways / contaminant migration routes
- Receptors / exposure and uptake

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(3) Guidance on BAT & BEP for management of POP contaminates sites

- Module 1 - Background to POPs contaminated sites
- Module 2 - Site investigation, Assessment and Conceptual Site Model
- Module 3 - Environmental Risk Assessment
- Module 4 - Principles and Approaches for Contaminated site Management and Remediation
- Module 5 - Remediation technologies and techniques
- Module 6 - Technology selection tool for remedial options
- Module 7 - Safety, Health and Public Engagement
- Module 8 - Getting started: Legislation, Policy and Inventory Development
- Module 9 - Case Studies

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(4) Phased approached of the contaminated sites management

Phase 1 Preliminary Site Assessment

Phase 2 Site Assessment

Phase 3 Site Remediation Assessment

Phase 4 Site Remediation Management

Phase 5 Site Monitoring & Aftercare

For each phase

- *The responsible party should be appointed*
- *Accountable party should contracted*
- *The parties to be informed should established*

The project planning should be

- *Project specific*
- *Realistic – cost – objectives - time*
- *Flexible*

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(4) Phase 1 - Deliverables

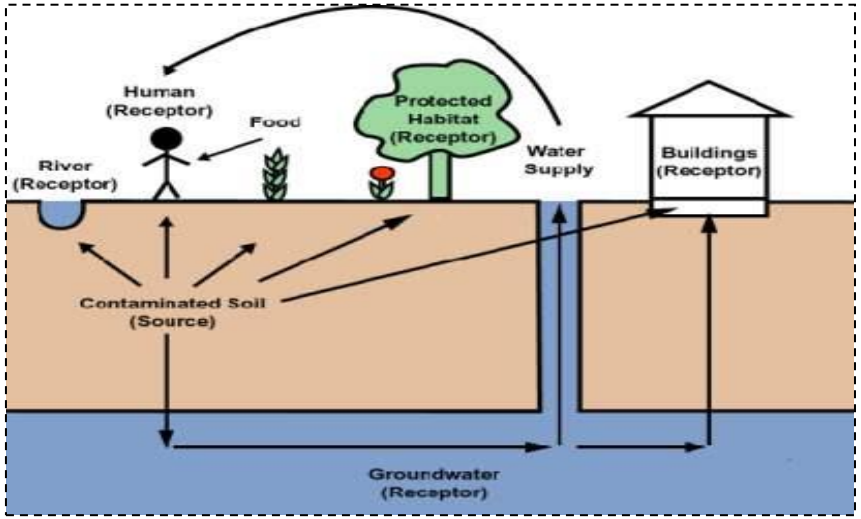
Phase 1 Preliminary Site Assessment

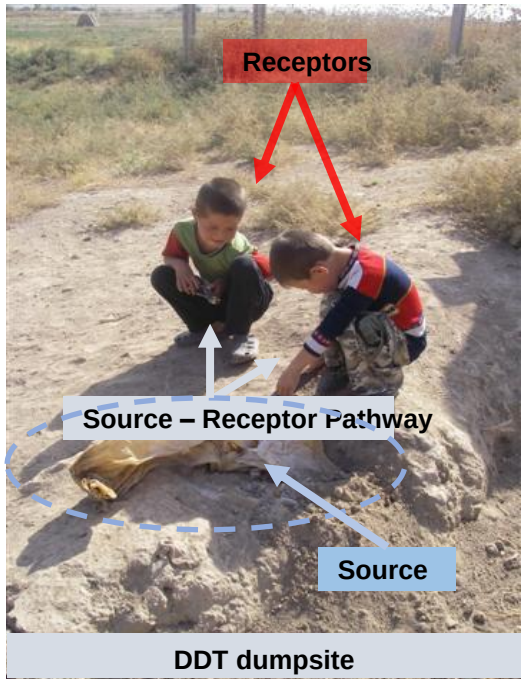
↓

Initial Conceptual Site Model

↓

Preliminary/Tier 1 Risk Assessment





DDT dumpsite

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(4) Phase 2 - Deliverables

Phase 2 Site Assessment

↓

Gap analyses ICSM and sampling and analyses plan

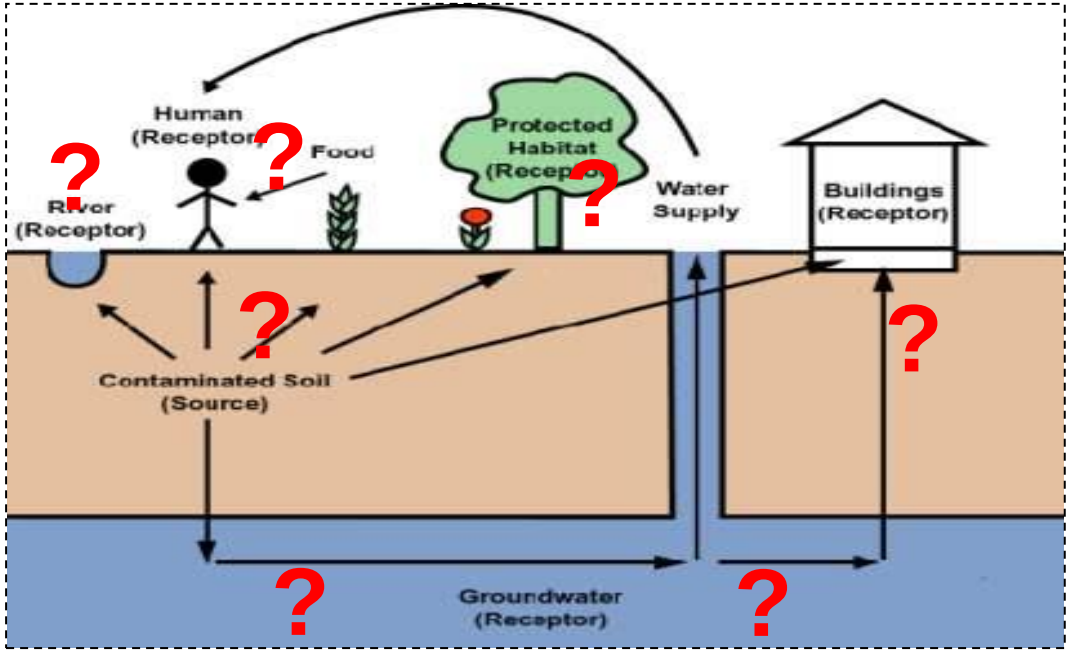
↓

Improved Conceptual Site Model

↓

Tier 2 and Tier 3 Risk Assessment

Gap analyses Initial CSM



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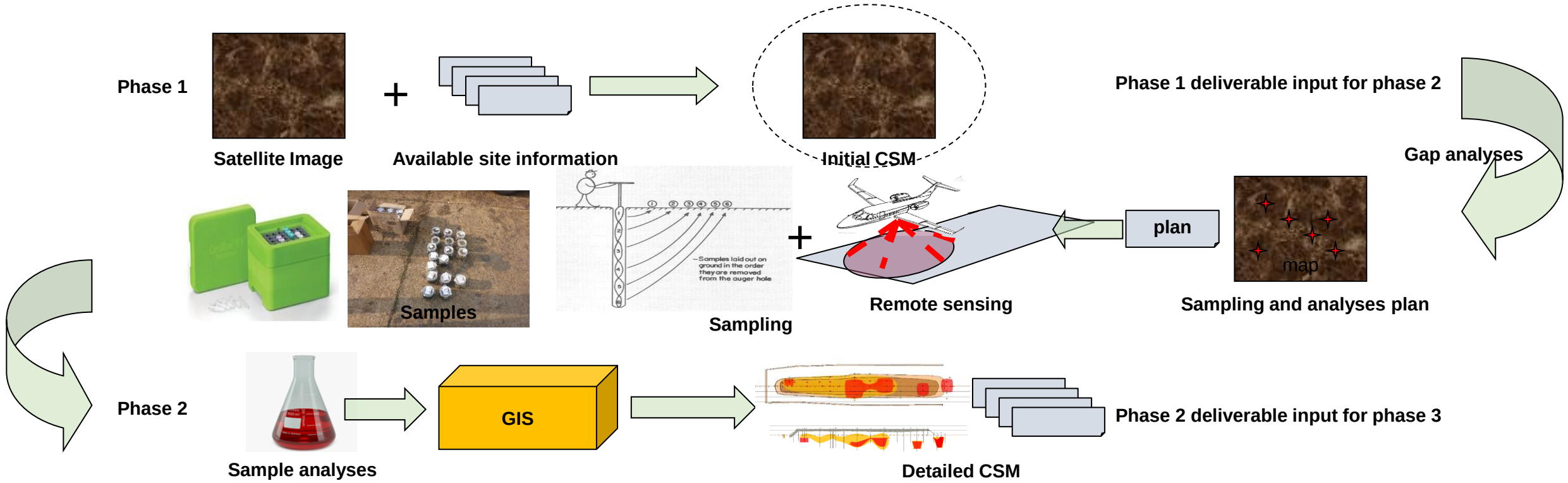
(4) Phase 1 and 2 – Survey strategy

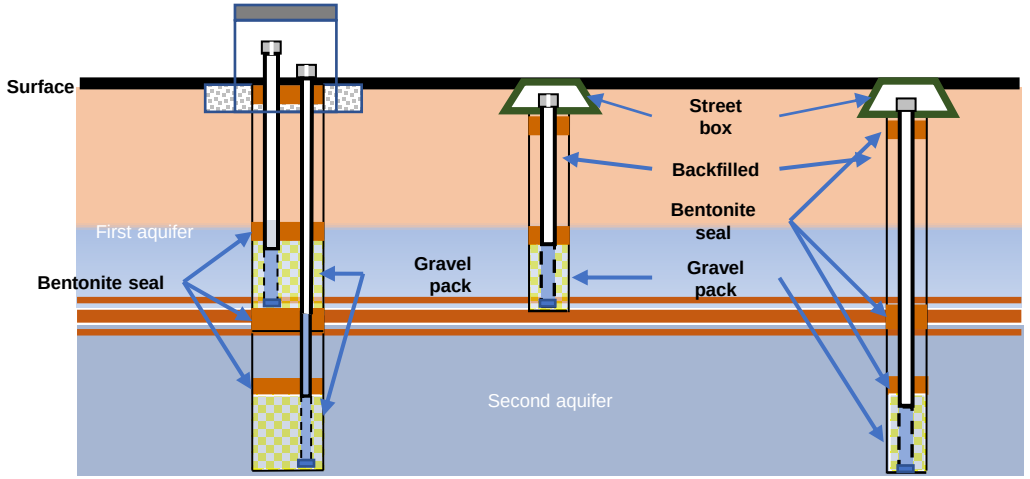


Bu proje Avrupa Birliği ve Türkiye Cumhuriyeti tarafından finanse edilmektedir.

(4) Phase 2 - Improved Conceptual Site Module

Source(s) of contamination

- Description of the cause of the contamination
  - ✓ The history of the contamination
  - ✓ The current situation
  - ✓ If the source(s) is/are eliminated or still is emitting
- Description of the type of contaminants
  - ✓ The compounds and the concentrations in soil and groundwater
  - ✓ Do they exceed the target levels
- Description of the extent of the source
  - ✓ Horizontal
  - ✓ Vertical



Not to scale

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(4) Phase 2 - Improved Conceptual Site Module

Receptor – source pathway(s)

- Description of the identified receptor's pathways
  - ✓ Wind dispersing contaminated fine soil particles
  - ✓ Run-off of rainwater spread contaminated soil off-site
  - ✓ Percolation of rainwater leaches contaminants in soil and groundwater
  - ✓ Groundwater flow disperse contaminants in the groundwater

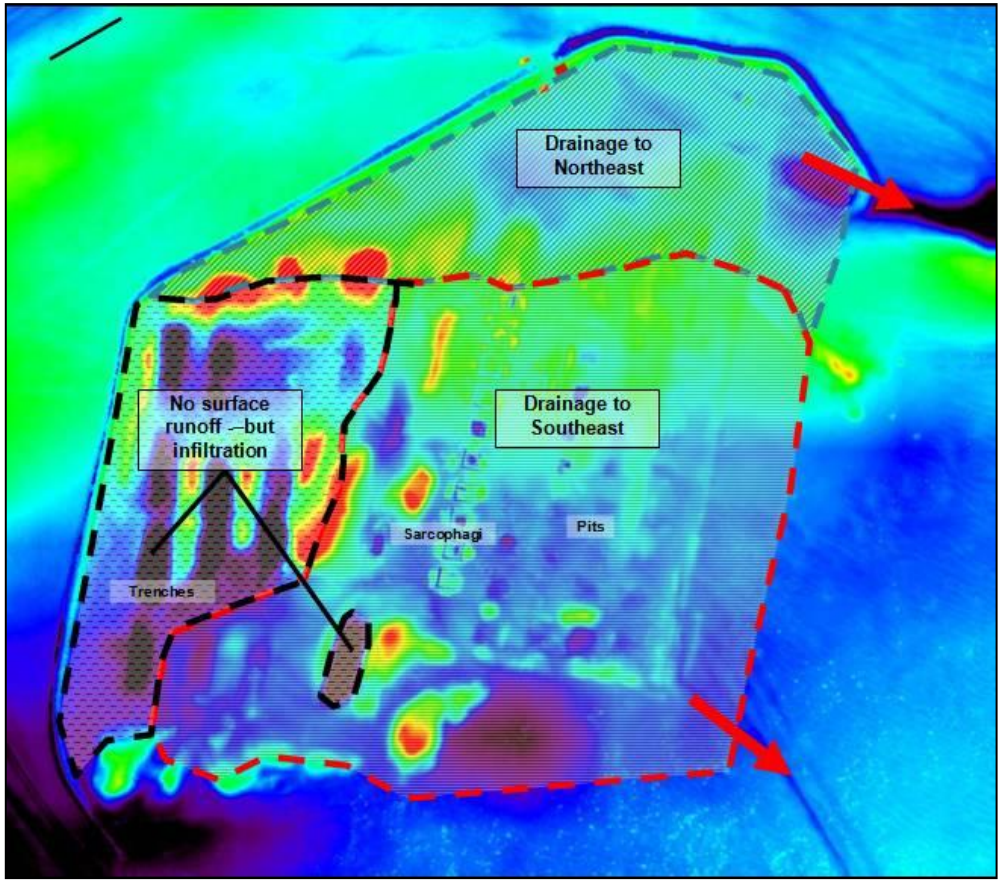
- Description of the type of contaminants
  - ✓ The compounds
  - ✓ The concentrations in soil and groundwater
  - ✓ Do they exceed the target levels
- Description of the extent of the pathways
  - ✓ Vertical
  - ✓ Horizontal

Bu proje Avrupa Birliği ve Türkiye Cumhuriyeti tarafından finanse edilmektedir.

(4) Phase 2 - Improved Conceptual Site Module

Receptors

- Description of the identified receptors
  - ✓ Human
  - ✓ Ecosystem



Improved Conceptual Site Module

Secondary Source

Receptor

Floating layer

Groundwater flow direction

Watershed

Contaminated groundwater

Primary Source

Pathway

Bu proje Avrupa Birliği ve Türkiye Cumhuriyeti tarafından finanse edilmektedir.

(4) Phase 2 – Risk Assessment

- **Quantification of direct, potential & latent risks for**
  - Human health
  - Ecosystem
  - Migration into the environment
- **The levels of contaminants in soil & groundwater**
  - ✓ Are analyzed
  - ✓ Analytical results are tested against national reference levels -**Tier 2**

  And/or
  - ✓ Risk assessment models are used to establish the risks - **Tier 3**

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(4) Phase 3 - Deliverables

Phase 3 Remediation assessment

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Selection remediation techniques for each site component

↓

Conceptual design remedial options describing feasible remediation measures for all site components

↓

Selection of the best remedial option based on risk reduction, environmental merits and cost

↓

Improved Conceptual Site Model

↓

Preliminary design of the best remedial option

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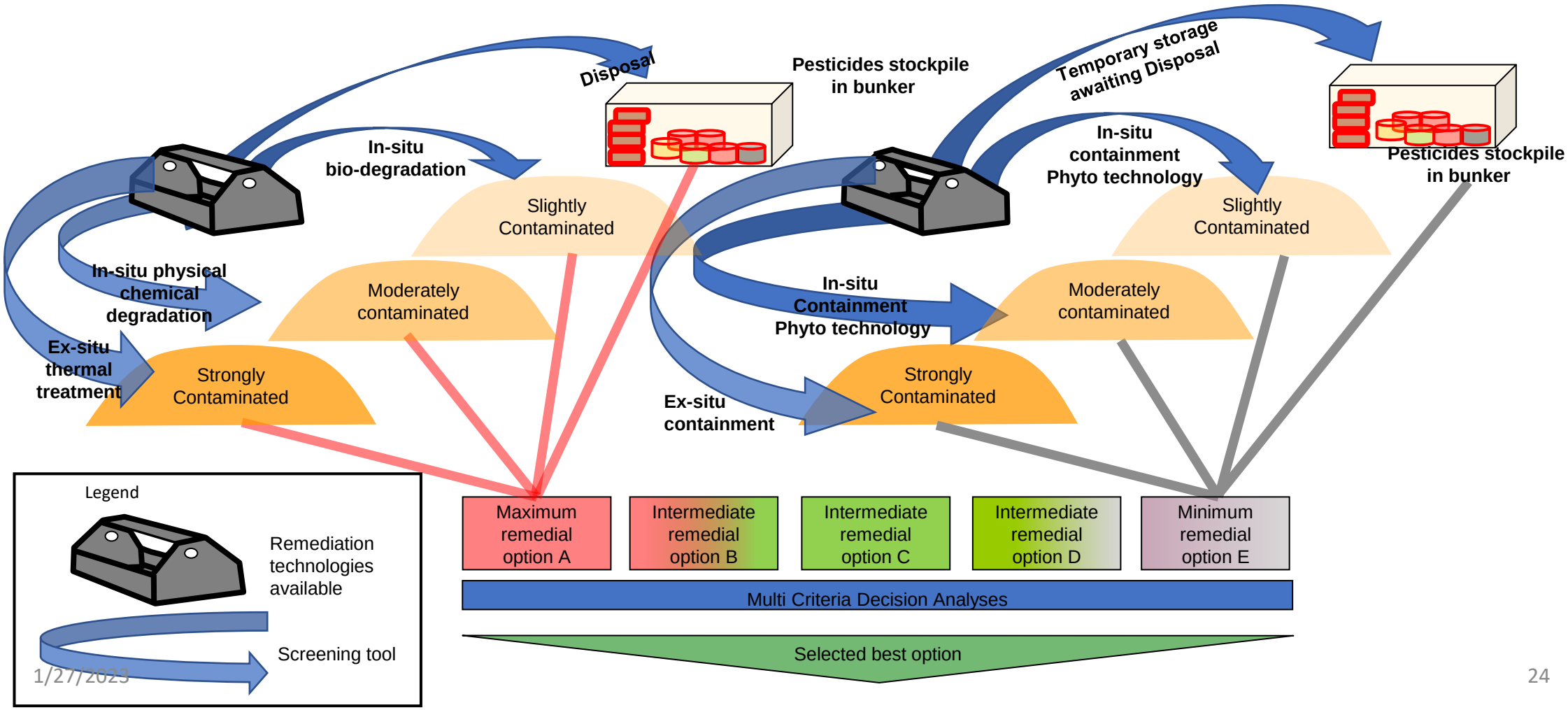
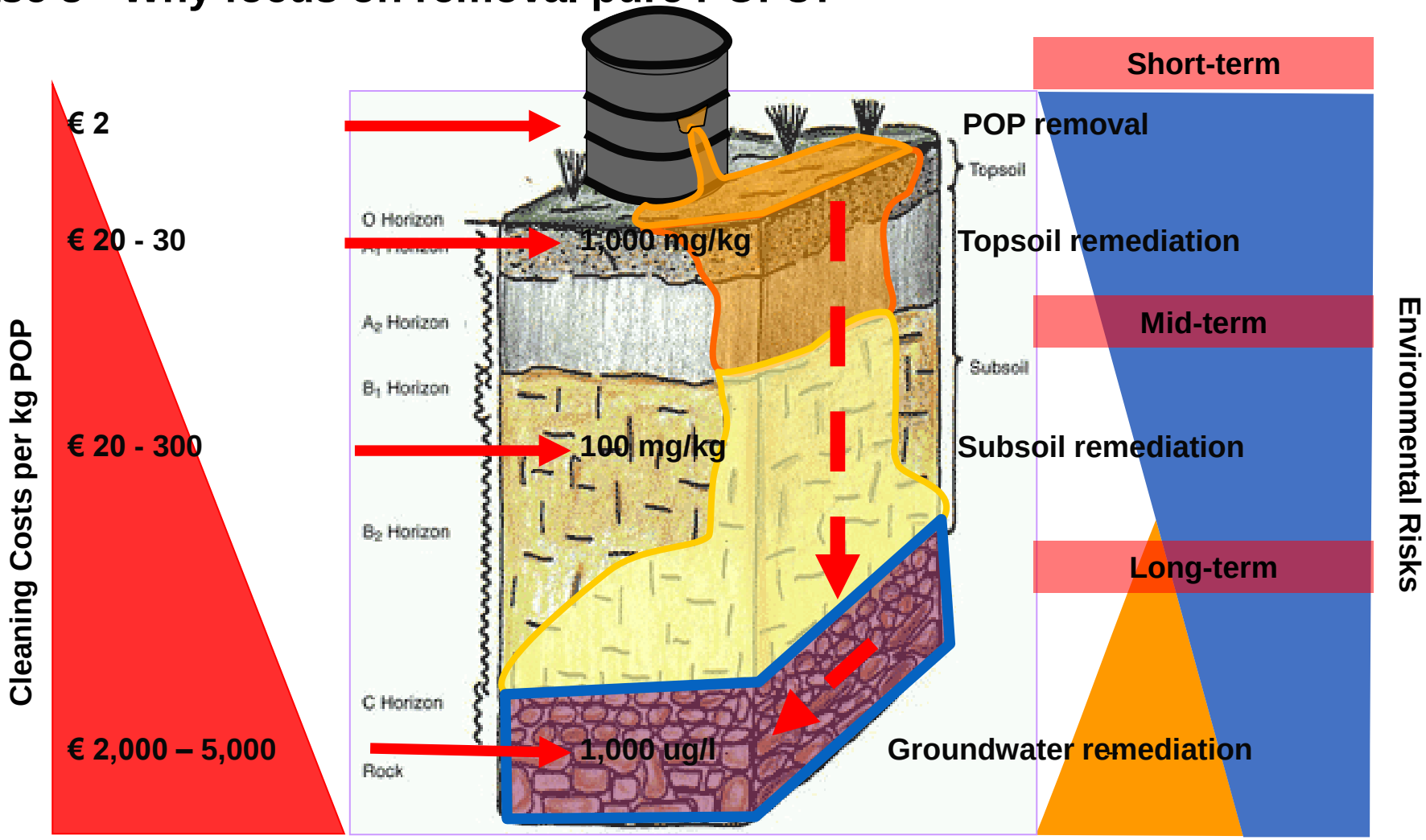
(4) Phase 3 - Remediation Assessment process



(4) Phase 3 - Why focus on removal pure POPs?



1 cubic meter of soil = 1.700 kg

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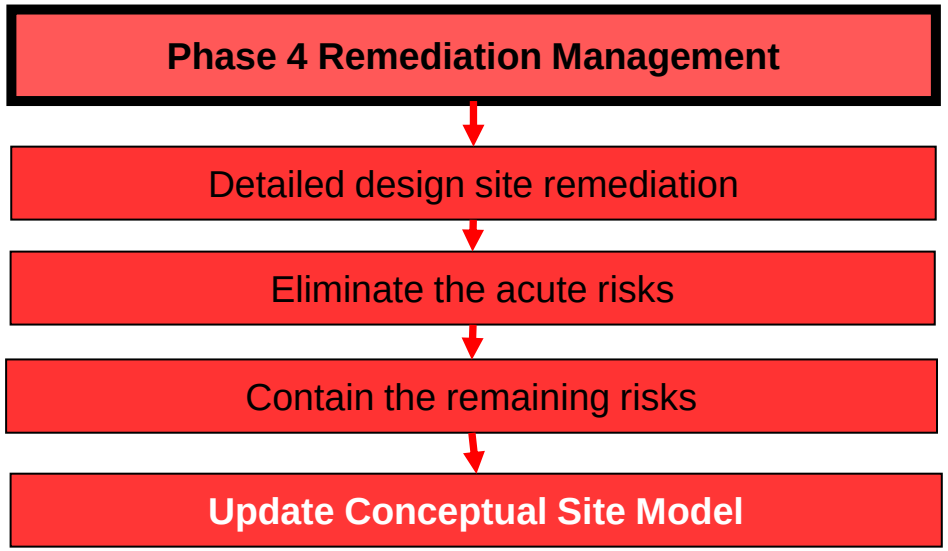
(5) Phase 4 - Deliverables



*Detailed design best remedial option**

- *Eliminate the direct risks*
- *Contain remaining potential risks*
- *Monitor the remaining latent risks*

Best remedial option is using the best available techniques, using environmentally sustainable methods, while not entailing excessive costs, reducing as much as possible the environmental risks

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(4) Phase 4 - Site Remediation Management

Remediation strategy

- Risk based approach
- Phased implementation
- Dynamic work plan

Start by elimination of direct risks

- Remove the source(s)
  - ✓ Excavate, repack and destruct source areas
- Cut of the receptor's pathways
  - ✓ Control erosion
- Protect the receptors
  - ✓ Fence source areas
  - ✓ Restrict land-use

Containing potential risks

- Maintain fencing
- Maintain restricted land-use
- Implement erosion control measures
- Pump & treat contaminated groundwater
- Restore vegetation cover

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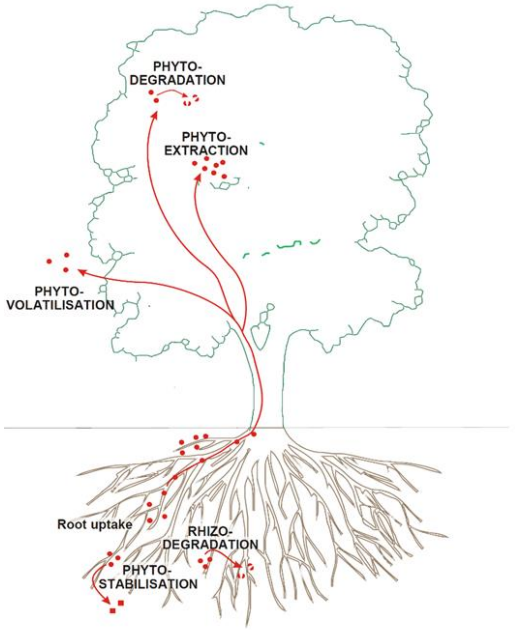
(4) Phase 4 - Ex-situ versus In-situ soil remediation



Ex-situ

- Excavate and thermal treatment
  - ✓ Combustion
  - ✓ Co-incineration/processing
  - ✓ Indirect Thermal Desorption
  - ✓ Base Catalyzed Decomposition
- Excavate and bio-degradation
- Excavate and physical-chemical degradation
- Excavate and phyto-containment/remediation
- Excavate and landfill

In-situ

- Thermal
  - ✓ Indirect Thermal Desorption
  - ✓ Base Catalyzed Decomposition
- Bio-degradation
- Physical-chemical degradation
- Phyto-containment/remediation
- Containment

Before a full-scale in-situ soil remediation plant is installed, lab scale, bench scale testing and piloting have to proof that the considered techniques are effective

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(4) Phase 4 - Ex-situ groundwater - Pump and treat in treatment train versus In-situ groundwater

Ex-situ

- Pump or drain
- Sedimentation in basin
- Aeration oxidize iron followed by
- Sand filtering removing iron
- Active carbon filter absorbing the CoC

or

- Stripping, bringing CoC in a gaseous phase followed by
- Active carbon filtering or combustion.

In-situ

- Chemical oxidation and reduction - Permeable Reactive Barrier PBR – Funnel and gate
- Biological treatment - Reactive mat / Natural Catch
- Containment
- Phytoremediation/containment
- Monitored Natural Attenuation

Before a full-scale in-situ or ex-situ groundwater treatment plant is installed, lab scale, bench scale testing and piloting have to proof that the considered techniques are effective

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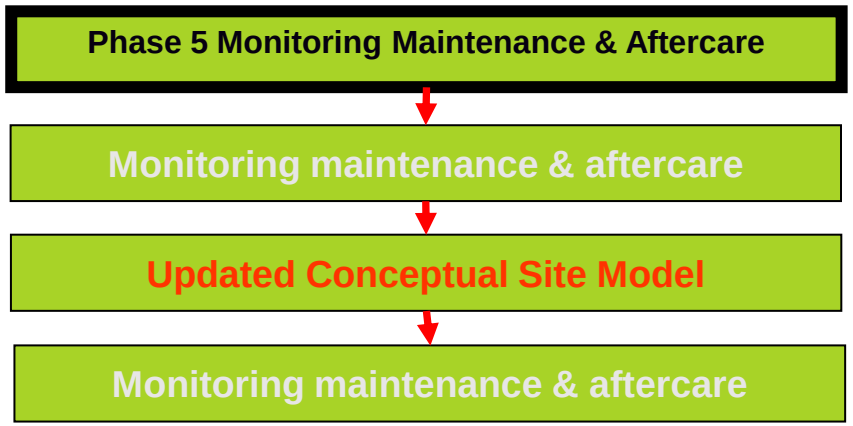
(4) Phase 5 - Deliverables



Monitor the latent risks

- Inspect and repair containment measures
- Sample and analyse groundwater quality
- Sample and analyse drinking water quality
- Sample and analyse surface water quality

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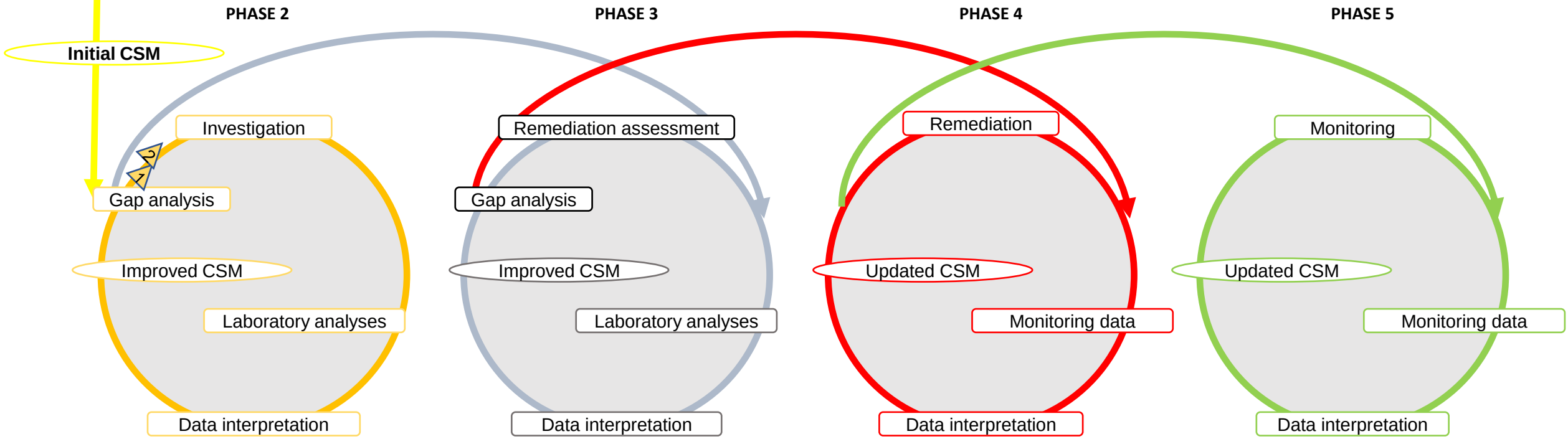
(4) Phase approached of the management of POPs contaminated sites

PHASE 1
Site visit
Desktop study
Reconnaissance survey



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Module	Guidance on BAT & BEP for management of POP contaminates sites	Phase
	Executive Summary	All
	Introduction	
1	Background to POPs contaminated sites	
2	Site investigation, Assessment and Conceptual Site Model	1 & 2
3	Environmental Risk Assessment	1 & 2
4	Principles and Approaches for Contaminated site Management and Remediation	3, 4 & 5
5	Remediation technologies and techniques	3, 4 & 5
6	Technology selection tool for remedial options	3
7	Safety, Health and Public Engagement	All
8	Getting started: Legislation, Policy and Inventory Development	
9	Case Studies	

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Thank you very much for your attention

Any questions?