



## Training

under the project to improve the safety of mining facilities,  
including tailings, in Kazakhstan and Central Asia

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UNECE Convention on the  
Transboundary Effects of  
Industrial Accidents

**Assistance  
Programme**



# Visual inspection of tailings Introduction to the catalog of activities of the tailings methodology

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Schweizerische Eidgenossenschaft  
Confédération suisse  
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# Introduction

Visual inspection is an essential element in assessing the safety of tailings.

It allows you to identify deviations from the project and violations of the normal operation of the facility.

Obviously, over time, the number and quality of such deviations will increase, which will be reflected in the appearance of signs indicating problems in the safe functioning of tailings.

These signs can be divided into two groups - explicit, clearly visible and allow unambiguous assessment, and implicit, hidden, non-obvious.

These signs are not always noticeable, cause different interpretations, however, they are the first signals that processes have begun on the tailings, which can lead to serious problems in the future, but they can be prevented now.

# 1. Drainage and spillway

To answers to questions No. 5-9 of subgroup B1  
("Detailed visual inspection") of the Tailings  
Checklist





Spillway tunnel type.  
The spillway guard is destroyed (vandalism)





Tunnel spillway from the tailings.  
Destroyed wall - plot of the future breakthrough of the dam





Spillway mine type.  
Clogged mine - cause overflow over dam





Spillway mine type.

The protective grill is destroyed by corrosion - the spillway is not functioning.





Emergency spillway of the tailings.  
Inputs blocked by sediment





Clogged tail spillway

## 2. Dam flooding, filtration and leaks

To answers to questions No. 15, 19 of subgroup B1 (“Detailed visual inspection”) of the Tailings Checklist

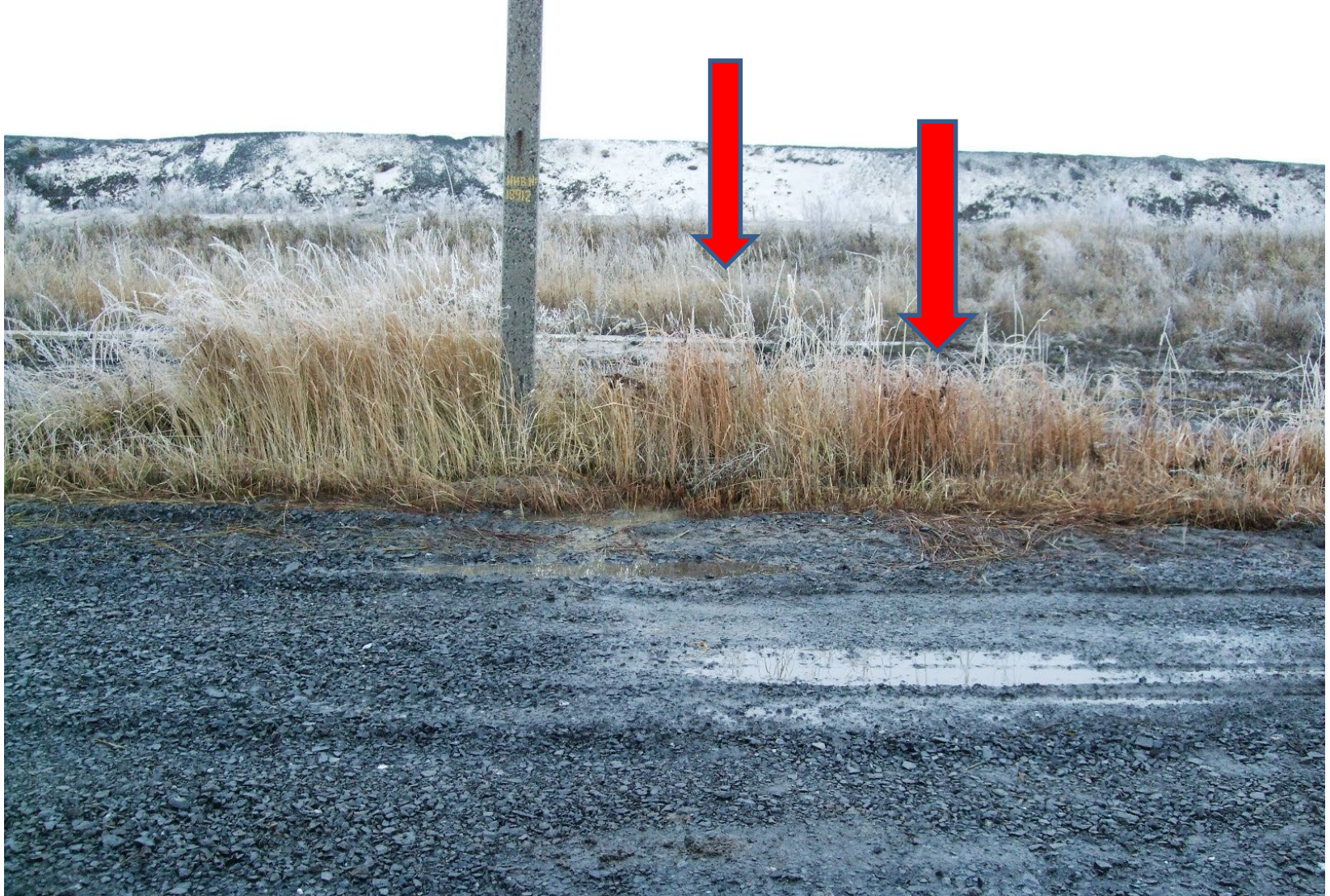




The third upper ledge of the tailings dam.

Excessive waterlogging of the dam, precipitation is not absorbed.  
(View from the second ledge)





The second on top is the outer ledge of the tailings dam.  
An implicit sign of filtration is the development of moisture-loving vegetation





The outer slope of the dam.  
Water leaking past a spillway





The outer foot of the tailings dam.  
Filtration of water through the dam and exit in the form of a spring.  
(View from the dam)





Concrete tailings dam.  
Filtration of water  
through pores in a  
monolith ("tear")





The central part of the outer slope of the tailings dam. Filtration in the form of weak soil soaking





External slopes of the tailings dam.

Salt deposits as a result of filtration of solutions through the dam body

### 3. Waterproofing of tailings

To the answers to question No. 20 of subgroup  
B1 (“Detailed visual inspection”) of the Tailings  
Checklist





The interior of the tailings dam.

Sliding concrete slabs, exposure and violation of film waterproofing





The bottom interior of the tailings dam.

Damage to waterproofing due to destruction of the protective coating





Inner bowl of the tailings.

The mine spillway rises above the water level.  
Implicit sign of filtration from the tailings due to waterproofing

## 4. Erosion of tailings dams

To answers to questions No. 13, 16, 21 of subgroup B1 (“Detailed visual inspection”) of the Tailings Checklist





Inner slope of the tailings dam.  
Erosion due to leaks from sludge pipes





External slope of the tailings dam.  
Ravine resulting from unorganized runoff of atmospheric water





External slope of the tailings dam: rain gullies.  
Gullies may occur in these places.





The crest and slope of a dam  
folded with loose materials.  
Suffusion Ravines and  
Channels







Tail dam crest.

The accumulation of salt water on leading to the suffusion of the dam material. initial stage





Shield at the tailings with hazardous waste.

Linear erosion caused by precipitation. Furrows were formed as a result of improper formation of the protective shield with a bulldozer. Atmospheric waters destroy the screen and accumulate on the inside of the dam, which can lead to its erosion and the release of waste to the surface.

This is an implicit sign of the poor state of the tailings with serious problems that are delayed in time.





Upland drainage ditches and trays.  
Bottom erosion of the thalweg of a  
beam or ravine caused by improper  
drainage from the territory of the  
tailing dump.

With the further development of erosion, the drainage system  
will be destroyed

## 5. Landslides and subsidence in the dam body

To answers to questions No. 16, 19 of subgroup B1 (“Detailed visual inspection”) of the Tailings Checklist





The outer slope of the dam.  
Flowing landslide (mudflow), indicating its severe flooding. (View from  
the dam)





The outer slope of the abandoned tailings dam.  
Implicit sign: a wooden pile row indicates a landslide that has come down earlier





Outer side of the tailings  
dam.  
Landslide separation crack



Tail dam crest.  
Detachment crack is an implicit  
sign of an emerging landslide





The outer slope of the tailings dam.

Implicit signs of a landslide forming:  
rickety road chipper and separation  
crack in this place

# FINDINGS

- 1. The obvious visual signs of the unsatisfactory state of the tailings and their dams indicate an active stage in the development of adverse processes that could lead to an emergency. To stop these processes, a set of short-term measures is required.
- 2. Implicit visual signs of an unsatisfactory state of objects can speak of the initial stages of the development of adverse processes and phenomena. The measures used here are medium-term, in some cases short-term and will prevent the transition of hazardous processes to the active stage



# **Introduction to the catalog of activities of the tailing methodology**



# Introduction

The catalog of activities includes a list of actions that must be taken in case of inconsistency (partial or full) of the status of the tailings with modern requirements and safety standards. It is based on world experience in the sustainable development of the mining industry and the restoration of the environment, on modern and advanced safety standards.

Activities cover all stages of the tailing dump life cycle and are grouped in such a way as to solve specific problems (inconsistencies) identified during tailing dump assessment.

Experts should identify appropriate measures for each problem found at the tailing dump.



# Event Catalog Structure

The catalog of events includes the following elements:

- Problem to be solved;
- Prescribed measures;
- A priority.

No	Problem to be Solved	Prescribed Measures	A priority
<b>ПРОЕКТИРОВАНИЕ И СТРОИТЕЛЬСТВО</b>			
<b>1</b>	Incomplete project documentation	1A. Update project documentation using a licensed company	Short term
		1B. Update project documentation, involving experienced personnel who have the appropriate license	Short term
		1C. Perform an expert assessment of the design documentation for the competent authorities	Short term
		1D. Prepare or complete project documentation in accordance with regulatory requirements	Short term
		1E. Prepare a detailed map of the tailing site and the surrounding area	Short term
<b>2</b>	The tailings project has not been discussed with local authorities and the public	2A. Discuss tailing projects with local authorities and the public	Short term
		2B. To inform the local community and public organizations about the nature of the tailings projects and get their opinion	Short term



***The problem to be solved*** is a clearly and concisely formulated discrepancy between safety requirements and the actual state of the tailings components or its functioning. Each question of Group B or C is associated with a specific problem, the solution of which is proposed in the Catalog of Events.

***The measures envisaged*** are one or more measures intended to increase the level of safety of the tailing dump. Several measures may be proposed to address or mitigate the severity of the same problem.

***Priority*** depends on the urgency and cost of implementing the prescribed measure and can be defined as short, medium and long term.



# Short-term events

Purpose and applicable standards	Resources	Recommended Dates
Urgently eliminate non-compliance with safety requirements at the tailings according to national technical standards	Available resources of the tailing operator sufficient to provide low-cost activities or actions	To be performed, as a rule, no later than 3 months after the prescription

# Mid-term events

<b>Purpose and applicable standards</b>	<b>Resources</b>	<b>Recommended Dates</b>
Eliminate non-compliance with safety requirements, for which several months are necessary for geotechnical and technological reasons, in accordance with a national or international technical standard	Available resources of the tailings operator and external sources; activities should be justified by the criterion of “cost - effectiveness”	Must be completed no later than 1 year after the prescription



# Long term activities

Purpose and applicable standards	Resources	Recommended Dates
Technical transformation of the inspected vault to ensure compliance with safety requirements and recommendations, taking into account the implementation of modern international standards of industrial and environmental safety	Available resources of the tailings operator and external sources, including government sources; activities should be justified by the criterion of “cost - effectiveness”	Must be completed no later than 5 years after the prescription

# General recommendations for selecting events from the Event Catalog

1. Select all the questions that were answered in the negative (“Yes, rather yes, rather no, No,”), taking into account the stage of the tailings storage life cycle.
2. First select all the proposed measures for each issue and create an appropriate table.
3. Analyze the degree of identified discrepancies and optimize the list of selected measures, taking into account the priority of measures and available resources.
4. Preliminary estimate the cost and effectiveness of the proposed activities, taking into account the available expert assessments.
5. Develop an investment program to improve the safety of the tailings.



# The most dangerous (critical) problems

When choosing activities, priority should be given to those that will prevent the occurrence of the most dangerous (critical) situations and accidents. These situations in terms of importance include the following:

1. The danger of the destruction of the tailings dam and the spread of waste throughout the territory.
2. The danger of volley ingress of waste from the tailings and sludge pipelines into the environment.
3. Danger of inflating dry waste by wind.

All other problems at the tailings can be eliminated jointly or after elimination of the indicated threats.

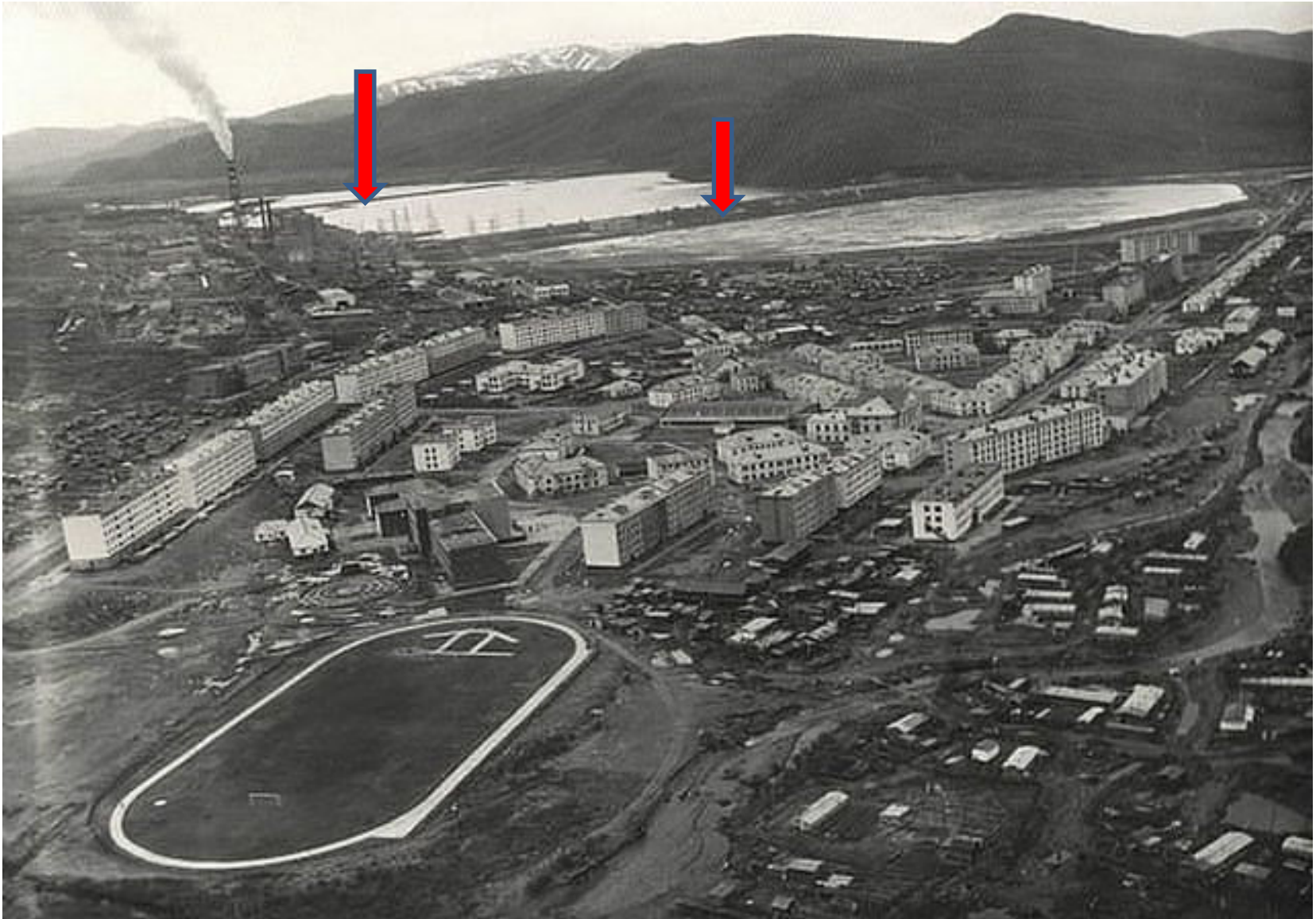
If there is at least one critical situation, short-term and / or urgent measures should be applied to resolve it.

# **1. Critical problem “Danger of destruction of the tailings dam and spreading of waste across the territory”**

- (Problems from the event catalog
  - No. 19, 21, 32, 33, 36)

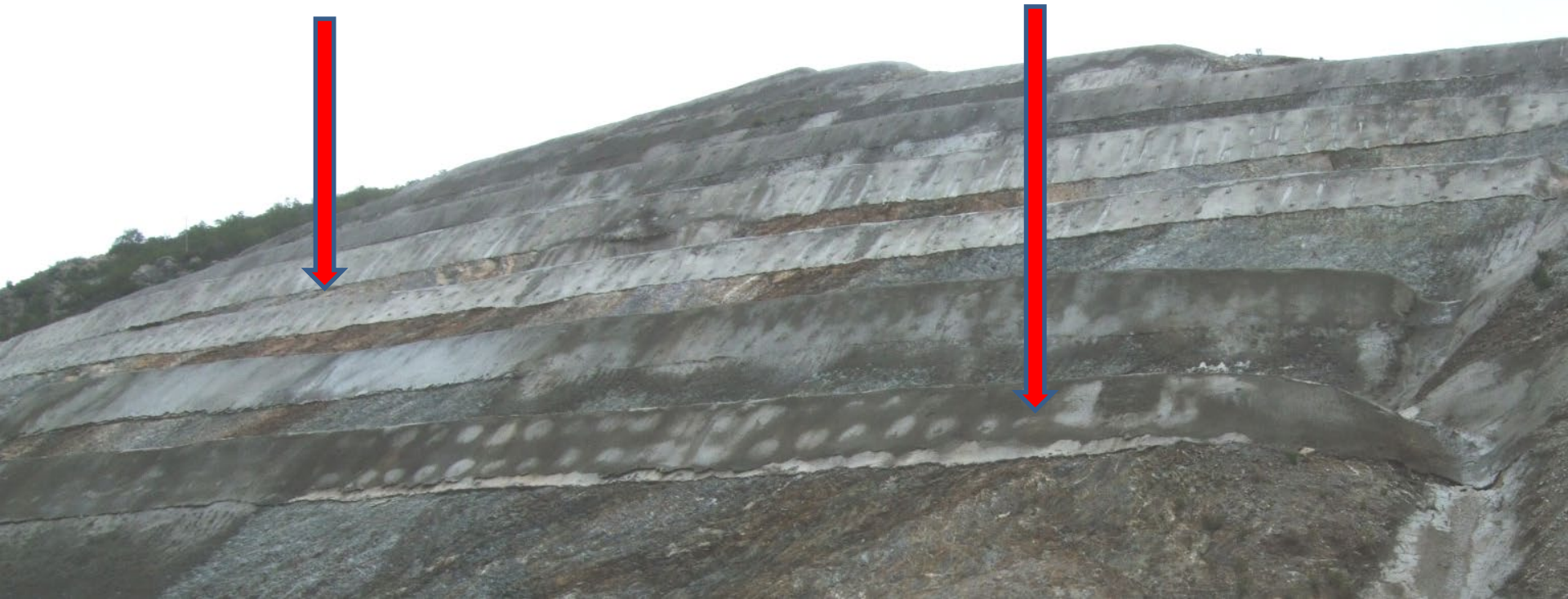


## Recommendation 19B. Build up dividing bulk dams



Separating dams of the ash dump of a thermal power station

## Recommendation 19C. Strengthen the dam with cementation or drainage curtains



Cementation of the slope of the tailings dam





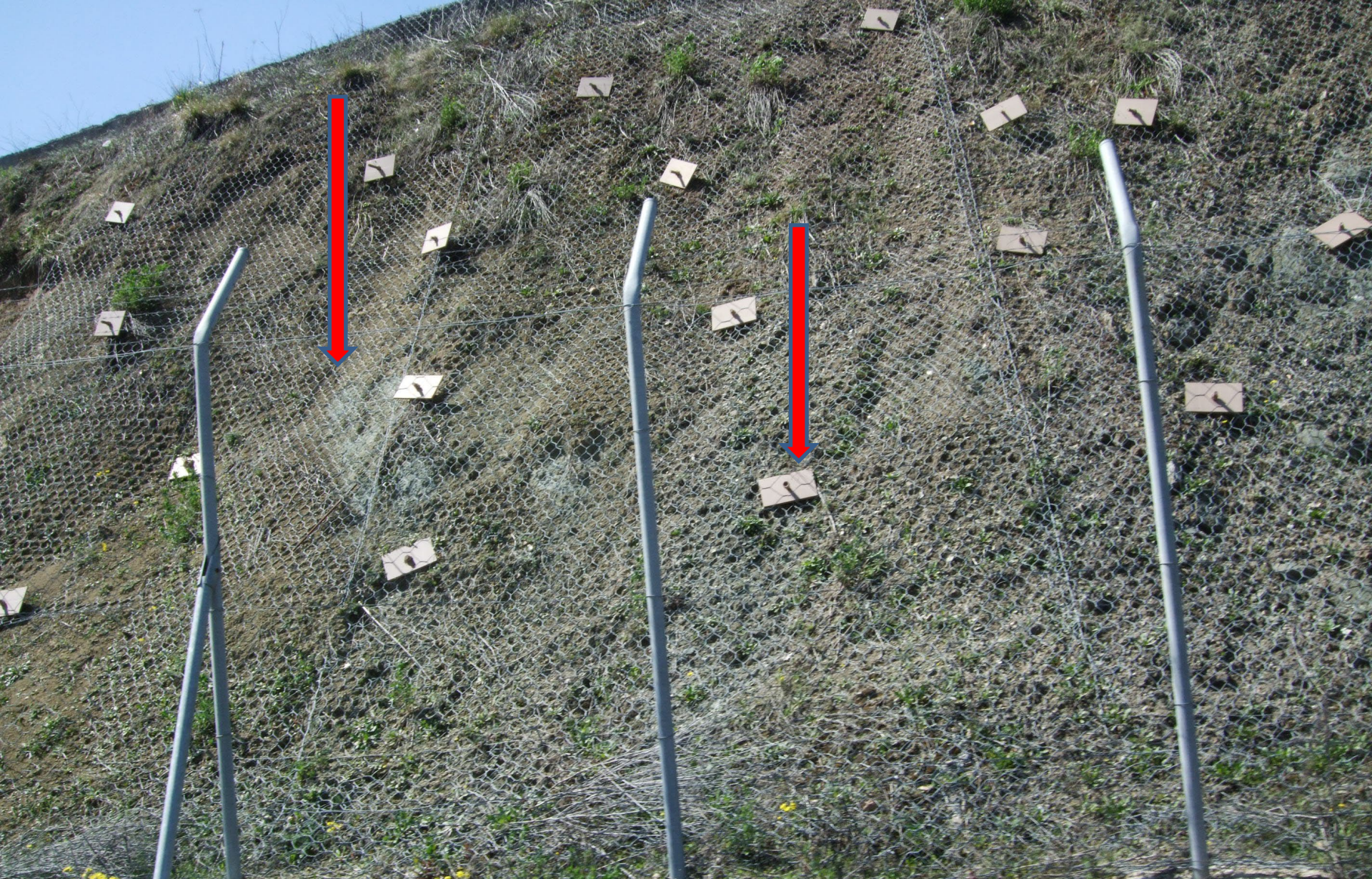
Concrete retaining wall to prevent the dam section from slipping





Support slopes protecting the dam from destruction





Fixation of the slope of the tailings dam dam  
and mesh support



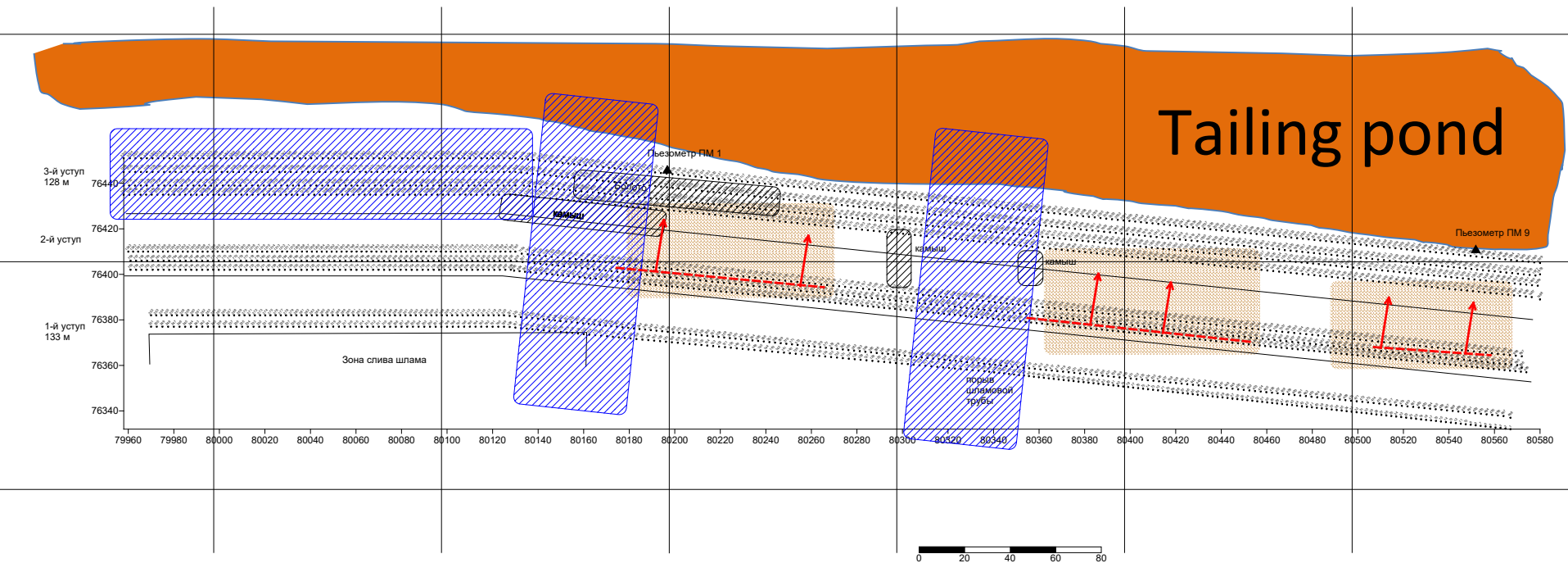
Recommendation 19F. Determine the places of seepage, filtration and streams flowing through the dam, as well as the location of the instability of its slope

To do this, it is advisable to use both visual inspection and use a complex of geophysical methods to reveal hidden filtering zones and unstable state slope.

One of the fastest and cheapest is the method Earth's natural pulsed electromagnetic field (EEMPZ)



# Hidden zones of the damaged technical condition of the tailings dam according to geophysical research



Blue shading - hidden areas of flooding and increased filtration in the dam body

Brown shading - bodies of forming landslides on the slopes of the dam

Red lines and lines with arrows are the likely landslide separation planes and the direction of sliding.

## Recommendation 21C. Install optional drainage equipment



Cascade type spillways in  
tailing dams





## Recommendation 21F. Increase the throughput capacity of the tailings pond drainage equipment



Extended drainage concrete spillway

Recommendation 21G. Create or repair a ditch ditch to reduce the flow of surface water into the pond



Upland (concrete drainage gutter) on the tailings dam



## 2. Critical problem “Danger of volley ingress of waste from tailings and sludge pipelines into the environment”

(Problem from the catalog of events No. 18)

## Recommendation 18I. Create barriers and shock protection for pipelines



Bulk dam under the pipeline for the supply of tailings (sludge)



### 3. The critical problem "The danger of inflation of dry waste by wind

(Problem from the catalog of events No. 14)

## Recommendation 14C.

Create, if justified, a surface coating over tail materials



Covering hazardous waste with a layer of liquid (water)





Overlapping hazardous waste with a solid layer (bulk)

## Recommendation 14D.

Create, if justified, a lower protective shield in the tailings bed

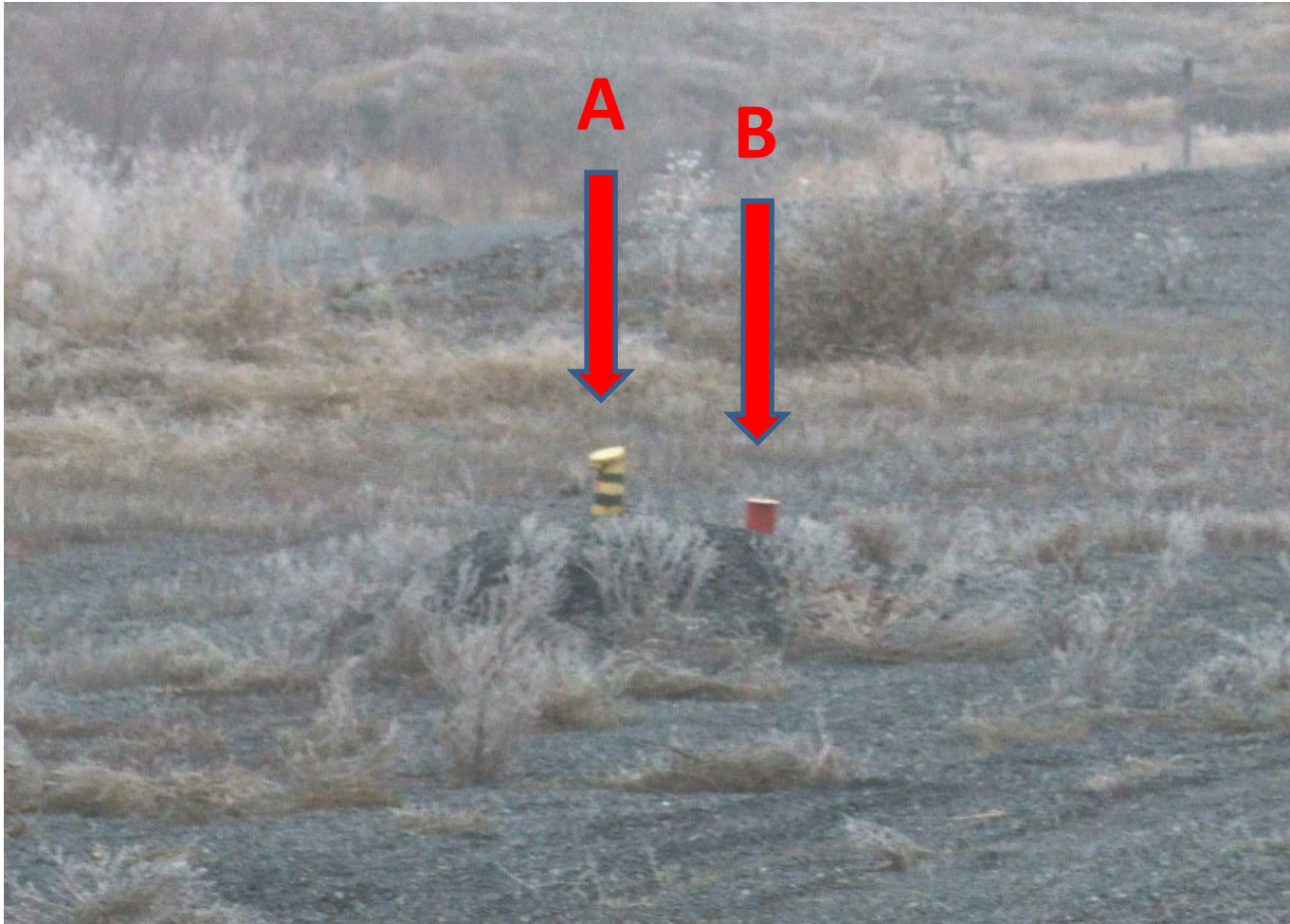


Protective screen in the form of concrete slabs with underlying film



## 4. Examples of other activities

Recommendation 23F. Install additional wells and control points at the tailing site to monitor key parameters



Hydrogeological observation well (A) and piezometer (B) in the body of the tailings dam



## Recommendation 34C. Develop phytoremediation technical measures участка хвостохранилища



Biological Plateau for Drainage Water Treatment  
(View from the tailings dam)

# Event Catalog Application Example

In the framework of the international project “Improving the Safety of Tailings by the Example of Ukrainian Facilities” in 2014, expert groups (trainees) evaluated the safety levels of tailing ponds No. 1 and No. 2 of the State Enterprise “Potash Plant” OJSC “Oriana” in Kalush (Ivano-Frankivsk Region, Ukraine).

Based on the results, a “Report on assessing the safety level of the tailing dump” was compiled (Methodology for improving the safety of tailings, 2018, Appendix 5).

Analyzing each question of the Checklist for the tailings with a non-positive answer (answers “no”, “rather no” or “rather yes”), the experts after visiting the facility selected the following recommended activities prescribed by the Catalog of measures. According to the results of the tailings assessment, the tailings operator should develop an individual investment program aimed at improving the safety of the tailings, and subsequently approved by the competent authorities.



# Recommended measures to improve the safety of tailing pond No. 2

(App. 5, Methodology ..., 2018)

No	Recommended Activities
<b>SHORT-TERM EVENTS</b>	
1.	1C. Perform an expert assessment of the design documentation for the competent authorities
2.	1D. Prepare or complete project documentation in accordance with regulatory requirements
...	.....
<b>MEDIUM-TERM EVENTS</b>	
38	21C. Install additional drainage equipment
39	21E. To increase the capacity of storage ponds for storing water in the event of severe flooding
40	23H. Check your monitoring settings regularly.
...	.....
<b>LONG-TERM EVENTS</b>	
46.	34B. To develop technical measures for the rehabilitation of the tailings using suitable soil
47.	35A. Develop and / or implement measures to ensure the sustainability of the tailings after its closure.

# FINDINGS

In each specific case, it is necessary to apply its own set of measures for the safe operation of the tailings.

Depending on the scale of the manifestation of problems and processes, priorities over time may change, some activities become short-term, and others become long-term.

In terms of importance, short-term activities should:

1. Ensure the safety of the population;
2. Prevent an environmental accident or disaster;
3. To be technologically affordable and cost-effective.

Therefore, in the list of short-term measures, it is advisable to allocate a subgroup of urgent (immediate) measures, failure to take which will inevitably lead to a quick incident.



**Thanks for attention!**