XA9846520

ENVIRONMENTAL RESTORATION OF URANIUM CONTAMINATED SITES IN ESTONIA WITHIN THE FRAMEWORK OF IAEA PROJECT (RER/9/022) IN 1995-1996

R. RATAS
Ministry of the Environment,
Tallinn, Estonia

Abstract

In Estonia there are several radioactively contaminated sites left from the military and uranium processing activities by the former Soviet Union. Enhanced radiation levels are prevalent in the Paldiski area, a former nuclear submarine training centre; on the territory of the waste depository at Saku/Tammiku, and at Sillamäe, where a large depository of uranium milling tailings is situated. During the last two years considerable effort has been put into restoration of these sites. To start with, designing of reasonably achievable remediation projects have been taken up. Estonia has received large contributions from many western countries and organisations. Practical remediation work on contaminated areas, e.g. at Sillamäe is , however, delayed due to lack of funds.

1. INTRODUCTION

Radioactive wastes are generated by a number of nuclear activities: application of radioisotopes in medicine, research and industry and nuclear power programme. In addition, waste with enhanced concentrations of naturally occurring radionuclides is generated in mining and milling of uranium and thorium. Although Estonia is called a non-nuclear country, as a consequence of military and uranium processing activities during the Soviet era, areas of higher radioactive contamination have been left at Paldiski, Saku/Tammiku and Sillamäe sites. In order to ensure safe management of these sites in the country, it is necessary to establish a proper waste management infrastructure which should include legal, organizational and technical components.

2. LEGISLATIVE ACTIVITIES

Riigikogu (the Estonian Parliament) has extended the validity of former USSR norms and rules on safety and radiation protection untill they are replaced by new national legislation. It means that in the field of radioactive waste management Sanitary Regulations for Radioactive Waste Management (SPORO-85), adopted in 1985 and developed according to the Basic Sanitary Regulations for Handling Radioactive Materials and other Radiation Sources (OSR-72/87), and Radiation Protection Norms (NRB-76/87) will be still in force.

The Estonian Radiation Protection Law has been under preparation for more than two years. The final version of this law has now been submitted to the Government and will be further referred to the Parliament in the coming months. Draft version of the law has been reviewed by the experts of the IAEA, and the Finnish Centre for Radiation and Nuclear Safety. The Law is expected to be approved by the end of 1996.

The Radiation Protection Law will be the basic law in the field of radiation protection in Estonia. This will form the basis for other regulatory documents to follow.

Saku/Tammiku waste facility

A low and intermediate level radioactive waste facility was established at Saku/Tammiku in the beginning of the 60's. There is a 200 m^3 underground concrete vault for solid waste storage divided into 9 compartments [1]. The facility is filled up to 55 % and delivery rates have ranged from 10.530 kg in 1963 to 480 kg in 1991. For liquid waste there is a cylindrical stainless steel tank at present containing 6.3 m^3 of waste with a total activity of about 590 GBq.

A preliminary safety assessment has shown that medium and long term safety of the waste disposed of at Saku/Tammiku does not meet present day international standards. To improve the physical security of the site and to modernise the facility performance in 1995, a reconstruction project was formulated by Construction Design Company "Tööstusprojekt". Due to the high cost of renewal work amounting to 2.6 MEEK, this project was cancelled and only minor activities for upgrading the physical protection were carried out.

The responsibility for the depository was transferred in October 1995 from the Tallinn Special Motor Depot to AS ALARA Ltd., the new institution dealing with radioactive waste management. In early 1996 the waste facility was shut-down temporarily and no radioactive waste material was received for storage. The present plans are to initiate a process of safety and performance assessment to facilitate decision on further management of the site. One of the feasible scenarios could involve sorting and classification of the radioactive waste material over the next few years, proper repackaging and transfer to the Paldiski facility.

Paldiski facility

On a special agreement between the Russian Federation and Estonia two nuclear reactors of the former submarine training facility were transferred, fuel rods and main equipment transported to Russia. Two radioactive waste storage facilities remained, one for liquid and the other for solid waste containing more than 700 m^3 of liquid and about 213 m^3 of solid low level radioactive waste, respectively. By September 30, 1995 the site was turned over to Estonia including the responsibility for radiation and environmental safety of the surrounding territory.

Due to lack of expertise in the area of decommissioning and decontamination work, the Paldiski International Expert Reference Group (PIERG) was organised under the leadership of the Swedish Government. Presently, this group includes experts from several countries and international organisations, as for instance, from Finland, USA, Russia, Denmark, IAEA etc.

The main tasks of the PIERG are to promote safe and timely decommissioning of nuclear facilities by advising and assisting the organizations involved in the work on technical, organizational, financial, waste management and radiation protection matters. PIERG identified a number of tasks for implementation. For instance, in the area of environmental radiation protection, the main tasks implemented during 1995-96 are:

- treatment of over 700 m^3 of low level radioactive liquid waste so that it could be safely released into the sea. This was done during the summer of 1995 (joint task of Finland, Russia, Estonia);

- site and building characterisation to determine the location and extent of radiological and other hazardous materials on the site (joint USA-Estonian task);
- airborne multi spectral analysis of the peninsula (USA task).

Presently, the work at site is focused on territory control and security, and maintaining the facilities that are expected to remain in operation.
The major tasks to be carried out in the near future and important in the field of environmental radiation protection, are :
- treatment of radioactive bottom sludge of the liquid waste storage tanks;
- treatment of separated radioactive liquid;
- proper packaging and storage of solidified waste.

Sillamäe uranium mill tailings depository (SILMET Plant)

During the whole period of operation of the Sillamäe uranium milling facility about 4 million tons of uranium ore and approximately the same amount of loparite were processed [2]. Remaining tailings are deposited in an oval retention impoundment located on the coastline of the Gulf of Finland with an overall area of about 33 ha. The bottom of the depository consists of permeable coarse-grained material lying in a 2-10 m thick layer of Cambrian clay, at about 4 m above sea level. The closest point of the embankment to the shoreline is about 30 m and the top of the dam is about 25 m above sea level. About 30% of its area is covered by a sedimentary pond containing approximately 150 000 cubic metres of acid waste water with a depth of up to 3 m.

During the period 1993-96 several international as well as national investigation projects have been carried out concerning radiation and geotechnical safety problems of the Sillamäe site [3,4]. It is concluded that the total amount of uranium mill tailings in the depository is about 6.3 million tons. The rest of the waste, about 6.1 million tons, is oil-shale sudge and residues from loparite processing. The total amount of elemental uranium and thorium is estimated to be 1830 and 850 tons, respectively, and radium about 7.8 kg. In general, investigations done up to now have given sufficient information about the distribution of contaminants in the depository and allowed to conclude that the environmental impact of the waste depository in Sillamäe is limited. The only possibility for radioactive contamination of the surrounding area could arise due to the dust lifted up from the dry surface of the depository by wind in the periods of low precipitations. As a counteraction against this, the surface was wetted artificially at some periods. Aeolian erosion of the depository has occurred very seldom as in Estonia in general, the amount of precipitation exceeds natural evaporation remarkably. However, some losses of surface water occur due to the infiltration through the embankment.

Leakage from the impoundment into the sea does occur, but radiological hazard is not very serious. However, it was concluded that there is an active erosion weakening of the barriers and that the stability coefficient of the depository dam is smaller than normally required. The stability coefficient given by geotechnicians calculated according to different methods ranges between 1.05-1.2 and 1.3-1.4, while the internationally accepted value for long-term exploitation of depository should be about 1.8-2.0 .

Two years ago a workshop was held in which all institutions of Estonia involved in the investigation of Sillamäe tailing depository participated. In this meeting the coordination flow chart was elaborated to achieve practical restoration outcomes in the site (Fig. 1). One of the urgent tasks was to promote accident prevention activities. The following example demonstrates the designing of a remediation project to reinforce the embankment from the sea side.

As the waste depository is lying on a Cambrian clay, some shifts of the embankment toward the sea can be foreseen. Slip danger dam zones with a small stability factor may exist in places where marine terrace which forms the bottom of the depository, is subjected to the wave erosion process. Geotechnical monitoring has shown that some shifts of the dam occur ranging 11 - 20 mm per year.

PROJECT IMPLEMENTATION

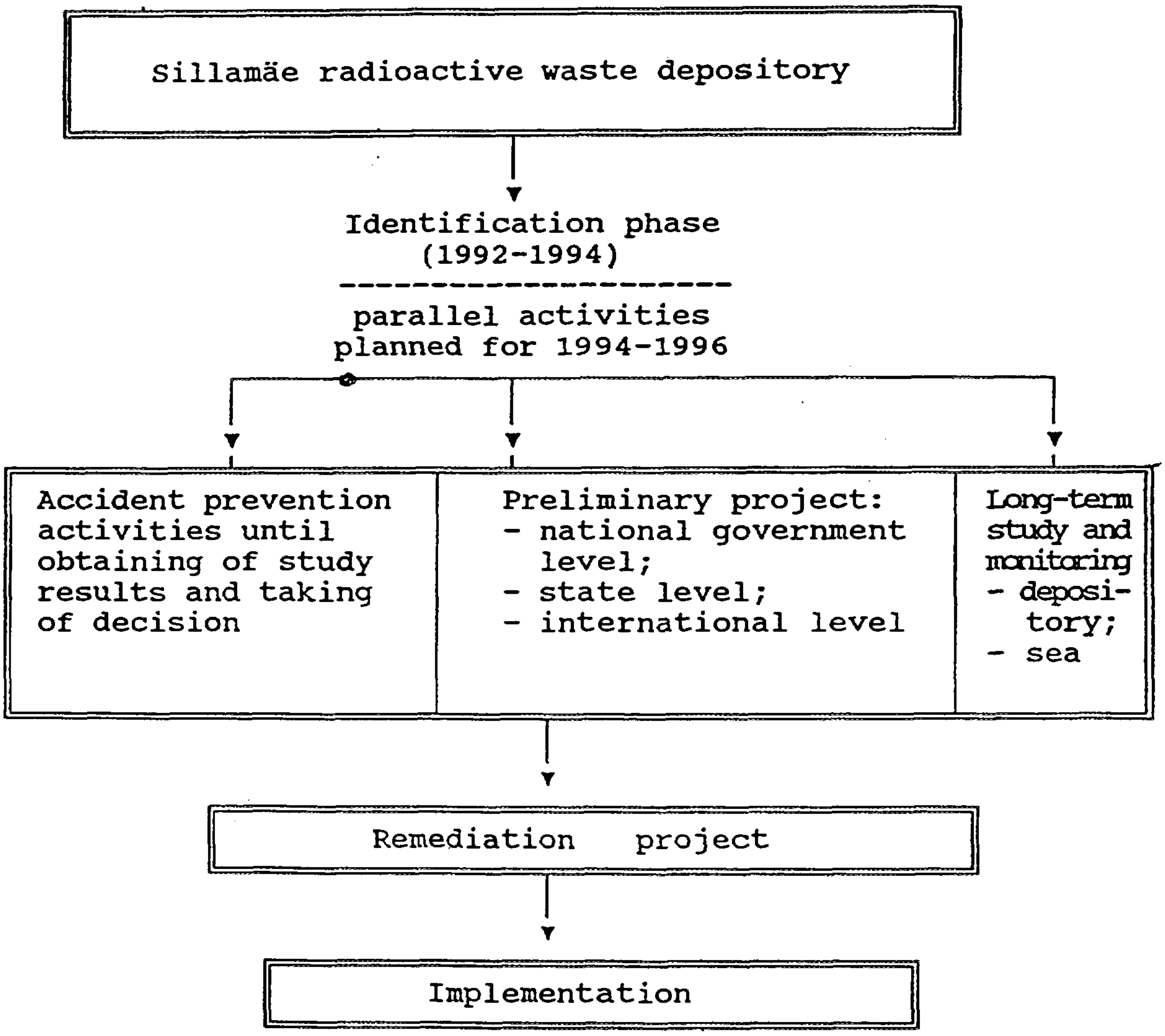

Fig.1. General flow chart of activities for environmental restoration of Sillamäe uranium mill tailings depository.

To get a preliminary overview about the sea erosion activity necessary for future planning, a special research project was carried out. This initial work [5] showed that most active damaging of shore line is occurring in the range of dam sections D and C (Fig. 2). Based on this and on the results of geotechnical observations, an accident prevention project [6] was designed to reinforce the dam in some key locations (cross-sections A-A and B-B in the Fig. 3). The main idea of the project is to build counter balance prisms on the shore-line to avoid possible slides of the dam sections where the stability factor is insufficient (Fig. 4). Designed peripheral dam will increase the stability factor estimated for the existing embankment from about 1.2-1.4 upto the value of 1.8-2.2 which will meet international requirements. However, several ways for practical implementation were indicated in the project that needed additional expertise. At present this work is going on the results which

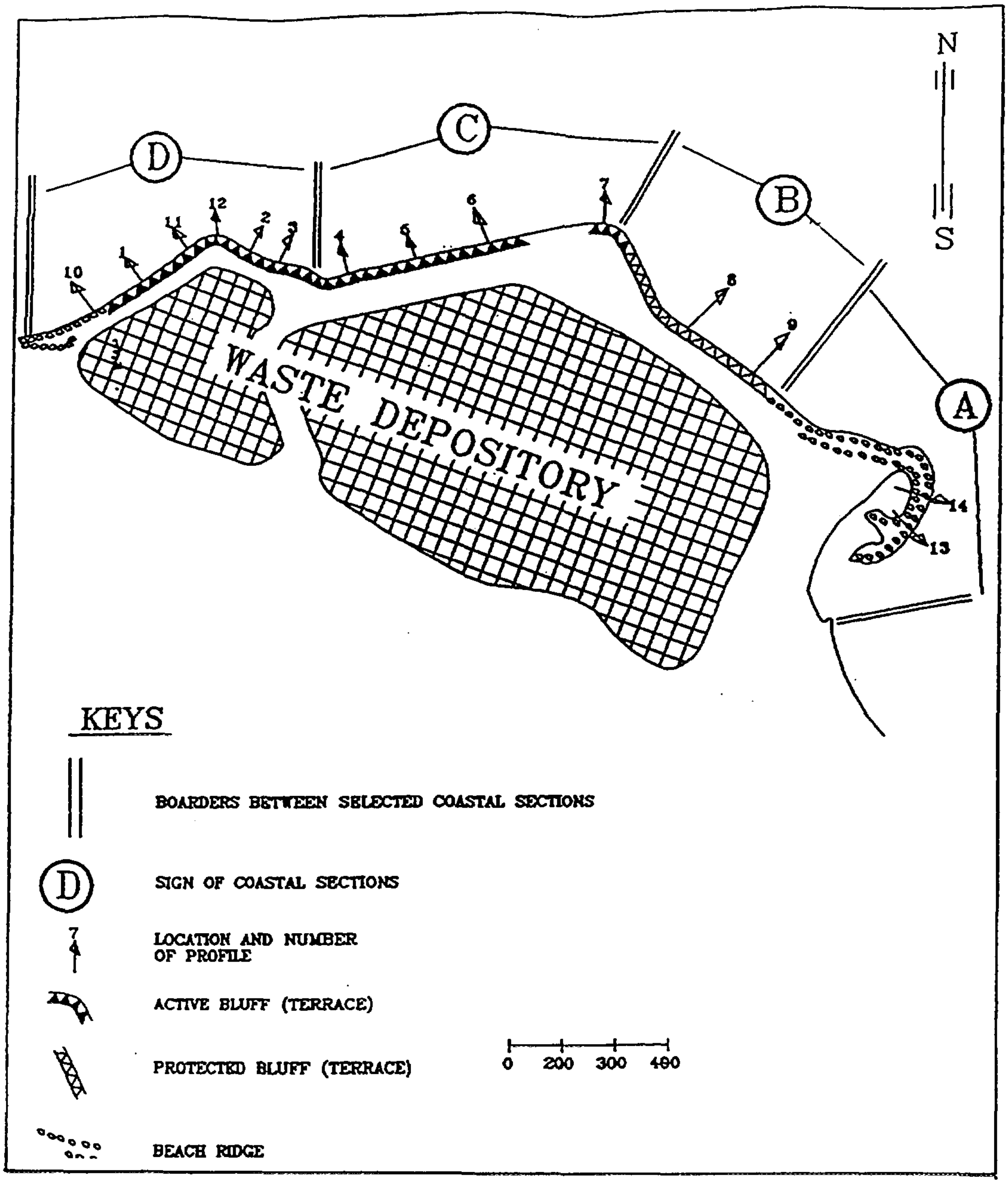

Fig.2. Geological structure of coastal area bordering to the depository.

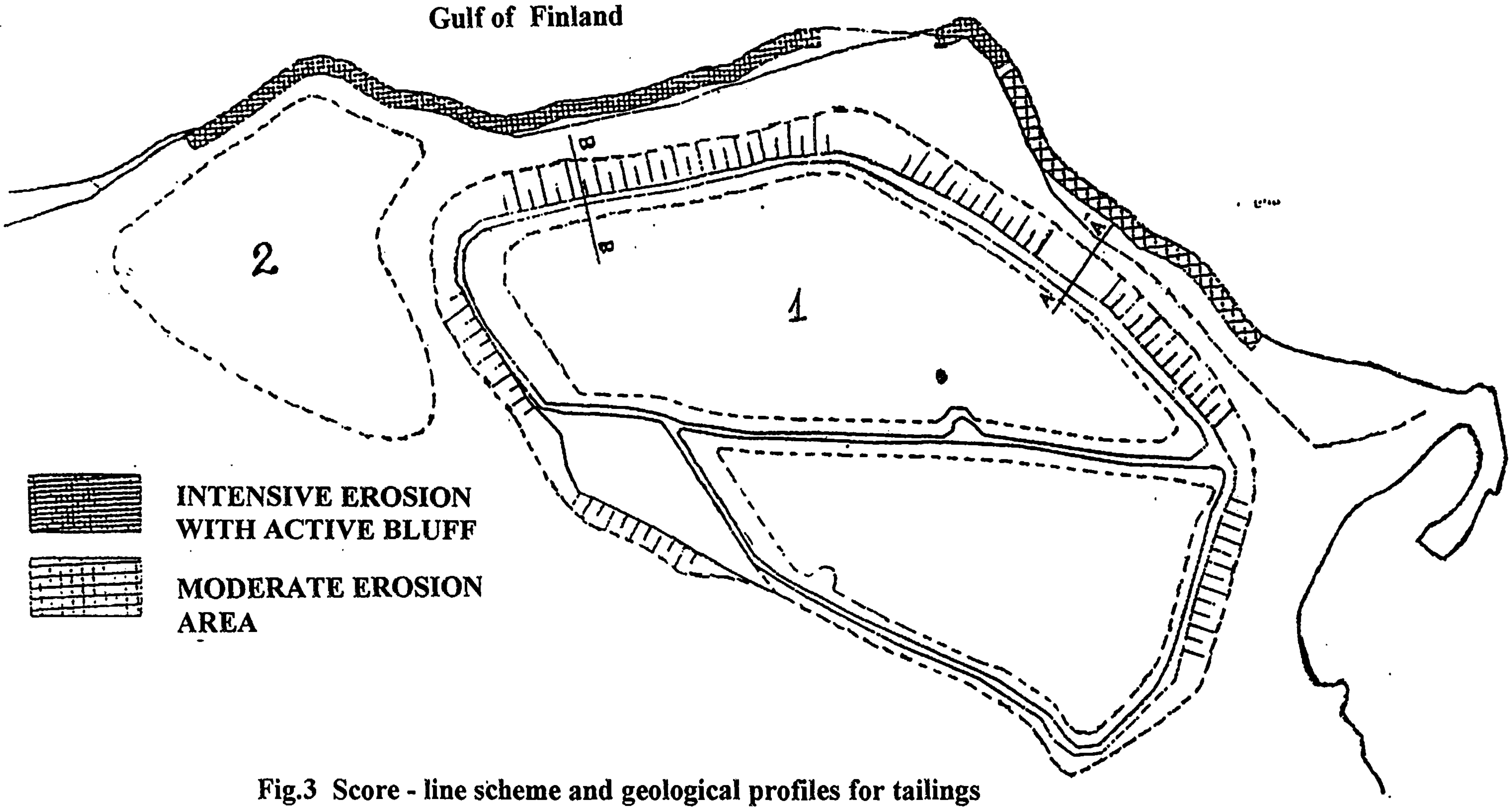

Fig.3 Score - line scheme and geological profiles for tailings depository
A - A; B - B - location of geological profiles

1 - old compartment,
2 - new compartment.

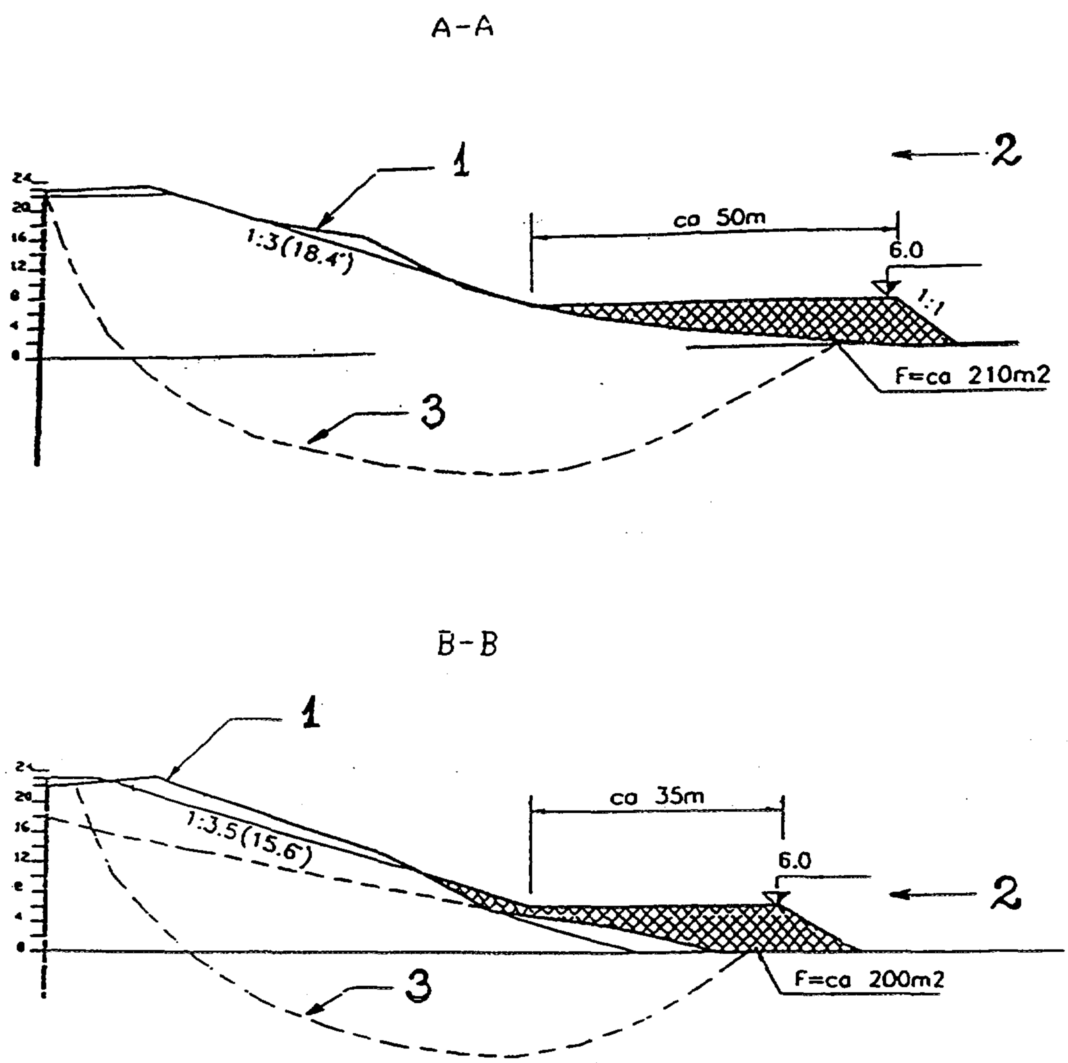

Fig. 4. Geological cross-sections of counter balance prisms designed.

1 - outline of the existing slope
2 - filling direction
3 - slide surface

will allow taking a final decision on how to perform remediation activities and to close the depository. It is proposed to include waste water seepage through the dam into the sea in the existing monitoring network of Sillamäe. Acknowledging the importance of starting practical restoration works as soon as possible, the Estonian Government has funded the factory with 4.8 MEEK for immediate remediation work this year.

In addition, a multi country PHARE project on the topic of remediation concepts for uranium mining and milling sites in the Central and Eastern European Countries was launched this year. It has been proposed to compile a detailed data bank on the situation at sites under this project and to offer basis for further design of pilot projects. The latter is planned to be carried out in the second phase of the project which will bring knowhow on remediation practices and technologies accepted world-wide to Estonia.

Under the present circumstances and plans for the future, the state as well as SILMET plant have to:

- increase the stability of the impoundment dam during the next year by reinforcing the dam slope against wave erosion;
- keep under control the leaking water from the depository and work out measures for its treatment;
- start designing a project for the close-down of the depository;
- finish exploitation of the depository in 3-4 years;
- solve problems concerning storage of the radioactive and non-radioactive waste, especially of thorium, proceeding from the technology planned to be used;
- find a place for construction of the new waste depository;
- work-out a temporary solution for treatment of filtrate waters and find funding needed for practical realization.

Special tasks for the SILMET plant to be fulfilled in the near future are as follows:

- proceeding from the technology used to formulate a programme for management of radioactive and non-radioactive waste, plan funding;
- apply a special licence for such activities;
- within the framework of preparation for closing down the depository, to initiate design of a new depository, and arrive at a technology and technical solutions for actual closing down of the existing depository.

Carborne radioactive mapping

In 1995 environmental mapping of radioactive sources along the main roads of Estonia was carried out in co-operation with the Finnish Centre for Radiation and Nuclear Safety [7]. For cost-effective reasons carborne radiological surveys were used. Data revealed that radioactivity was on the average 0.04-0.1 μSv/h, somewhat higher was radioactivity near Kiisa due to the vicinity of the low level radioactive waste depository at Tammiku.

3. CONCLUSIONS

The overall stragegy for environmental restoration of contaminated sites in Estonia calls for several actions to solve the impending problems. An Action Plan for 1995-1996 was drawn and some success has been achieved in its implementation as for example, the Radiation Protection Law finalized and Radiation Protection Centre established. However, dur to very limited funding, some important tasks need urgent solutions in the near future:

- passing the Radiation Protection Law in the Parliament;
- development of a monitoring system;
- refurbishment of the Saku/Tammiku and Paldiski waste depositories;
- finalization of the restoration project for the Sillamäe tailings depository.

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