Tauw

OSCE

Executive Summary

Site Assessment and Feasibility Study of the Obsolete Pesticides and Persistent Organic Pollutants Burial Site in Nubarashen, Armenia

The Nubarashen landfill was used mid-1970's as a disposal site for Persistent Organic Pollutants, and is located in a valley subject to severe erosion processes. The Government of Armenia has set up the Emergency Working Group led by the Ministry of Emergency Situations in July 2010. After some of the waste in the landfill was illegally mined, around USD 100,000 was allocated from a special fund for an interim containment and repair measures until a permanent solution could be developed. After these repair measures, human health and environmental risks still exist, therefore the Government of Armenia - through the Ministry of Emergency Situations - decided to take action. With funding from the Organization for Security and Co-operation in Europe (OSCE) it was initiated to perform investigations and a feasibility study supporting the selection of a long term sustainable solution for the elimination of human health and environmental site risks. This project is supporting development of a follow on and now approved GEF co-financed investment UNDP project.

The Request For Proposal for this OSCE investigation and a feasibility study was published in June 2012. The contract for this assignment was signed between the OSCE and Tauw on January 2013. To reach the objective, the assessment and feasibility study is split in three project phases. Phase 1 is the initial site assessment. Phase 2 is the detailed site assessment and Phase 3 concerns the initial design of the best two selected site remediation scenarios mitigating the environmental and human site risks.

The landfill site at Nubarashen, comprising of a landfill body and surrounding land, is situated to the South-East of Yerevan on a steep mountain slope. The landfill site is fenced and the landfill body, a hillock, is enclosed on three sides by concrete runoff drains. Two deep trenches, collecting run-off water with sediments are situated 10 m down slope from the landfill body. The landfill body has a surface area of approximately 0.2 hectares with a height of around 1-1.5 m above the surroundings; it is covered with a 40-70 cm top cover of clay lying on top of a 2 mm ruberoid liner. The estimated in-situ volume of this top cover is 890 m^3. The quality of this top cover is relatively clean with DDT concentrations below or just above the Dutch I-value. Traces of pesticides, remains of packaging materials and erosion features are observed in the top cover. Below the ruberoid liner is a liner support layer of 5-10 cm coarse sand on contaminated clay layers with or without pure pesticides. From archives it is known that 512 ton of POP and obsolete pesticides supposedly was dumped in the Nubarashen landfill. From the survey it has become clear that the pesticides are dumped in five separate cells (see figure 1). The most eastern cell contains wet pesticides and is a small squared structure made of stones/concrete. The central two cells have been severely affected by the illegal waste mining. But pure pesticides are still

present in these cells and there has been significant mixing with the surrounding soil. The two western cells do not seem to have been affected by the waste mining.
These cells also contain pure pesticides but very little mixing with the surrounding soil has taken place. Except for the most eastern cell, all other cells seem to have been made by excavation and no materials were used for the cell structure. The most western cell and part of one of the central cells is present outside of the hillock. Here pure pesticides are present less than 50 cm below the surface.

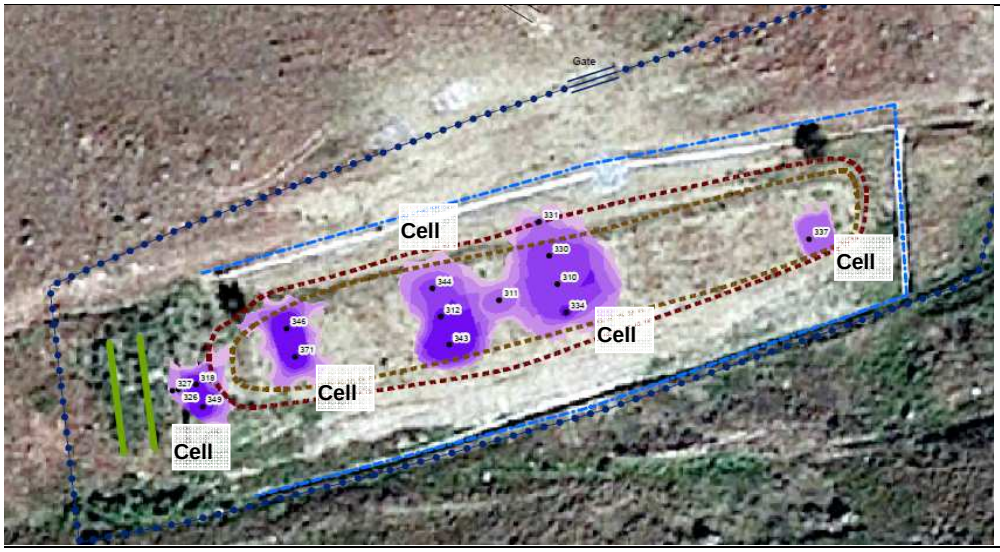

Figure 1 Location of the five cells and the landfill body

Around 605 m^3 of pure pesticides is still present in these five cells, the clay bottom of the pits is contaminated; the expected volume is 29 m^3. In additional, approximately 1,127 m^3 of heavily contaminated soil with traces of pure pesticides is present in the hillock. Surrounding the landfill, within the fence, is a barren area of around 0.6 hectares. The topsoil of this area is (heterogeneously) heavily contaminated with pesticides till a depth of at least 0.5 m. The in-situ volume of the surrounding contaminated top soil is estimated at around 3,000 m^3. The table 1 gives a summary of the estimated quantities of the contaminated soil and the pure pesticides present at the landfill site.

Table 1 Estimated quantities of the contaminated soil and the pure pesticides present at the landfill site.

Total estimated quantities landfill site and landfill body	In situ	Weight*
Contaminated top soil with traces of pure pesticides fenced area landfill site	3,000 m^3	5,100 ton
Slightly contaminated top cover landfill body	890 m^3	1,513 ton
Heavily contaminated top soil with traces of pure pesticides in landfill body	1,127 m^3	1,916 ton
Pesticides	605 m^3	605 ton

Total estimated quantities landfill site and landfill body	In situ	Weight*
Contaminated clay at bottom of four excavated pits	29 m^3	49 ton

* Moisture content and density have not been determined; the used specific weights are based on expert judgement

The groundwater and the surface water at a few hundred meters downstream from the landfill site were not found to be impacted by the contaminants present at the landfill site.

A pond and a leaking water main parallel to a dirt road are located uphill from the landfill site. The water main and a culver filled with soil crossing the dirt road are blocking the natural drainage pathway of the uphill catchment area which results in standing water in the pond. The water in the pond and the water from the leaking water main infiltrate in the soil and percolates laterally in the catchment area of the landfill. This is causing extra water to accumulate in the active landslide body above the landfill site. Slope movement upstream of the landfill site is the mechanism behind the observed mass movement at the landfill site and its surrounding area. The stability of the upstream area of the landfill site is influenced by the perched ground water levels. The run-off drains surrounding the landfill site are partly dislocated, damaged and tunnelled by rain water run off causing increased accelerated erosion of the landfill area and extra infiltration of water into the contaminated soil.

A Tier 2 risk assessment concluded that only the people entering and/or working at the landfill site and a zone of 100 m around the landfill site have direct contact risk with the contaminated soil. Direct contact can be avoided when proper personal protective equipment is used when entering the 100 m zone and the site. The landfill site fence has to be maintained to prevent animals and unauthorized people to enter the site. Warning signs, warning trespasses for the risk when entering the 100 m (buffer) zone and/or the site have to be installed. The other possible receptor pass way is the air born contaminated fine soil particles; however significant off-site impacts are not expected given the distance to receptors and dispersion. The receptor pathways of runoff water and percolating rainwater are not established. It has to be noted that this area is not and never would be considered high value agricultural soils. However, if nothing is done accelerated site erosion will continue and off site migration of contaminants will increase, enlarging the environmental and human risks.
In the remediation scenario review, for all relevant components of the landfill site (low contaminated soil, heavily contaminated soil, pure pesticides and contaminated construction materials) the possible remediation techniques have been reviewed using a Multi Criteria Decision Analysis (MCDA, see figure 2). For the heavily contaminated soil, the contaminated construction materials and the pure pesticides ex-situ destruction is considered the most appropriate option. For the low contaminated soil, containment and phytoremediation are considered the most appropriate techniques.

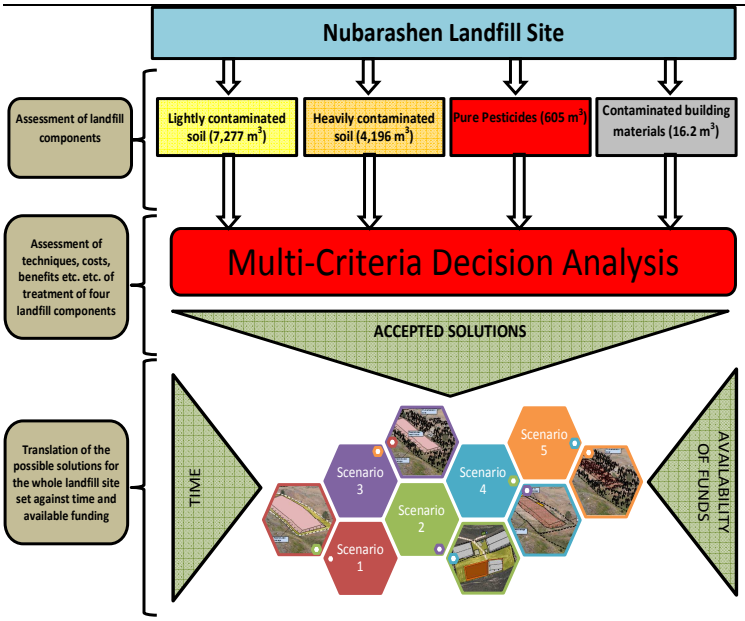

Figure 2 Step wise process of selection of the five remediation scenarios by MCDS

Using the previously mentioned preferred techniques the following five scenarios are drafted that took into account the availability of funding for the remediation of the site:

1. Merely minimal funding is directly available. Only after a significant period of time (more than ten years) the funding for the full clean-up can be at hand
2. Funding is available over the course of the years in several intervals, until the site has been fully remediated. In this review it is assumed that the period for this scenario is 15 - 20 years
3. Within a short timeframe (coming two years) significant funds are available but not sufficient to fully remediate the site. To completely remediate the site a second tranche of funding becomes available after a period of more than ten years
4. Delay in the availability of funds of several years after which the full funding becomes available
5. Funding for the complete site remediation is available within the next two years

Below figure illustrates the required time set out against the proceeding of the remediation in these five scenarios.

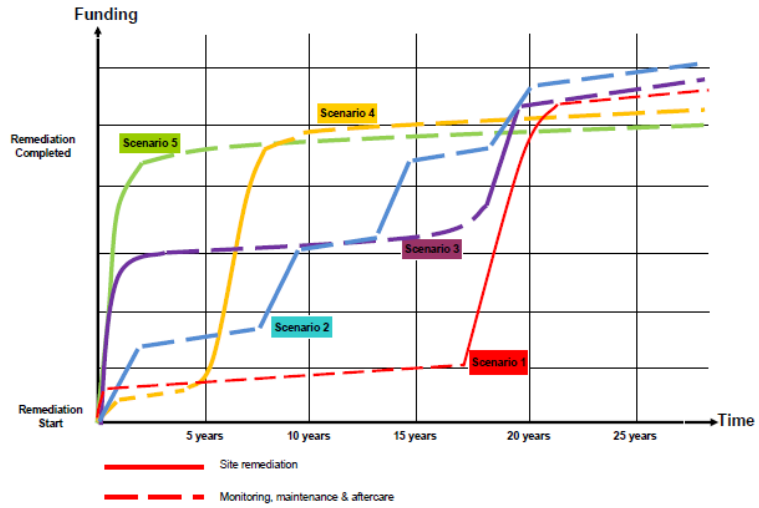

Figure 3 The funds availability plot against the time of the five remediation scenarios

The main conclusion of the scenario review is that the steps required for the final clean-up of the landfill site can be done in accordance with availability of the funding, i.e. even if in the short term only very limited funding is available steps can be made to improve the landfill site and mitigate the current risks. Based on the review it becomes clear that the technical measures needed for the landfill are quite similar for all scenarios. The timing of the funding will determine when, which steps can be taken. Therefore scenario 2 and 4 are pre-designed in the scope of this feasibility study. These scenarios contain nearly all elements that make up the five scenarios and should give a good insight in the cost and the feasibility. Based on the recent UNDP information concerning the upcoming GEF POPs elimination project the GEF funding (USD 4.6 mln) will be available in late 2014-early 2015. In addition, financial commitment from the government for the project stands for USD 20 mln. The preliminary conclusion of the feasibility study is that Scenario 5 or 4 will be followed to implement the UNDP / GEF project.
For scenario 2 and 4 the measures required to ensure the geo-stability of the site are included. These measures are guarantee a permanent drainage of the pond with standing water and repair water main upslope the landfill site and subsurface partition to redirect all surface run-off from the area just above the landfill. These measures should increase the slope stability upslope of the landfill site.

Scenario 2
The precondition of scenario 2 is that the funds are available in trances over the years. In this scenario the pure pesticides and heavily contaminated soil are excavated, re-packaged and stored off-site in purposely build/renovated central storage. This Centralized Intermediate

Collection Centre to be constructed/renovated within the larger scope of the implementation of the UNDP / GEF. The storage of the re-packaged heavily contaminated soil and pure pesticides allows for secure storage until funds are available for the final destruction of the pure pesticides and the cleaning of the heavily contaminated soil. This can be done by exporting the pure pesticides and heavily contaminated soil to a facility outside the country or to a suitable facility in the country. Most likely this activity will subjected to an international tender and based on the quality and the prices the choice will be made. The low contaminated soil is re-distributed in a new landfill site constructed on the now empty old area.

Scenario 4

In scenario 4 only limited measures are implemented until all funds for the complete site remediation become available. After that the pure pesticides and heavily contaminated soil are excavated, re-packaged and transported to an off-site destruction and respectively soil cleaning facility in or outside the country as explained for in scenario 2. The low contaminated soil is re-distributed in a new landfill site constructed on the now empty old area.

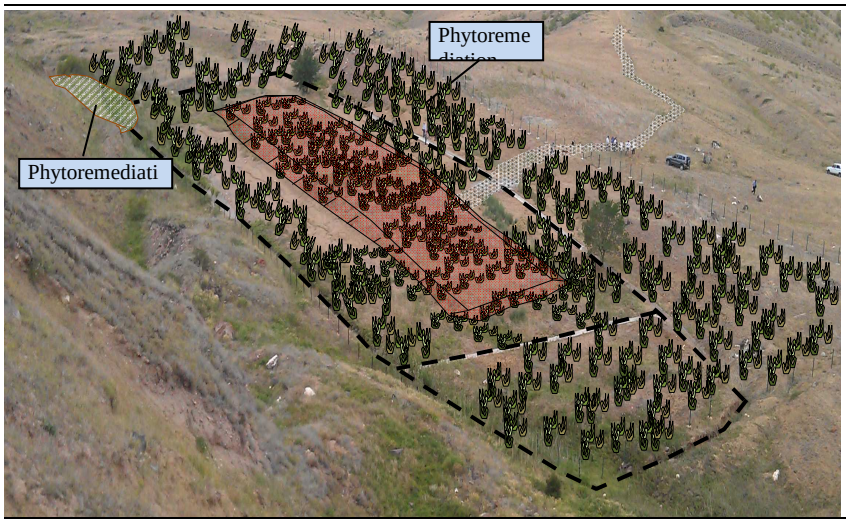

Figure 4 Long term measures of scenario 4 (artist impression)

Stakeholder involvement

In addition to the availability of the required funding, the deciding factor in the improvement of the Nubarashen landfill site is mainly the commitment of the various stakeholders. The purpose for stakeholder involvement in the Nubarashen project is the explorations of fresh ideas, networking to share ideas and best practices, awareness raising to reach decision makers and vulnerable groups, advocacy to support efficient political decision making and creation of commitment and project ownership among stakeholders. All these activities are targeted to support the overall project aim to reduce and finally eliminate the health and environmental risks of Nubarashen landfill site.