



LIFE12 ENV/FI/000592



# Utilisation of by-products and alternative construction materials in new Mine Construction

## ABSTRACT

UPACMIC LIFE12 ENV/FI/000592 (Utilisation of by-products and alternative construction materials in new mine construction) is an EU LIFE funded project studying the utilization of alternative construction materials in the mining facilities. The project tests different waste and by-product materials in pilot construction as such and as refining components together with local moraines and mine enrichment sands. The project started in 2013 and will be continued until the year 2020. The coordinator of the project is Ramboll Finland and the associated beneficiaries are Suomen Maastorakentajat Oy and Fortum Environmental

## Objectives

The UPACMIC project demonstrates through pilot applications the utilisation potential of waste materials and industrial by-products that these alternative materials are a true option for construction tailings ponds' bottom and cover layers and reactive barrier layer, when used together with locally available materials. The piloting action tests all the details of the process including material storage, treatment and transports until the construction of the application has been finished. This demands a well-designed synchronisation of the materials flow to achieve financial benefits in logistic and material costs.

All the obtained information and experience will serve the future needs of the stakeholders and the target audience. The UPACMIC project will supply the environmental authorities with valuable background data needed for the development of the legislative and decision-making tools. The project is a practical implementation of the EU waste hierarchy and a step towards building a more circular economy society.

## Alternative materials

Materials to be used in the UPACMIC applications are waste materials and industrial by-products, such as fly ashes, fibre clay and foundry sands. These materials will be used together with local moraines and mine enrichment sands. Refining local materials together with alternative materials, it is possible to impact significantly on the properties of different structure solutions, such as compactibility and water permeability.

The objective of the material studies is to find a right solution to a right purpose by utilizing alternative materials together with local materials. This will allow financial savings in the use of non-renewable natural aggregates like moraines and commercial insulating materials. When the local materials are utilized, it is important to consider the availability of the materials, cost-effective distance of the material transportations and forming waste material amounts as the mining areas are large and the needed material amounts are very voluminous.

## Material tests for Hitura Mine materials

Material studies of the UPACMIC project show that by mixing ash with moraine, the water permeability value can be decreased. This allows in many cases the use of such local moraines that otherwise would not fill the requirements set for the protective structures.

The material studies made in the project has included extensive laboratory tests:

1. to find out the solubilities of the nickel and gold enrichment sand,
2. to explain the differences and joint effects when materials are together in the cover structure,
3. to find out the functional differences of the materials and
4. to preliminary study if the recovered materials can be used in the cover structures of the enrichment sand basins.

The material studies included column tests (Figure 1), made according to the standard CEN/TS 14405 (Characterization of waste - Leaching behaviour tests - Up-flow percolation test (under specified conditions)). The diameter of the columns were 50 or 100 mm and height 280 mm. When compared to the field situation, the materials in the column were packed downwards to have the same water flow direction as in the real situation. The total amount of different material compositions was 10 (total of 10 columns).



Figure 1. The sample packed in the column before starting the test. The materials starting from the below are moraine, gold enrichment sand and nickel enrichment sand. In both ends of the column is placed 1 cm layer of inert glass pearls.

The tested materials are presented in the Table 1.

Table 1. Column ID's and materials used in column tests.

Column ID	Materials
HK1	Gold enrichment sand
HK2	Nickel enrichment sand
HK3	Gold enrichment sand, nickel enrichment sand
HK4	Moraine, gold enrichment sand, nickel enrichment sand
HK5	Gold enrichment sand + 15 % biotite, nickel enrichment sand
HK6	Stabilised gold enrichment sand + piled fly ash, nickel enrichment sand
HK7	Stabilised gold enrichment sand + fly ash, nickel enrichment sand
HK8	Stabilised nickel enrichment sand + fly ash, nickel enrichment sand
HK9	Lime stabilised gold enrichment sand
HK10	Stabilised gold enrichment sand + lime, gold enrichment sand, nickel enrichment sand

## Field tests in Pyhäsalmi Mine

In Pyhäsalmi, preliminary field tests were done in spring 2016 (Figure 2). The intention of these field tests was to study the previously tested material compositions performance in actual field conditions. The main emphasis of the tests was to complement the laboratory results, especially for water permeability and solubility characteristics. These field tests also tested the actual manageability of the materials and construction works together with the material logistics.

The most interesting solutions according to the customer and the materials that need more material studies, were chosen for these field tests to have complementary information for the future pilot structures.



Figure 2. Field tests in Pyhäsalmi Mine. 10 lysimeters were built in 2016.



Pyhäsalmi Mine (2016)

## AUTHORS

Tarja Niemelin, Ramboll Finland Oy

Merja Autiola, Ramboll Finland Oy

Harri Jyrävä, Ramboll Finland Oy

Noora Lindroos, Ramboll Finland Oy

Matti Helaakoski, Suomen Maastorakentajat Oy

Anne Kulmala, Fortum Environmental Construction Oy

Jan Österbacka, Fortum Environmental Construction Oy

## CONTACT US

Tarja Niemelin, Ramboll Finland Oy  
[tarja.niemelin@ramboll.fi](mailto:tarja.niemelin@ramboll.fi)

