EXCAVATION MATERIALS MANAGEMENT STRATEGY

Luisa ULRICI, CERN, on behalf of the MATEX working group

WG3 – Integrate Europe
Task 3.4 - Management of excavated materials
D3.4: Preliminary excavation materials management plan (CETU)
Management of excavated materials: rationale

**Goal:** identify credible concepts for the management of the molasse materials

**Excavated material seen as “resource” rather than waste**

- **8.1 Mm³ of excavation material** (bulk volume after excavation)
- **96% heterogeneous sedimentary molasse**, 3% limestone, 1% moraine

Today **no known industrial-scale re-use** for the molasse

**Credible plan** for the management of the materials is a key ingredient of the feasibility

**Leverage** different sectors to develop solutions for a future science project with benefits for the entire society

The excavation material management plan played a role in the **acceptance** of the major infrastructure projects (TELT, Grand Paris etc.).
Participants on the work for deliverable D3.4:

FR:
- CETU Center for tunnel studies
- Cerema Center for studies and expertise on Risk, environment, mobility and urban planning

CH:
- Republique et Canton de Geneve Geology, soil and waste department (GESDEC)

A:
- Montan Universitaet Department of Subsurface Engineering, Leoben, Austria

In addition to:
- Collaborations with external experts:
  - Regulatory framework: University of Lyon 3,
  - 3D subsurface modelling: University of Geneva, GESDEC, University of Grenoble, University “La Sorbonne” (Paris)
- Support by external consultants:
  - Inventory of regional opportunities: SETEC/Lerm, BG engineurs
  - Feasibility study for railroad connection: EGIS-rail
As mentioned in the FCCIS Grant Agreement:

“A technical/managerial report that summarises the approach for managing the approximately 9* million cubic meters of excavation materials in a resource- and cost-effective way, pointing to innovation potentials with economic benefits for companies and environmental advantages for the European society. The plan is considered to be preliminary, since specific management processes, the economic viability and the environmental benefits of the envisaged excavation materials use cases depend strongly on the precise sub-surface investigations, the evolution of legal frameworks in the EU and Switzerland and the response of companies to market surveys, all of which are expected to evolve after this H2020 project ends.”

Objectives:

→ To demonstrate the FCC feasibility from the point of view of the management of excavated materials.
→ To show that the project owner takes into account all aspects (technical, regulatory, timing…).
→ **To define a strategy** and to communicate commitments of the project owner.
The re-use of excavated materials

The degree of actual reuse depends largely on the geochemical, mineralogical and geotechnical properties of the excavated materials.

The choice of the tunnelling method is of particular importance. It influences the particle size distribution and on anthropogenic contamination.

Possible presence of geogenic pollution (hydrocarbons and heavy metals) also impacts the re-use possibilities.

Depending on the quality, typical areas of application for excavated material are the production of aggregates for concrete and shotcrete, street and other public infrastructure supports as well as filler material.

Risk management: subsurface investigations at regular intervals along the tunnel path and with increased frequency at geotechnically unknown regions are compulsory.

To avoid the creation of temporary surface storage, the results of geochemical, mineralogical and geotechnical analysis should be available as soon as possible - preferably via online-analyses in the underground during tunneling.
Challenges for the re-use

The **negative impacts created by landfilling** include degradation of the countryside, potential impacts on nature and potential degrade of the quality of life of surrounding residents.

According to the current regulation in France, **excavation material is classified as waste** as soon as it exits the project site. This is why it is important that FCC is considered an **undividable, single project in a transnational context**. Discussion with the authorities of the Host States is ongoing.

In this respect, the five-step “waste hierarchy”, established in the EU Waste Framework Directive is applied. It establishes an order of preference for managing and disposing of waste.
Opportunities for the re-use

Application of **Avoid-Reduce-Compensate** approach (french: “ERC: Éviter-Réduire-Compenser”)

<table>
<thead>
<tr>
<th>Principle</th>
<th>Examples</th>
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<tbody>
<tr>
<td><strong>Éviter</strong> (Avoid)</td>
<td>Adjust the project (tunnel length, number of shafts, depths)</td>
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<tr>
<td></td>
<td>Avoid waste by introducing innovative re-use and re-use on site.</td>
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<tr>
<td></td>
<td>Avoid introduction of pollutants due to excavation methods</td>
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<tr>
<td><strong>Réduire</strong> (Reduce)</td>
<td>Treatment of polluted materials</td>
</tr>
<tr>
<td></td>
<td>Reduce transport, nuisances and pollution by local re-use</td>
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<tr>
<td></td>
<td>Regional reuse offsite for agricultural and re-naturation purposes</td>
</tr>
<tr>
<td><strong>Compenser</strong> (Compensate)</td>
<td>Create or improve agricultural spaces</td>
</tr>
<tr>
<td></td>
<td>Reforestation with transformed materials</td>
</tr>
<tr>
<td></td>
<td>Create economic benefits through innovative approaches for industry</td>
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<td></td>
<td>Develop approaches for the profit of other projects</td>
</tr>
</tbody>
</table>
Re-use scenarios for socio-economic studies

Based on previous CERN projects (LHC and, more recently, HL-LHC).

<table>
<thead>
<tr>
<th>Polluted material</th>
<th>Optimistic Scenario</th>
<th>Realistic Scenario</th>
<th>Pessimistic Scenario</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geogenic pollution:</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>% pollution removed</td>
</tr>
<tr>
<td>Treatment and partial reuse or landfilling</td>
<td></td>
<td></td>
<td></td>
<td>% reuse</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>% recovery</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>% Disposed</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>% special landfilling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>% landfilling</td>
</tr>
</tbody>
</table>

| Non-polluted material / Used | 60%                  | 35%                | 10%                  | % treated                                |
| re-use (with or without treatment) on site or offsite and/or recovery |                      |                    |                      | % reuse                                  |
|                            |                      |                    |                      | % recovery                               |

| Non-polluted material / Not Used | 10%                  | 35%                | 60%                  | Standard landfilling                      |
| Material not suited for reuse because of lack of adapted treatment or regional opportunities |                      |                    |                      |                                           |

The scenarios will be refined taking into consideration the transport constraints / nuisances.
Approach

Excavation material strategy

Polluted materials
- % polluted material
  - Specific conditions
    - Pollution removal
      - % pollution removed
  - Specific Landfill
    - Normal Landfill
      - % non polluted material

Non-polluted materials
- % non polluted material
  - Reused
    - Reuse on site
      - Reduce transport nuisances and global footprint
  - Not reused
    - Treatment
      - Recovery (including recycling)
        - Normal Landfill
          - Normal Landfill
Regional opportunities

The collected data will be used to:

- build a **preliminary cost analysis** for the excavation material reuse and disposal.
- develop **scenarios for a LCA study** for the potential construction of railroad connections.
Feasibility study for railroad connections

Criteria retained:
- Possibility to install a connection
- Modifications needed on the railroad lines
- Maximum allowable load
- Number of wagons / train length
- Capacity of traction / n. of train engines
- Number of trains vs. quantity of material
- Train slots available on the line

Connection installation feasibility

Capacity to evacuate the excavated material

See also presentation by Ch. Barre and T. Halle, «Railway access study preliminary results», Tuesday 6th June, 9:30.
# Railroad connection opportunities

<table>
<thead>
<tr>
<th>Site d'extraction Site d'exploitation ferroviaire</th>
<th>PA</th>
<th>PB</th>
<th>PG</th>
<th>PF</th>
<th>PG</th>
<th>PM</th>
<th>PJ</th>
<th>PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crête de sélection</td>
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</tbody>
</table>

| La proximité du site potentiel avec une voie ferroviaire existante | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| La débranchabilité avec le Réseau Ferré National (RFF) français ou suisse | 2 | 2 | 2 | 2 | -2 | 1 | 2 | 1 |
| La présence de voie de service ou d'installation embranchée ferroviaire existante à proximité | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| La méthode de connexion entre le site ferroviaires et le site d'extraction | -2 | -2 | -1 | -1 | -1 | 1 | -1 | -1 |
| Les contraintes d'environnement urbain (poussière/bruit) pour le chargement | -2 | -2 | -2 | -2 | 0 | -2 | 0 | 2 |
| L'espace disponible sur chaque site | 2 | 1 | 2 | 2 | 1 | 2 | 0 | 2 |
| Les contraintes environnementales associées | NA | NA | NA | 2 | 2 | 2 | 2 | 2 |
| Le nombre de convois nécessaire pour transporter la totalité des débâlais | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| La capacité de circulation de la ligne | 0 | -2 | -2 | -1 | 0 | 0 | 0 | 0 |
| Moyenne des scores obtenus Numérotation FCC (1 à 5) | 1 | 0 | 1 | 0 | 0 | -2 | 1 | 1 |
| Moyenne des scores obtenus Numérotation CEVA (1 à 3) | 4 | 3 | 4 | 3 | 3 | 1 | 4 | 4 |
| Note par site d'extraction Numérotation CEVA (1 à 3) | 3 | 3 | 1 | 3 | 3 | 1 | 4 | 3 |
“Mining the Future®”

- **Publication** of the competition on 1st May 2021
- **First phase** ended in October 2021: 12 proposals, 4 selected by the international jury (9 members)
- Proposed applications focus on different phases of the excavated material treatment and reuse.
- Type of participants: **Key players in excavation projects** as well as new startup and research institutes
- **Second phase**: 4 selected are progressing with the feasibility study to bring the proposal to at least TRL4*. Submission by end of June 2022.
- **Final event** with announcement of the winner: 27 September 2022.

*TRL: Technology readiness level. Level 4: Technology validated in laboratory*
A "locally innovative" approach

The priority for FCC is to propose a large-scale re-use of excavated materials including carbon capture potentials (follow up of Mining the Future®, which was seen by the EC as an excellent initiative).

The aim is to re-use the material locally as much as possible, keeping transport nuisances low and providing fertile soil for agriculture and re-forestation.

Work is ongoing since December 2022 to establish the framework for a real-scale demonstration of the innovative solutions.
Next steps

Proposals need to be
• demonstrated at real scale level
• developed jointly with the host state technical public administration services (e.g. DT, DDT, DREAL) and local actors
• validated and accepted by the host state authorities accompanying CERN.

Phases:
• Identification of demonstration land plots
• Definition of type of culture (crops, trees, etc.) and parameters to be monitored
• Study of tolerance to pollution
Schedule

- 2021 S1: Initial material characterisation
- 2021 S2: Excavation reuse cases (including agricultural study)
- 2022 S1: Risk management
- 2022 S2: Regulatory framework
- 2023 S1: Logistics
- 2023 S2: Input on strategy for construction contracts
- 2024 S1: First draft for MATEX management plan
- 2024 S2: Update of the document, verification and approval

Legend:
- Documentary effort
- Ongoing Activity
- Activity
- To be started

Locally innovative approach following the "Mining the Future" competition
Conclusions

**First draft** of FCCIS deliverable D 3.4.

**First draft** of cost estimate for the excavation material management is being used as basis for cost estimates including re-use.

**Continuous update** will be performed when more information on layout and technical solutions become available.

**Draft of mid-term review deliverable 3.8** "Molasse re-use potentials, based on the outcome of the "Mining the Future®" is being finalized.

Large scale reuse of excavation material depend on:
- Availability of **precise geotechnical and geomechanical data**
- **Detailed geological investigations are needed well in advance of the tendering for a construction project** (management of risks)
- **Excavation methods** are important to reduce pollutants

**Territory and regional regulations are evolving continuously.** Agreement with regional and local authorities for a joint effort in making the innovative local reuse a valid and rentable solution.
Thank you for your attention.

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