Properties of materials mined from landfills

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Overview

- Understanding the composition of legacy landfill sites
- The available metals and plastics
- Other benefits of ELFM and the way forward

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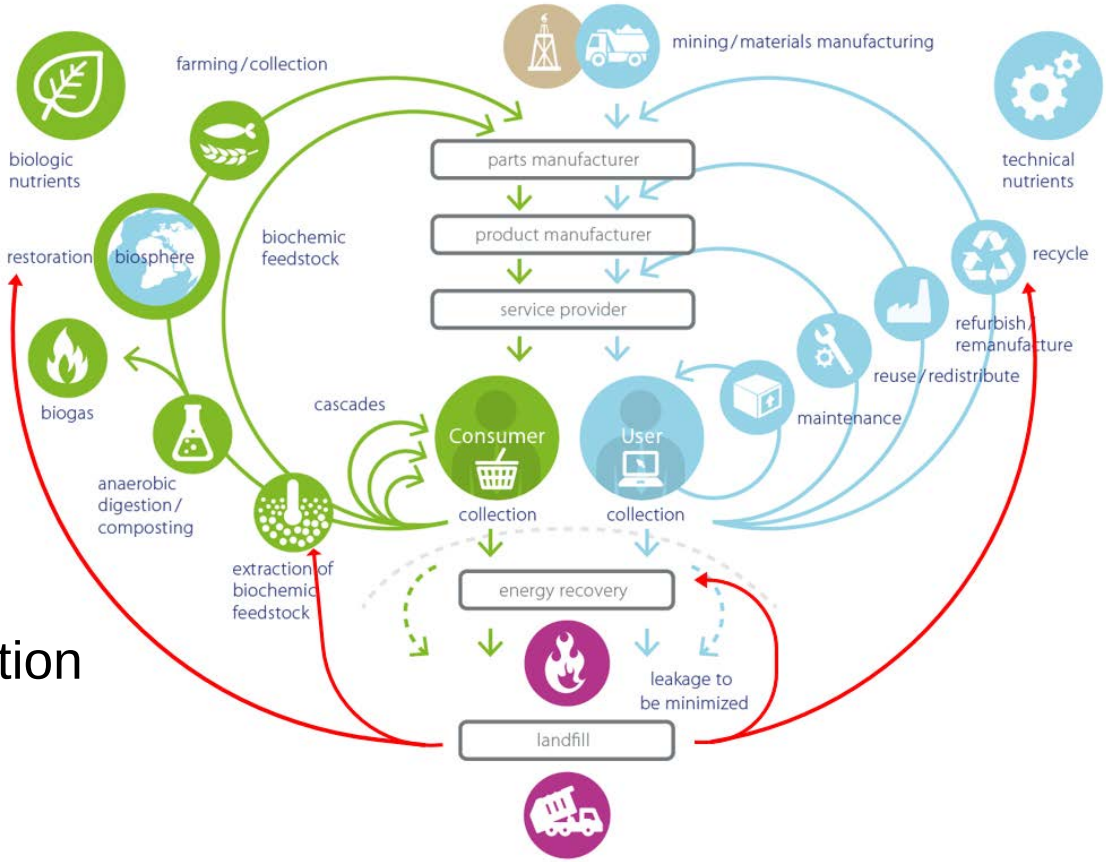
Enhanced landfill mining in the circular economy

Need to consider the whole picture

- Waste-to-Energy
- Waste-to-Material
- Chemical feedstock
- Land restoration/reclamation



Integration of landfill mining in the circular economy
Modified from Ellen Macarthur Foundation system diagram

Rising interest in enhanced landfill mining [ELFM]

EU-wide agenda

- European Enhanced Landfill Mining Consortium [EURELCO] established (currently 58 members);

EURELCO
EUROPEAN ENHANCED LANDFILL MINING CONSORTIUM

- Recent EU projects funded in recognition of the importance of this topic:
  - SMART GROUND
  - NEW MINE
  - COCOON
  - RAW FILL

SMART GROUND
NEW-MINE
EU TRAINING NETWORK FOR RESOURCE RECOVERY THROUGH ENHANCED LANDFILL MINING

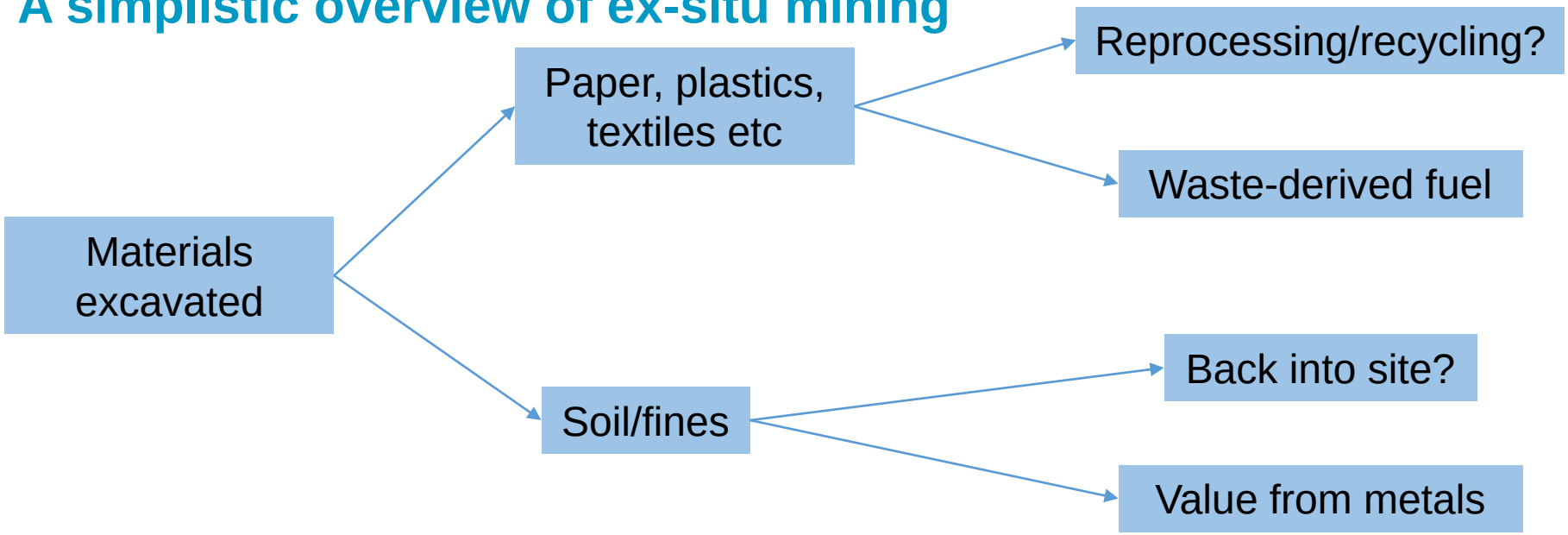
COCOON
Interreg Europe
European Union
European Regional
Development Fund

Interreg
EUROPEAN UNION
North-West Europe
RAWFILL
European Regional Development Fund

- 2nd seminar held in the EU parliament (November 2018) (https://eurelco.org/2018/11/22/2nd-elfm-ep-seminar-shows-landfill-directives-blind-spots/)

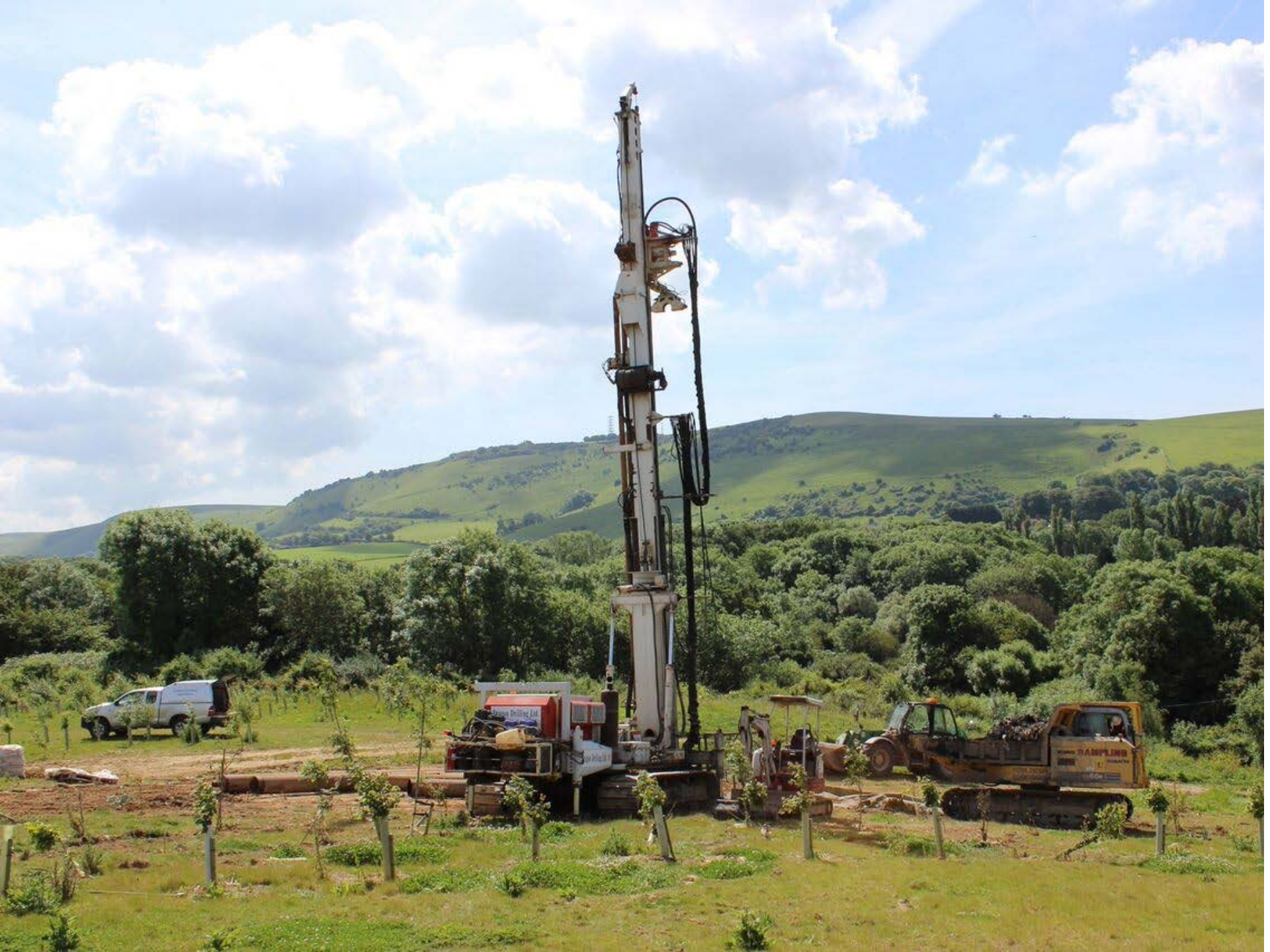
Resource or a fuel?

A simplistic overview of ex-situ mining

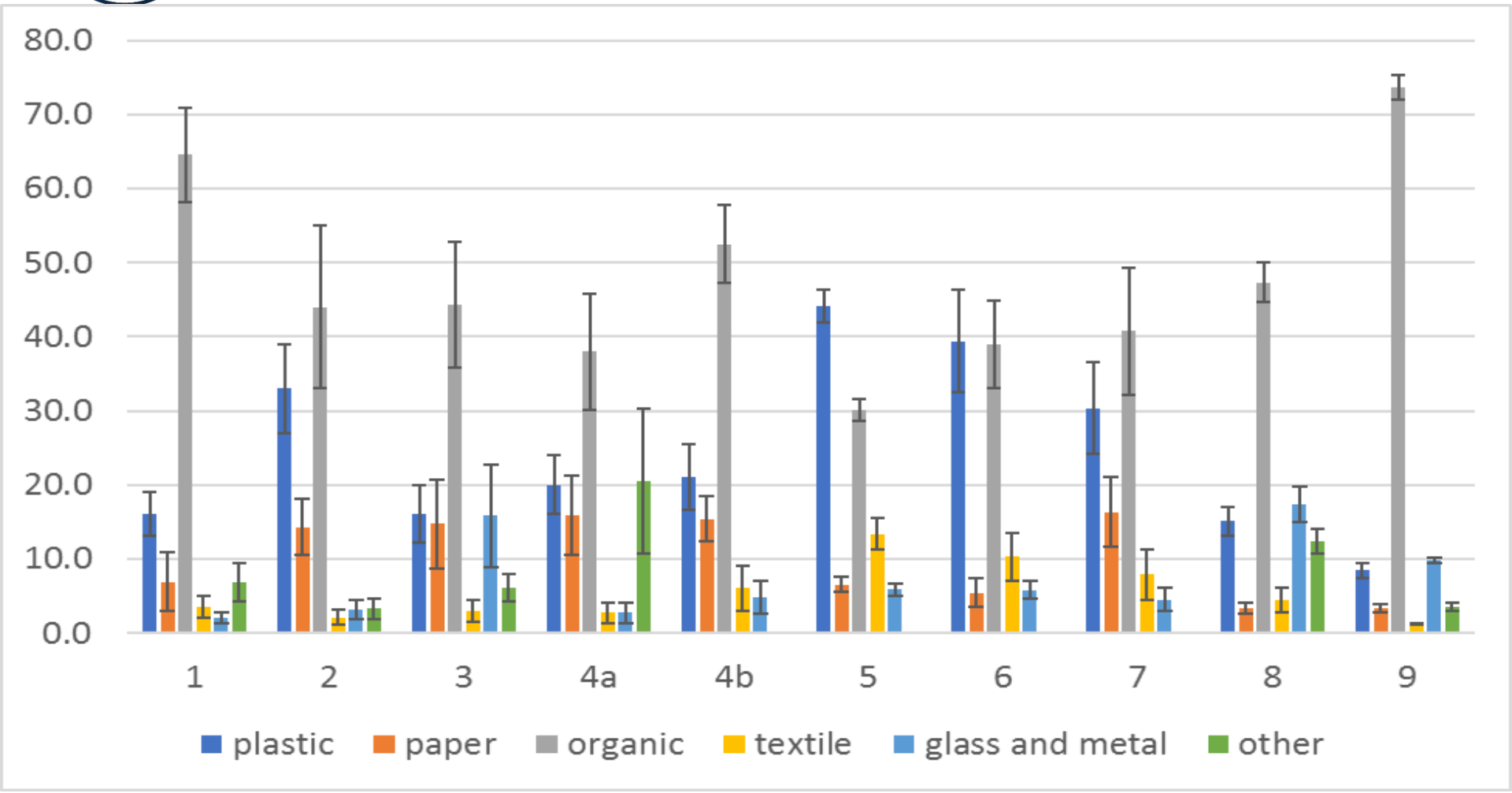


Key considerations include:

- **Significantly increased proportion of soil/fines vs fresh MSW**
- **Surface contamination and degradation of recovered commodities (impact on reprocessing and use as a fuel)**

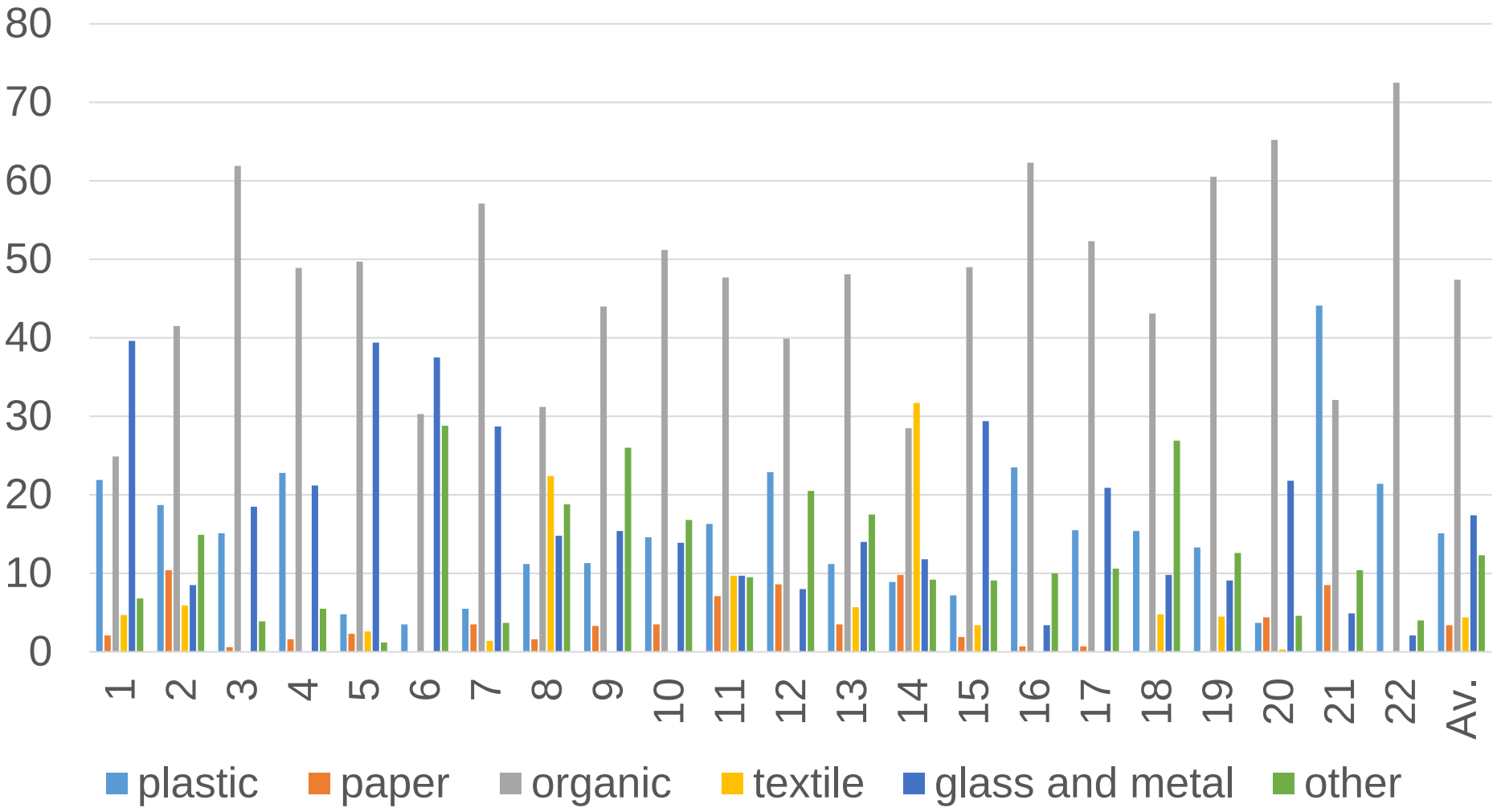


Composition overview (% w/w)



Lots of data accumulated

Site 8- 1x core drill, but split into 22 samples (at 1 metre intervals)



Metal recovery potential from fines/soil

Manual sieving and grinding

- Removal of plastic, metal, paper, textile, glass and other materials >19 mm
- Dried over night at 105˚C
- Ground to ≤1.5 mm

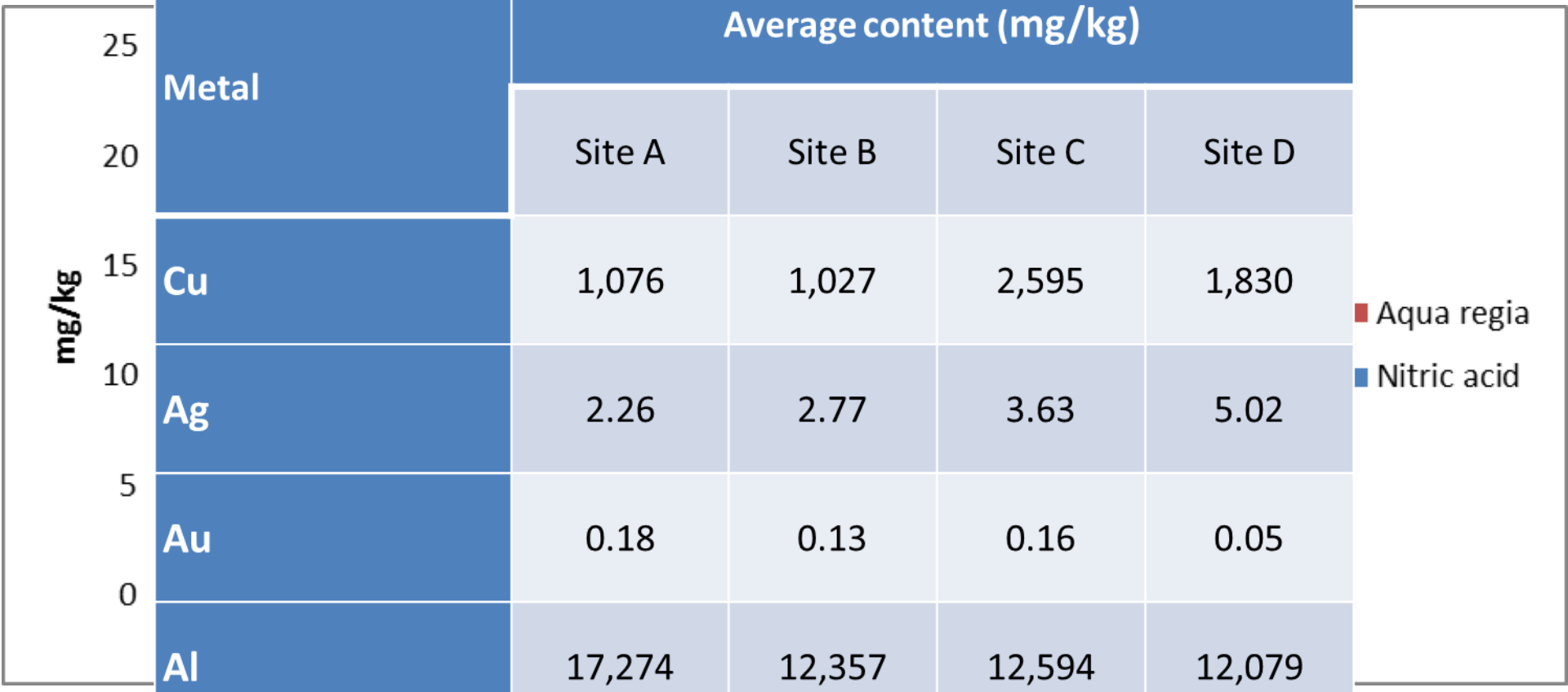
2-stage acid-microwave digestion

- HNO_3 → microwave digestion
- Aqua regia (HCl + HNO_3) → microwave digestion

Inductively coupled plasma mass spectrometry (ICP-MS)

Results from sites 1-4

Metal	Average content (mg/kg)			
	Site A	Site B	Site C	Site D
Cu	1,076	1,027	2,595	1,830
Ag	2.26	2.77	3.63	5.02
Au	0.18	0.13	0.16	0.05
Al	17,274	12,357	12,594	12,079



Sites 8 and 9 (all in ppm)

	HEAVY METALS					
	Cd	Cr	Pb	Zn	Sn	As
Paper	0.51	1,056	94.10	215.55	18.44	2.97
Wood	0.77	2,435	175.91	325.32	18.88	6.59
Fines	1.11	834	303.73	565.66	30.83	4.81
Film Plastics	1.27	1,187	293.97	519.89	18.98	3.00
Dense Plastics	1.48	59.14	529.09	1,652	104.96	5.13
Textiles	1.69	1,866	567.91	650.75	35.47	6.23

All elevated, Pb and Cr are a concern

	Cu	Ag	Li	Sb	Co	Al
Paper	134.38	0.85	5.85	7.08	10.53	10,707
Wood	166.40	2.21	3.49	8.59	24.73	5,045
Fines	254.22	16.66	8.91	58.32	8.49	12,806
Film Plastics	148.43	1.71	4.30	182.64	12.21	6,269
Dense Plastics	588.75	2.61	8.37	16.49	17.43	8,238
Textiles	377.86	2.91	11.94	13.88	19.11	14,182

Al and Cu may suggest recovery opportunities

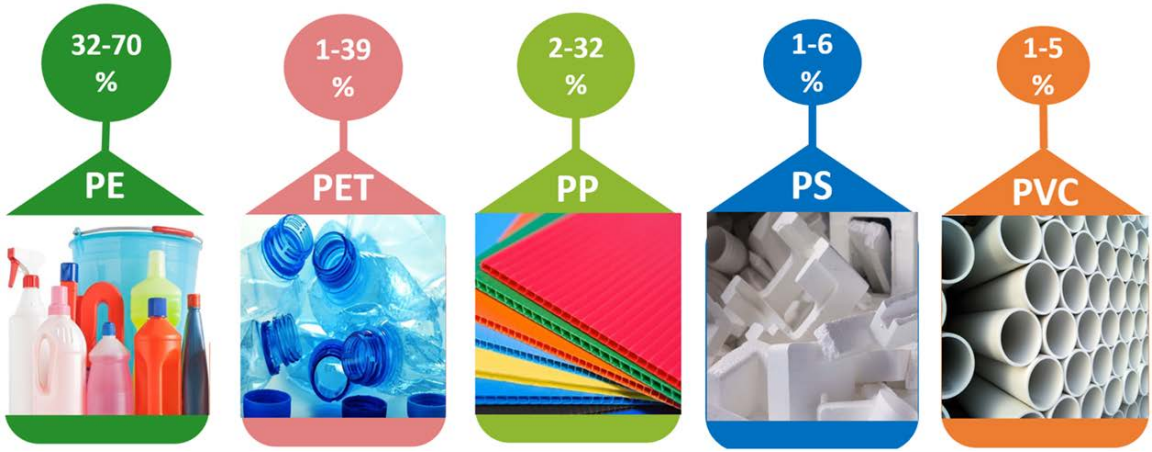
	LREES				
	La	Ce	Pr	Nd	Sm
Paper	4.17	8.84	1.00	3.67	0.69
Wood	3.97	9.00	0.99	3.76	0.71
Fines	10.07	21.25	2.40	9.22	1.79
Film Plastics	4.09	9.08	1.00	4.07	0.72
Dense Plastics	7.15	15.92	1.78	6.75	1.24
Textiles	8.78	20.52	2.26	8.64	1.69

Too low to justify focused recovery

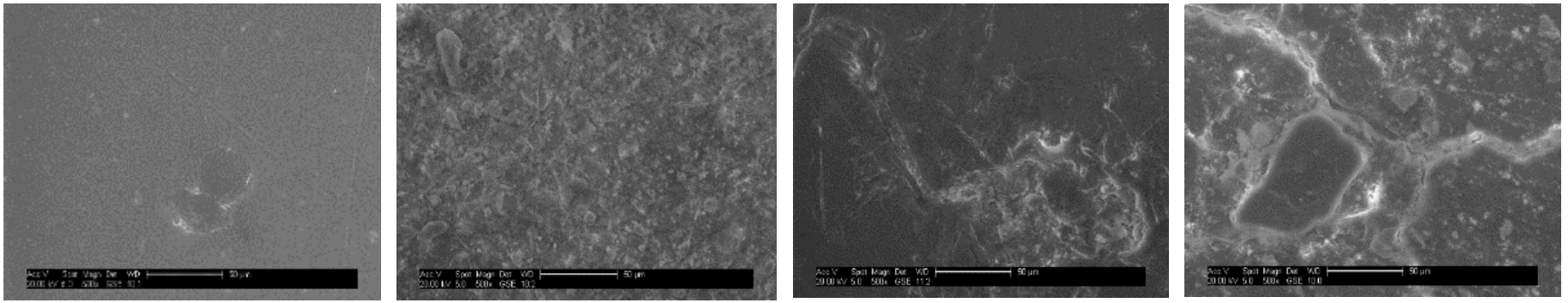
All images courtesy of Luisa Canopoli

Plastics

- Plastics represent around 20-30% by weight of excavated landfill material



- Understanding degradation and contamination



Fresh PP | 5 m | 6-8 m | 39 m

SMART GROUND example outputs

SMART GROUND aimed to foster resource recovery in landfills by improving the availability and accessibility of data and information on Secondary Raw Materials (SRM) in the EU

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INVESTIGATION OF MUNICIPAL SOLID WASTE (MSW) AND INDUSTRIAL LANDFILLS AS A POTENTIAL SOURCE OF SECONDARY RAW MATERIALS

Heikki Särkkä [1,*], Tommi Kaartinen [2], Esa Hannus [1], Sami Hirvonen [3], Tuire Valjus [4], Jouni Lerssi [4], Giovanna A. Dino [5], Piergiorgio Rossetti [5], Zoe Griffiths [6], Stuart T. Wagland [6] and Frederic Coulon [6,*]

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[2] VTT Technical Research Centre of Finland, Biologinkuja 7, 02150 Espoo, Finland
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[6] Cranfield University, School of Water, Energy and Environment, Cranfield MK43 0AL, United Kingdom

Data and decision support tools. Both open access

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A DECISION SUPPORT TOOL FOR ENHANCED LANDFILL MINING

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Summary

- Not all landfill sites are suitable for enhanced landfill mining, for a combination of environmental, economic or practical reasons;
- But some sites may require mining for other reasons
- High volumes of soil/fines to manage, however potential value exists within
    - Major challenges and costs involved in recovering metals to a high efficiency and yield; mining **only** for metals is unlikely to be economically viable.
- Direct recycling of remaining plastics/paper/textiles might not be economically viable due to contamination and degradation;
- Advanced Thermal Treatment [ATT] present further opportunities- energy plus liquid fuels and chemicals

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