C-Cure Solutions

Treatment of Mercury and Heavy Metal Impacted Sites in Colombia

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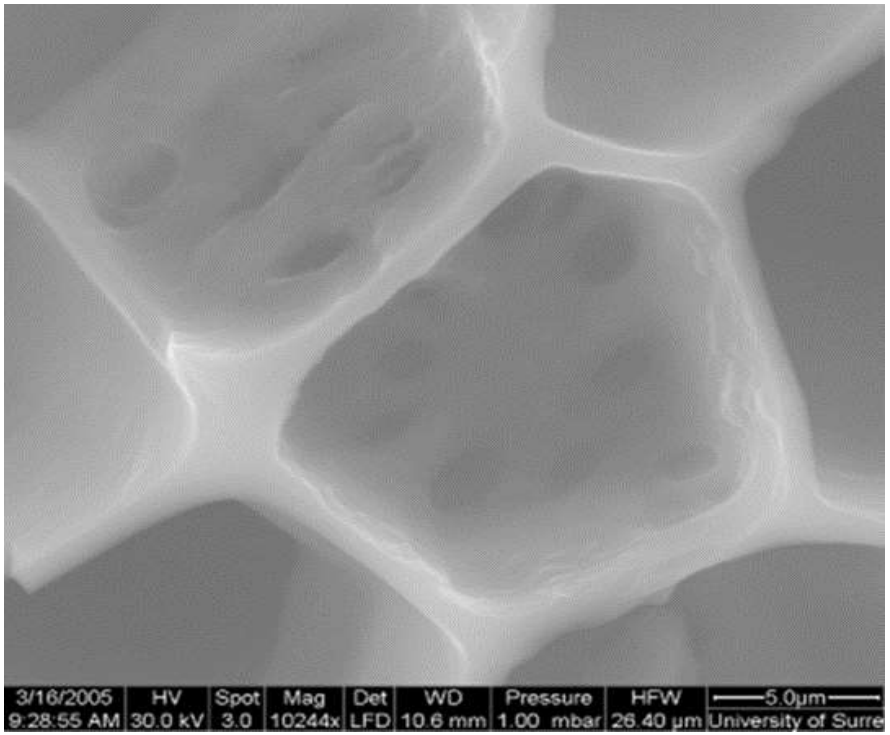
Background to C-Cure Solutions

- Metal Treatment
  - Charcoal [Biochar] based products with >40% Metal Adsorption capacity by weight
- Organic contaminants
  - Activated carbons with >1200 m^2/g
- Oil Absorbent products
- Coagulant and flocculant products
- Modified carbons - specialist applications



- Spin-out of Forest Research (UK Government) and University of Surrey
- >$4million USD invested in product development and testing
- 5 Patents central to IP

C-Cure Product Markets

- Remediation of mine tailings and mine water discharges
  - Pb, Cu, Zn, Ni, Cd
  - Mercury
  - As, P
  - Oil Sands Bitumen Extraction
- Metal recovery products
- Treatment of Remediation of organic contaminants
- Treatment of drilling wastes for Oil and Gas

C-Cure Production

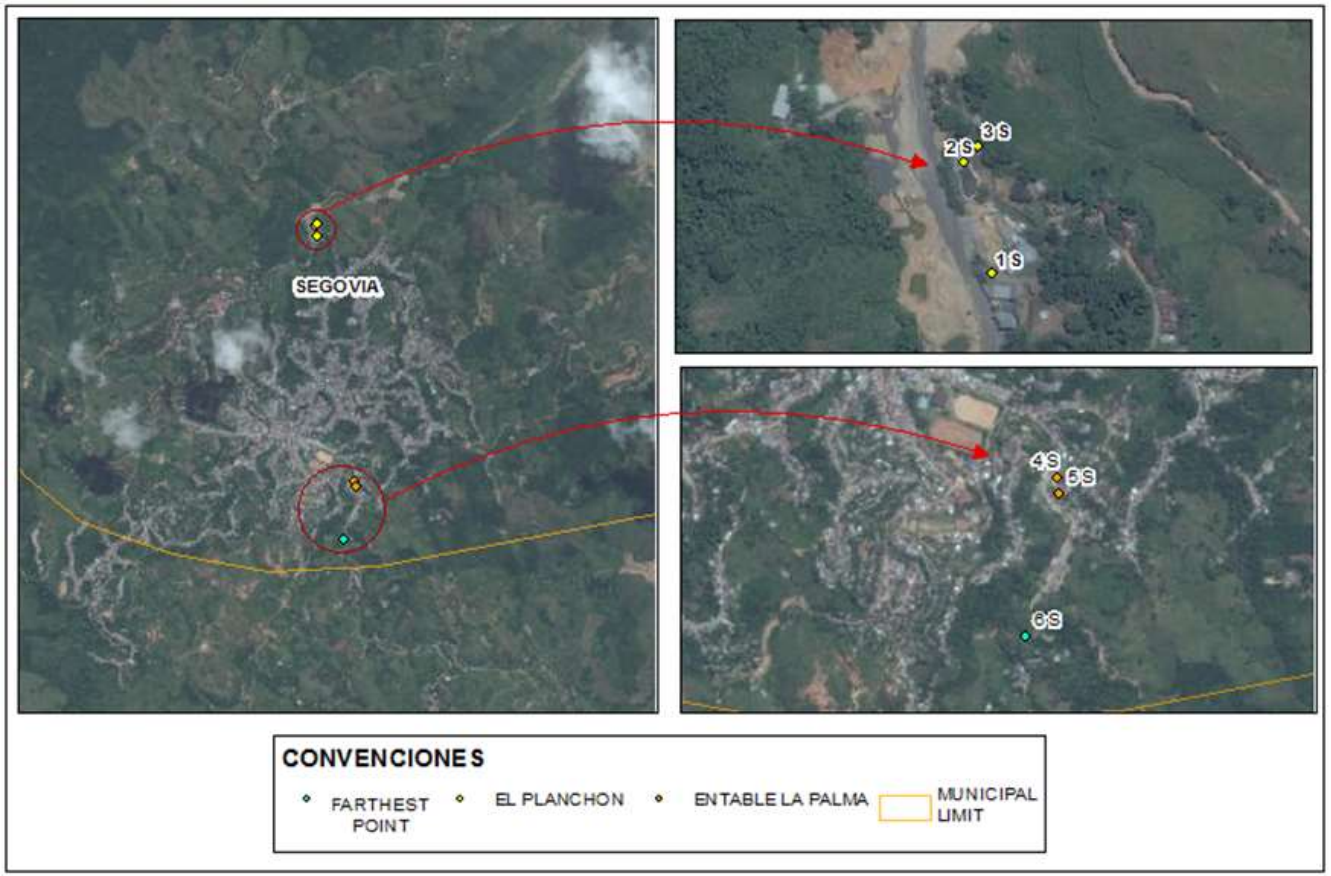
- Production of products yields heat which can be converted to electricity
- Large scale – up to 50,000 Tonnes per year processing capacity per unit
- Majority of C-Cure product range use renewable materials, yield renewable energy and a net carbon benefit

Towards Restoration of a Metal Contaminated Site

- **Providing a solution that reduces erosion and stabilises the site is key**
- Vegetation will improve soil conditions and stimulate succession towards greater bio-diversity and higher ecological value
- Potential Land Re-use for Renewable Energy
- Recover valuable metals whilst treating waters

Mercury and Metal Contamination Trial on Samples from Colombia

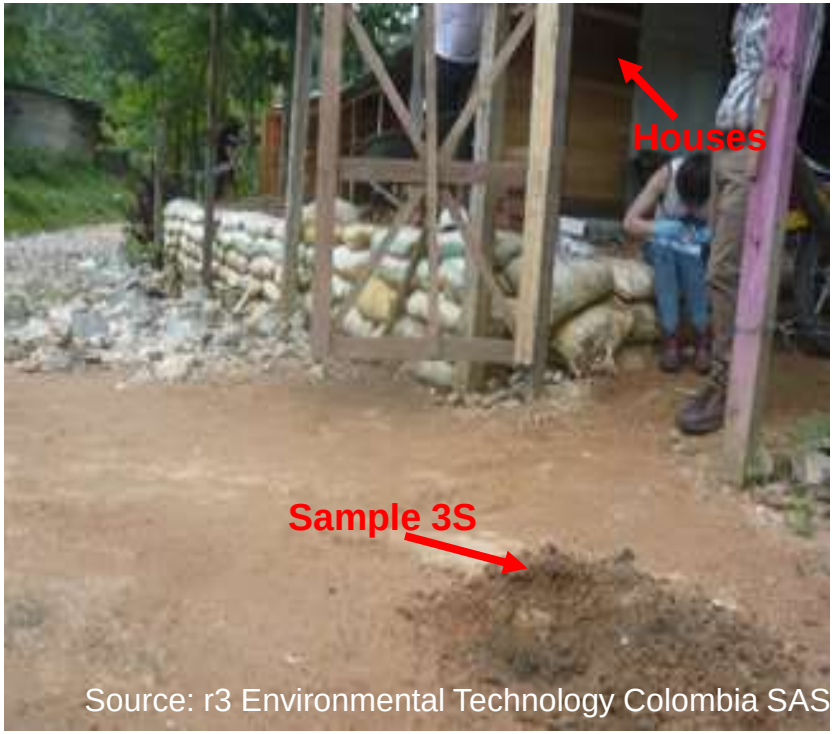
Sampling Locations



- Segovia is a traditional mining town
- Estimated production >3000 kg of gold and >1,700 kg of silver per year (DAMMA, 2008)
- 6 samples from 2 gold mine sites

El Planchon Mine: Metal Contaminated Soil

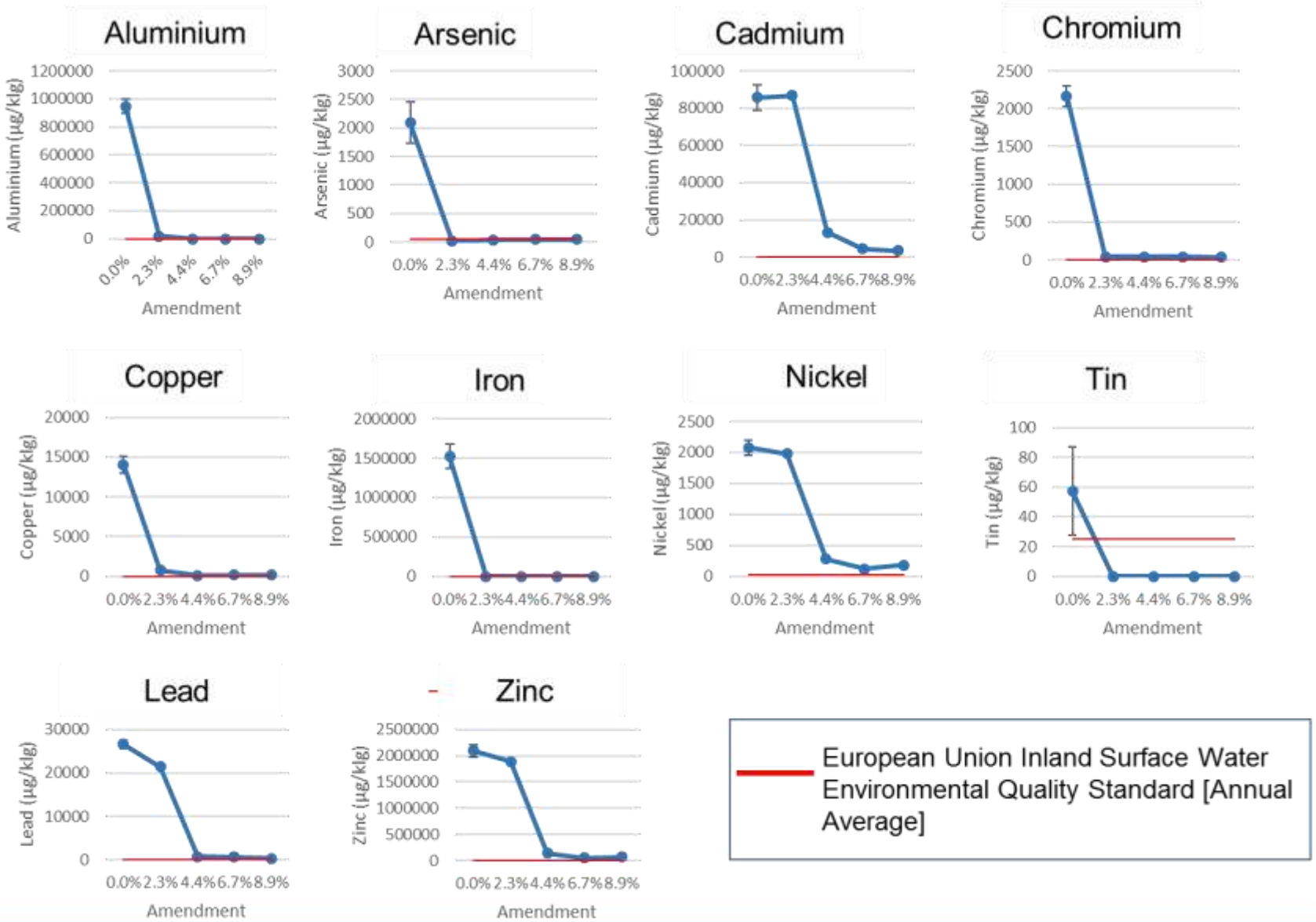
Metal	Total Concentration (mg/kg)	UK Soil Guideline Value (mg/kg)	Leachable Concentration (mg/kg)	EU Surface Water Standard (mg/l)
Aluminium	38516	n/a	947	0.015
Arsenic	224	32	2.09	0.05
Cadmium	97.4	10	85.8	0.00008
Chromium	22.8	130	2.17	0.0034
Copper	81.2	n/a	14.0	0.001
Iron	30565	n/a	1519	1.00
Nickel	4.72	130	2.08	0.02
Lead	3103	450	26.6	0.0072
Tin	1.53	n/a	0.06	0.025
Zinc	2741	n/a	2092	0.008



Source: r3 Environmental Technology Colombia SAS

Sample taken in El Planchon, crossing the creek downstream the processing plant, very close to the neighbouring town houses.

Treatment of Metal Contaminated Site

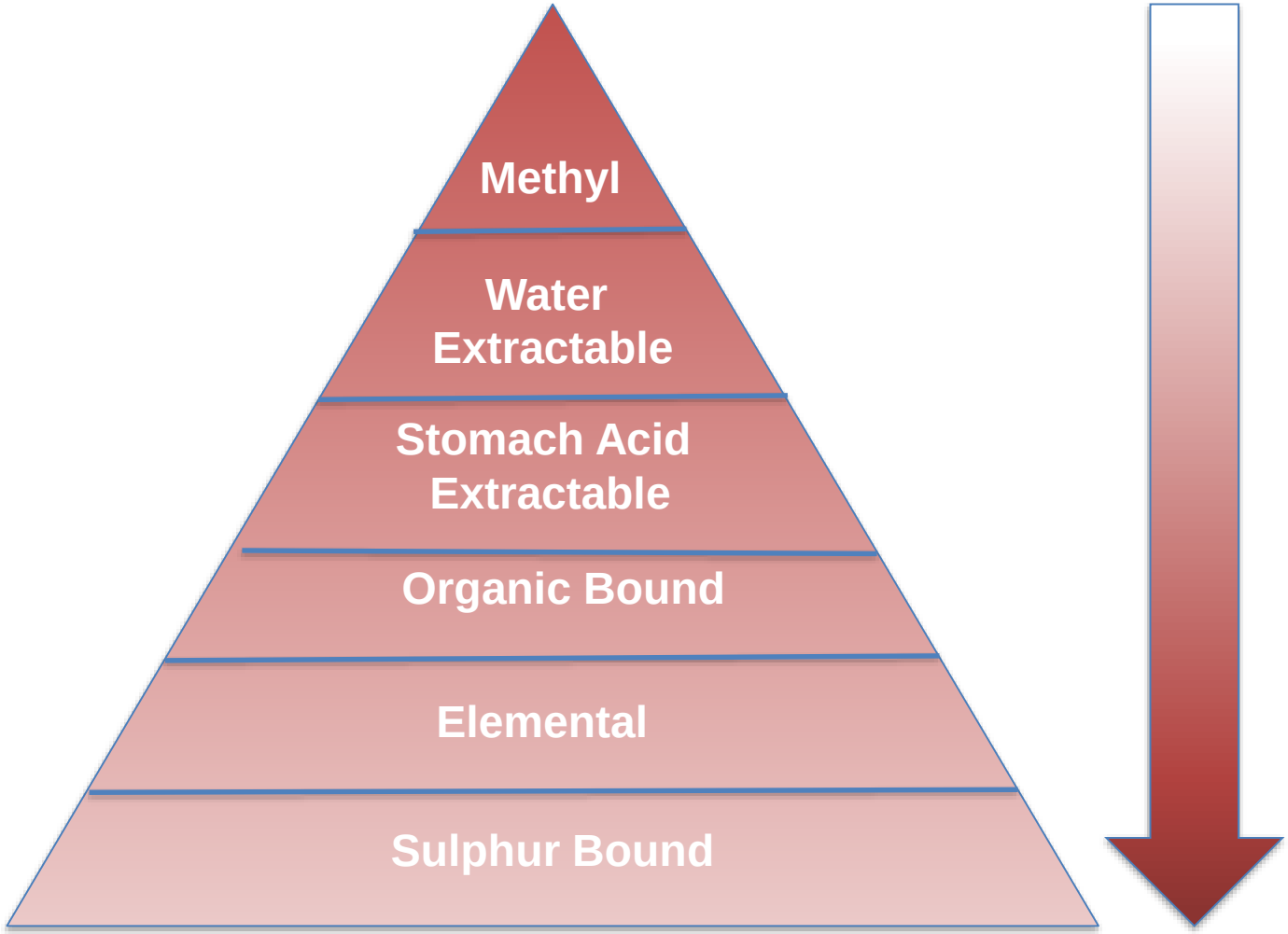


La Palma: Mercury Contaminated Tailings Waste

Benefit plant involved in the gold mining process in Segovia, Antioquia

Inside the processing plant La Palma, a pile of tailings emerging as a by-product of the plant is stored. On top of this stack, the dry solid sample was taken.

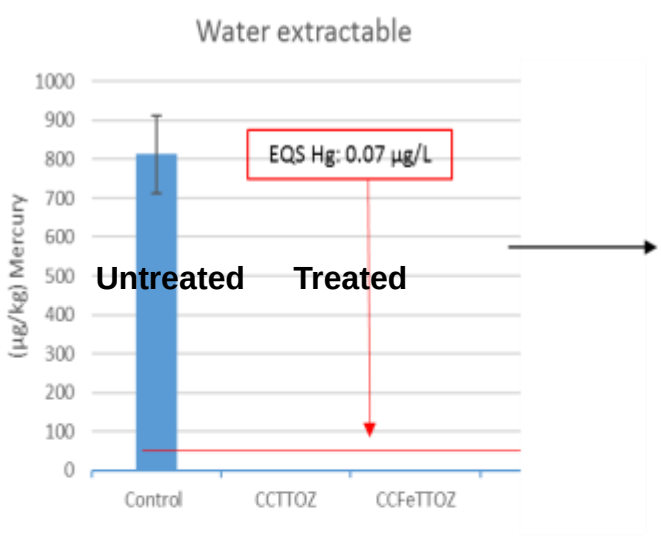
General Relative Risk of Mercury Fractions

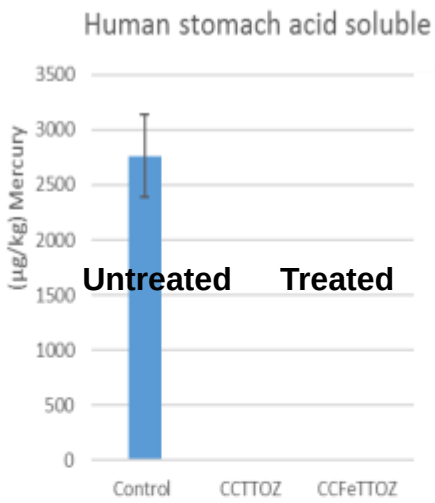


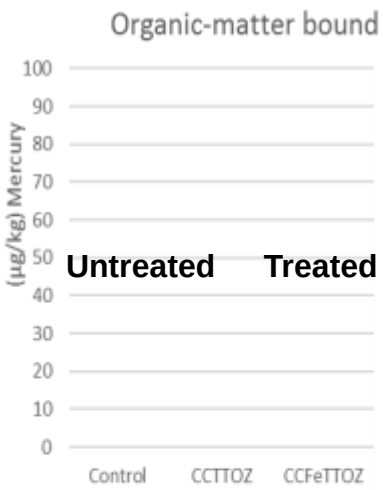
Highest Risk

Lowest Risk

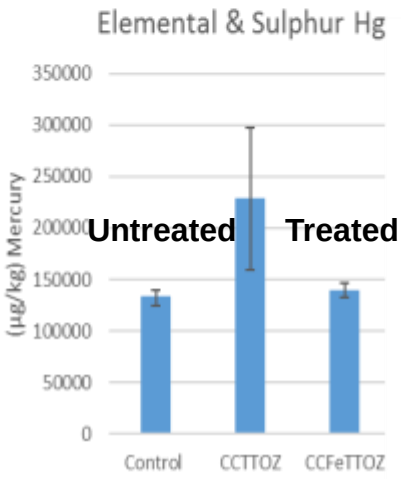
C-Cure Treatment of Mercury







- 5% (wt/wt) Treatment Rate
- Needs to be optimised i.e. treatment rate may be much lower
- Would reduce costs



Case Studies:

C-Cure Treatment of Metal Contaminated Sites

Case Study 1

Copper, Lead and Zinc Contaminated Site

The Problem: Metal Pollution of Surface water

Determinand	Unit	EA Target Level	Maximum Value Recorded	Mean Value Recorded
Total Aluminium	µg/l	100 (combined with a pH of 5 to 5.4)	**540**	109
Dissolved Aluminium	µg/l	No value	3700	513
Dissolved Copper	µg/l	5	**478**	**148**
Total Copper	µg/l	20	**610**	**244**
Dissolved Iron	µg/l	1000	1600	106
Total Iron	µg/l	2000	16,000	2019
Dissolved Lead	µg/l	4	**26**	**17.5**
Total Lead	µg/l	75	37	24.1
Dissolved Nickel	µg/l	50	32	23.1
Total Nickel	µg/l	50	31	25.1
Dissolved Zinc	µg/l	10	**3693**	**1488**
Total Zinc	µg/l	30	**27250**	**4418**
Phosphorus	µg/l	60	100	18.9
Suspended Solids	mg/l	25,000	220	24.5
pH Value		-	5.73 (max) 4.66 (min)	5.1

Site causes contamination of river due to leaching, erosion and run-off

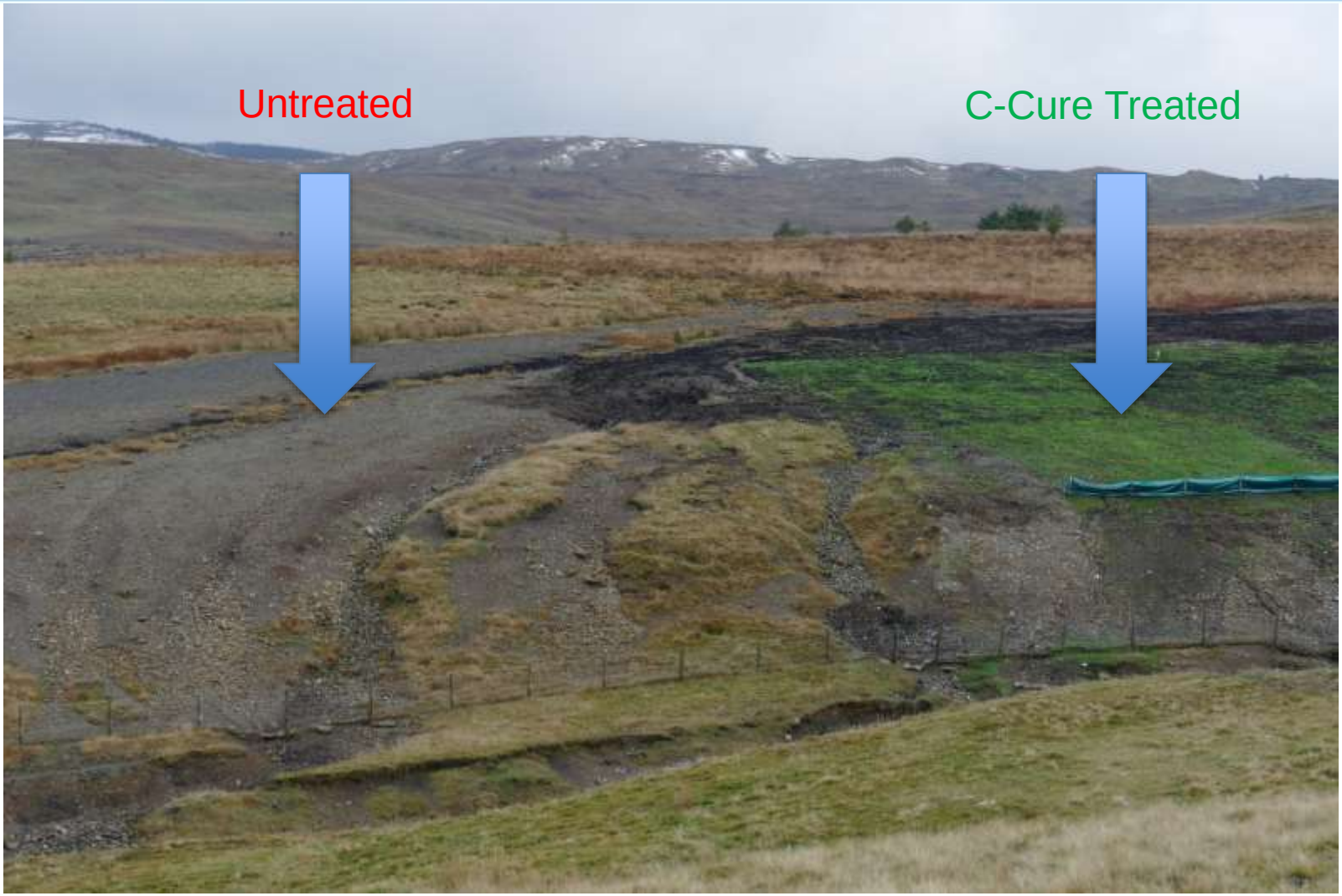
Aims of C-Cure Treatment

- Remediate the contaminated soil
- Reduce metal leaching to non-toxic levels
- Prevent further erosion by re-vegetation

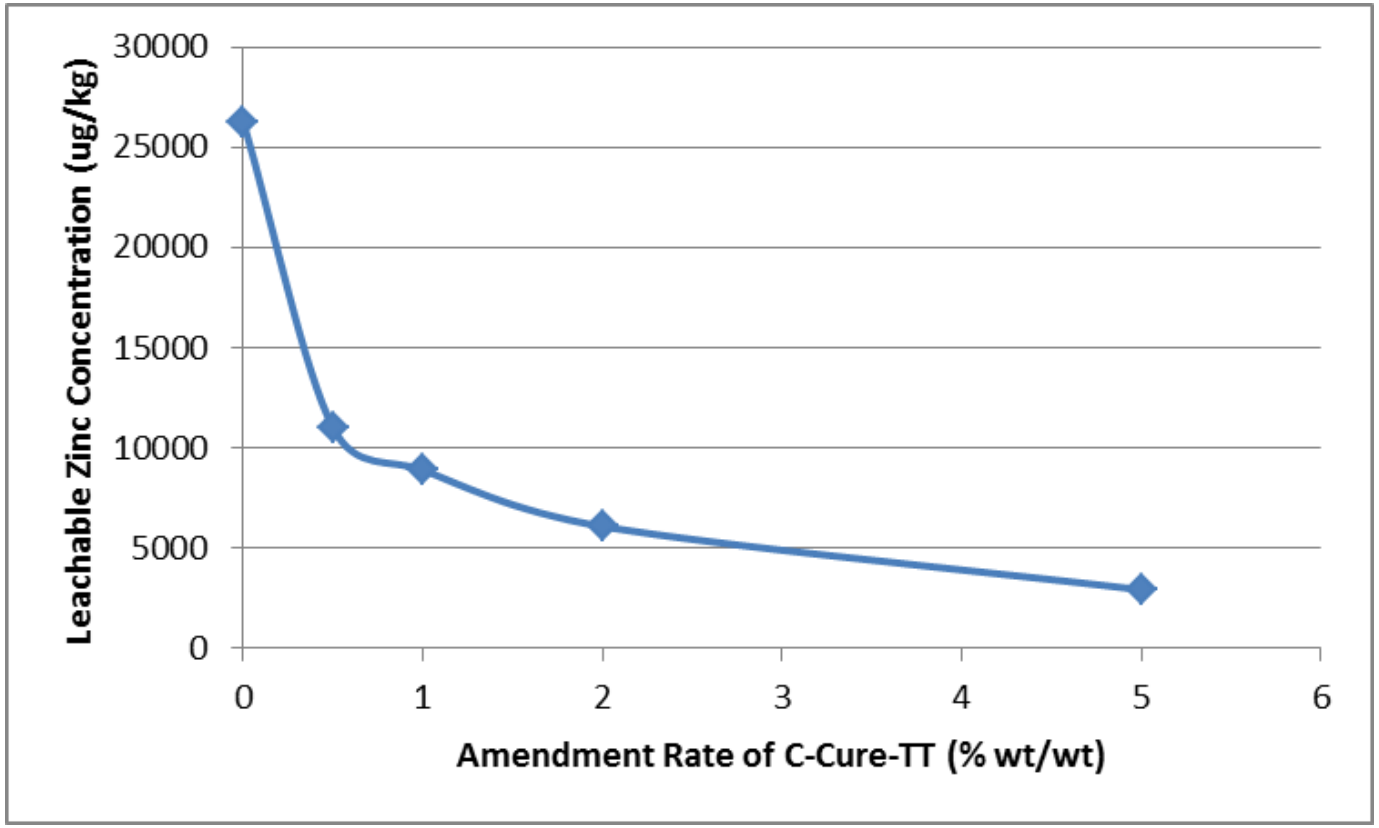
Sacks with C-Cure Product

Incorporation of C-Cure Product

Site 2 Months after C-Cure Treatment



Effects of C-Cure Product on Leachable Zinc Concentrations



Reduction of Heavy Metal Uptake by Plants

Treatment	Foliar Metal uptake (mg kg^{-1} dry wt)			
	Al	Fe	Cu	Zn
Control	6,434	14,254	2,437	5,717
C-Cure Treated	160	406	56	287
% Reduction	97.5%	97%	98%	95%
Significance	<0.001	<0.001	<0.001	<0.001

- Remove plant toxicity
- Reduce metal uptake
- Prevent food chain transfer

Case Study 2

Former Lead and
Zinc Mine

Lead and Zinc Mine

- High concentrations of leachable heavy metals
- Low pH (5)
- No vegetation
- Extensive Gully Erosion

Leachable metals

Cd: 0.34 mg/kg
Cu: 3 mg/kg
Pb: 160 mg/kg
Zn: 127 mg/kg

C-Cure Treatment

Treatment	Leachable Metals [mg/kg]			
	Cd	Cu	Pb	Zn
Untreated	0.34	3.01	160	127
C-Cure treated	0.01	0.05	11	3
% Reduction	97%	99.5%	93%	97%

POTENTIAL USES OF THE C-CURE TECHNOLOGY IN COLOMBIA

Legacy Sites

Treatment of contamination on legacy sites

- Identify targeted areas for treatment of contaminated materials
- Reduce mass of material to be treated
- Reduce cost
- Prevent contaminant movement and food-chain transfer
- Restore site to productive use e.g. Renewable Energy

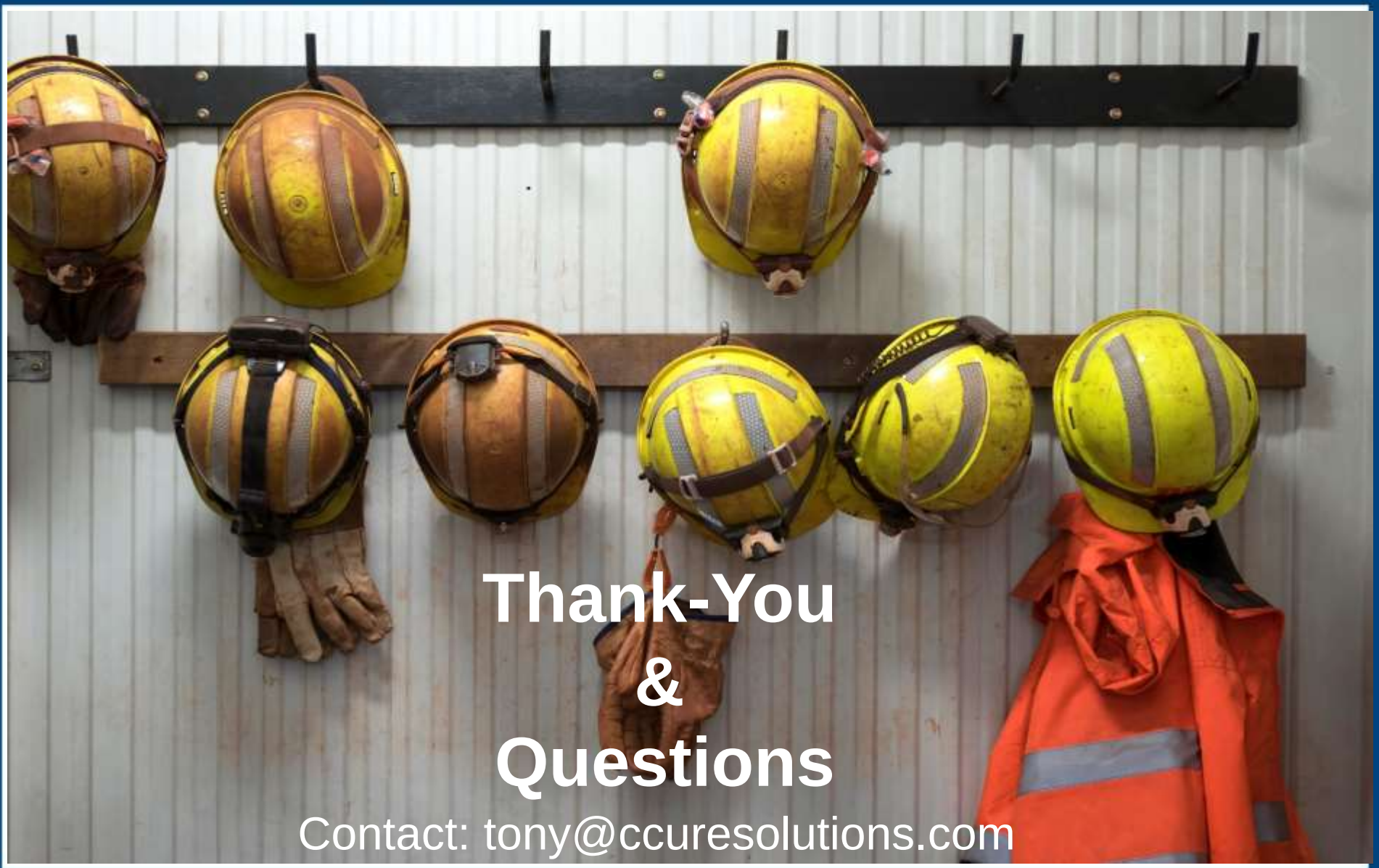
Process Based Treatment

Treatment of process tailings and waters as they are generated

- Treat only contaminated wastes
- Prevent movement of contaminants and contamination of greater amount of materials
- Reduce waste volume being treated
- Metal recovery from water treatment and sale
- Reduced costs

Potential Next Steps

- Demonstration on sites in Colombia
  - Mine Tailings
  - Contaminated soils
  - Mine Waters
  - Mercury and other heavy metals
  - Re-vegetation of remediated materials
  - Renewable energy crop establishment
  - Metal recovery from process waters



Thank-You
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Questions

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