EDTA for SAR control in Drilling Waste Disposal

John Ashworth, ALS Environmental, Edmonton AB;
Stephen Goudey and Leila Oosterbroek,
HydroQual, Calgary AB

Part 1:

- **Brief overview of salinity and sodicity problems**
- **EUB "D-50" post-disposal EC & SAR criteria**
- **Effect of Ca and Mg amendments on EC & SAR**
- **SAR remediation using EDTA**
- **Effects of EDTA on clay dispersion**

Part 2:

- **Bioassays of EDTA-treated soil**
- **On-site rates of EDTA; Costs, etc.**

Salinity and sodicity (EC & SAR) are assessed by analyzing the filtrate from a saturated paste of soil and water (USDA, 1954)

$$SAR = [Na^{+}] / \sqrt{\{ [Ca^{2+} + Mg^{2+}] \}}$$ **[ions in mmol/L]**

- **Salinity = high EC** **(soluble salts affect plants)**
- **EC < 2 dS/m, non-saline.** **EC > 12 dS/m, sterile**
- **Sodicity = high SAR** **(Na disperses clay in soil)**
- **SAR < 2, non-sodic.** **SAR > 7, plastic soil, no drainage**

Draft Directive 50
EUB, July 2007

	Disposal Method	Maximum Increase in EC (dS/m)	Maximum EC[a] (dS/m)	Maximum Increase in SAR	Maximum SAR
Topsoil[b]	Land treatment, DSPL, LWD, Landspray, Pump-off	1	2	1	4
Subsoil[c] to 1 m Good[d] receiving soil	Land treatment, Landspreading	2	3	3	6
Subsoil[c] to 1 m Fair[d] receiving soil	Land treatment, Landspreading	1	No limit[e]	2	No limit[e]
Subsoil[c] >1m &= 1.5 m	Mix-bury-cover	2	No limit[e]	4	
Subsoil[c] >1.5	Mix-bury-cover	3	No limit[e]	6	

Traditional remedies for saline / sodic soil

- **Add sources of Ca and Mg to lower the SAR and thus improve soil drainage & salt removal**
- **Epsom salts ($MgSO_4$), Gypsum ($CaSO_4$), calcium nitrate (EnviroFloc), calcium chloride**
- **Add an acid to react with free lime $CaCO_3$ in soil, e.g. H_2SO_4 to produce gypsum *in situ***

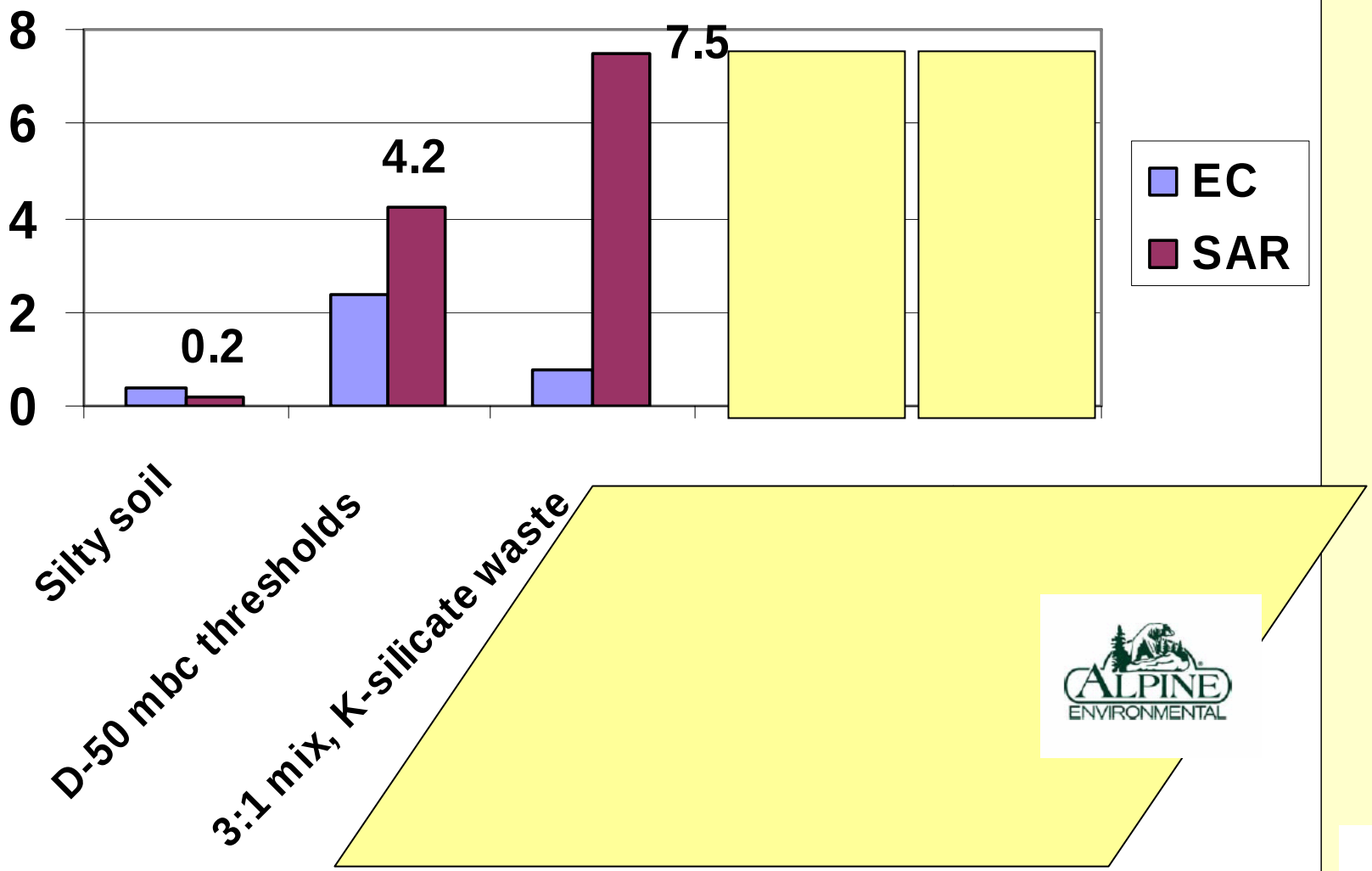
$$H_2SO_4 + CaCO_3 = CaSO_4 + H_2O + CO_2$$

All these materials will lower the soil's SAR

So what's the problem . . ?

The SAR comes down but, at the same time, the EC increases due to the added soluble salt

Effect of Ca & Mg salts on mix EC & SAR



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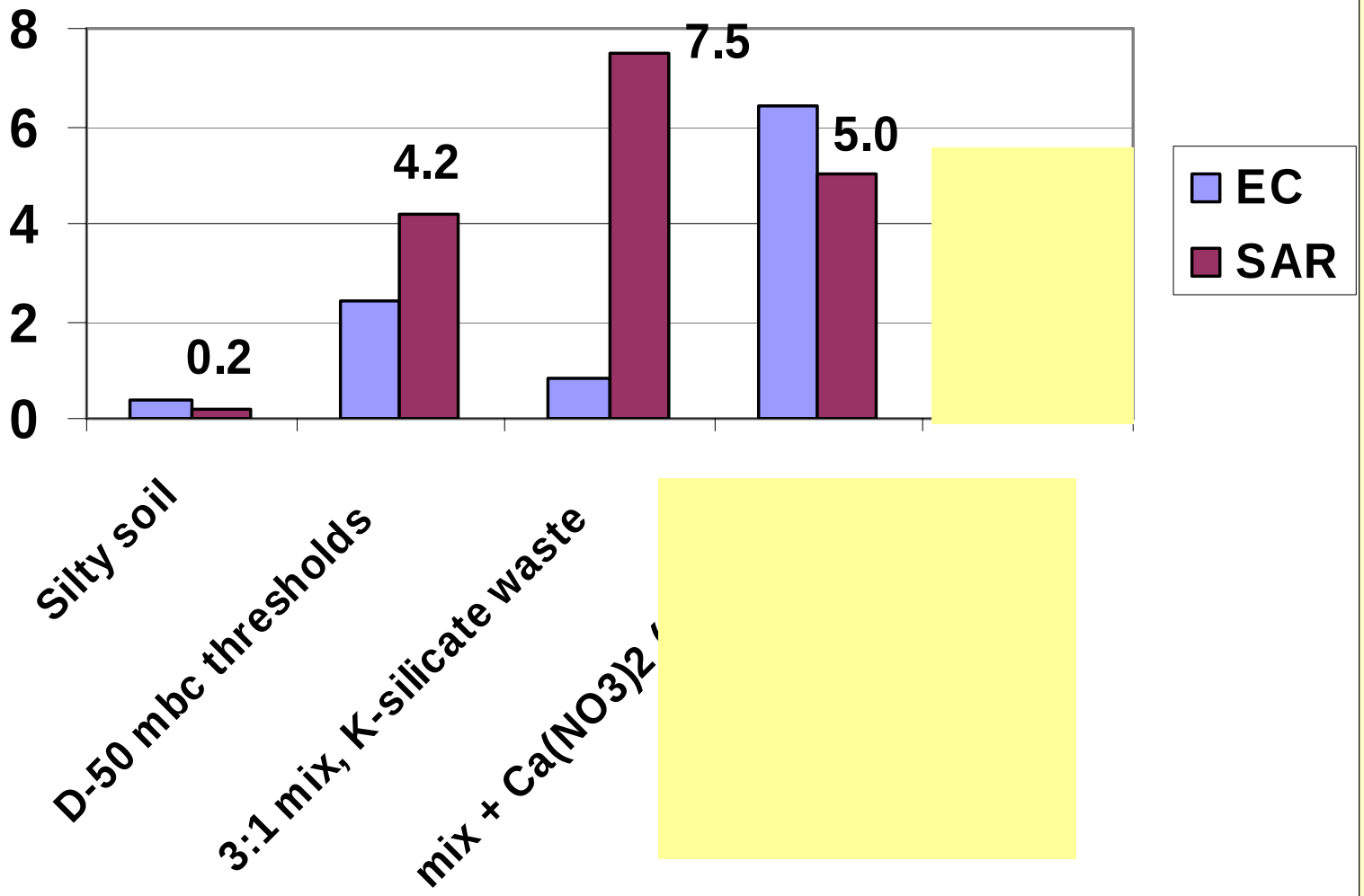
Effect of amendments on mix EC & SAR



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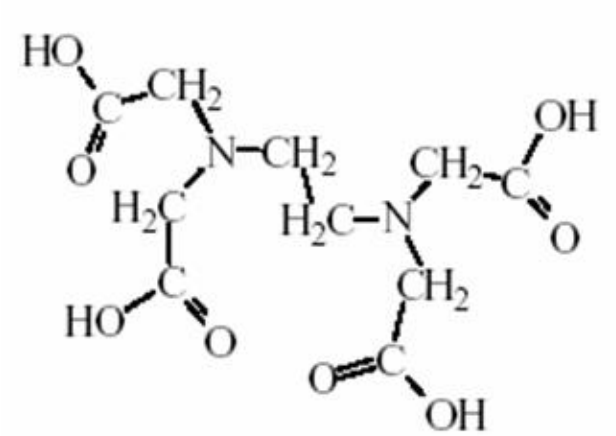

← EDTA molecule

$CaCO_3$ + H_2-chelator = Ca-chelator + H_2O + CO_2

Soil-waste mix needs to contain only 0.1 % $CaCO_3$ equivalent

Left side vial, EDTA-treated. Right vial, untreated

Kavanagh soil
1:2 soil : water suspension

EC = 0.9 dS/m
SAR = 9.4

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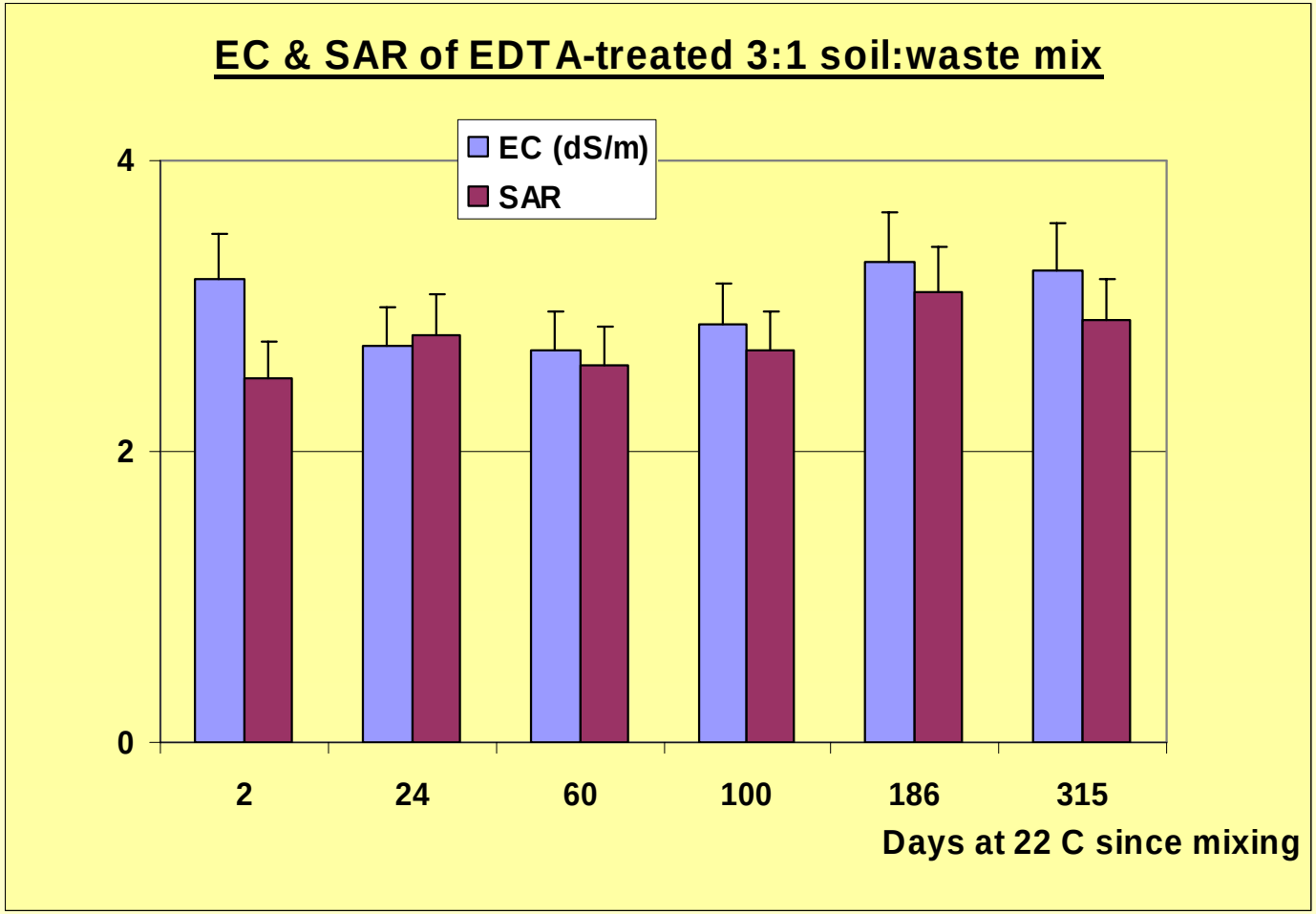


1 year at room temp = 3 - 4 years in cold subsoil

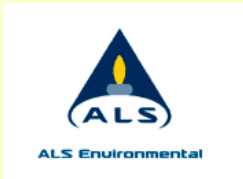
J. Soil & Sediment Contamination 16: 301-312 (2007)

Remediating SAR in Drilling Waste Disposal

Part 2:

- **Bioassay tests of EDTA-treated soil**
- **Safe rates of EDTA**

- **Practicality, costs etc. of EDTA treatment**
- **Pilot-scale trial of EDTA on drilling lease**



Bioassays

- 2 invertebrates – springtails, earthworms
  - Endpoint was survival
- 2 plant species – northern wheatgrass, lettuce
  - Endpoints included emergence, shoot and root length, shoot and root biomass

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Bioassays – Continued

- **Soil was amended with different rates of EDTA, and the organisms exposed**
- **The NOEC (no observed effect concentration) and LOEC (lowest observed effect concentration) were determined for each endpoint / organism**
- **The NOEC should be used to determine the "safe" level of EDTA to the respective organism**

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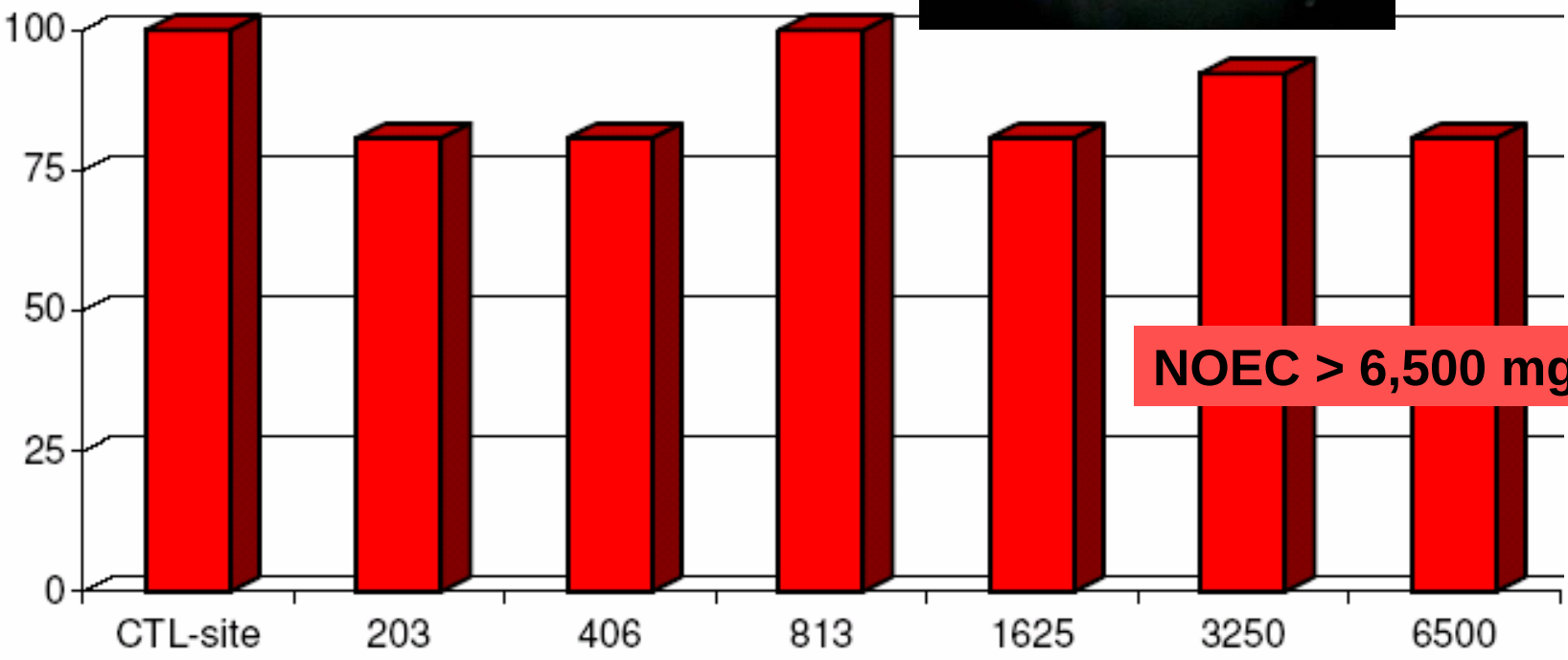
Springtail survival (% of control)



NOEC > 6,500 mg/kg

mg EDTA / kg soil

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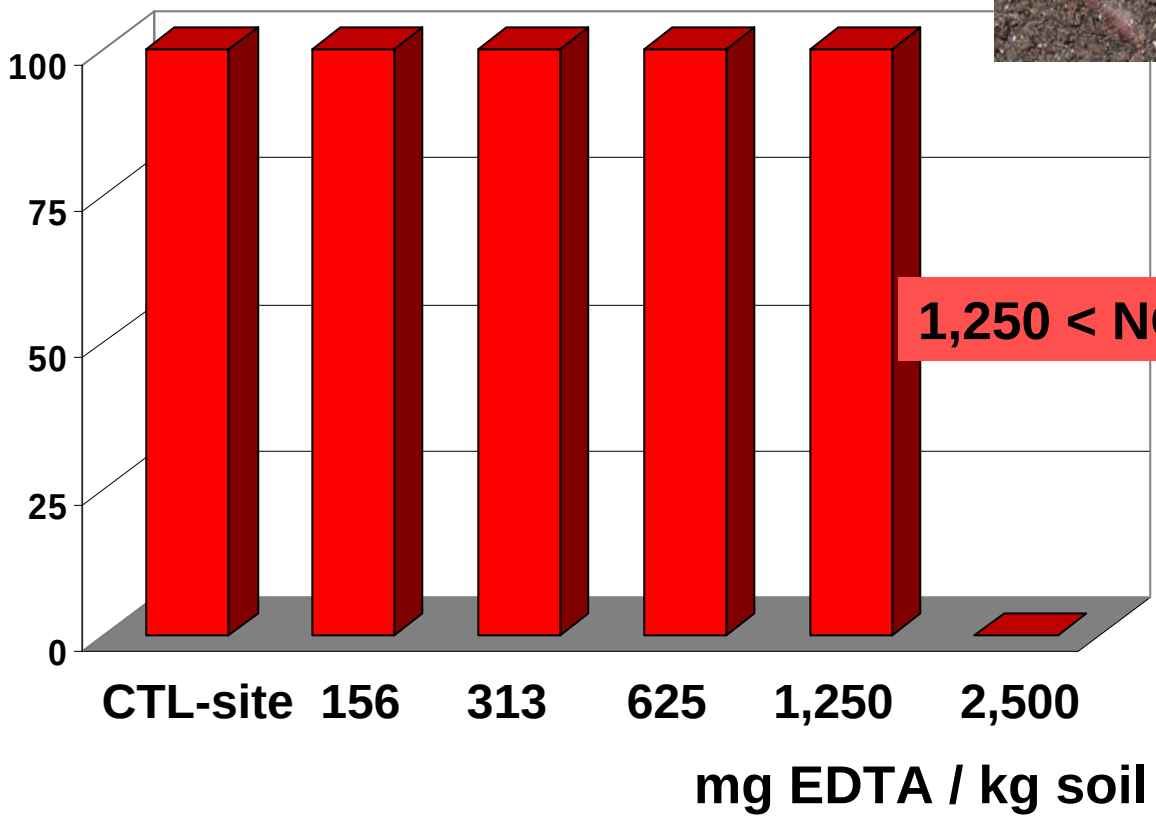
Earthworm survival (a)
(% of control)



1,250 < NOEC < 2,500 mg/kg

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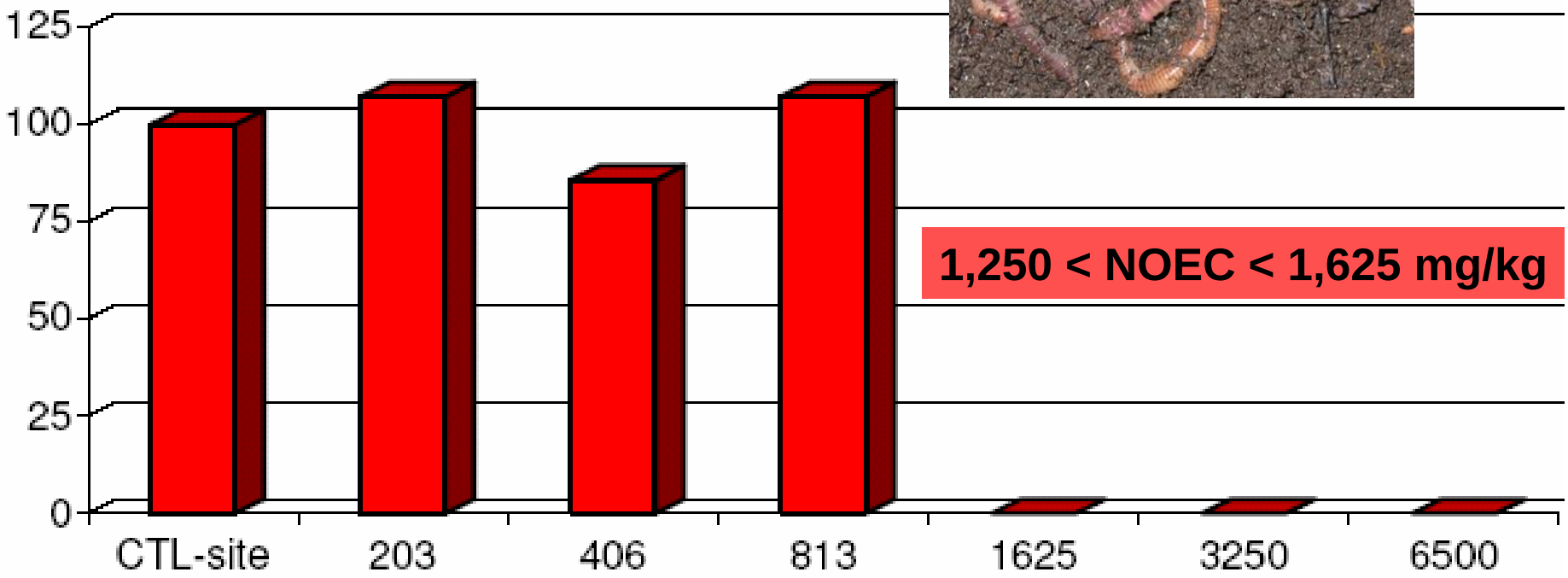
Earthworm survival (b)
(% of control)



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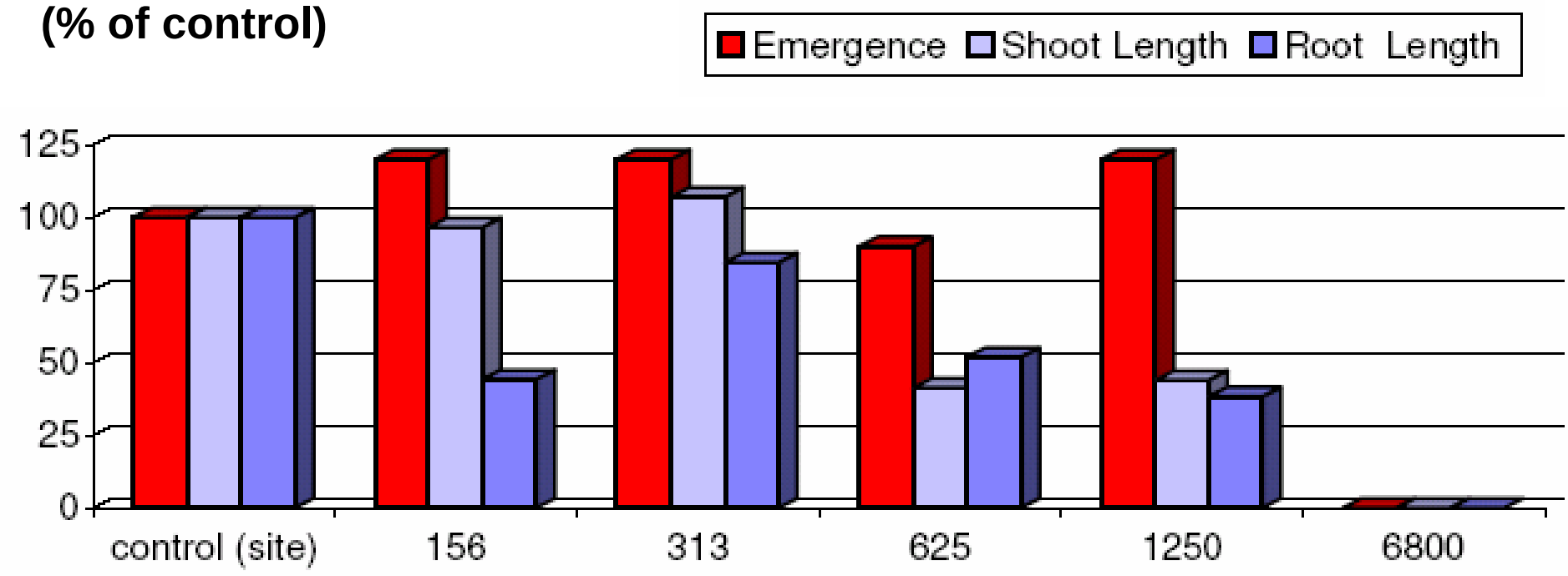
N. wheatgrass growth (% of control)



NOEC levels

- **Emergence; 1,250 < NOEC < 6,800 mg/kg**
- **Shoot/root length; 150 < NOEC < 300 mg/kg**
- **Shoot/root biomass; NOEC < 150 mg/kg**

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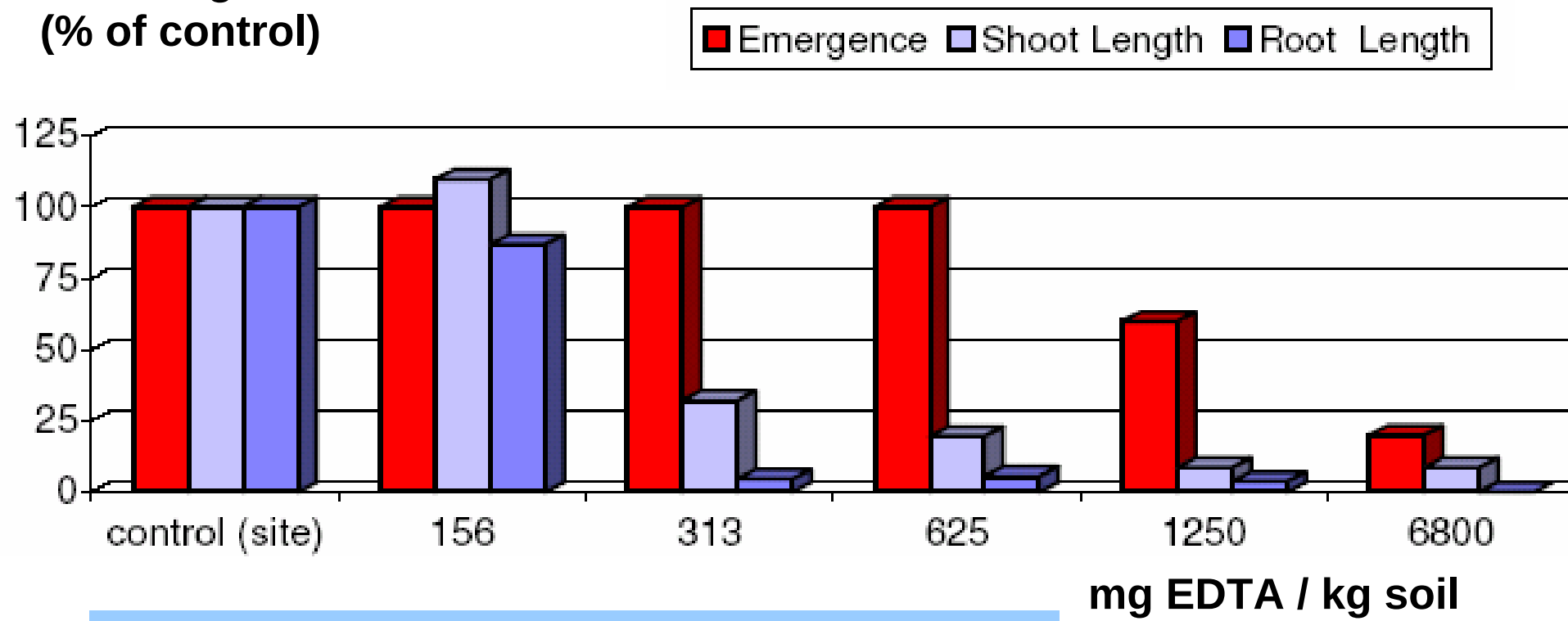
Lettuce growth (% of control)



NOEC levels

- **Emergence; 600 < NOEC < 1,200 mg/kg**
- **Shoot/root length; 150 < NOEC < 300 mg/kg**
- **Shoot/root biomass; NOEC < 150 mg/kg**

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EDTA concentration in soil after disposal by mix, bury & cover

mg EDTA/kg = (1,000,000 x kg/m^3) / (R x 1,700 + DBD)*

*** EDTA concentration will depend on site-specific mix ratio R, actual dry bulk density of soil (= 1,700 kg/t ?) and waste DBD.**

EDTA rate	Mix ratio	EDTA / kg mix*
5 kg/m^3	3	800 - 1,000 mg/kg
10	3	1,600 - 2,000
10	5	1,000 - 1,200
15	7	1,100 - 1,300

(A soil-waste mixture with 12,000 mg EDTA / kg passed the Microtox bioassay)

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Capacity of backhoe bucket = 1 cubic metre approx.

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Blending EDTA into the soil-waste mix

Estimated Costs (Approx).

- **EDTA in bulk, up to $ 4 per kg**
- **Readily available, via an ALS sister company**
- **Application rate, up to 10 kg/m^3**
- **Estimated cost, less than $40 per m^3**
- **Trucking / Landfilling, $80-$120 per m^3**

NB. This is a treatment for high SAR, not for high EC.

EDTA is (unfortunately) not a miracle cure for salt spills.

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