Which Came First: the Toxicity or the Loss of Function?

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What are the functions of a soil?

NITROGEN PATHWAYS

MYCORRHIZAS

ORGANIC MATTER

BACTERIA

FUNGI

PROTOZOA

ciliates

flagellates

amoebas

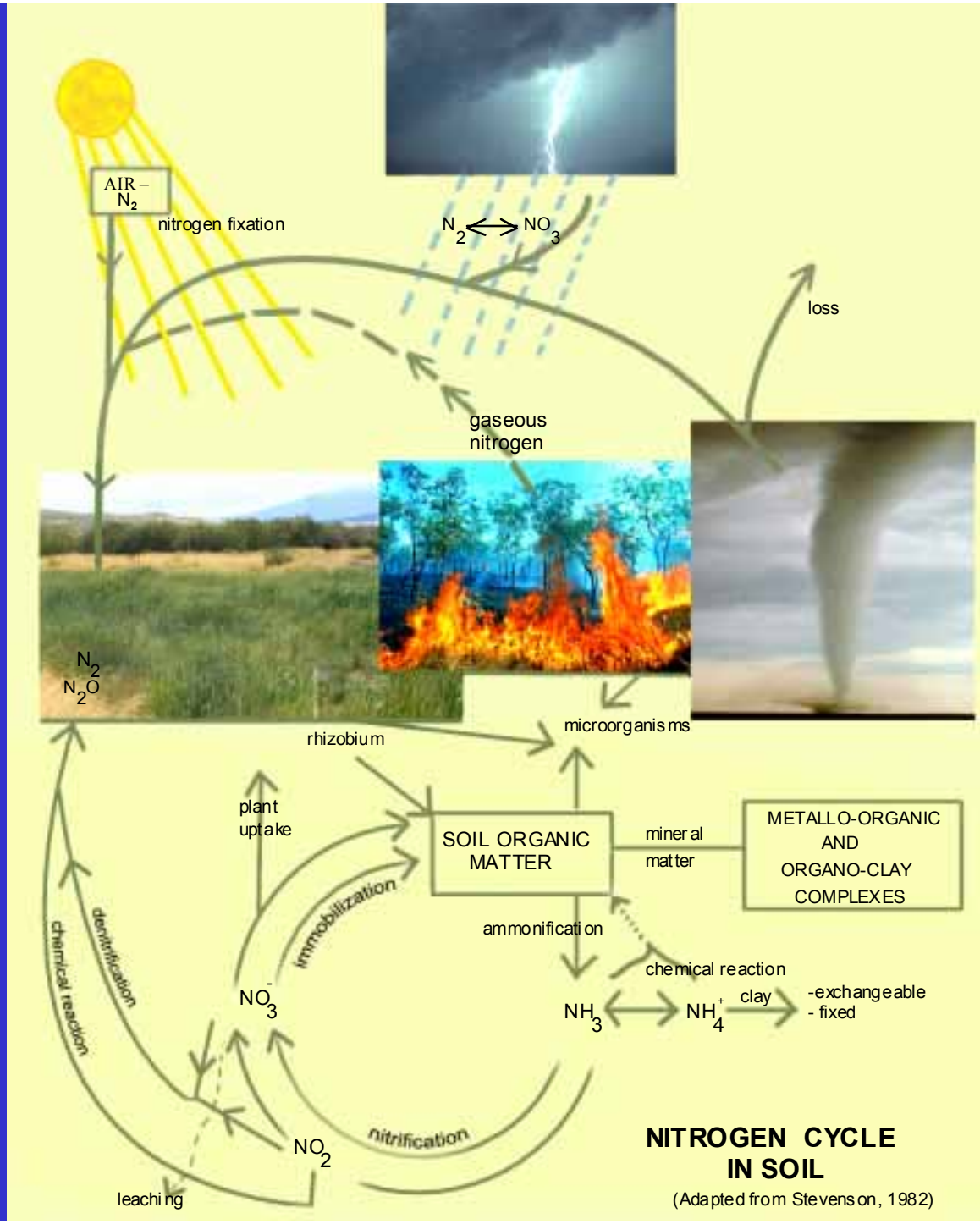
NEMATODES

bacterivorous
omnivorous
predatory

MICROARTHROPODS

fungivorous
nematophagous
predatory

Adapted from *Biology & Fertility of Soils* 3,57-58


AIR – N_2
nitrogen fixation
$N_2 \leftrightarrow NO_3$
loss
gaseous nitrogen
N_2
N_2O
microorganisms
rhizobium
plant uptake
SOIL ORGANIC MATTER
mineral matter
METALLO-ORGANIC AND ORGANO-CLAY COMPLEXES
ammonification
chemical reaction
immobilization
denitrification
chemical reaction
NO_3^-
NH_3
NH_4^+
clay
-exchangeable
- fixed
NO_2
nitrification
leaching
NITROGEN CYCLE IN SOIL
(Adapted from Stevenson, 1982)


9 24 '99

Contaminants of Concern (COCs)

- Cadmium
- Lead
- Zinc
- Copper
- Manganese

Physical Parameters Measured

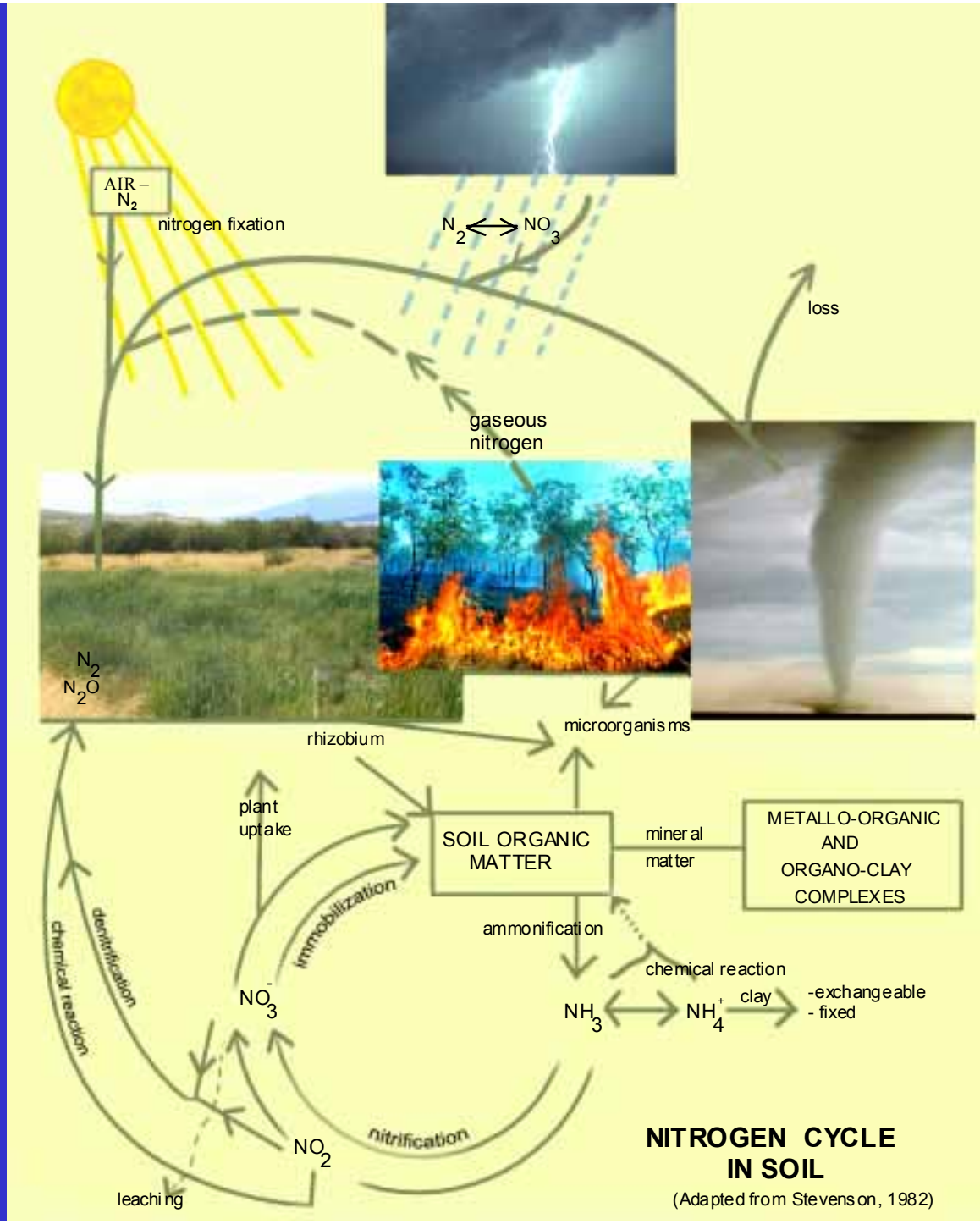
pH → increased

TOC → increased

Grain Size Distribution → same

Specific Gravity → same

Water Holding Capacity → increased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NITROGEN CYCLE IN SOIL
(Adapted from Stevenson, 1982)

Chemical Parameters Measured

Nitrogen
(TKN → increased, NO_2 → decreased,
NH_3 → same, NO_3 → same)

Available Phosphorus → increased

Sulfate → same

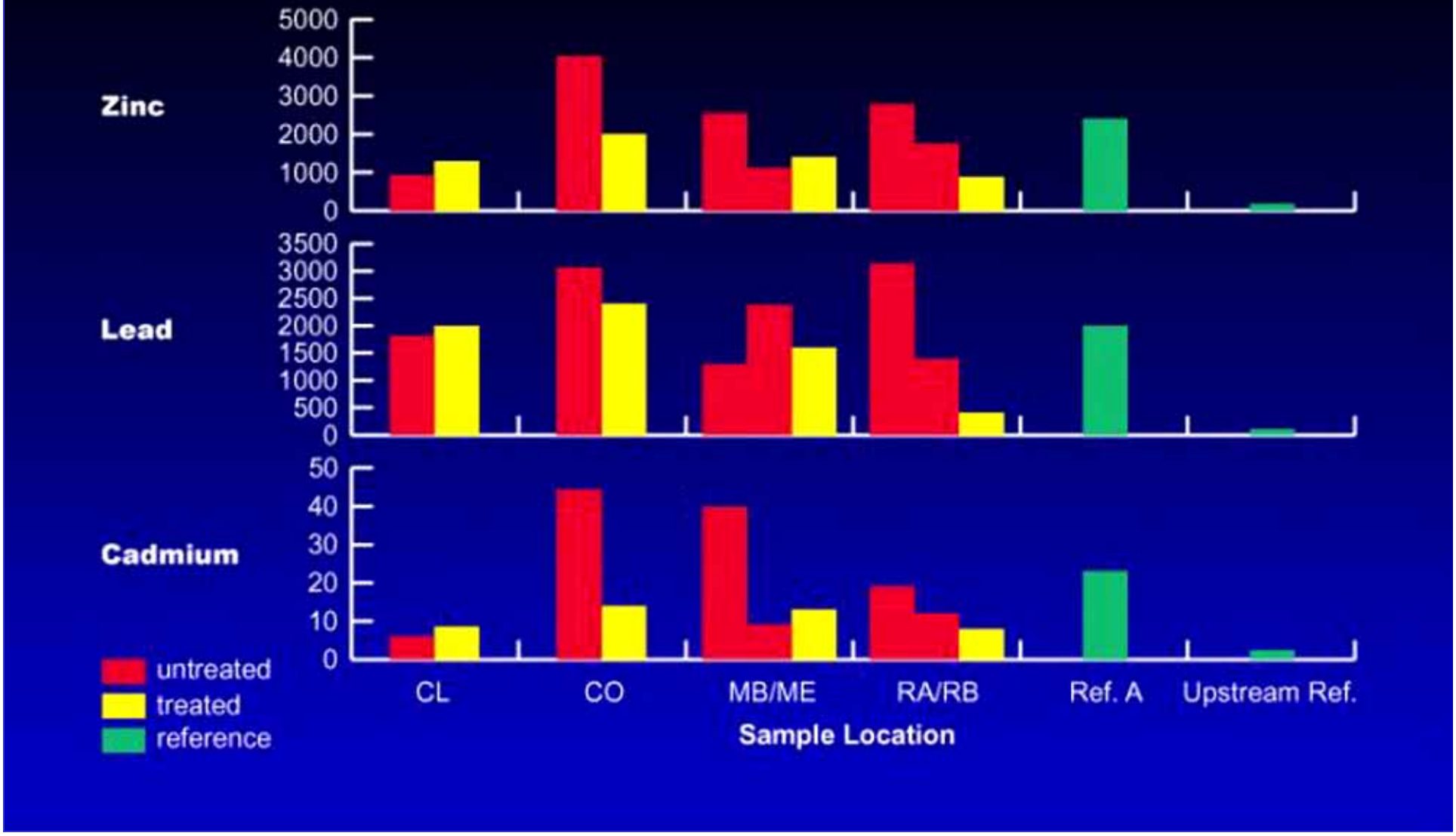
Chloride → increased

Soluble Salts → increased

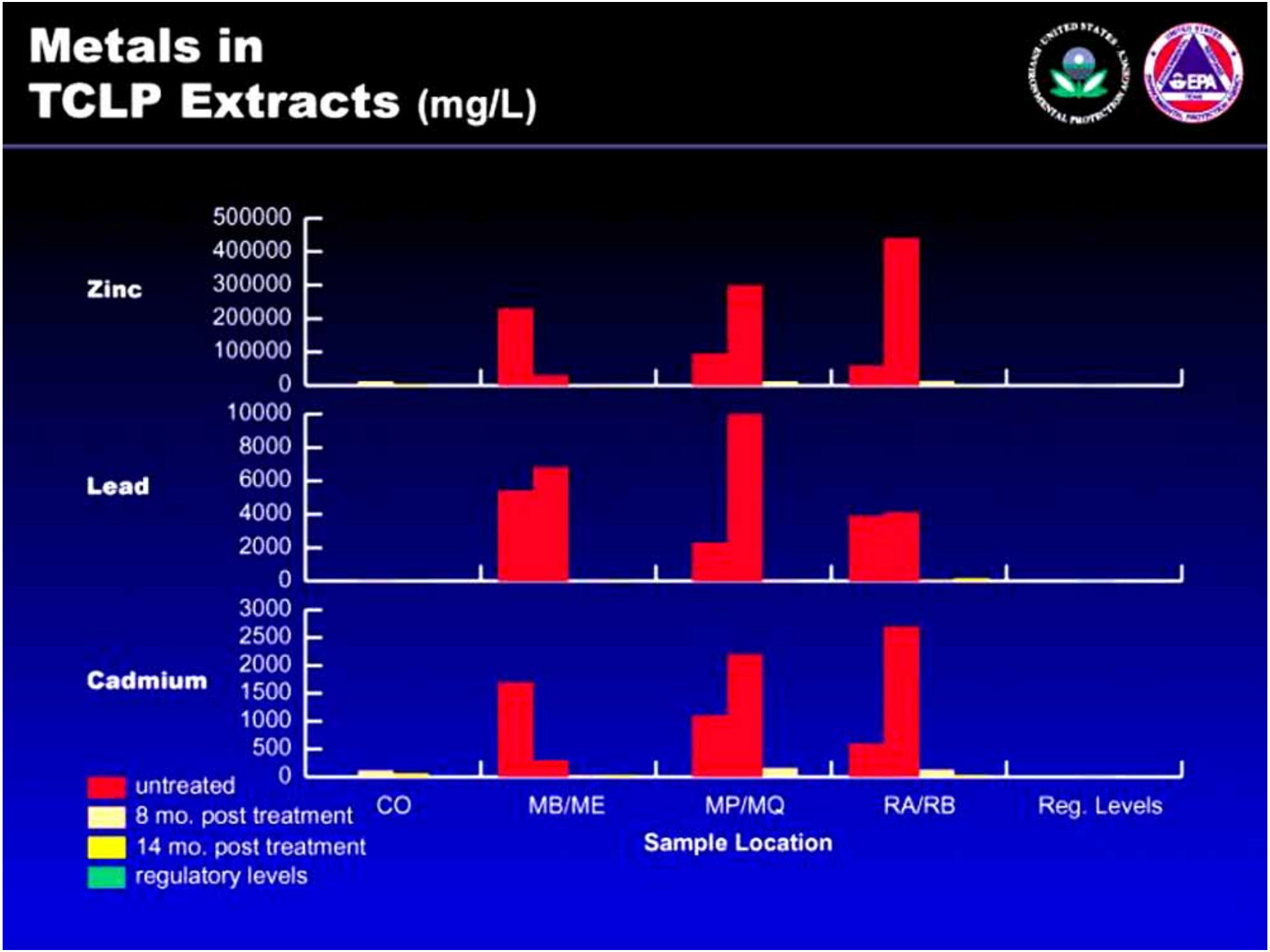
Cation Exchange Capacity (CEC) → same
(K → increased, Mg → increased, Ca → increased)

Available Micronutrients
(B → increased, Cu → same, Mn → same, Zinc → same)

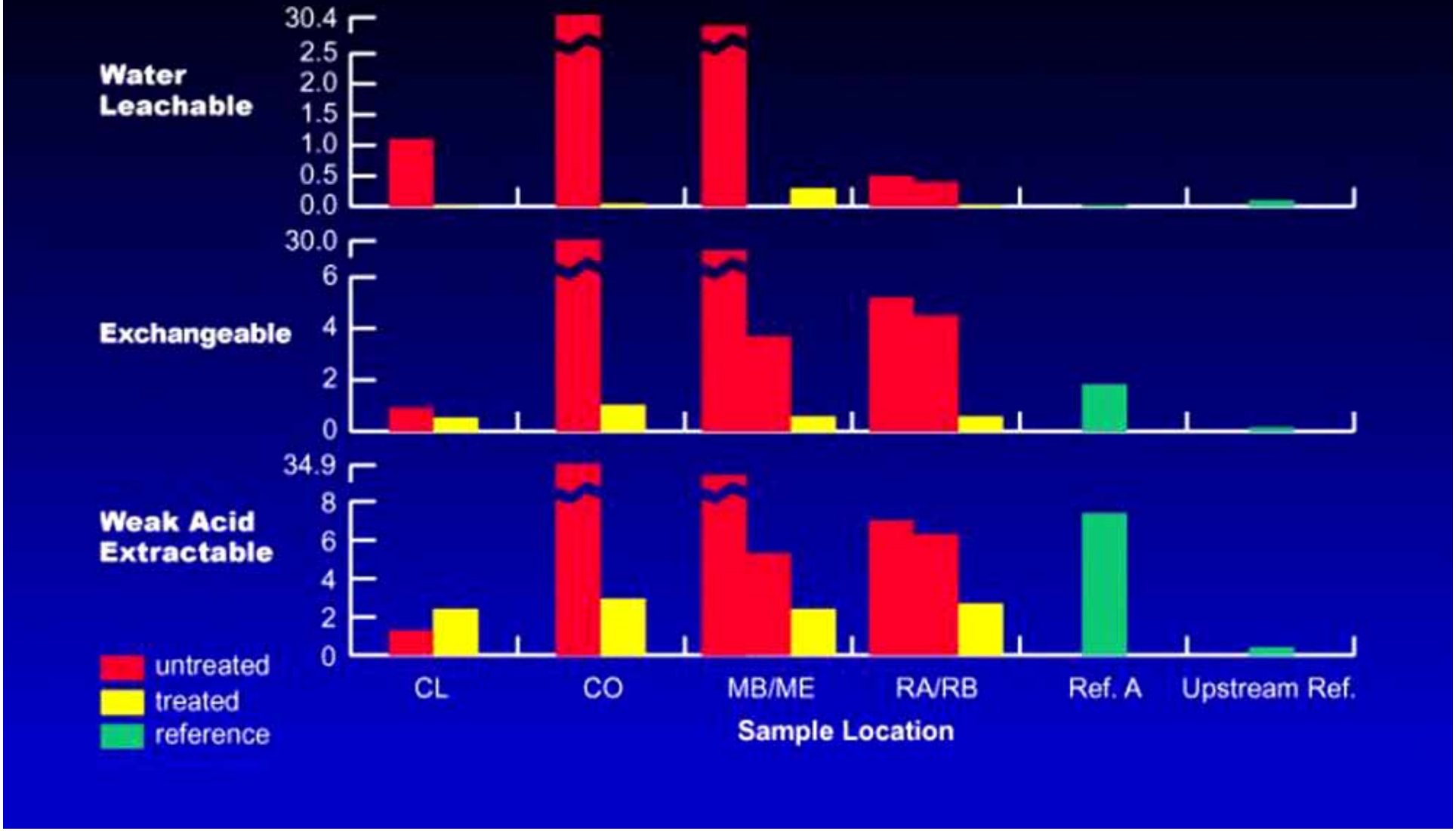
TAL Metals in Soil (mg/kg)



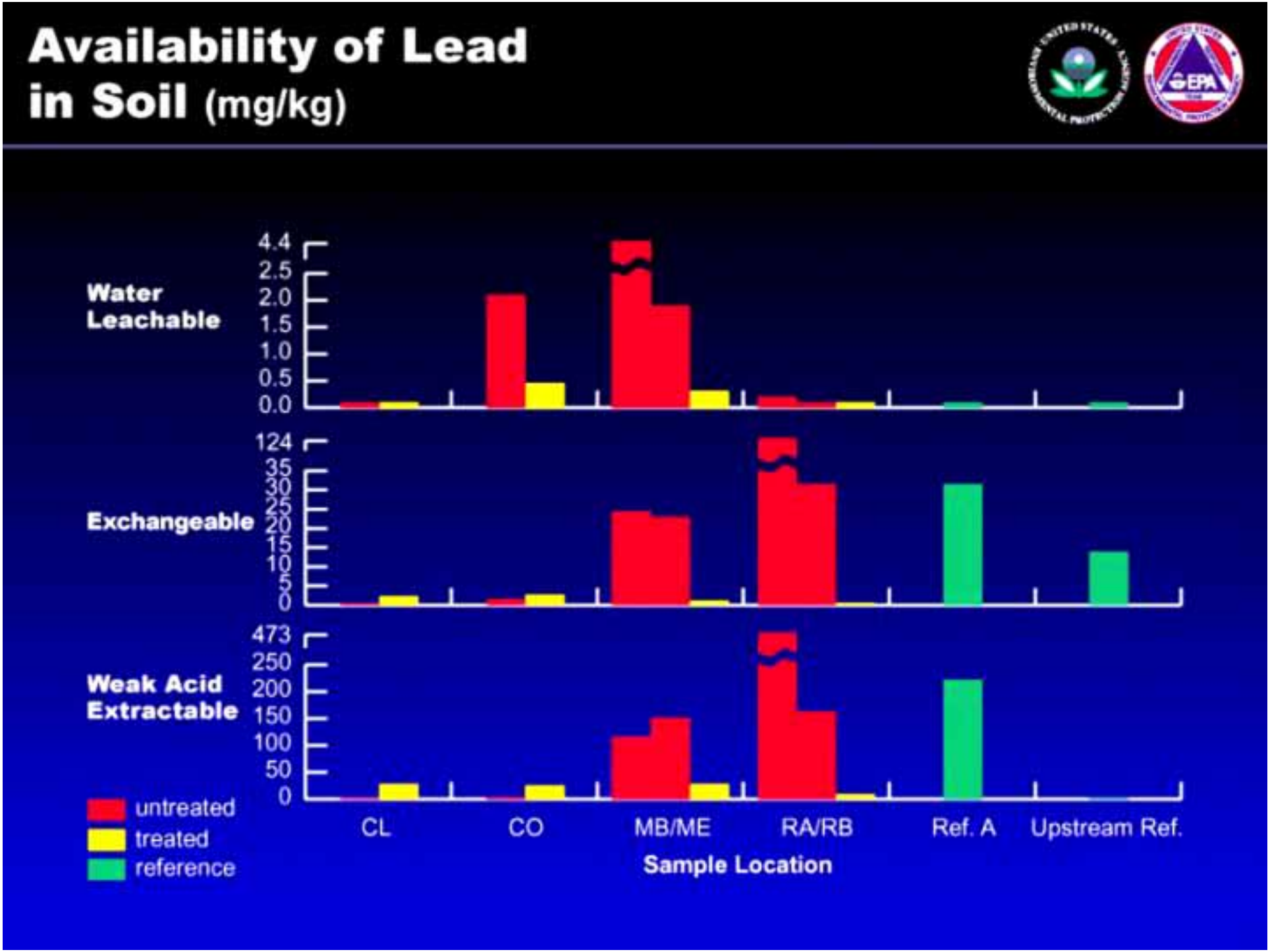
Metals in TCLP Extracts (mg/L)



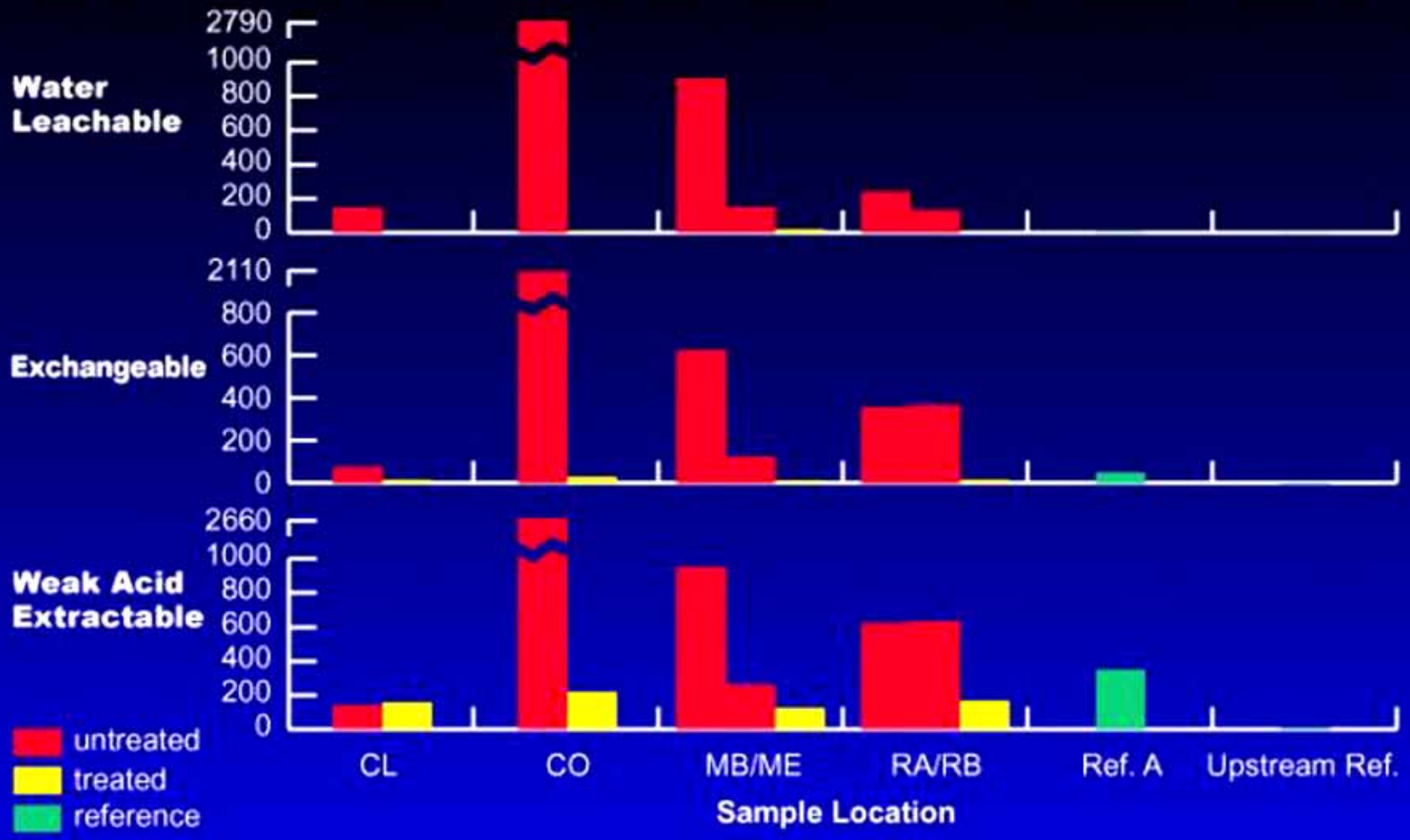
Availability of Cadmium in Soil (mg/kg)



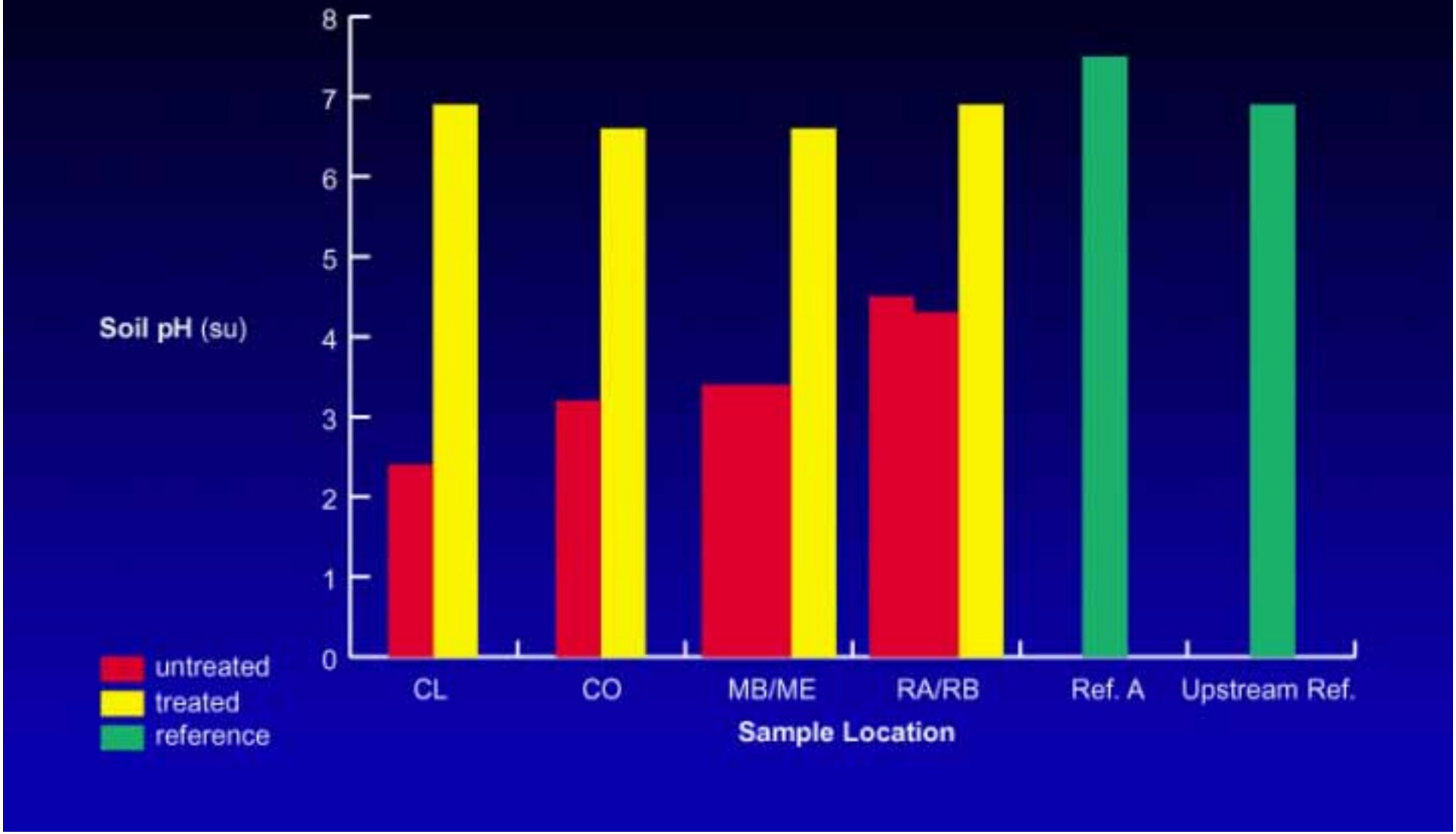
Availability of Lead in Soil (mg/kg)



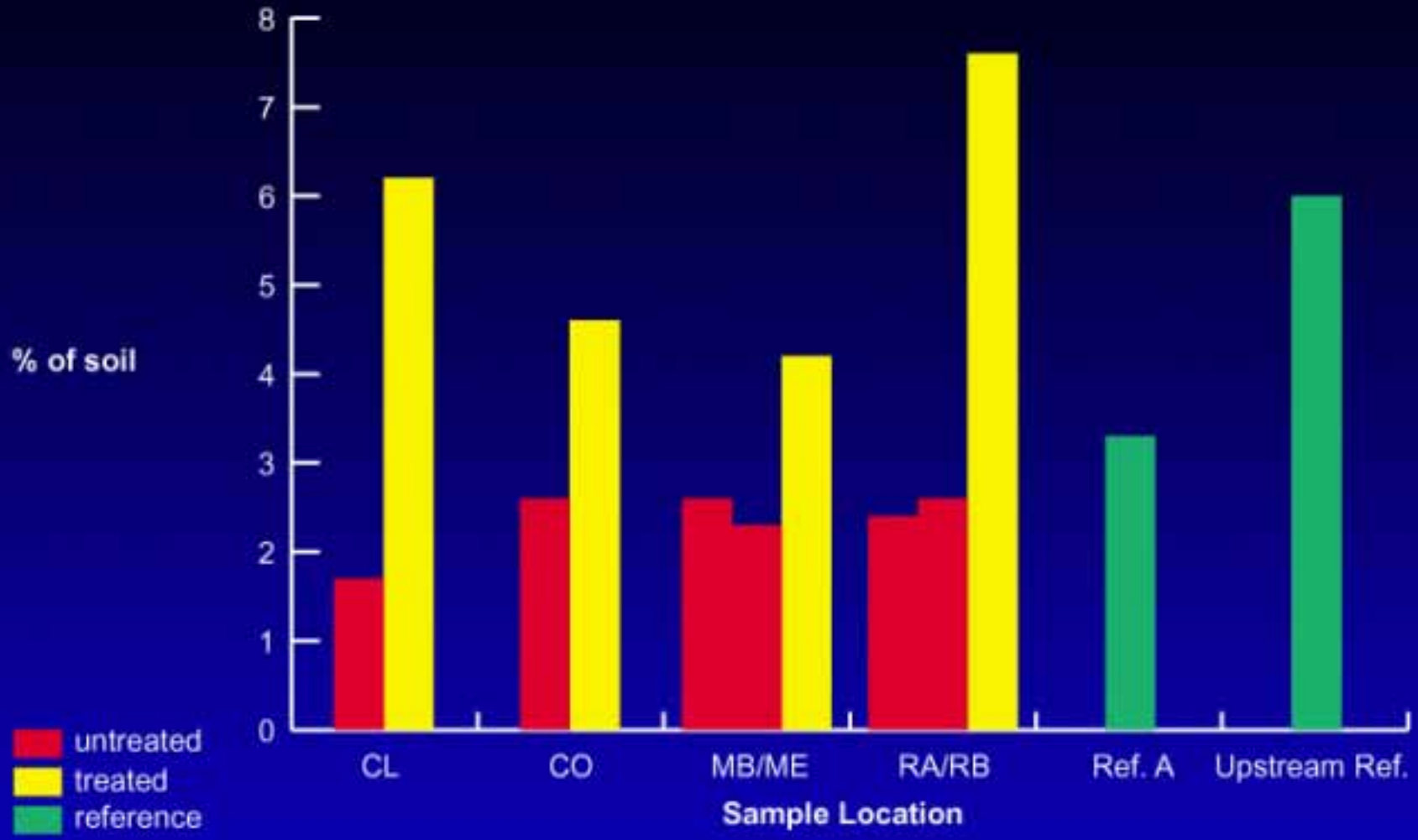
Availability of Zinc in Soil (mg/kg)



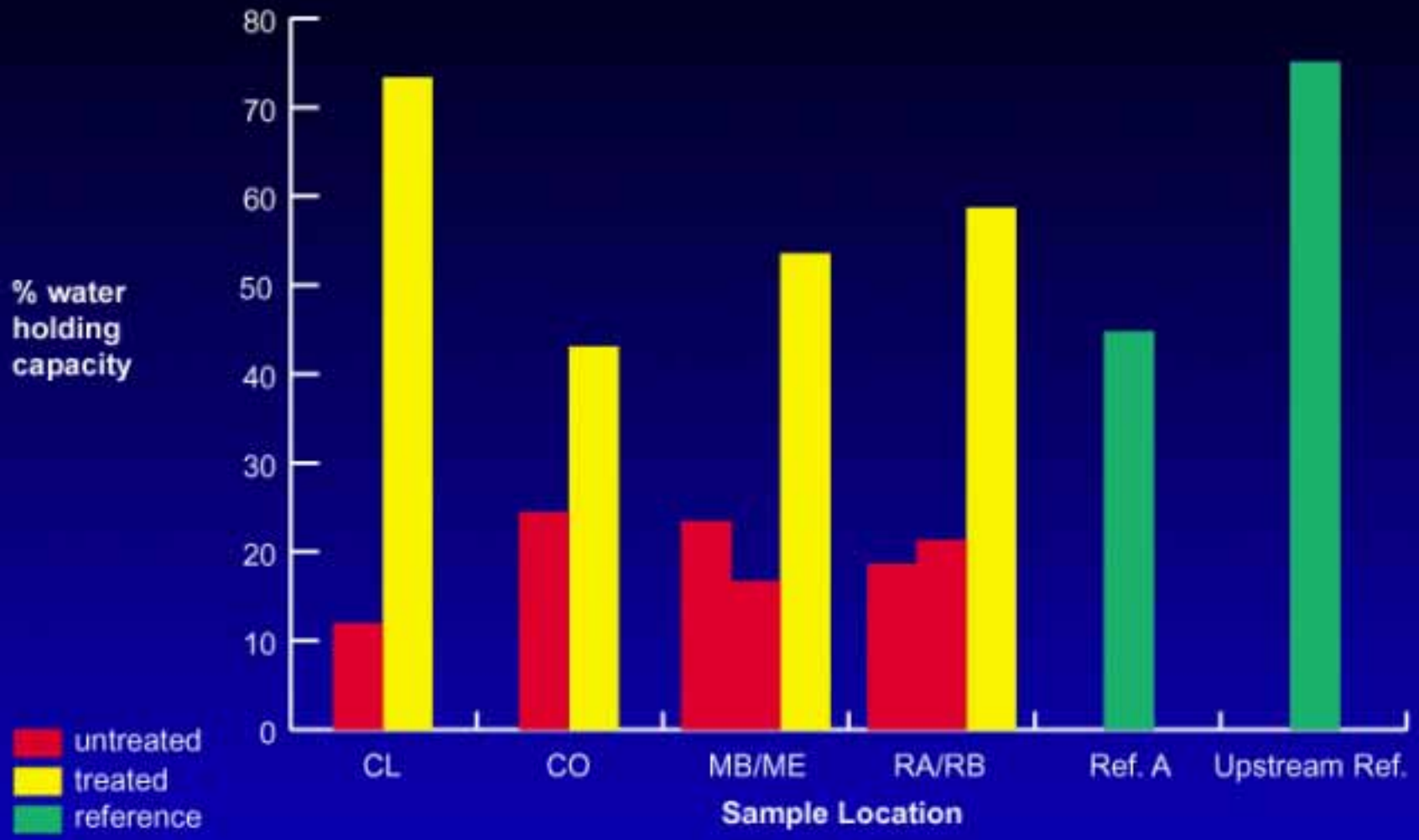
Soil pH


Soil pH (su)
8
7
6
5
4
3
2
1
0
CL
CO
MB/ME
RA/RB
Ref. A
Upstream Ref.
Sample Location
untreated
treated
reference

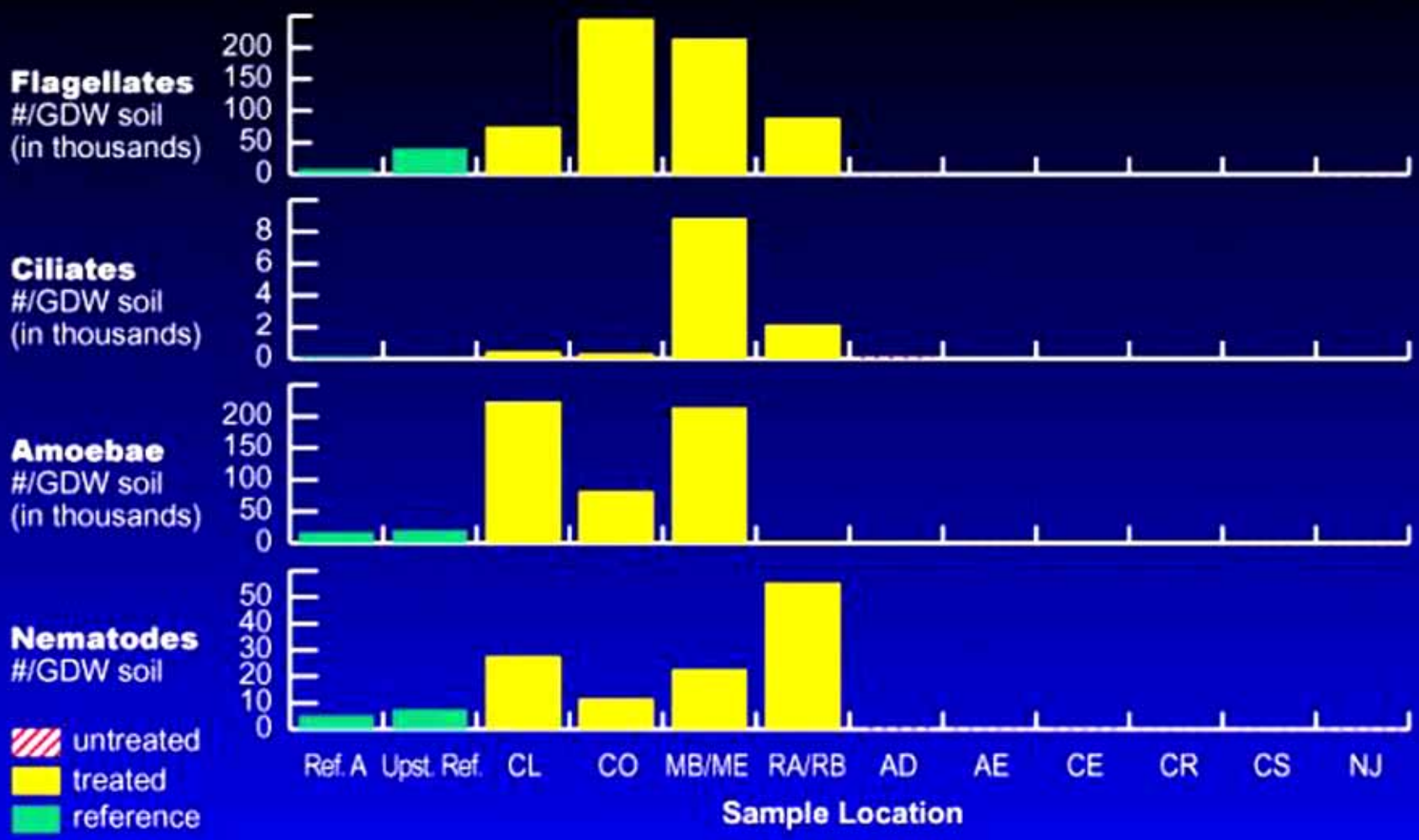
Total Organic Carbon



Water Holding Capacity



Higher Level Microorganisms



Ryegrass *(Lolium perenne)* Assays - Germination

Sample	Untreated (%)	Treated (%)
CL	0	85.7
CO	0	71.4*
MB/ME	-	100.0
RA/RB	-	90.5
Ref. A	-	95.2
Upst. Ref.	-	90.5
Lab Con.	85.7	95.2

* significantly < reference samples and/or control sample

Earthworm *(Eisenia foetida)* Assays - Survivorship & Biomass/Organism

Sample	Untreated		Treated	
	Survival (%)	Biomass (mg)	Survival (%)	Biomass (mg)
CL	0	NA	100.0	329.3
CO	0	NA	98.9	323.0
MB/ME	0/0	NA	90.0	372.0
RA/RB	0/0	NA	10.0*	280.3
Ref. A	-	-	98.7	244.0
Upst. Ref.	-	-	96.7	196.0
Lab Con.	100	not measured	100.0	258.6

* significantly < reference samples and/or control sample

Conclusions

The apparent reduction in available metals in tailings treated with biosolids was reflected in reduced lethal toxicity of tailings to perrenial ryegrass and earthworms after remediation with biosolids.