



Manaaki Whenua
Landcare Research

Deriving soil guideline values, with a focus on lead

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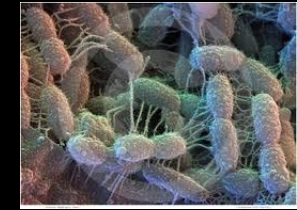


Purpose of soil guideline values

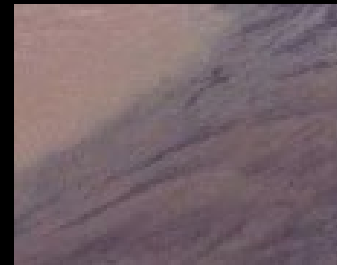
- Indication of potential effects on....



Human health



Terrestrial ecological receptors



Aquatic ecological receptors/aquatic systems

- Derived through AGREED processes, related to policy context of use



Purpose of soil guideline values

- Indication of potential effects on....

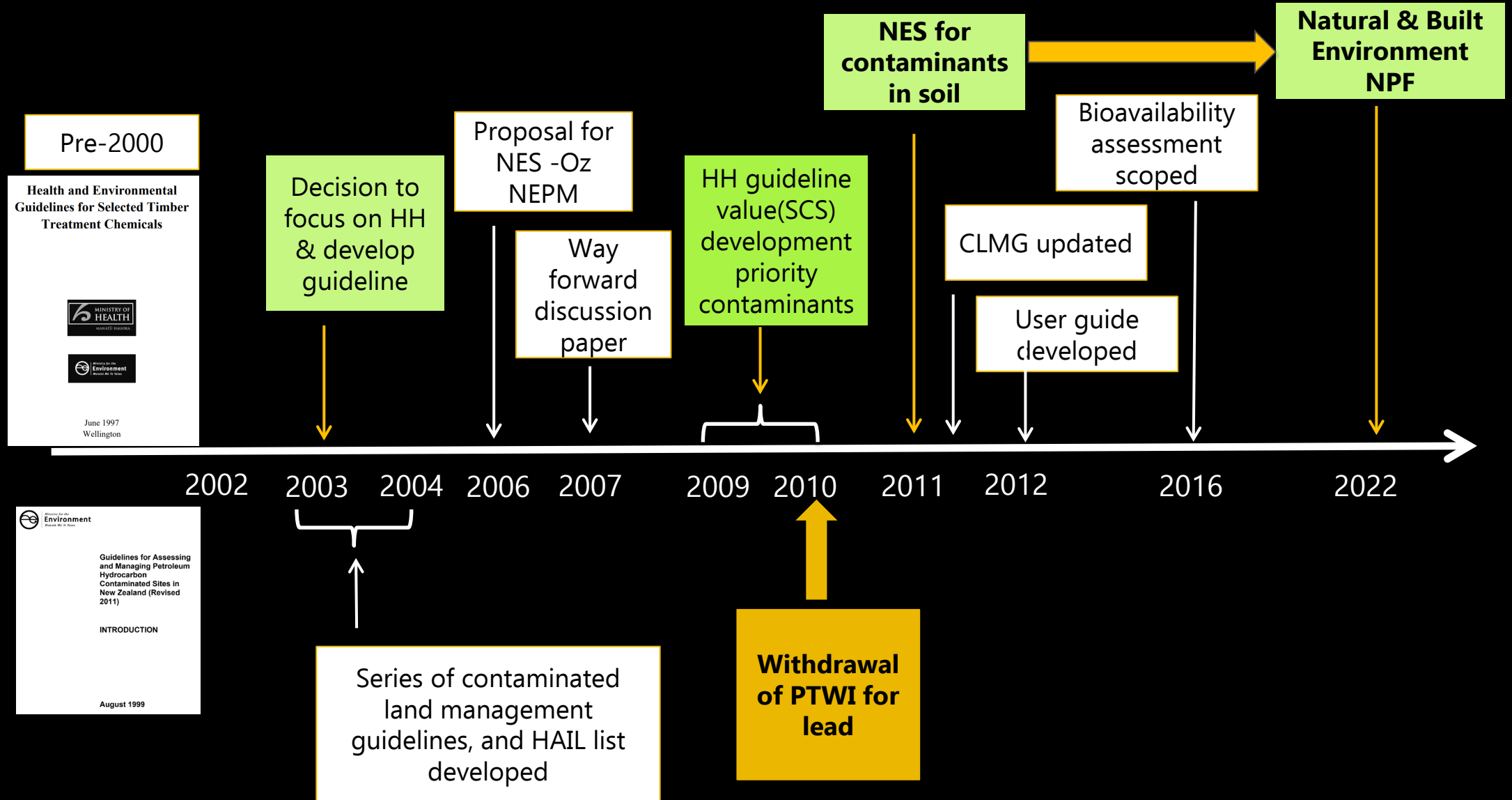


Human health

- Derived through AGREED processes, related to policy context of use



Setting the scene.....

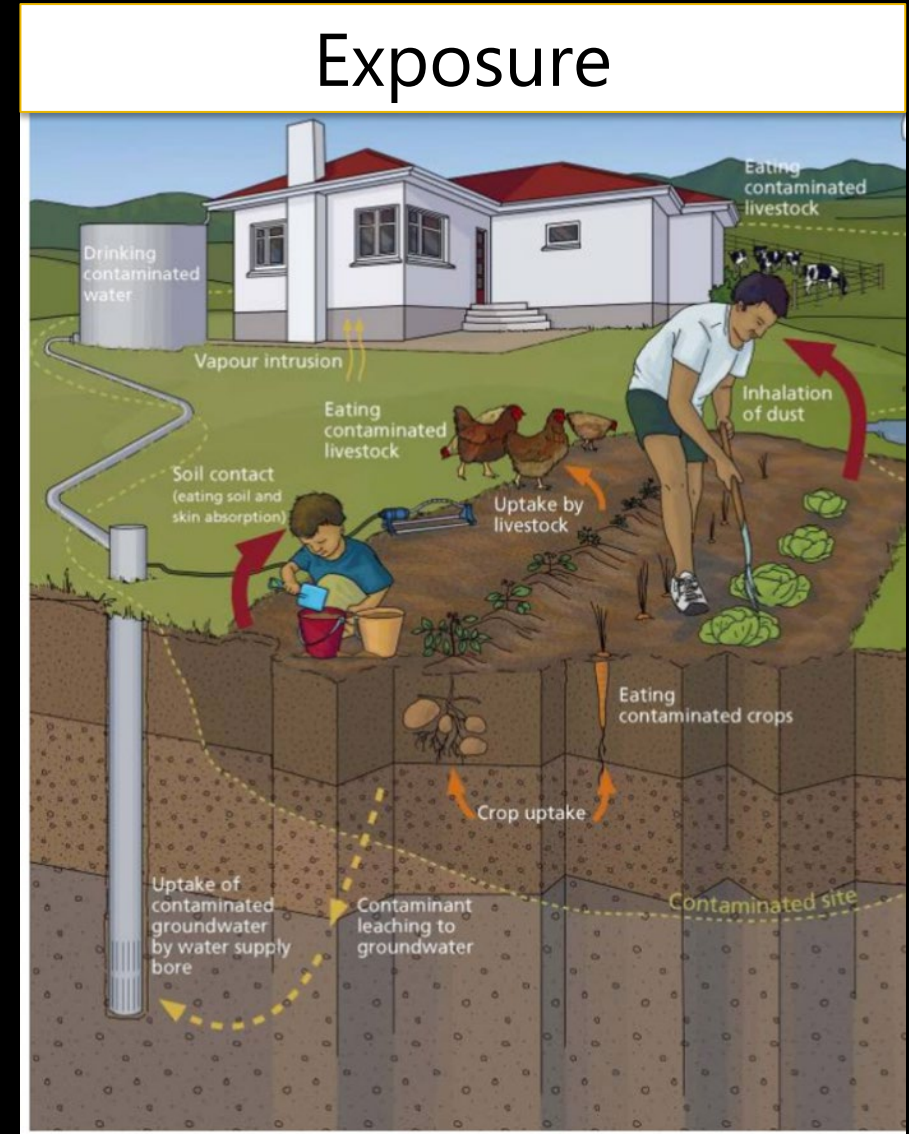


Deriving soil guideline values for HH



- Toxicological effects
 - Threshold e.g. neurodevelopmental effects
 - Non-threshold e.g. cancer

+



Current soil contaminant standards



- Toxicological effect
- Exposure



**Toxicological Intake Values for
Priority Contaminants in Soil**



**Methodology for Deriving Standards
for Contaminants in Soil
to Protect Human Health**



Toxicological endpoint for lead

- FAO/WHO Expert Committee on Food Additives (JECFA) Provisional Tolerable Weekly Intake (PTWI) of 0.025 mg/kg bw for child and infants established in 1986
- Extended to adults in 1993
- Reconfirmed in 2000
 - most sensitive effect reduced cognitive function and intellectual performance in children
- **WITHDRAWN June 2010**
 - No safe threshold below which effects are observed
 - JECFA recommendations to use modelling as a guide for magnitude of effect at a given dose
 - At PTWI effects insignificant at individual level, but significant at population level



Table 30: Recommended toxicological criteria for inorganic lead

Parameter	Value	Basis
Contaminant status	Threshold	Refer to weight of evidence
Oral index dose ($\mu\text{g}/\text{kg}$ bw per day)	1.9	Dose-response modelling by FAO/WHO (2010) that indicated this level of exposure may give rise to decreased IQ at a population level, but effects were considered insignificant at an individual level.
Inhalation intake	NA	Lack of volatility of inorganic lead indicates inhalation exposure is negligible
Skin absorption factor	NA	Available data indicate that dermal absorption of inorganic lead is negligible (Guy et al, 1999)
Background exposure ($\mu\text{g}/\text{kg}$ bw per day) or [per week]	0.97 [6.7] 0.41 [2.85]	Child (1–3 years) Adult (25+ years) Dietary intake (Davies et al, 2001; Vannoort and Thomson, 2005)

NA – not applicable.

Food

2005 0.85 $\mu\text{g}/\text{kg}/\text{bw}/\text{week}$

2016 0.55 $\mu\text{g}/\text{kg}/\text{bw}/\text{week}$

Water intake

2001 477,000 > MAV

2021 17,000 > MAV



Factors influencing intake

- Bioavailability
 - as the fraction of ingested dose that reaches the systemic circulation
- Bioaccessible
 - the fraction of the contaminant that is mobilised from the ingested material (whether this be soil, food etc.) into the digestive juice (i.e. chyme)
 - Conservative estimate of bioavailability – can be measured in lab
- Current SGV assumes 100% bioavailability
 - because of the absence of a valid model to predict blood lead concentrations for New Zealand, and the suggested absence of a threshold of effect for neurodevelopmental impairment

Generic equation



$$\text{Soil guideline value}_i = \frac{\text{acceptable intake}_i \times \text{body weight} \times \text{averaging time}}{\text{contact rate}_i \times \text{exposure frequency} \times \text{exposure duration}}$$

- Child = critical receptor for threshold contaminants
- Lifetime (30 years) exposure for non-threshold = combined child and adult exposure
- All parameters **agreed** for different land use scenarios
- **Actual** use of the site may be different



Selected exposure parameters

Land use	Soil ingestion rate (mg/day)	Exp freq (days/yr)
Rural residential (25% home-grown produce consumed)	50 (25)	350
Residential (10% home-grown produce consumed)	50 (25)	350
High density residential	25 (15)	350
Recreation	25 (75)	200
Commercial/industrial worker	50	240 (48 weeks)

- Child body-weight – 15 kg
- Adult body-weight – 70 kg



Soil contaminant standards

Land use	Soil contaminant standard (mg/kg)
Rural residential (25% home-grown produce consumed)	160
Residential (10% home-grown produce consumed)	210
High density residential	500
Recreation	880
Commercial/industrial worker	3300



International approaches to SGVs

- Australian, Dutch, Canadian SGVs still based on JECFA PTWI
- US EPA rule (2001)
 - **Bare** residential soil 400 mg/kg in play areas, and 1,200 mg/kg for **bare** soil in the rest of the yard – modelled exposure IEUBK
 - [since 2018 greater focus on dust-lead levels]
- UK – C4SLs (2014)
 - modified approach to base exposure to blood-lead level based on blood-lead level of 3.5 ug/dL using IEUBK to derive intake level used in CLEA
 - Allotments 30-84 mg/kg, residential 82-330 mg/kg

What does it mean if SCS is exceeded?

- “SCSs(health) may be applied as:
 - Tier 1 or screening criteria;
 - as **conservative** clean-up targets,
 - to inform on-site management actions;
 - or to trigger further investigation within a Tier 2 assessment”
- SCS based on **agreed** exposure parameters for different land use scenarios
- **Actual** use of the site may be different

Getting the balance right



Proportionate response to risk required

BUT there is a disconnect between soil lead concentrations, blood-lead level and decision-making based on risk (inc other sources of exposure)



Summary

- Toxicological intake value set in 2010
- Background exposures appear to be reducing
- Increased awareness of effects occurring at low blood-lead levels
 - E.g NZ blood lead notification level reduced in 2021
 - Concern is at population level rather than individual level
- Substantial data on health effects related to blood lead level
 - Various models to relate intake to blood lead level e.g. IEUBK
- In NZ, remains a disconnect between soil lead concentrations, blood-lead level and risk-based decision-making at sites where elevated lead concentrations are observed