



Common Forum/DD 2016.009

Soil Screening Values revision

Synthesis of the answers received after Christiane Wermeille's request (29/06/2015)

Updated the 22 April 2016

The request:

We are currently reviewing the Swiss guidelines for the derivation of soil screening values (guide values, trigger values, clean-up values) for inorganic and organic soil pollutants in residential and agricultural/horticultural soils. The goal is to bring the Swiss guidelines to the today's "state of the art" from the scientific point of view. For this purpose, we started to look for derivation methods applied in other countries. Therefore, I would appreciate if you could provide an insight into the methods which are used to derive the soil screening values in your country. We are interested in the following questions:

- When were the derivation methods established?
- Do you consider these methods at "state of the art" from the today's point of view?
- Are revisions in process or planned?
- Are the derivation methods documented in form of a technical guideline which is ready to derive soil screening values with respect to both, pollutant type and soil use? If so, can you give us access to a copy of this document?
- Which types of soil use are addressed (residential, agricultural, horticultural, industrial, etc.)?
- What are the subjects of protection (e.g. human health, livestock health, wildlife health, crop health, soil ecology, water ecology etc.)?
- Which risk pathways are taken into account (e.g. soil-human (ingestion), soil-plant-human, soil-plant-animal-human, soil-animal (ingestion)-human, soil-groundwater, soil-surface water, soil-air-(plant), etc.)?
- Is the exposition assessed on the basis of experimental data (e.g. measured soil-plant-transfer) or on the basis of model calculations (e.g. bio concentration factors)?
- What toxicological standards are used for hazard assessments?
- Which model(s) is/are used (e.g. CSOIL, EUSES, CLEA etc.)? Which of the today's models do you consider best for deriving agricultural/horticultural soil screening values (if applicable at all for this type of soil use)?

Thank you in advance for your support and your answer if **possible until the 20th of March!**



Austria / Dietmar Müller – Grabherr (31/03/2016)

As a reference on background in contaminated land management in Austria by 2006 a general and brief summary on soil and groundwater screening values (2nd generation) has been provided and is available through the “HERACLES-report” [3]¹.

In 2008 the Austrian Ministry of Environment (BMLFUW) contracted EAA for coordinating a major project/initiative for developing a new national risk assessment framework and suitable guidance documents. Technical approaches within the respective framework were supposed to reflect state-of-the-art approaches in Europe, but should be as well respecting and meeting expectation of practitioners for pragmatic solutions. This is felt to be key for preparing acceptance of new concepts, which would be fundamental for implementation under a possible transformation towards a new legal framework for historically contaminated sites.

Q1) When were the derivation methods established?

The Austrian Standard ÖNORM S 2088-2 “Contaminated Sites – Part 2: Risk assessment for polluted soil concerning impacts on surface environments” was part of technical guidance in its 2nd generation and had been published in its 1st edition by June 2000. The “HERACLES-report” [3] provides a general summary, also indicating for scientific and practical weaknesses.

As a revision and transformation of the legal framework was envisaged in 2009, the 1st revision of ÖNORM S 2088-2 was started as a complementary activity. The body responsible for revision was the Austrian Standards (AS) and its working group 157e02 (“Contaminated site assessment”). WG 157e02 discussed the revision of ÖNORM S 2088-2 during the period from 2010 to 2013.

The 2nd edition ÖNORM S 2088-2 was adopted by 1. September 2014 [2].

Q2) Do you consider these methods at “state of the art” from the today’s point of view?

EAA considers the general concepts underlying ÖNORM S 2088-2:2014 as being “state-of-the-art”.

In particular with regard to human health risk assessment ÖNORM S 2088-2 and its soil screening values on the exposure pathway “soil-human” the standard is in line with a more detailed technical guidance [1] published by EAA in 2011.

With regard to a possible uptake of contaminants by plants existing and generally accepted guidance documents (e.g. ÖNORM L 1075: Principles for the evaluation of the content of selected elements in soils) were referenced.

Q3) Are revisions in process or planned?

No.

¹ Contributing to AquaConSoil in Barcelona (2013) one of the authors, Frank Swartjes (RIVM, The Netherlands) launched a questionnaire for assembling an updated review. The document on the Austrian answer in 2013 is attached.



Q4) Are the derivation methods documented in form of a technical guideline which is ready to derive soil screening values with respect to both, pollutant type and soil use? If so, can you give us access to a copy of this document?

Yes, in terms of human health risk assessment technical considerations are transparently documented by guidance documents (see references).

WG157e02 discussed and decided for a concept of simple scenarios, which related:

- land use-classes to possible activities (e.g. residential use to gardening) and,
- activities to sensitive exposure pathways (e.g. gardening to inhalation of dust particles),

and finally became characterized by mathematical algorithm including exposure parameters involved to each simple scenario.

ÖNORM S 2088-2 in its 2nd edition provides by Annex B complete details (including data justifying exposure parameters) how soil screening values have been derived mathematically². However each single screening value was matter of a further expert dialogue at WG 157e02 considering a plausibility testing (e.g. against background values) and possible further evident general knowledge on toxicological profiles (e.g. speciation, bioavailability). Without any knowledge-based adaptation mathematical results were at least rounded (up).

Q5) Which types of soil use are addressed (residential, agricultural, horticultural, industrial, etc.)?

With regard to the exposure pathway “soil-human” ÖNORM S 2088-2 suggests a classification of 5 different soil uses:

- a. playground (oral ingestion scenario)
- b. residential use (inhalative scenario)
- c. agricultural and horticultural use (inhalative scenario)
- d. recreational use (no scenario)
- e. industry, commerce and infrastructure

However, soil screening values are only provided for “playgrounds” (table 1) and residential uses (table 2). Soil screening values for agricultural and horticultural uses are referenced identically to residential uses³.

Q6) What are the subjects of protection (e.g. human health, livestock health, wildlife health, crop health, soil ecology, water ecology etc.)?

(i) Human health, (ii) food production (as a basic ecosystem service).

² In attempting complete and transparent information ÖNORM S 2088-2 and in particular Annex B provide as well the potential to recalculate screening values site-specifically.

³ **Note:** As a result of discussion WG 157e02 agreed that for (b) residential use and (c) agricultural/horticultural use, inhalation is likely the most sensitive exposure route “soil-human”. Each land use class was characterised by a specific algorithm/formula and its own parameter set on exposure parameters (e.g. time budgets). The specific assumptions are provided within ÖNORM S 2088-2:2014 through Annex B. The general approach in defining exposure parameters (default numbers) was characterising a reasonable (realistic but as well conservative) exposure scenario. However, by coincidence the over-all calculation of human exposure against minor soil particles (dust) ends up to a similar exposure and such soil screening values for 2 different use classes are equal.



Q7) Which risk pathways are taken into account (e.g. soil-human (ingestion), soil-plant-human, soil-plant-animal-human, soil-animal (ingestion)-human, soil-groundwater, soil-surface water, soil-air-(plant), etc.)?

ÖNORM S 2088-2:2014

- a. soil-human (ingestion)
- b. soil-human (dust inhalation)
- c. soil-human (dust-inhalation)
- d. soil-plant

Q8) Is the exposition assessed on the basis of experimental data (e.g. measured soil-plant-transfer) or on the basis of model calculations (e.g. bio concentration factors)?

L 1075 "Principles for the evaluation of the content of selected elements in soils" generally reflects best national expert knowledge, which substance-specifically might stem from experimental data, model calculations or a combined approach.

Q9) What toxicological standards are used for hazard assessments?

Substance-specific data sheets are provided as a Annex in [1]. In general

- *"Berechnung von Prüfwerten zur Bewertung von Altlasten" (MEKEL et al. 2007; Umweltbundesamt Berlin)*

complementary

- *ITER (International Toxicity Estimates for Risk)*
- *US-EPA: IRIS*
- *ATSDR (Agency for Toxic Substances and Disease Registry)*
- *RIVM*

Q10) Which model(s) is/are used (e.g. CSOIL, EUSES, CLEA etc.)? Which of the today's models do you consider best for deriving agricultural/horticultural soil screening values (if applicable at all for this type of soil use)?

To be complemented



References

- [1] Reichenauer T., Friesl-Hanl W., Edelmann E., et al: Arbeitshilfe zur Expositionsabschätzung und Risikoanalyse an kontaminierten Standorte - Endbericht zum Arbeitspaket 2 des Projektes "Altlastenmanagement 2010" (Neuausrichtung der Beurteilung und Sanierung von kontaminierten Standorten). Wien, 2011 ISBN: 978-3-99004-154-3 , 168 S.; German only (including a 2 pages summary in English)

DOWNLOAD:

http://www.umweltbundesamt.at/aktuell/publikationen/publikationssuche/publikationsdetail/?pub_id=1935

- [2] ÖNORM S 2088-2 "Kontaminierte Standorte – Teil 2: Nutzungsspezifische Beurteilung der Verunreinigungen des Bodens von Altstandorten und Altablagerungen"; (Ausgabe: 2014-09-01); available for purchase:
www.austrian-standards.at/webshop.

- [3] Carlon, C. (Ed.) (2007). Derivation methods of soil screening values in Europe. A review and evaluation of national procedures towards harmonisation. European Commission, Joint Research Centre, Ispra, EUR 22805-EN, 306 pp. Annex 2 : Country Reports - Austria: see p127-131

DOWNLOAD:

http://eussoils.jrc.ec.europa.eu/esdb_archive/eussoils_docs/other/EUR22805.pdf



Belgium / Johan Ceenaeme (14/03/2016)

I received in good order your questions on the methods to derive soil screening values. Below you can find the answers for Flanders (Belgium). Do not hesitate to ask us more information, e.g. on the S-Risk model we use.

Q1) When were the derivation methods established?

The general approach was established in 1995, when the first decree on soil remediation was implemented.

Soil remediation standards for soil are based on the protection of human health and on the protection of the ecosystem. Soil remediation standards for groundwater represent drinking water quality.

Critical values for concentration in the soil are calculated based on human toxicology and others based on ecotoxicology. The most critical value is retained as soil remediation standard. Until 2013, the methodology for deriving soil remediation standards based on human health was based on the model Vlier-humaan. (See [annex for English version](#)).

In 2013 a new model, S-Risk, was introduced for human health risk assessment of soil contamination. This model includes an application for the calculation of soil screening values. For more information see: <https://s-risk.be/> (model and website are available in English).

Q2) Do you consider these methods at “state of the art” from the today’s point of view?

Yes. (cfr. recently updated model for human health protection S-Risk)

Q3) Are revisions in process or planned?

No major revisions are planned. Small updates are continuously performed.

Q4) Are the derivation methods documented in form of a technical guideline which is ready to derive soil screening values with respect to both, pollutant type and soil use? If so, can you give us access to a copy of this document?

See <https://s-risk.be/> under item Documents

Q5) Which types of soil use are addressed (residential, agricultural, horticultural, industrial, etc.)?

In Flanders 5 land use types are used in the legislation: nature, agriculture, residential, recreation and industry.

Q6) What are the subjects of protection (e.g. human health, livestock health, wildlife health, crop health, soil ecology, water ecology etc.)?

Main subjects of protection are human health, ecology and water (surface and groundwater) (For groundwater spreading of contamination is avoided).



Q7) Which risk pathways are taken into account (e.g. soil-human (ingestion), soil-plant-human, soil-plant-animal-human, soil-animal (ingestion)-human, soil-groundwater, soil-surface water, soil-air-(plant), etc.)?

See https://s-risk.be/sites/s-risk.be/files/SRisk_model_equations_2016_02_04.pdf
on p 25-26

Q8) Is the exposition assessed on the basis of experimental data (e.g. measured soil-plant-transfer) or on the basis of model calculations (e.g. bio concentration factors)?

For soil-plant transfer route, we prefer to use relevant (!) experimental data. When not available model calculation can be used.

In 2008, soil screening values of heavy metals were revised. The revision included processing on all available data relevant for Flanders (both plant type and soil types).

Q9) What toxicological standards are used for hazard assessments?

See chapter 10 of:

https://s-risk.be/sites/s-risk.be/files/SRisk_model_equations_2016_02_04.pdf

Q10) Which model(s) is/are used (e.g. CSOIL, EUSES, CLEA etc.)? Which of the today's models do you consider best for deriving agricultural/horticultural soil screening values (if applicable at all for this type of soil use)?

S-Risk. For different soil types.see chapter 3 of:

https://s-risk.be/sites/s-risk.be/files/SRisk_model_equations_2016_02_04.pdf



Czech Republic / Milan Sanka (19/03/2016)

Q1) When were the derivation methods established?

The basic methodology was established in 2002, but since that time it was amended several times.

Q2) Do you consider these methods at “state of the art” from the today’s point of view?

Yes, we do, for the purpose of the basic decision making in state administration and as a first step of the complete assessment. This step can be followed by risk assessment procedure.

Questionable is perhaps the method of extraction of bio available fraction - NH_4NO_3 .

Q3) Are revisions in process or planed?

Not in this time.

Q4) Are the derivation methods documented in form of a technical guideline which is ready to derive soil screening values with respect to both, pollutant type and soil use? If so, can you give us access to a copy of this document?

No. The indication (trigger) limit values are constructed for worst case scenario. Therefore if they are exceeded, the risk assessment study should be conducted using relevant conceptual models for the locality.

Q5) Which types of soil use are addressed (residential, agricultural, horticultural, industrial, etc.)?

Both prevention and indication limits are addressed for agricultural soil, however, the indication limits can be used also for other land uses.

Q6) What are the subjects of protection (e.g. human health, livestock health, wildlife health, crop health, soil ecology, water ecology etc.)?

See the tables below.

Q7) Which risk pathways are taken into account (e.g. soil-human (ingestion), soil-plant-human, soil-plant-animal-human, soil-animal (ingestion)-human, soil-groundwater, soil-surface water, soil-air-(plant), etc.)?

See the tables below.

Q8) Is the exposition assessed on the basis of experimental data (e.g. measured soil-plant-transfer) or on the basis of model calculations (e.g. bio concentration factors)?

Both these attitudes were used.



Q9) What toxicological standards are used for hazard assessments?

US EPA

Q10) Which model(s) is/are used (e.g. CSOIL, EUSES, CLEA etc.)? Which of the today's models do you consider best for deriving agricultural/horticultural soil screening values (if applicable at all for this type of soil use)?

US EPA

The system of limit values (SSL) is expected to be valid from May 2016. The relevant decree is prepared to be issued by the Ministry of Environment of the Czech Republic. The system is presented in tables below.

Prevention limits: In case of their exceeding it is not possible to apply sewage sludge or sediments on agricultural land. (Depends also on level of contamination in sludge or sediment).

Indication (trigger) limits: In case of their exceeding, the competent authority should decide on measures (including further study or natural attenuation).

Table 1. Proposed prevention limits for risk elements in agricultural soils

Soil Category	Prevention value (mg/kg of d.m.)												
	As	Be	Cd	Co	Cr	Cu	Hg	Mn	Ni	Pb	V	Zn	Tl
Standard texture soils ¹⁾	20	2.0	0.5	30	90	60	0,3	1200	50	60	130	120	0.5
Light texture soils ²⁾	15	1.5	0.4	20	55	45	0,3	1000	45	55	120	105	0.5

¹⁾Soils except light texture soils

²⁾Sandy soils, loamy-sandy soils, gravel-sandy soils

Table 2. Proposed prevention limits for persistent organic pollutants in agricultural soils

POPs	Prevention value (mg/kg of d.m.)
Polycyclic aromatic hydrocarbons	
Σ PAHs ¹⁾	1.0
Chlorinated hydrocarbons	
Σ PCB ²⁾	0,02
Σ DDT ³⁾	0,075
HCB ⁴⁾	0,02
HCH ⁴⁾ (Σ α + β + γ)	0,01
PCDDs/Fs ⁵⁾	1.0*
Petroleum hydrocarbons	
Hydrocarbons C10 – C40	100

¹⁾ Σ PAHS – polycyclic aromatic hydrocarbons (anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(ghi)perylene, phenanthrene, fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, naphthalene, pyrene)

²⁾ Σ PCB congeners – 28+52+101+118+138+153+180

³⁾ Σ DDT, DDE, DDD

⁴⁾HCB and HCH (Σ α + β + γ) – analysed only by suspicion of their contents in soil

⁵⁾International toxic equivalent value (I-TEQ PCDDs/Fs) (ng/kg) – analysed only by suspicion of increased PCDDs/Fs contents in soil.

Table 3. Proposed indication (trigger) limits for food chain contamination - risk elements

Element	Soil texture	pH/CaCl ₂	Indication value (mg/kg of d.m.)	
			Aqua regia	1mol/L NH ₄ NO ₃
As	-	-	-	1.0
Cd	standard texture light texture	<5	1	-
		5 – 6.5	1.5	-
		> 6,5	2.0	0.1
		> 6,5	2.0	0.04
Ni		<5	90	-
		5 – 6.5	150	-
		> 6,5	200	-
		-	-	1.0
Pb		-	300	1.5
Tl		-	10	0.2
Hg*		-	1.5	-

*Total content by AMA method

The exceeding of limit value is valid in the case of any exceeding, a) Aqua regia extraction, b) 1mol/L NH₄NO₃ extraction when both analyses must be done if the limit values are available

Table 4. Proposed indication (trigger) limits for plant growth inhibition - risk elements

Element	pH/CaCl ₂	Indication value (mg/kg of d.m.)	
		Aqua regia	1mol/L NH ₄ NO ₃
Cu	<5	150	-
	5 – 6.5	200	-
	> 6,5	300	-
	-	-	1.0
Ni	<5	90	-
	5 – 6.5	150	-
	> 6,5	200	-
	-	-	1.0
Zn		400	-
		-	20

The exceeding of limit value is valid in the case of any exceeding, a) Aqua regia extraction, b) 1mol/L NH₄NO₃ extraction when both analyses must be done if the limit values are available



Table 5. Proposed indication (trigger) limits for human health protection - risk elements

Element	Indication value (mg/kg of d.m.)
As ¹⁾	40
Cd ¹⁾	20
Hg ²⁾	20
Pb ¹⁾	400
Tl ¹⁾	60

¹⁾Aqua regia extract – valid for all soil texture categories

²⁾Total content by AMA method

Table 6. POPs indication limits of human health protection

Substance	Indication value (mg/kg of d.m.)
Σ PAHs ¹⁾	30
Benzo(a)pyrene	0.5
Σ PCB ²⁾	1.5
Σ DDT ³⁾	8.0
HCB ⁴⁾	1
HCH ⁴⁾ (Σ α+β+γ)	1
PCDDs/Fs ⁵⁾	100*

¹⁾Σ PAHS – polycyclic aromatic hydrocarbons (anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(ghi)perylene, phenanthrene, fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, naphthalene, pyrene)

²⁾Σ PCB congeners – 28+52+101+118+138+153+180

³⁾Σ DDT, DDE, DDD

⁴⁾HCB and HCH (Σ α+β+γ) – analysed only by suspicion of their contents in soil

⁵⁾International toxic equivalent value (I-TEQ PCDDs/Fs) (ng/kg) – analysed only by suspicion of increased PCDDs/Fs contents in soil



Finland / Jussi Reinikainen (14/03/2016)

Q1) When were the derivation methods established?

In 2007. An overview of the derivation process is described in the HERACLES report, which is still valid as we haven't updated the values after that.

http://eusoils.jrc.ec.europa.eu/esdb_archive/eusoils_docs/other/EUR22805.pdf

Q2) Do you consider these methods at "state of the art" from the today's point of view?

Not necessarily. For example, some of the data we've used is already a bit outdated (e.g. the ecotoxicity data that mainly originates from the 1990s or early 2000 based on the Dutch RIVM documents), and some of the principles for assessing human exposure could also be revised. However, in my opinion, the application of SSVs in actual decision-making is a lot more important aspect and in our case involves more problems than the values or their derivation methods. See the recent article on the issue:

<http://dx.doi.org/10.1016/j.scitotenv.2015.12.074>.

Q3) Are revisions in process or planned?

We've been discussing that possibility every now and then, but there are no exact plans for such revision at the moment. One of the reasons for that is that our SSVs are not legally binding so, in principle, decision-making should be based on site-specific assessment rather than SSVs. Well, the practice has been something else though, as you can read from the article above, so maybe we'll also need to revise our values at some point, if we can't change the practice otherwise.

Q4) Are the derivation methods documented in form of a technical guideline which is ready to derive soil screening values with respect to both, pollutant type and soil use? If so, can you give us access to a copy of this document?

Yes (the document, however, is only in Finnish: <http://hdl.handle.net/10138/38431>). In addition, it should be noted that the derivation of our SSVs did not follow the technical guidelines directly (i.e. the official values are not exactly the same as the calculated, risk-based values), but some additional criteria were also taken into account when the final values were set. These additional criteria have also been described in the document.

Q5) Which types of soil use are addressed (residential, agricultural, horticultural, industrial, etc.)?

Residential (with garden) and industrial.

Q6) What are the subjects of protection (e.g. human health, livestock health, wildlife health, crop health, soil ecology, water ecology etc.)?

Human health and soil ecology.



Q7) Which risk pathways are taken into account (e.g. soil-human (ingestion), soil-plant-human, soil-plant-animal-human, soil-animal (ingestion)-human, soil-groundwater, soil-surface water, soil-air-(plant), etc.)?

See the above mentioned reports.

Q8) Is the exposition assessed on the basis of experimental data (e.g. measured soil-plant-transfer) or on the basis of model calculations (e.g. bio concentration factors)?

Mainly on the basis of theoretical estimates /calculations. However, some of the parameters in the exposure assessment are based on experimental data based on the literature (see the reports).

Q9) What toxicological standards are used for hazard assessments?

Mainly the Dutch values (Baars et al. 2001), but also the US.EPA (IRIS) standards for some contaminants.

Q10) Which model(s) is/are used (e.g. CSOIL, EUSES, CLEA etc.)? Which of the today's models do you consider best for deriving agricultural/horticultural soil screening values (if applicable at all for this type of soil use)?

We've used the Dutch RiscHuman (the commercial version of CSOIL) with some modifications. It's quite impossible to say what is the best model, but in principle one should try to select the most appropriate equations and parameters with regard to national needs and circumstances using as much national/regional data as possible, e.g. experimental soil-plant transfer factors taking into account the local soil conditions and crops whenever such data is available.



Luxemburg / Sophie Capus (08/03/2016)

Au Luxembourg nous sommes lancés dans un projet assez laborieux pour établir notre premier set de données « de déclenchement » en vue de notre future loi sols. Nous considérons les 3 récepteurs suivants : santé humaine, eaux (souterraines et par ce biais de surface), écosystèmes.

Le projet n'est pas encore fini, mais nous avançons bien pour l'instant et nous sommes en train de compiler les premières normes.



The United Kingdom / Paul Bardos (07/03/2016)

Main UK web page is here:

<https://www.gov.uk/government/collections/land-contamination-technical-guidance>

Also for agriculture sludge to land regulations are often used as a bench mark, which includes limit vales for some metals in soils.

<https://www.gov.uk/guidance/managing-sewage-sludge-slurry-and-silage>

There are also ecologically derived soil screening values.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291141/sc_ho1008bost-e-e.pdf

I am not sure of their regulatory “weight” though.