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Fact Sheet
European Union Environmental Risk Assessment of Nickel

The Derivation and Implementation of an Environmental Quality Standard for Nickel in European Surface Waters

The Water Framework Directive (WFD, 2000/60/EC) establishes a legal framework for the protection of inland surface waters, transitional and coastal waters, and groundwater in the European Union (EU). One of the objectives of the WFD is to protect, enhance, and restore surface water and groundwater in the EU, with the aim of achieving Good Status by 2015.

Waterbodies achieving good chemical status will need to pass all the EQS in Annex X of the WFD.

Substances that present a significant risk to the aquatic environment in the EU have been identified in Annex X of the WFD. These "priority substances" are further classified as having either "priority" or "priority hazardous" status. Compliance with Environmental Quality Standards (EQS) for priority substances is a requirement for achieving Good Status. In addition, priority hazardous substances will be subject to cessation or phasing out of discharges, emissions and losses within 20 years. Nickel and its compounds are priority substances, but not currently priority hazardous substances. Annex X of the WFD was superseded by Annex II of the Priority Substances Daughter Directive (2008/105/EC) in 2008. Annex I of the Priority Substances Daughter Directive includes details of the EQS values to be used for WFD surface water classification. In the absence of a comprehensive technical basis to set an EQS for nickel and nickel compounds an interim value of 20 µg/L was established as the EQS for nickel for inland and other surface waters. The Daughter Directive also states (Article 3, Paragraph 4) that the European Commission (EC) will examine technical and scientific progress, including the conclusion of the Existing Substances Regulation (793/93/EEC) risk assessments [*i.e.*, the European Union Risk Assessment Report (EU RAR) for Nickel,] and registrations under REACH (EC 1907/2006), when proposing revisions to priority substances. In late 2009, the second review of WFD priority substances was initiated to revisit the priority status of existing EQS and revise existing EQS on the basis of new data. The review also proposed to identify additional substances that met the criteria for priority substances. The information from the nickel EU RAR has been considered in the recent revision of the Priority Substances Daughter Directive (2013/39/EU). As a result of this review the existing interim value of 20 µg Ni/L has been revised to 4 µg/L bioavailable nickel based on the following reasons:

- The Priority Substance Daughter Directive requires that the results of the EU RAR are taken into account,
- The value of 20 µg Ni/L has no ecological relevance (confirmed by the findings of the EU RAR), and
- Several Member States have stated that the interim nickel EQS is not protective of aquatic systems and requires review.

This fact sheet describes the process of deriving and implementing the new EQS for nickel, which is applicable to all European freshwaters.

1 INTRODUCTION TO NICKEL EQS PROCESS

An environmental quality standard (EQS) is defined under the Water Framework Direct (WFD) as "the concentration of a particular pollutant or group of pollutants in water, sediment, or biota which should not be exceeded in order to protect human health and the environment." While most EQS are derived as limits in the ambient environment, they can also be translated into controls at the point of emission, *i.e.*, discharge permits. EQS are either set to protect against adverse effects after long-term (chronic) exposure (Annual Average EQS), or short-term (acute) intermittent chemical exposures [Maximum Admissible (or Allowable) Concentrations]. In the European Union (EU), Annual Average (AA) EQS have a range of uses including WFD surface water classification (compliance assessment) and permitting of industrial discharges (Section 4). Maximum Admissible Concentrations (MAC) are generally used to investigate pollution incidents or intermittent discharges of chemicals and are not routinely used by Member States. The focus of this fact sheet is the nickel AA EQS. Where the term EQS is used, it refers to the freshwater AA EQS. The EQS is derived from relevant toxicity data and should be protective of all relevant human health and environmental endpoints across all surface waters in the EU.

2 DERIVING A NICKEL EQS FOR FRESHWATERS

2.1 WHY ACCOUNT FOR BIOAVAILABILITY?

The Priority Substances Daughter Directive states that when assessing monitoring results against the EQS for metals account may be taken of:

- natural background concentrations for metals and their compounds where such concentrations prevent compliance with the relevant EQS; and
- hardness, pH, dissolved organic carbon, or other water quality parameters that affect the bioavailability of metals.

Accounting for bioavailability represents the most technically robust method for assessing the potential risk of nickel in the freshwater aquatic environment. Bioavailability is a function of the various physicochemical factors governing metal availability at the biological receptor (Drexler *et al*. 2003). Effectively this means that bioavailability reflects the actual metal exposure to an aquatic organism. For many metals, including nickel, adverse effects on aquatic organisms in the water column are assumed to be as a consequence of exposure to the bioavailable Ni^{2+}-ion. This is important as it has long been established that total (dissolved and undissolved) metal concentrations in waters have limited relevance to potential environmental risk (Campbell 1995; Niyogi and Wood 2004). In addition, hardness-based EQS for metals are also poor metrics of ecological risk (The Netherlands 2004).

The misidentification of potential risks in surface waters can result in inappropriate regulatory intervention (Environment Agency 2009). Subsequent regulatory actions (*i.e.*, Programs of Measures under the WFD) based on existing EQS have the potential to result in considerable financial implications that are likely to deliver limited ecological benefit.

The conclusions of the EU RAR were scientifically underpinned by the development of chronic biotic ligand models (BLM).[1] These models, by taking account of site-specific water chemistry, relate toxicity to bioavailable nickel concentrations, rather than total nickel or dissolved nickel concentrations. The use of BLMs for deriving and implementing metal EQS was supported by the Scientific Committee on Health and Environmental Risks (SCHER)[2] in their comments on the EQS Technical Guidance (European Commission 2010), although they acknowledge that accounting for bioavailability in a regulatory compliance framework would mean a step-change in the regulatory paradigm.

The revision of the nickel EQS represents the first time that the development and implementation of a bioavailable EQS using chronic BLMs has been undertaken in a regulatory framework at a European level.

2.2 PREDICTED NO EFFECT CONCENTRATION VERSUS EQS?

Predicted No Effect Concentrations (PNECs) for freshwater have been calculated in the EU RAR under several bioavailability scenarios. These scenarios are described in greater detail in Fact Sheet 4, Incorporation of Bioavailability in the Aquatic Compartment,[1] but effectively they represent water conditions at seven locations within the EU that reflect a range spanning the 10th to 90th percentile of the physicochemical water chemistry conditions across the EU. However, the PNECs used in the EU RAR are different from a final nickel EQS that will be derived for the WFD. The key differences are that a PNEC is not legally binding and is part of an iterative risk assessment process, meaning that refinement is possible if risks are identified. In addition, an overly conservative PNEC is of little concern if no risks are identified. Alternatively, an EQS under the WFD is:

- legally binding,
- must be protective in all situations (defined in the EQS Technical Guidance as representative of at least 95 percent of the surface waters), and
- not overly stringent as there is no capability to refine the value if it is exceeded.

In addition, the EU Commission and Member States prefer a single EQS value for a substance to cover the whole of Europe, *i.e.*, a generic EQS not multiple EQS across Member States. This preference limits the possibility of setting site-specific EQS to account for differences in bioavailability, and instead means that correction for bioavailability should be made by normalizing exposure concentrations to "bioavailable metal."

Therefore there is a need to derive a generic nickel EQS that builds on the understanding of bioavailability made in the EU RAR, but that in principle will be protective for all waterbodies monitored in the EU.

2.3 DERIVING A NICKEL EQS UNDER THE WFD

In addition to a numerical value, a robust EQS must also meet other implementation requirements (Crane *et al.* 2010) to ensure that it can be used within a regulatory framework. These requirements may include considerations of analytical sensitivity or uncertainty, the need to collect data on supporting parameters (*e.g.*, those required to support bioavailability calculations) or any requirements for data processing (*i.e.*, undertaking bioavailability calculations).

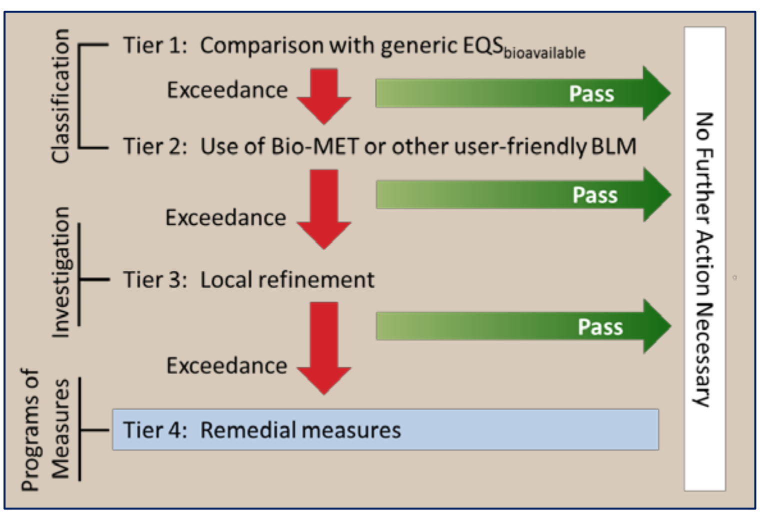


Figure 1: Tiered approach to the implementation of bioavailability assessment

The EU EQS Technical Guidance advocates the use of a tiered approach (*e.g.*, Figure 1). A tiered approach allows low priority sites to be removed from the assessment at early tiers, whilst concentrating regulatory (and financial) effort on higher priority sites. The first tier in this approach does not explicitly consider bioavailability and uses a generic EQS to which annual average dissolved nickel concentrations are compared. If a site fails a compliance assessment based on the generic EQS then it is subject to further evaluation before any decision on compliance is made.

The EC recommends that the generic EQS is set to reflect the conditions of maximum bioavailability which are likely to be observed for the region of application (European Commission 2010). For nickel, high bioavailability conditions are generally observed in waters with relatively high pH, low hardness, and low dissolved organic carbon (DOC).

In order to determine the generic EQS for nickel in EU waters it is necessary to identify the conditions that reflect maximum bioavailability in the EU, *i.e.*, those conditions that result in the lowest HC_5 values.[3] Based on the EU RAR, the scenario that had the greatest bioavailability was that for Lake Monate in Italy. The HC_5 for this waterbody was 7.2 µg/L (based on a pH of 7.7, 48 mg Ca/L and 2.5 mg DOC/L). Table 1 reports nickel PNECs for additional European freshwater scenarios based on regional datasets for Great Britain, France, Austria, Spain, The Elbe, Sweden, and Walloon (Belgium).

Dataset and Number of Sites or Samples		10^{th} Percentile of PNECs (µg/L)	5^{th} Percentile of PNECs (µg/L)
*Great Britain**	*n=184*	6.62	5.86
France	*n=249#*	*5.28*	*4.62*
Austria	*n=1553#*	*4.34*	*3.70*
Spain	*n=48^*	*7.34*	*7.32*
The Elbe	*n=294^*	*8.22*	*7.46*
Sweden	*n=3997#*	*11.20*	*10.08*
Walloon	*n=559^*	*6.36*	*5.82*
All Data	*n=6885*	*6.58*	*5.20*

* This dataset is for annual average nickel concentrations for waterbodies

\# These data have been obtained direct from Member States and EIONET

^ These data are the same as those used in the EU RAR

Table 1: The 5^{th} and 10^{th} percentiles of Predicted No Effect Concentrations for nickel (µg/L) for EU Member States as calculated using the user-friendly NiBLM (from the Nickel EQS Dossiers, Draft 2010)[4]

It is important to note that the PNECs reported in Table 1 are the HC_5 values with an Assessment Factor (AF) of 1. This is in line with the nickel EQS as proposed under the amended Daughter Directive (2013/39/EU). This is a change from the EU RAR where the absence of field and/or mesocosm data led the Technical Committee for New and Existing Substances (TCNES) to propose that an AF of 2 should be used in the EU RAR PNEC derivation process to account for residual uncertainties in the assessment. However, since the completion of the EU RAR, mesocosm (Hommen *et al.* 2011) and field data (Peters *et al.* 2013) have been generated and this has been judged by Member State Experts and DG Environment to have reduced uncertainty to a level whereby an AF of 1 is acceptable.

The lowest of the 5^{th} percentiles of frequency distributions of site-specific PNECs reported in Table 1 are approximately 4 µg/L (at pH 8.2, DOC 2 mg/L, Ca 40 mg/L). Therefore, setting the generic EQS as 4 µg/L as finalized in the amended Daughter Directive ensures that the first tier of the compliance assessment is adequately protective of most conditions likely to be encountered in the EU.

The generic nickel EQS is expressed as "bioavailable nickel" (*i.e.*, generic $EQS_{bioavailable}$). The use of the term generic $EQS_{bioavailable}$ is effectively the same as defining an EQS on the basis of a specific form (or species) of a chemical. A generic $EQS_{bioavailable}$ can only be used in a tiered approach in which bioavailability is accounted for in at least some of the tiers. Using the generic nickel $EQS_{bioavailable}$ as a single pass/fail criterion without accounting for bioavailability (*i.e.*, assuming that all measured dissolved metal is bioavailable) would result in many sites erroneously being identified as being at risk (Figure 1).

3 METHODOLOGY FOR THE IMPLEMENTATION OF BIOAVAILABILITY

The derivation of a single generic $EQS_{bioavailable}$ for nickel fulfills the need of European Member States to have a single EQS. However, the robust implementation of the EQS relies upon the use of a bioavailability factor, or BioF, to deliver bioavailability normalization in later tiers of assessment. The BioF is calculated as the generic $EQS_{bioavailable}$ divided by the local EQS.

3.1 TIERED APPROACH TO THE IMPLEMENTATION OF BIOAVAILABILITY

A tiered approach for implementing the nickel $EQS_{bioavailable}$ has been proposed by the Danish EPA (Figure 1). The first tier of the approach has been described in Section 2.3 and simply considers a direct comparison between the annual average monitored dissolved nickel concentration for a site and the generic nickel $EQS_{bioavailable}$.

At Tier 2 bioavailability normalization is performed using the ***bio-met*** bioavailability tool or a similar user-friendly NiBLM tool (see Section 3.2 and Section 7).[5] The ***bio-met*** bioavailability tool calculates the concentration of "bioavailable nickel" at a site and compares this value against the $EQS_{bioavailable}$. Samples with bioavailable nickel concentrations exceeding the $EQS_{bioavailable}$ progress to Tier 3.

At Tier 3 local factors that may influence nickel risks are considered. These factors could include the use of nickel ambient background concentrations (ABCs). ABCs should be considered only after normalizing for bioavailability. Other local refinements that may be considered could include:

- the collection of improved site-specific water chemistry data,
- the use of the full NiBLM, and
- an assessment of local ecological data to determine the magnitude of any biological effects.

Tier 4 is reached when it is clear that the EQS has not been achieved and the site (or waterbody) will not attain Good Chemical Status. A program of measures to mitigate the situation may be required.

3.2 THE USER-FRIENDLY NIBLM *BIO-MET*

The chronic Nickel Biotic Ligand Models (NiBLM) are sophisticated and represent the most advanced understanding about chronic nickel ecotoxicity in freshwaters (Fact Sheet 4, Section 6, BLM Software).[1] However the data input requirements and expertise required to interpret the outputs mean that the NiBLM is too complex and resource intensive for routine regulatory use.

In order to facilitate regulatory application, a user-friendly version of the NiBLM has been developed. The ***bio-met*** bioavailability tool is based on the NiBLM but only requires data on three physicochemical input parameters: DOC, calcium and pH. These three parameters have been found to predominantly influence HC_5 predictions by the NiBLM. The ***bio-met*** bioavailability tool has been developed from nearly 700 NiBLM HC_5 predictions, where DOC, calcium, and pH are varied, but other input parameters are fixed.

The ***bio-met*** bioavailability tool is a multi-metal tool that also calculates bioavailable metal concentrations for copper and zinc.[5]

Other ***bio-met***.net resources include:[5]

- A comprehensive base of information on metal bioavailability and its use in the regulatory risk assessment of metals. This section also contains information on the development and validation of the ***bio-met*** bioavailability tool.
- A series of case studies that demonstrate the application of bioavailability-based approaches within the risk-management of metals in the aquatic environment.

The ***bio-met*** bioavailability tool is also available as an online application, which means that bioavailability calculations can be performed irrespective of corporate IT restrictions, software versions and individual computer processing power.

The performance of the ***bio-met*** bioavailability tool against the NiBLM was evaluated using data from Great Britain and The Netherlands that cover a broad range of water chemistries. The ***bio-met*** bioavailability tool makes predictions that are moderately precautionary (over protective) when compared to the NiBLM (Figure 2). This is because the ***bio-met*** bioavailability tool was designed to behave conservatively relative to the NiBLM, which is appropriate for a second tier assessment.

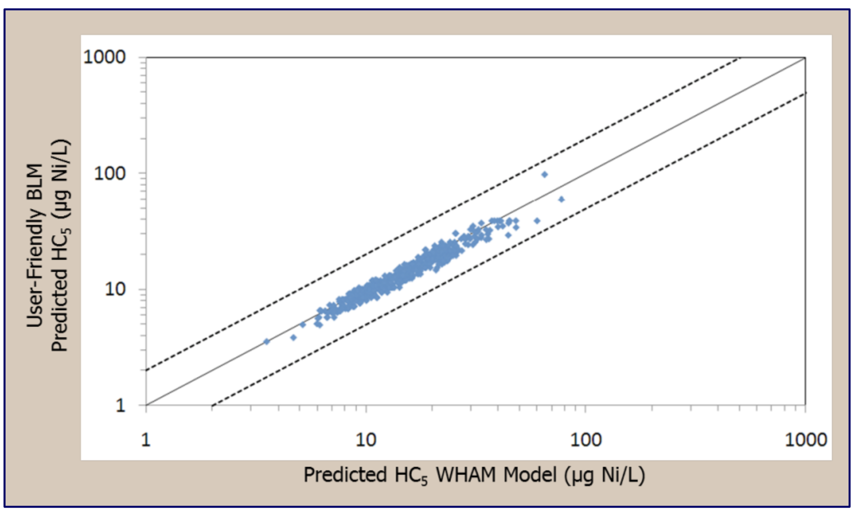


Figure 2: The NiBLM HC_5 predictions (WHAM Model) versus the HC_5 predictions from the ***bio-met*** bioavailability tool. The solid line is the 1:1 relationship and the hatched lines are with a factor of 2.

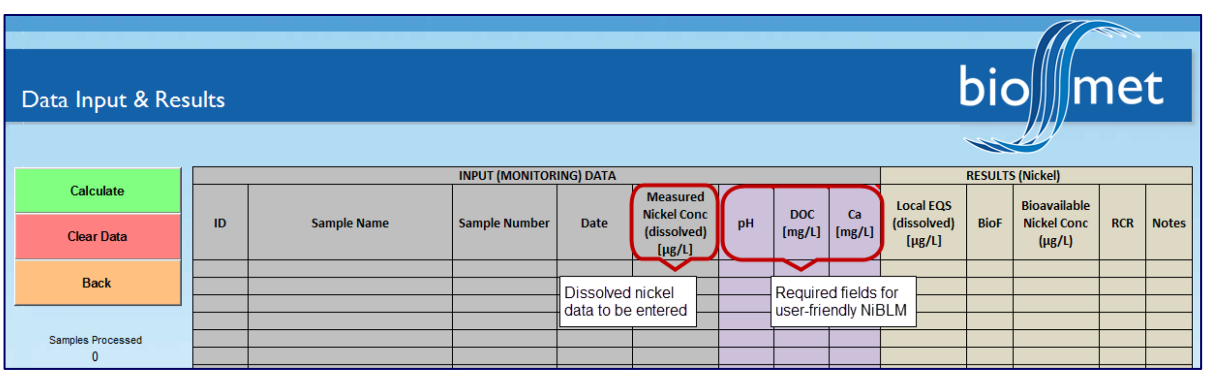


Figure 3: Data entry screen of the ***bio-met*** bioavailability tool, the user-friendly NiBLM

Inputs, outputs, interpretation

The ***bio-met*** bioavailability tool is designed to be simple to use. Full instructions are provided on the ***bio-met*.net** website.[5]

If pH, calcium concentration, and DOC concentration data for a site are entered into the ***bio-met*** bioavailability tool, without corresponding dissolved nickel concentrations, the tool reports a local nickel $EQS_{dissolved}$ and corresponding BioF (Figure 3).

If dissolved nickel data are added to the ***bio-met*** bioavailability tool, the bioavailable nickel concentration and the corresponding risk characterization ratio (RCR) are calculated. This last term, also sometimes called the risk quotient, is calculated by dividing the bioavailable nickel concentration by the $EQS_{bioavailable}$. Values equal to or greater than 1 represent a potential risk (resulting in progression to Tier 3).

The ***bio-met*** bioavailability tool can be used in two ways:

- to calculate a bioavailable metal concentration from monitoring data for direct comparison with the $EQS_{bioavailable}$, or
- to calculate a site specific $EQS_{dissolved}$ (dissolved metal monitoring data are compared to the site specific $EQS_{dissolved}$).

The ***bio-met*** bioavailability tool operates within the same validated boundary conditions of the NiBLM, which has been modified since the EU RAR as more ecotoxicity data have become available *(i.e.*, pH 6.5-8.7, Ca 3.8-88 mg/L, DOC 0-20 mg/L).

Missing input data?

Not all European Member States measure DOC. However, many Member States have recently started monitoring programs. Consequently, there may be some situations where an assessment of bioavailability is required, but data on supporting parameters needed for the ***bio-met*** bioavailability tool is not available. This can present a considerable obstacle to the implementation of a bioavailability-based approach.

Alternatives to site-specific monitoring data are sometimes available, although the results from calculations using these data need to be interpreted with caution. For example, "default" values for DOC have been estimated from historic monitoring data (Environment Agency 2009), or predicted from dissolved and total iron concentrations (Peters *et al.* 2011a) or UV absorption (Tipping *et al.* 2009).

In addition to surrogate input data, robust data may be available from regulators. For example, Austrian,[6] Swedish,[7] and French[8] data are available from their respective websites. It is possible to undertake targeted bioavailability assessments using these data in order to determine where exactly site-specific data are needed. If only water hardness data are available it is possible to convert these to calcium concentrations from relationships developed using European surface waters (Peters *et al.* 2011b).

4 WHAT DOES THIS MEAN AND HOW SHOULD THIS EQS BE USED?

The two main uses of an EQS are compliance assessment and permitting. For a compliance assessment the arithmetic mean concentration of "bioavailable nickel" for a site is compared against the $EQS_{bioavailable}$. Some member states will also assess the "confidence of failure" of an EQS so as to provide statistical certainty to any resulting regulatory decisions (ISO/WD 5667-20). However, many Member States do not consider this, meaning that the EQS is treated as a legally binding regulator limit.

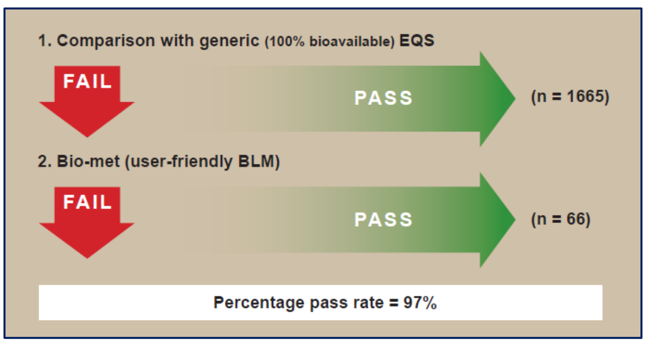
Under the WFD, compliance with the EQS for nickel is a component of chemical status. If the EQS for nickel is exceeded then the waterbody will be classified as not achieving Good Status, irrespective of the ecological quality measured in a waterbody, or the concentrations of other priority substances, and would be reported to the European Commission. This is known as the "one out, all out" principle.

The revision of permits taking into account the new EQS is likely to have a profound effect upon nickel producers and downstream users. Permits are generally set in such a way that the EQS would not be exceeded in any effluent receiving water (after due consideration of mixing zones). Where there are multiple dischargers within a catchment or waterbody this may mean that each discharger is only allowed to contribute a proportion of the EQS. Existing background levels may also be considered. Some authorities may set permits or consents to discharge on the basis of achieving no more than one tenth of the EQS in the receiving water.

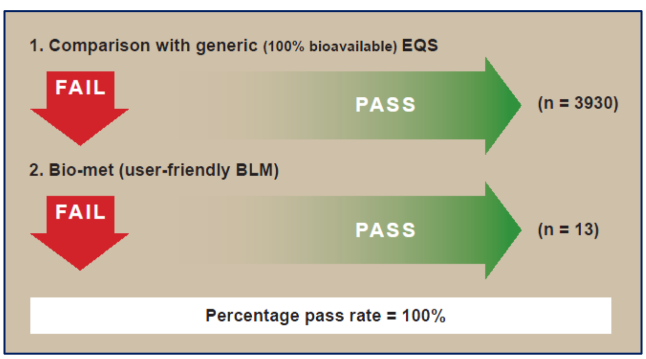
However, not all the uses of an EQS are tied to the WFD and there are numerous 'localized' examples were site prioritization and hazard assessment may be performed in order for regulators to target resources (*e.g.*, Environment Agency 2011).

5 EXAMPLES OF IMPLEMENTATION

An example compliance assessment exercise with the nickel $EQS_{bioavailable}$ for waters of contrasting physicochemical properties is shown in Figure 4. Figure 4a shows monitoring data for 1779 samples from 76 rivers in Austria[6] were assessed using the tiered approach. Only 3 percent of samples passed to Tier 3 for consideration of local issues. Waters in Austria have previously been identified as sensitive to nickel exposures due to relatively low DOC, high pH, and low hardness. Figure 4b shows 3942 samples for 49 waterbodies in Sweden (provided by the Swedish Chemicals Agency) were assessed. At Tier 1 less than 1 percent of the samples exceed the $EQS_{bioavailable}$. None of the sites exceeded the EQS when nickel bioavailability was taken into account at Tier 2. Many Swedish waters have relatively high levels of DOC as well as low hardness and pH, and these conditions represent low bioavailability to nickel.



a) Austria



b) Sweden

Figure 4: Examples of an indicative compliance assessment of Austrian (a) (starting value of 1779) and Swedish (b) (starting value of 3942) nickel monitoring data

Permits and consents for discharges into rivers are often set in order to control the overall inputs of potentially toxic substances over whole river basins or catchments. Water treatment plants that discharge effluents to surface waters will all have consented discharges. An industry discharge that goes to sewer will be regulated by the same processes, *i.e.*, the water company will need to ensure any changes to its main permitted discharge is met through regulating the input from industry to their treatment plant. The specific approaches taken will vary locally from one country to another, although there are some general principles likely to be relatively consistent between them and all will likely use an EQS to set the limit.

For example, to set a discharge consent for a nickel containing effluent into a river with a pH of 7.3, an average DOC concentration of 3.9 mg/L, and an average Ca concentration of 8 mg/L the following process *could* be followed. The site specific $EQS_{dissolved}$ for this site is ≈ 11 µg/L dissolved Ni, and the BioF value for conversion of dissolved nickel concentrations to bioavailable nickel concentrations is 0.37. If one tenth of the EQS is permitted in the receiving water per discharge then the maximum acceptable concentration of nickel in the receiving water from this discharge is 1.1 µg/L dissolved nickel.

Therefore, the permissible concentration in the discharge can be calculated from the effluent flow and the flow of the river, in combination with the permissible contribution of nickel in the river from this discharge. If the effluent discharge from the site is 2886 m^3/d, and the flow of the receiving water 12,441,600 m^3/d then the permissible concentration of nickel in the discharge can be calculated as:

$$C_{discharge} \times V_{discharge} = C_{receiving\ water} \times (V_{receiving\ water} + V_{discharge})$$

Where $C_{discharge}$ is the permissible concentration in the discharge (mg/L), $V_{discharge}$ is the volumetric flow rate of the discharge (m^3/d), $C_{receiving\ water}$ is the permitted nickel concentration in the receiving water from this discharge (mg/L), and $V_{receiving\ water}$ is the volumetric flow rate of the receiving water (m^3/d).

$$C_{discharge} = C_{receiving\ water} \times \frac{(V_{receiving\ water} + V_{discharge})}{V_{discharge}}$$

$$C_{discharge} = 0.0011\ \text{mg/L} \times \frac{(12{,}441{,}660\ m^3/d + 2{,}886\ m^3/d)}{2{,}886\ m^3/d}$$

$$C_{discharge} = 4.7\ \text{mg Ni/L}$$

Although the concentration in the discharge calculated in this manner is a dissolved concentration the permitted concentration in the discharge may, in some cases, be expressed as a total nickel concentration.

6 SUMMARY

For Member States the revision of the EQS has a considerable effect on many WFD related activities (*e.g.*, surface water classification). Accounting for bioavailability in a regulatory context provides an evidence-based way to assess compliance and, importantly, to prioritize and rank locations at potential risk. However, it will be a new way for regulators to work.

Permits for nickel dischargers will inevitably change with the revision of the nickel EQS from the current value of 20 µg/L. However, there is limited consistency across Member States on how these are calculated, the timeframe over which revisions will occur and, importantly, what the implications are for nickel producers and downstream users.

7 WHAT NEXT?

For many Member States and Stakeholders the adoption of a bioavailability approach represents a considerable challenge compared to the previous ways of working with metals, which was primarily through the use of hardness-banded EQS. A working group of interested Member States has been established to draft practical guidance on the implementation of the bioavailability-based approaches for metals. The guidance is to be specific and practical enough to deliver a way forward for compliance assessment and classification. Permitting effluent discharges using $EQS_{bioavailable}$ remains challenging and the UK regulatory authorities are currently considering this in a project that is scheduled to complete in the autumn of 2013.

8 LINKS TO NICKEL EU RISK ASSESSMENT DOCUMENTS

8.1 EU DOCUMENTS

The Water Framework Directive (2000/60/EC). Available at (last accessed January 2014):

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF

The Daughter Directive (2008/105/EC). Available at (last accessed January 2014):

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:348:0084:0097:EN:PDF

The amended Daughter Directive (2013/39/EU). Available at (last accessed January 2014):

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:226:0001:0017:EN:PDF

The technical specifications for chemical analysis and monitoring of water status [The so-called QA/QC Directive (2009/90/EC)]. Available at (last accessed January 2014):

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:201:0036:0038:EN:PDF

8.2 TECHNICAL DOCUMENTS

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http://bio-met.net/eu-member-state-workshop-on-metal-bioavailability-and-the-wfd/

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Peters, A.; Simpson, P.; Merrington, G.; Schlekat, C.; Rogevich-Garman, E. 2013. Assessment of the effects of nickel on benthic macroinvertebrates in the field. Environ. Sci. Pollut. Res. DOI 10.1007/s11356-013-1851-2.

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1 http://www.nipera.org/en/EnvironmentalScience/FS4-BioavailabiltyAquaticCompartment.aspx (last accessed January 2014)

2 http://ec.europa.eu/health/scientific_committees/environmental_risks/docs/scher_o_127.pdf (last accessed January 2014)

3 As discussed in Fact Sheet 1,* the PNEC is calculated as PNEC = HC_5/AF, where:

HC_5 = hazard concentration at the 5th percentile of the Special Sensitivity Distribution and
AF = Assessment Factor.

The EQS is equivalent to the HC_5.

* http://www.nipera.org/en/EnvironmentalScience/FS1-FreshwaterEffects.aspx (last accessed January 2014)

4 The 2010 Draft Nickel EQS Dossiers are available on request from NiPERA (see last page for NiPERA's contact information).

5 The user-friendly NiBLM is incorporated into the multi-metal bioavailability tool available at http://bio-met.net (last accessed January 2014).

6 http://wisa.lebensministerium.at/ (last accessed January 2014)

7 http://www3.ivl.se/miljo/db/IVL_screening_registersida.htm (last accessed January 2014)

8 http://www.eionet.europa.eu/ (last accessed January 2014)

Fact Sheets on the European Union Environmental Risk Assessment of Nickel

This is a special issue fact sheet addressing the nickel environmental quality standards under the Water Framework Directive (WFD, 2000/60/EC). The fact sheets are intended to assist the reader in understanding the complex environmental issues and concepts related to nickel by summarizing key technical information and providing guidance for implementation.

NiPERA welcomes questions about the concepts and approaches discussed herein. For inquiries, please contact:

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