Workshop on ‘Significant adverse effects on use or the wider environment’ of measures in the context of HMWB designation and GEP definition

23-24 April 2018, Brussels

Discussion Paper

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1 Introduction

The current work program of the Common Implementation Strategy (CIS) for the Water Framework Directive pays particular attention to the topic of hydromorphology and related issues. Activities are currently ongoing to elaborate guidance on harmonized requirements and emerging good practices on 'Good Ecological Potential' (GEP) for Heavily Modified Water Bodies (HMWB), complementing the existing CIS Guidance No. 4 on HMWB designation[1]. The Ad-hoc Task Group on Hydromorphology is steering this work. Related discussions are ongoing within the Working Group ECOSTAT.

In the context of HMWB designation and GEP definition the question of which measures for achieving GES or GEP constitute a 'Significant adverse effect on use or the wider environment' requires particular attention.

In the first cycle RBMPs, only half of the reported RBMPs included a description of the approach on defining significant adverse effects of measures for achieving GES on the use or wider environment as part of the designation of HMWB. In half of the first cycle RBMPs, such descriptions were not provided or were unclear. Criteria and/or specific thresholds of 'significance' were reported only in few of the first cycle RBMPs, and in most cases using qualitative rather than quantitative criteria. In many RBMPs, the significance of effects was estimated simply on the basis of expert judgement. As a result, the assessment was often vague and not transparent, leading to a lack of comparability between Member States (EC, 2012).[2]

At a CIS workshop on the WFD and HMWB (in 2009), it was concluded that the reasons and criteria for judgements on significance should be made clear. It was recommended as good practice to be clear on what is taken into account when making judgements.[3]

Similarly, in the context of defining GEP in the first RBMPs, there was little transparency on the specific criteria used to define significant adverse effects of measures for achieving GEP on the use or the wider environment (EC, 2012). A specific study on mitigation measures to define GEP for water bodies impacted by storage, it was concluded that few countries have set national framework criteria for determining significant effects of measures on hydropower. Thus, it remains unclear how countries that have no relevant criteria or guidelines make sure that there is consistency in decision-making from case to case.[4]

One of the reasons why the standard for ecological potential can vary between water bodies and between countries is that it depends on what can be done by way of improvement to the hydromorphological characteristics of the water body without a significant adverse effect on the

[1] See https://circabc.europa.eu/sd/a/f9b057f4-4a91-46a3-b69a-e23b4cada8ef/Guidance%20No%204%20-%20heavily%20modified%20water%20bodies%20-%20HMWB%20(WG%202.2).pdf

[2] Commission Staff Working Document 2012 WFD implementation (volume 2 of supporting material); see http://ec.europa.eu/environment/water/water-framework/pdf/3rd_report/CWD-2012-379_EN-Vol2.pdf

[3] Conclusions of CIS Workshop Heavily Modified Water Bodies. Brussels, 12-13 March 2009.

[4] JRC technical report on common understanding of using mitigation measures for reaching Good Ecological Potential for heavily modified water bodies (2016); see http://publications.jrc.ec.europa.eu/repository/bitstream/JRC110957/jrc110957_online_flood_gep_jan202018_jrc20technical20report_final_clean.pdf

benefits served by the water use.[5] At a CIS workshop on the definition of GEP related to water storage, it was noted that there is high heterogeneity of approaches and thresholds for significance between countries. Most countries have not established a standardised approach and significant adverse effects are usually assessed with a case by case approach. However, if significant adverse effects are very different for a certain measure between various countries, then GEP definition becomes quite case-specific and not possible to harmonise.[6] Consequently, decisions on when such adverse effects are significant are important.

Against this background, a workshop on the subject of significant adverse effects will be organized on 23-24 April 2018 in Brussels, allowing for related discussions. The results of the workshop will feed into the ongoing work on guidance related to 'Good Ecological Potential'.

1.1 Aim of the discussion paper

The aims of this discussion paper are to:

- Provide background information and introduce the topic in preparation of the workshop
- Facilitate the identification of issues which require more in-depth discussions
- Provide the structure for the compilation of the main results of the workshop and identification of possible next steps
- Serve as a starting point towards the elaboration of draft guidance on the assessment of significant adverse effects in the upcoming Appendix to CIS Guidance Document no. 4.

The paper compiles key issues and previously agreed principles from existing CIS guidance documents and Member State exchange in CIS workshops.

1.2 Aim of the workshop

The aims of this workshop are to:

- Exchange practical experiences on the assessment of significant adverse effects in the context of HMWB designation and definition of GEP;
- Gain clarification on common understanding which is already in place;
- Gain clarification on still open issues and challenges concerning the assessment of significant adverse effects;
- Discuss relevant input on the assessment of significant adverse effects to a new Appendix to CIS Guidance Document no. 4.

It is planned to have specific discussions at the workshop on particular water uses which are most common for HMWB designation, especially on water storage (incl. hydropower, drinking water supply and irrigation), flood protection, agricultural drainage and waterway transport. Issues relevant to

[5] JRC technical report on common understanding of using mitigation measures for reaching Good Ecological Potential for heavily modified water bodies (2016)

[6] Workshop on GEP inter-comparison case studies on water storage, 13- 14 February 2017 – Vienna, Summary Report.

transitional and coastal water bodies can be addressed as part of the discussions on flood protection and waterway transport.

2 HMWB designation and definition of GEP

2.1 HMWB designation

Under certain conditions the WFD permits Member States to identify and designate artificial water bodies (AWB) and heavily modified water bodies (HMWB) according to Article 4(3) WFD.

For water bodies designated as HMWB (or artificial water bodies), the objective is to reach good ecological potential, not good ecological status which is the objective for natural water bodies. The objective to achieve good chemical status and the non-deterioration principle apply to the category HMWB, as they apply for the categories of natural water bodies.

The concept of HMWB was introduced into the WFD in recognition that many water bodies in Europe have been subject to major physical alterations so as to allow for important water uses which would otherwise be significantly affected. Article 4(3)(a) lists the following types of activities which were considered likely to result in a water body being designated as a HMWB:

- navigation, including port facilities, or recreation;
- activities for the purposes of which water is stored, such as drinking-water supply,
- power generation or irrigation;
- water regulation, flood protection, land drainage;
- other equally important sustainable human development activities.

These specified uses tend to require considerable hydromorphological changes to water bodies of such a scale that restoration to “good ecological status” (GES) may not be achievable even in the long-term without preventing the continuation of the specified use. The concept of HMWB was created to allow for the continuation of these specified uses which provide valuable social and economic benefits but at the same time allow mitigation measures to improve water quality (CIS Guidance no. 4).

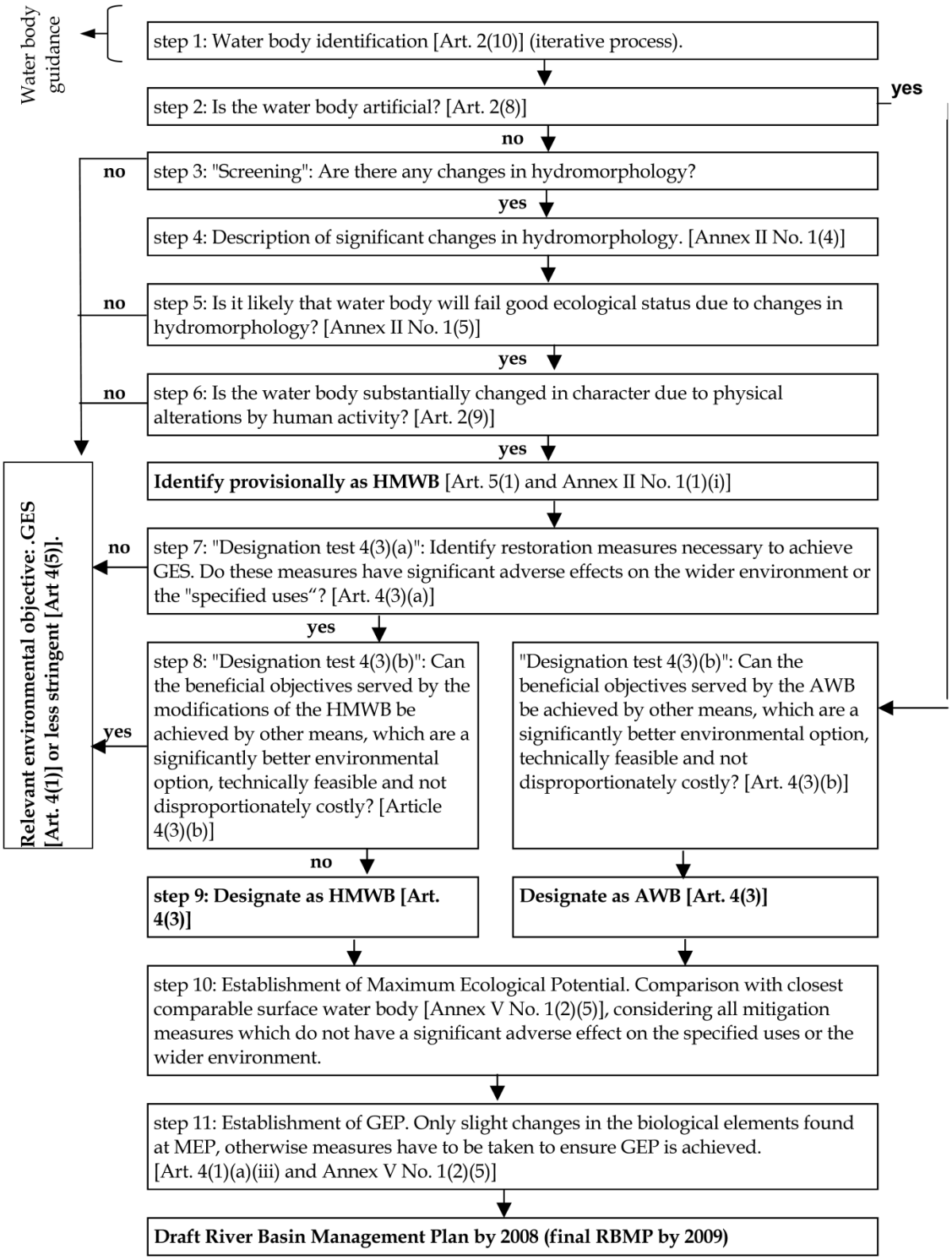
The figure below illustrates the overall stepwise approach to the identification and designation of HMWB and AWB as proposed in the CIS Guidance no. 4. Steps 1-6 lead to the provisional identification of HMWB, which takes place in the context of WFD Article 5 assessment. Following the provisional identification, HMWB can be finally designated and reported as such (see steps 7-9) in the river basin management plan. The designation should be reviewed every 6 years.

The main requirements for the designation of a water body as heavily modified are that:

- The water body is substantially changed in character due to physical alterations by human activity [WFD Art. 2(9)]
- The restoration measures necessary to achieve good ecological status have significant adverse effects on the wider environment or the uses linked to the designation [WFD Art. 4(3)(a)]

- The beneficial objectives served by the modifications of the HMWB cannot be achieved by other means, which are a significantly better environmental option, technically feasible and not disproportionately costly [WFD Article 4(3)(b)]

Figure 1 Steps of the HMWB & AWB identification and designation process



2.2 Definition of GEP

In the HMWB identification and designation process it is necessary to identify the appropriate reference conditions and environmental objectives for HMWB (see steps 10 and 11 in Figure 1 above). For HMWB, the reference conditions on which status classification is based are called “Maximum Ecological Potential (MEP)”. The MEP represents the maximum ecological quality that could be achieved for a HMWB or AWB once all mitigation measures, that do not have significant adverse effects on its specified use or on the wider environment, have been applied. HMWB and AWB are required to achieve "good ecological potential" (GEP) and good surface water chemical status. GEP accommodates ”slight” changes in the values of the relevant biological quality elements at MEP (CIS Guidance no. 4).

Therefore, all key hydromorphological modifications with significant impact on ecology need to be mitigated to achieve good ecological potential (GEP), except if the mitigation measure has (i) a significant adverse effect on the (water) use or (ii) on the wider environment. Mitigation measures without significant adverse effects on the use or wider environment need to be clearly indicated in defining GEP and criteria for the 'significance' of adverse effects need to be transparently identified (also linked to HMWB designation) (EC, 2012).[7]

The hydromorphological conditions at MEP are the conditions that would exist if all hydromorphological mitigation measures were taken to ensure the best approximation to the ecological continuum. The mitigation measures for defining MEP should therefore (CIS Guidance no. 4):

a) not have a significant adverse effect on the specified use (including maintenance and operation of the specified use). This consideration includes an assessment of possible economic effects incurred by mitigation measures but not an assessment of disproportionate cost of the measures themselves or on the wider environment; and
b) ensure the best approximation to ecological continuum, in particular with respect to migration of fauna and appropriate spawning and breeding grounds.

Although all mitigation measures should be identified, it would not be useful to further consider measures that were impractical. Such impractical measures should be excluded from any detailed assessment. The combination of considering only measures which do not have a significant adverse effect upon the use/environment and of excluding clearly impractical measures will result in the definition of reasonable values for MEP (CIS Guidance no. 4).

2.3 Does HMWB designation and definition of GEP differ in relation to significant adverse effects?

The designation of HMWB and the definition of GEP are two distinct processes, with differences in the measures considered in each process, as well as differences in the assessment of the significance of effects.

[7] Commission Staff Working Document 2012 WFD implementation (volume 2 of supporting material).

Difference in measures and goals to achieve

Although the measures to achieve GEP and the measures to achieve GES can in general be very similar, there are certain differences which need to be pointed out between the two processes.

In the designation process of HMWB (WFD Article 4(3)), we need to consider changes to the hydromorphological characteristics of the water body which would be necessary to achieve GES. These changes (measures or their combination) focus (to a greater or lesser extent) on reversing the physical changes. E.g. in the case of an impoundment, GES can normally only be achieved by removing the dam, in order to achieve again riverine conditions in the impounded (stagnant) waters. For HMWB designation, it should be checked whether the dam removal to achieve GES would have a significant adverse effect on the use.

In the process of defining MEP and GEP, we consider measures which mainly seek to restore the ecological functionality, while accepting that the water body is physically modified to serve a specific use or the wider environment. In the example of an impoundment (change of a riverine condition to a more stagnant one), such measures may include the construction of bypass channels, creation of habitats at the source area of the impoundment etc. These measures (or their combinations) could improve the situation but would never fully reach riverine conditions (needed for achieving GES). For MEP and GEP definition, it should be checked whether these measures have a significant adverse effect on the use.

Therefore, there is a significant difference between measures which aim at restoring the hydromorphological character of a water body (to reach GES) and measures which aim at restoring the ecological functionality (to reach GEP).

Table 1 Examples of measures to achieve GES and measures to achieve GEP

Measures for achieving GES	Measures for achieving GEP
Dam removal	Installing a bypass channel , creation of habitats
Flood defence removal	Installing a sluice to allow waters back onto the floodplain in a controlled manner
Breakwater removal	Sediment bypassing measures

Difference in scale at which to assess significance

In the process of designating HMWB, the assessment of effects of measures on the use and their significance normally takes place at a regional or national scale. In this context, we need to assess whether the effect is important and to what extent it matters at a national or regional scale. For example, in the case of dam removal to restore a water body, or if we allow a previously dredged channel to infill and behave naturally from a geomorphological perspective, we may lose or significantly reduce the contribution of the modified water body to the regional or national economy.

In the process of defining GEP, the assessment of significant adverse effects of measures for achieving GEP on the use or wider environment should always also address the water body level. This

is because, depending on the local conditions, one measure may be possible in one location, but not in another site. After a water body is designated as HMWB, we should seek to do the best we can for the ecology given the use responsible for the modifications. Therefore, the assessment is about understanding how the measures that could be taken to improve or restore the ecological function will compromise or have another effect on the use, usually at the level of the water body and the specific facility.

3 Main uses related to designation of HMWB

According to WFD Article 4(3)(a), Member States may designate a water body as artificial or heavily modified, when the changes to the hydromorphological characteristics of that body which would be necessary for achieving GES would have significant adverse effects on: :

- The wider environment.
- Navigation, including port facilities, or recreation.
- Activities for the purpose of which the water is stored, such as drinking water supply, power generation or irrigation.
- Water regulation, flood protection, land drainage.
- Other equally important sustainable human development activities.

In the 1st RBMP cycle, several uses such as water storage, flood defence and navigation, were clearly specified by the Member States as outlined in Art. 4.3(a) of the WFD. However, several other uses of HMWB were not as clearly specified or not mentioned in Art. 4(3) such as agriculture, whereby it was not clear whether it refers to land drainage or other activity. In addition, electronic reporting into WISE on the uses (and physical alterations) of each HMWB was not required.

In the 2nd RBMP cycle, it is required to report separately under WISE 1) the water use and 2) the physical alteration for which a water body has been designated as HMWB. Pre-defined lists are provided for water uses and physical alterations[8], reducing the scope for interpretation. It should be noted however that Member States may be using much finer and detailed kinds of water uses linked to the designation of HMWB, which are not reported (or not represented) according to the WISE pre-defined list.

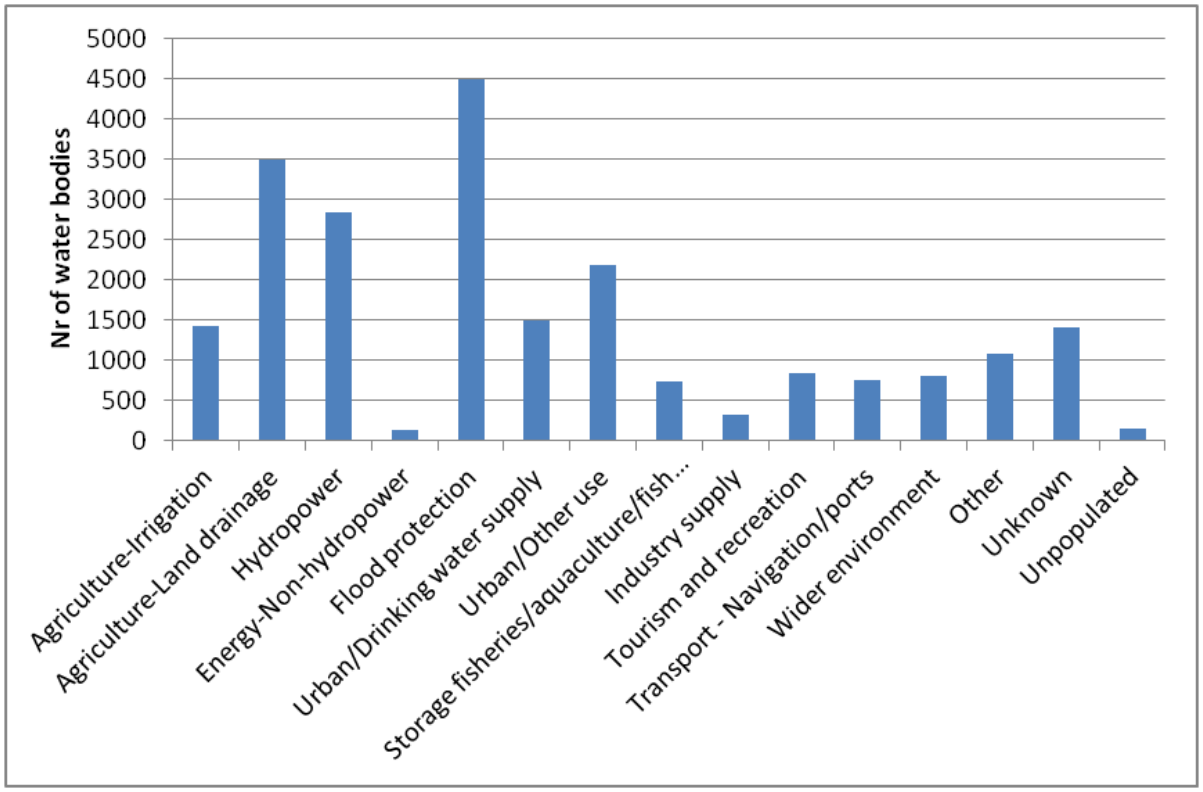
Figure 2 below presents the uses for which water bodies were designated as heavily modified in the 2nd RBMPs of 25 MS. According to this data, flood protection (4500 water bodies) followed by land drainage for agriculture (3500), hydropower (2700), urbanisation (often combined with flood protection) (2200), drinking water provision for urban areas (1500) and irrigation for agriculture (1400) are the most common uses for designating HMWBs. Hydropower, drinking water supply and irrigation are all related to water storage.

A similar (but lower; less than 1000) amount of water bodies is designated as heavily modified due to navigation, tourism and recreation, the wider environment and storage for fisheries, aquaculture and fish farms.

A large number of water bodies are reported as heavily modified for unknown uses (1400 water bodies) or other uses (1100) (i.e. not matching the water use categories in the WISE reporting).

[8] The pre-defined list of physical alterations is: Locks; Weirs / dam / reservoir; Channelisation / straightening / bed stabilisation / bank reinforcement; Dredging / channel maintenance; Land reclamation / coastal modifications / ports; Land drainage; Other.

Figure 2 Number of HMWB designated for specific water uses - based on WISE reporting from the 2nd RBMPs



Notes: Data from https://tableau.discomap.eea.europa.eu, 31 Jan 2018. Based on preliminary data reported for 25 MS; no data are included for EL, IE and LT. The uses in this figure are based on the pre-defined list for reporting water uses of HMWB in WISE.

4 How to assess significant adverse effects on use or wider environment

4.1 Key issues in the process of assessing significant adverse effects

Previous Member States exchange within the CIS process has led to the following conclusions[9], with the intention to take these now forward in the discussions planned at the workshop on 23-24 April 2018:

- A common set of criteria and thresholds on the significance of adverse effects may be beneficial to ensure consistency in decision-making between countries.
- Agreement on certain thresholds of assessment criteria may be difficult; therefore, it is important to agree on a transparent and clear process of assessing significant adverse effects.
- The decision-making basis needs to be made transparent, to make the assessments on the designation of HMWB and the definition of GEP comparable and support the "intercalibration" of GEP as required by the WFD.
- Significant adverse effects on use or wider environment should be discussed with stakeholders in transparent way, as part of public participation and consultation processes required by the WFD.

[9] Workshop on GEP inter-comparison case studies on water storage, 13- 14 February 2017 – Vienna, Summary Report.

The following issues are considered as necessary to be addressed in order to achieve a transparent and clear process for assessing significant adverse effects:

- Issue 1: Define the key uses and scope of wider environment
- Issue 2: Define the benefits of the key uses and of wider environment
- Issue 3: Define measures and distinguish between measures for achieving GES and measures for achieving GEP
- Issue 4: Define the types of effects of measures on the key uses and the wider environment
- Issue 5: Define the scale of assessment of significant adverse effects for each key use and the wider environment (and distinguish between HMWB designation and GEP definition)
- Issue 6: For each key type of adverse effect, define criteria for assessing adverse effects and thresholds of significance

Issue 1: Define the key uses and scope of wider environment.

The definition of some uses may be clear (e.g. storage for hydropower use), while for other uses, it may require some further clarification (e.g. urbanisation) or a clearer definition of the scope (e.g. for wider environment).

Issue 2: Define the benefits of the key uses and of wider environment.

It is important to define the specific benefits of the different uses (e.g. in case of hydropower, importance of energy generation or for certain types of facilities providing for peaks in energy demand and regulatory power).

Issue 3: Define measures and distinguish between measures for achieving GES and measures for achieving GEP).

See section 2.3 above for differences in measures, goals to achieve and scale of assessment between the two processes of HMWB designation and GEP definition.

Issue 4: Define the types of effects of measures on the key uses and the wider environment.

Adverse effects on the uses may include losses of/in important services (e.g. flood protection, recreation or navigation) or production losses (e.g. hydropower or agricultural goods). In assessing "significant adverse effects" on the uses, economic effects[10] will play an important role, but also social aspects may need to be considered (e.g. removal of flood defences may lead to displacement of population) (CIS Guidance no. 4). Other considerations include possible health and safety, pollution or legal implications (e.g. if an authority is legally required to provide a certain function).

Issue 5: Define the scale of assessment for each key use and the wider environment (and distinguish between HMWB designation and GEP definition)

CIS Guidance no.4 gave different options for assessing significant adverse effects on different scales (national to regional to local). Effects can be determined at the level of a water body, a group of water bodies, a region, a RBD or at national scale. The appropriate scale will vary according to the situation and the type of specified use or sector. It will depend on the key spatial characteristics of the adverse

[10] In this context, economic effects should not include assessments of the effect of measures on a company's financial situation. The ability of the user to pay is not relevant at this stage as this would potentially discriminate against efficient and profitable enterprises (CIS Guidance no. 4).

effects. In some cases it may be appropriate to consider effects at more than one scale in order to ensure the most appropriate assessment (CIS Guidance N°4).

For a number of uses, the regional/national level or below may be considered as the appropriate level for assessing significant adverse effects at least in the process of designating HMWB. For the assessment of significant adverse effects of measures which are relevant for the definition of GEP, the local scale is also important as objectives are set at water body level (see section 2.3 of this discussion paper).

The scale of assessing significant adverse effects can be different for different uses and in the following some possible examples are outlined for the most appropriate scale of assessment for each of the key uses:

- Effects on energy production: assessed on national level
- Effects on agriculture: assessed on national level (similar to energy)
- Effects on flood protection: assessed on basin scale but local level also plays a role
- Effects on navigation: can be assessed on national level (e.g. nationally important seaport) but also on local level (i.e. navigation connecting the cities on one river cannot be substituted by navigation on another river)
- Effects on tourism/recreation: assessed on local level
- Effects on wider environment: national or EU scale (e.g. related to Natura 2000 protected areas)

In addition, it is often important to consider the whole river system when taking decisions on the significance of adverse effects. Economic losses may be compensated by benefits, e.g. energy losses upstream may bring gains for another hydropower plant further downstream. For this reason, there is a need to focus on the whole system and not only on individual hydropower stations.[11]

Issue 6: For each key type of adverse effect, define criteria on what is significant and what is not significant adverse effect (during HMWB designation and GEP definition)

According to CIS Guidance no. 4, it is not considered possible to derive a standard definition for "significant" adverse effect. “Significance” will vary between sectors and will be influenced by the socioeconomic priorities of Member States. It is however possible to give an indication of the difference between “significant adverse effect” and “adverse effect”. A significant adverse effect on the use should not be small or unnoticeable but should make a notable difference to the use. For example, an effect should not normally be considered significant, where the effect on the specified use is smaller than the normal short-term variability in performance (e.g. output per kilowatt hour, level of flood protection, quantity of drinking water provided). However, the effect would clearly be significant if it compromised the long-term viability of the specified use by significantly reducing its performance. It is important to undertake this assessment at the appropriate scale.[12]

[11] Workshop on GEP inter-comparison case studies on water storage, 13- 14 February 2017 – Vienna, Summary Report.

[12] A factor to consider in this context is the length of time in which there should be a significant effect. This may be on a yearly basis and only in exceptional cases in the longer term. The likelihood that the effect will occur must be weighed against the damage that occurs on the use.

Therefore, the distinction between the level of significance and levels of natural variation is important. For instance, how does a level of significance of adverse effect of less than 5% of reduction in annual energy production compare to natural variation in annual energy production of 5-10%? Natural variation implies that, in dry years, a country would have certain energy loss, therefore any reduction to energy production should not be considered automatically as significant adverse effect.

At a CIS workshop on WFD and HMWB (in 2009), it was also agreed that significant adverse effect cannot mean "no impact on use". [13]

According to the CIS Guidance no. 1 WATECO, there is no obvious way in which a single value could be considered significant. The assessment of significance will, by necessity, be based on the context and scale of the modification to the water body and also requires consideration of the scale of the effects on the uses.

After defining the specific benefits of the different uses and the types of effects of measures for achieving GES and GEP on the uses, it is recommended that Member States establish criteria and thresholds for deciding if measures would have a significant (or not significant) effect on the use. This is a key issue for achieving a clear and transparent process of designating HMWB and defining GEP.[14] Criteria need to reflect the effect on different benefits provided by the water use. Thus, not only one criterion may be considered but several criteria may need to be used.

CIS Guidance documents no. 1 and no. 4 have also highlighted the type of methods that can be used in the assessment of significant adverse effects. Simple qualitative descriptive methods are appropriate where the following situations apply:

- The adverse effects on uses are relatively small in relation to the use (clearly not significant); or
- The adverse effects on uses are very large and prejudice their viability (clearly significant). This is particularly relevant when the necessary "measures" imply the cessation of uses, functions and related human activities. For example, where the removal of flood defences would lead to widespread flooding of an urban area.

There may be a number of circumstances where the scale of adverse effect is more finely balanced. Under these circumstances, it is appropriate to undertake a quantitative assessment of the impacts to the use to justify their significance. Simple and consistent tools and approaches may therefore be required to assess the significance of impacts upon uses. This could include the following approaches.

- An assessment can be carried out of the change in use and function (e.g. the reduction in the quantity of electricity that can be generated from hydro-power). This can provide a first and robust quantification of the resulting change in use
- It may be possible to assess the economic impact resulting from necessary changes to achieve good status. Thus, the economic benefits (in monetary terms) linked to the use of

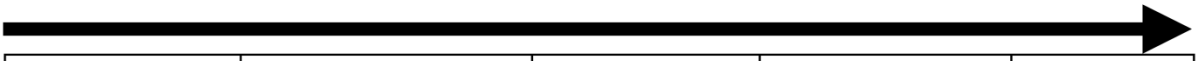
[13] Conclusions of CIS Workshop Heavily Modified Water Bodies. Brussels, 12-13 March 2009.
[14] JRC technical report on common understanding of using mitigation measures for reaching Good Ecological Potential for heavily modified water bodies (2016).

water under the present situation are compared with the economic benefits (in monetary terms) that would be obtained from the required change in use.

In both cases, relative values are preferred to absolute values for discussing the issue of significance. For example, a reduction of an irrigated area by 100 ha can be considered as significant as compared to a total irrigated area of 105 ha, but not significant as compared to a total area of 120,000 ha. This clearly makes the choice of the denominator of the relative value of particular importance (i.e. to identify the scale of the use to be considered). The information obtained can be fed to a consultative forum or group of experts for deciding whether changes are indeed considered as significant.

Table 2 Preliminary guidance on the selection of methods for Article 4(3)(a) test

INCREASING COMPLEXITY (move in this direction only when necessary, i.e. when a decision cannot easily be made with methods on the left of the table).



Test	Descriptive (qualitative) methods	Simple quantification	Benchmarking information	Economic assessment
Significant adverse effect on specified use (step 7.2)	If abandonment of, or very major change in, specified use/function/activity If very limited change in specified use /function/activity	When partial change in specified use/ function		Where significance of change in specified use/function is uncertain
Significant adverse effect on environment (step 7.3)	Description of scale of impacts relative to benefits provided by restoration measures		National / local scale benchmarking may be of assistance	

Source: CIS Guidance no. 4.

Questions for discussion at the workshop

1. What exactly is considered as a “use” and “wider environment”?
2. What are the key benefits and types of adverse effects which should be considered for the main uses and the wider environment?
3. How do you differentiate between measures for achieving GES and measures for achieving GEP with regard to different key uses?
4. Can we differentiate benefits of the uses on different levels (from national to local)?
5. At what scale are significant adverse effects of measures assessed for the key uses in the context of HMWB designation and in the context of definition of GEP? Are large-scale issues and water body level issues particularly relevant for specific parts of the process or for specific types of uses?
6. How can the adverse effects of measures on the use or wider environment be quantified?

4.2 Significant adverse effects on uses

The following sections outline possible benefits, types of adverse effects and criteria for assessing significance for the key uses, to be discussed in the workshop.
Please note that more specific criteria could be proposed in relation to water storage (based on previous CIS discussions) compared to other water uses. The intention is to discuss and jointly develop further criteria for the different uses during the workshop.
The discussion at the workshop on the assessment of adverse effects can be related to clusters of hydromorphological measures (for achieving GES and GEP) – see suggestions of clusters in sections below.

Questions for discussion at the workshop

7. How to decide whether an adverse effect on use is significant or not? What is considered as a significant adverse effect on the use (versus just adverse effect) for specific sectors?
8. Which clusters of measures are frequently considered to have a significant adverse effect on use?
9. Can you provide examples/cases where a certain measure (e.g. a fish pass) has a significant adverse effect on the use and cases where it has no significant adverse effect on the use?

4.2.1 Storage uses (hydropower, drinking water supply, irrigation)

The following table includes measures which are relevant for both achieving GEP and achieving GES. Measures for achieving GEP and GES usually largely overlap, although there are some measures which are only relevant for one or the other of these two environmental objectives. Measures which are only relevant for achieving GES are normally related to the complete removal of the physical structure which causes the hydromorphological changes (in the case of storage, this would be the removal of a dam).

Furthermore, the intensity of a measure and the combination of measures may be crucial to distinguish between measures for achieving GES and measures for achieving GEP. For instance, in the case of measures related to flow, the establishment of an environmental flow is needed to achieve GES but the establishment of additional flow with a different volume of water, e.g. only a low flow component, compared to environmental flow (also e.g. flushing flows) may be relevant for achieving GEP.

Main clusters of measures related to storage:

Clusters of measures	Detailed measures
Measures for interrupted continuity for fish	**For both upstream and downstream continuity** • Dam modification • Ramp • Fish-pass • By-pass channel **Only for downstream continuity**

	• Fish-friendly turbines • Fish screens
Measures for low flow	• Provide additional flow • River morphology changes
Measures for hydropeaking	• Balancing reservoir(s) (internal) • Relocate tailrace • Reduce rate • Modify river morphology • Balancing reservoir(s) (external)
Measures for sediment alteration	• Mechanical break-up of bed armouring • Removal of sediment • Re-introduce sediment (intake structures) • Re-introduce sediment (reservoirs) • Restore lateral erosion processes • Introduce mobilising flows
Measures for ponded rivers-impoundments	• Bypass channel • Reduce storage level • In-channel habitat improvements • Lateral reconnection

Based on JRC Technical Report, Working Group ECOSTAT report on Common understanding of using mitigation measures for reaching Good Ecological Potential for heavily modified water bodies, Part 1: Impacted by water storage, 2016

Possible benefits, types of adverse effects and criteria for assessing significance

Hydropower

Benefits of storage for hydropower	Effects of measures on storage for hydropower	Criteria for assessing adverse effect on use	Threshold for significance
Electricity production (base load)	Production loss (base load)	Exact figure (production, MWh) Compared to annual production (%) Compared to annual plant production (%) Compared to renewable energy targets (%)	To be discussed
Regulatory power	Loss in regulatory power	To be discussed	To be discussed
Peak load production	Loss in peak load production	To be discussed	To be discussed

Regional or national energy security	Reduction of the regional or national energy security.	To be discussed	To be discussed

Annex 1 of this discussion paper provides further specific information on the assessment of significant adverse effects related to hydropower from country practice.

Drinking water supply

Benefits of storage for drinking water supply	Effects of measures on storage for drinking water supply	Criteria for assessing adverse effect on use	Threshold for significance
Supply / demand balance	Impact on the supply / demand balance Reduction of security of supply	Decrease in the guaranteed level of water supply (%)	To be discussed
	Degradation of drinking water supply	To be discussed	To be discussed
	Impact on the interannual regulation capacity of reservoirs	To be discussed	To be discussed
	Increase in supply costs	To be discussed	To be discussed

Annex 2 of this discussion paper provides further specific information on the assessment of significant adverse effects related to drinking water supply from country practice.

Irrigation

Benefits of storage for irrigation	Effects of measures on storage for irrigation	Criteria for assessing adverse effect on use	Threshold for significance
Agricultural production	reduction of the agricultural production area	Exact figure (ha) Compared to annual production (%)	To be discussed
	Reduction or loss of irrigation possibilities	To be discussed	To be discussed

4.2.2 Flood protection

The following table includes measures which are relevant for both achieving GEP and achieving GES. Measures for achieving GEP and GES usually largely overlap, although there are some measures which are only relevant for one or the other of these two environmental objectives. Measures which are only relevant for achieving GES are normally related to the complete removal of the physical structure which causes the hydromorphological changes (in the case of flood protection, this would be the removal of a flood defence structure).

Furthermore, the intensity of a measure and the combination of measures may be crucial to distinguish between measures for achieving GES and measures for achieving GEP.

Main clusters of measures related to flood protection:

Clusters of measures	Detailed measures
Measures for interruption of longitudinal continuity (linked to dams for floods attenuation, Retention Check Dams, Grade control structures)	• fish passages • downstream sediment by-pass actions • openings (filtering action) for sediments • additional flows
Measures for interruption of lateral continuity (linked to bank reinforcements/protection, Embankments, Groynes, Concrete sea wall)	• Replacement of hard structures with soft engineering ones • Ccreation of natural-like irregularities • Set-back embankments • Increase of roughness trough wood/rocks • Beach creation or nourishment
Measures for complex works (linked to flood detention basins, Flood Deviation channels, Flood Drainage systems, Channel straightening, Channel revetment)	• Creation of natural-like diversity within the flood detention basin • Storage tanks at the delivery to attenuate discharge peaking • Irregular shaping of the banks to favour morhological diversity and habitat heterogeneity • Increase of roughness elements (cobbles or boulders)
Measures for sediment management and maintenance (linked to channel re-profiling (dredging included))	• Improve in-channel morphological diversity and riparian habitat • Create low-flow channel • Undertake habitat enhancement including provision of fish refuges

Based on JRC Technical Report, Working Group ECOSTAT report on Common understanding of using mitigation measures for reaching Good Ecological Potential for heavily modified water bodies, Part 2: Impacted by flood protection structures, 2018

Possible benefits, types of adverse effects and criteria for assessing significance

Benefits of flood protection	Effects of measures on flood protection	Criteria for assessing adverse effect on use	Threshold for significance
Protection of urban areas (households, businesses)	Increase of flood risk in close-by areas Reduction in value of real estate Relocation of households or businesses Endangerment of soil stability	To be discussed	To be discussed
Protection of infrastructure and traffic routes	Relocation of traffic routes	To be discussed	To be discussed
Protection of agricultural areas	Reduction of the agricultural production area Change of conditions for production through increasing soil wetness	Exact figure (ha) Compared to annual production (%)	To be discussed

4.2.3 Agricultural drainage

The following table includes measures which are relevant for both achieving GEP and achieving GES. Measures for achieving GEP and GES usually largely overlap, although there are some measures which are only relevant for one or the other of these two environmental objectives. Measures which are only relevant for achieving GES are normally related to the complete removal of the physical structure which causes the hydromorphological changes.

Furthermore, the intensity of a measure and the combination of measures may be crucial to distinguish between measures for achieving GES and measures for achieving GEP.

Main clusters of measures related to drainage:

Clusters of measures	**Detailed measures**
Measures for channel re-profiling (including deepened, narrow or widened channel and incision)	• Increase in-channel river bed and banks variation and complexity (gravel bars, rifles, etc) • Create two stage ditches • Substrate improvement (removal of sediment; Introduce mobilising flows)

Measures for bed fixation (e.g. revetment, rip-rap, foreshore armouring)	• Remove/replace hard with soft engineering • Mechanical break up of armouring • Reopen subsurface rivers/brooks from underground pipes
Measures for changed planform/channel pattern	• Re-meander river course • Connect/improve/create backwaters / buffer strips / riparian vegetation / wetlands
Measures for changed landscape hydrological regime	• Afforestation • Provide additional flow/minimum flow • Storage tanks / sediment traps • Create low flow channel
Measures for physical disturbance (e.g. through weed cutting, removal of riparian vegetation)	• Manage vegetation (e.g. selective cuts, mosaic and phased mowing) • Introduce woody debris • Changed maintenance frequency / practice

Based on JRC Technical Report, Working Group ECOSTAT report on Common understanding of using mitigation measures for reaching Good Ecological Potential for heavily modified water bodies, Part 3: Impacted by drainage, 2018

Possible benefits, types of adverse effects and criteria for assessing significance

Benefits of agricultural drainage	Effects of measures on drainage	Criteria for assessing adverse effect on use	Threshold for significance
Agricultural production	Reduction of the agricultural production area	Exact figure (ha) Compared to annual production (%)	To be discussed

4.2.4 Navigation

The following table includes measures which are relevant for both achieving GEP and achieving GES. Measures for achieving GEP and GES usually largely overlap, although there are some measures which are only relevant for one or the other of these two environmental objectives. Measures which are only relevant for achieving GES are normally related to the complete removal of the physical structure which causes the hydromorphological changes.

Furthermore, the intensity of a measure and the combination of measures may be crucial to distinguish between measures for achieving GES and measures for achieving GEP.

Main clusters of measures related to navigation:

Clusters of measures	Detailed measures
Depth modifications (deepening)	• Programme maintenance to avoid sensitive periods • Use technology to reduce risk safety risks whilst minimising maintenance dredging requirements • Sediment management • Enhance marginal habitats; create fish refuges
River course modifications (straightening, training)	• Programme maintenance to avoid sensitive periods • Reconnect meanders (fully or partially) • Implement sediment management measures • Remove (redundant) structures • Replace hard with soft engineering solutions; solid with open structures; artificial with natural materials • Lower or sever root of groynes • Enhance marginal habitats; create fish refuges
Width modifications (widening)	• Programme maintenance to avoid sensitive periods • Use groynes or lateral islands to improve diversity • Set back embankments to restore flood plain habitat • Enhance marginal habitats; create fish refuges
Longitudinal modification (changes to river banks)	• Use speed limits to reduce wash • Programme maintenance to avoid sensitive periods • Remove protection to restore natural erosion; implement other sediment management measures • Replace hard with soft engineering; solid with open structures; artificial with natural materials • Use groynes or lateral islands to improve diversity • Set back embankments to restore flood plain habitat • Enhance marginal habitats; create fish refuges
Flow interruption (impoundment)	• Remove redundant infrastructure • Operate structures to facilitate fish and sediment continuity; e-flows • Programme maintenance to avoid sensitive periods • Sediment bypassing; other sediment management • Install fish pass • Enhance marginal habitats; create fish refuges
Other structures	• Programme maintenance to avoid sensitive periods • Remove redundant infrastructure • Replace hard with soft engineering; solid with open structures; artificial with natural materials • Enhance marginal habitats; create fish refuges

Possible benefits, types of adverse effects and criteria for assessing significance

Benefits of navigation	Effects of measures on navigation	Criteria for assessing adverse effect on use	Threshold for significance
Direct employment associated with freight shipping; passenger transport; waterborne tourism	See text after table	Jobs lost; economic losses; reduction in direct or indirect value added	To be discussed
Significant economic multiplier effect of		Jobs lost; economic losses; reduction in direct	To be discussed

navigation-related industry: ports, terminals, marinas, tourism		or indirect value added	
Economic and consumer benefits of import, export, transport of goods		Reduced volumes of goods imported, exported, transported through country; shortages; revenues lost	To be discussed
Taxes associated with above		Loss of revenue for Government	To be discussed
Reduced CO2 emissions compared to road, air transport		Additional emissions from tonnage moved to other forms of transport	

Potential effects of measures on navigation

The following are some of the main possible implications of measures for the navigation use. The effects are not specific to a particular benefit; rather, the potential effects relate to the characteristics of the measure:

- Measure results in closure of water body to navigation, with loss of associated social and economic benefits
- Measure results in changes in hydromorphological processes (hydrodynamics, sediment transport) compromising navigational safety and increasing risk of accidents, incidents, or pollution
- Measure leads to reduction in (efficiency of) shipping and thus higher costs of goods and transport
- Measure is incompatible with the (legal) responsibilities of the navigation authority (e.g. to ensure safety of navigation)
- Measure is incompatible with policies or objectives in adopted existing Port Masterplan, Local Plan, etc.
- Measure leads to disturbance or remobilisation of contaminated sediment

4.3 Significant adverse effects on wider environment

Next to the significant adverse effects of measures on the use(s), the measures also have to be checked as to whether they would have significant adverse effects on the wider environment.

According to CIS Guidance no. 4, a restricted definition of environment would not be appropriate and the environment is considered to include the natural environment and the human environment including archaeology, heritage, landscape and geomorphology[15].

Some examples of changes in the hydro-morphological characteristics of a water body which may have significant effect on the wider environment include (CIS Guidance no. 1):

- The restoration of flood plains may threaten a specific landscape and biodiversity that has developed over the years as a result of the elimination of the floods in the riparian zones and former floodplains;
- The removal of a dam that may lead to the elimination of wetlands that have developed in connection to the water storage.

Where the modified water body could be designated under another Directive such as the Habitats Directive, it is assumed that the Directive with the highest standards will apply (CIS Guidance no. 1). If a HMWB is designated under the Habitats Directive, measures to achieve GES or GEP cannot go ahead if they detrimentally impact European protected areas.

The importance of the improvement which would be delivered by measures for achieving GES or GEP relative to the impact on the wider environment has to be considered. It would, for example, not be appropriate if a large environmental improvement programme was prevented because of a significant adverse effect on a small component of the wider environment (e.g. a reservoir that serves no current purpose which results in a valuable (local) wetland; removing the dam would result in losing the wetland, but it would allow fish migration for a large river length (region). In this example, the fish migration would probably represent a larger improvement to the environment than the loss of wetland, but it strongly depends on the circumstances) (CIS Guidance N°4)[16].

Possible benefits, types of adverse effects and criteria for assessing significance

Benefits of wider environment	Effects of measures on the wider environment	Criteria for assessing adverse effect on use	Threshold for significance
Protected areas (Natura 2000, RAMSAR, national parks etc)	Compromise or loss of protected areas	To be discussed	To be discussed
Archaeological or cultural heritage	Compromise or loss of archaeological or cultural heritage	To be discussed	To be discussed
Health of aquatic organisms	Compromise of the health of aquatic organisms /	To be discussed	To be discussed

[15] Geomorphology may refer to natural processes and forms in the landscape including fluvial ones.
[16] Note that in case a measure would have a likely significant effect on a Natura 2000 site, an exemption under the Habitats Directive may need to be justified.

/ populations	populations		

4.4 Avoiding adverse effects on the wider environment

In general, if wider biodiversity interests are to be protected, it is usually considered best practice to avoid adverse effects at source. If this does not completely address the effect, measures might then be taken to minimise any remaining effects to the maximum extent practicable. Thereafter it may still be necessary to offset any residual effects, for example through habitat enhancement or creation elsewhere. Selecting measures in this order is known as the mitigation hierarchy. The mitigation hierarchy forms an important element in environmental impact assessment for new projects, but it seems equally relevant and important given the requirement to 'avoid adverse effects on the wider environment' when seeking to reach the WFD objectives.

When selecting measures intended to reach or contribute to GES or GEP whilst at the same time avoiding adverse effects on use or the wider environment, it is therefore recommended that the principles enshrined in the mitigation hierarchy be applied. The mitigation hierarchy, interpreted in the context of the WFD GES and GEP objectives, is described below.

1. Measures that achieve GES/GEP by avoiding (or stopping) the ecological impact or restoring the previous (pre-modification) regime should be favoured (alone or in combination with other measures) where these exist;
2. Measures that improve ecological status or potential by minimising (or reducing) the effect of the modification should be considered if effects cannot be avoided;
3. Measures that achieve GES/GEP by enhancing or offsetting should be explored and implemented where there are outstanding residual effects on status. Such measures often do not directly address the original hydromorphological modification but rather seek to improve other aspects of the system such that the net effect is to reach GES/GEP.

Where a combination of measures is needed, measures should be selected first from 1, then item 2 and then item 3 until such time as GES or GEP is achieved. In other words, unless there are exceptional circumstances, measures intended to offset or compensate for adverse effects should not be selected if technically feasible and not disproportionately costly 'avoid' or 'minimise' options exist that can achieve the WFD objective without adversely affecting the wider environment.

4.5 Cross-cutting issues

In addition to avoiding adverse effects on the use for which the water body is designated, it is important to ensure that measures to achieve GEP or GES also avoid adversely affecting other uses. For instance, measures to achieve GES or GEP in water bodies affected by flood protection on the coastline may have an impact on navigation.

Another example is on a river channel which has been deepened and widened for flood defence purposes. The adverse ecological effects of the modifications could be mitigated in this case without a significant reduction in the channels' capacity to convey flood water by the establishment of a two stage channel (i.e. a deeper central channel and shallower margins within the artificially widened

channel). This measure would increase habitat diversity and allow rooted plants to grow in the shallower areas adjacent to the banks. However, if the channel is also being used for navigation, such a measure might have a significant adverse effect on the navigability of the channel and therefore be inappropriate. [17]

See table below for further examples.

Use for which measure is adopted	Description of proposed measure for achieving GEP	Other potentially affected use	Example of how other use can be adversely affected
Flood protection (river or estuarine water body)	Removal of flood banks to reconnect river with floodplain	Navigation	Changing the flow of water can result in a shift in location of the main channel or in general shallowing, both of which can have potentially significant consequences for navigational safety
Flood protection (coastal or estuarine water body)	Step-back: restoration of intertidal habitat lost to 'coastal squeeze' by removing part of a redundant quay wall to create an intertidal shelf that supports plant and invertebrate species	Navigation	Redundant wharves may need to be safeguarded for future use in order to be able to meet future market demands for navigation infrastructure without damage to currently unmodified (greenfield) sites
Navigation (river or estuarine water body)	Mitigation of widening or deepening by constructing lateral (shore parallel) islands to restore sheltered river margin environments for plants and invertebrates	Recreation	Recreational vessels might currently favour using the river margins for sailing, rowing, etc. to avoid possible conflicts with commercial navigation users in the main channel

Questions for discussion at workshop

10. How do you assess significant adverse effects of measures on more than one use (multiple uses of the same water body)?

[17] WFD and hydromorphological pressures – Technical report. Good practice in managing the ecological impacts of hydropower schemes; flood protection works; and works designed to facilitate navigation under the Water Framework Directive. November 2016.

5 Significant adverse effects versus financial cost of measures

CIS Guidance no. 4 gives an overview of the related cost (and benefit) considerations for the measures that are to be considered in the different steps of the designation of HMWB and the definition of GEP (see table below).

Overall, the assessment of significant adverse effects of measures on the use or wider environment should be kept separate from the assessment of disproportionate costs. To this purpose, countries need a system to clarify the difference between these issues.

According to the guidelines given in the following table, the financial costs of measures are not considered in the classification process of HMWB. The costs of measures are taken into account in the objective setting process when defining the programme of measures for reaching the environmental objectives under the WFD. If a measure is disproportionately expensive, an extended deadline (WFD Article 4(4)) or less stringent objective (WFD Article 4(5)) may be justified by the competent authority for the water body concerned.

Table 3 Overview of measures and cost considerations in the overall HMWB and AWB identification and designation process (CIS Guidance no. 4)

Step	Measures to be considered	Costs (and benefits) related to measures /other means
1-6: Up to provisional identification	None.	Not considered.
7: Designation test 4(3)(a)	**Restoration measures** necessary to achieve GES.	• When assessing the adverse effects on the specified uses and on the wider environment, **costs** need to be considered. • The **benefits** of achieving GES must be considered, other benefits may be considered. • Costs of restoration measures (including disproportionality of costs) are **NOT** considered.
8: Designation test 4(3)(b)	Not "measures" but "**other means**" are considered.	• Comparison of current benefits with benefits of **other means**. • Disproportionality of costs of other means should be considered. • Technical feasibility of other means should be considered.
9: Designation	None.	Not considered.
10: Establishing MEP	All **mitigation measures**[24] that: • do not significantly adversely affect the specified uses or the wider environment; and • ensure the best approximation to ecological continuum.	• When assessing the adverse effects on the specified uses and on the wider environment, **costs** need to be considered. • The benefits to the water body of applying the mitigation measures should be considered. • Costs of mitigation measures (including disproportionality of costs) are **NOT** considered. • Technical feasibility of mitigation measures **NOT** to be considered.
11: Establishing GEP	**Mitigation measures** that: • do not significantly adversely affect the specified uses or the wider environment; and • improve water body to slight deviation of MEP.	• When assessing the adverse effects on the specified uses and on the wider environment, **costs** need to be considered. • The benefits to the water body of applying the mitigation measures should be considered. • Costs of mitigation measures (including disproportionality of costs) are **NOT** considered. • Technical feasibility of mitigation measures **NOT** to be considered.
For all water bodies (natural, artificial and heavily modified):		
POM for reaching the environmental quality objectives (EQO)	All **measures** according to Article 11 WFD (including other means and mitigation measures considered in the designation process)..	• Costs of measures (including disproportionality of costs) should be considered. • Select the most cost-effective combination of measures to achieve the EQO. • Technical feasibility of the measures should be considered.

Note: In the table above, "costs which need to be considered when assessing the adverse effects on the uses and on the wider environment" refer to economic effects of measures on a sector or water use. The "costs of measures" refer to the financial costs for carrying out the measures (including cost disproportionality).

The assessment of significant adverse effects in the process of designating HMWB and of defining GEP involves the evaluation of the economic or social impact of measures for achieving GES (HMWB designation) or measures for achieving GEP (GEP definition). In assessing whether measures have

significant adverse effects on the use, not all aspects are relevant. For example, when considering an estuary used for navigation, the focus of the test should be on the effect of restoration measures upon the movement of ships. The ability of the user to pay is not relevant at this stage as this would potentially discriminate against efficient and profitable enterprises (CIS Guidance N°4).

Disproportionate costs are relevant to the following stages of WFD implementation concerning heavily modified water bodies:

- Assessment of better environmental options according to Article 4(3)b. One of the requirements for designating HMWB are that the beneficial objectives served by the artificial or modified characteristics of the water body cannot, for reasons including disproportionate costs, reasonably be achieved by other means, which are a significantly better environmental option;
- Time derogations according to Article 4(4) when completing the improvements in the status or potential of water bodies within the time scale would be disproportionately expensive;
- Less stringent environmental objectives according to Article 4(5) when the achievement of the objectives would be infeasible or disproportionately expensive and the environmental and socioeconomic needs served by such human activity cannot be achieved by other means, which are a significantly better environmental option not entailing disproportionate costs.

Previous discussions within the CIS on the definition of GEP have highlighted the need to "understand better the range of costs for disproportionality and how exemptions according to WFD Article 4(4) and 4(5) are applied" (CIS Workshop on GEP inter-comparison case studies on water storage, 13- 14 February 2017 – Vienna).

Generally speaking, the assessment of significant adverse effects should be based on the economic effects on a specific sector, while the income of a specific company should not be included in this assessment. At the same time, issues linked to investment costs are usually related to disproportionate costs (CIS Workshop on GEP inter-comparison case studies on water storage, 13- 14 February 2017 – Vienna).

CIS Guidance no.1 on the economics of the WFD (WATECO) notes that, in the context of disproportionality the decision-maker may also want to take into consideration the ability to pay of those affected by the measures and some information on this may be required. This analysis might need to be disaggregated to the level of separate socio-economic groups and sectors, especially if ability-to-pay is an issue for a particular group within the basin. Whether and where this information is available depends on the scale or geographical area for which costs and benefits are considered.

Questions for discussion at the workshop

11. How do you distinguish in practice between significant adverse effects of measures on a use and costs of measures (linked to exemptions)?

6 Questions for discussion at the workshop

1. What exactly is considered as a “use” and “wider environment”?
2. What are the key benefits and types of adverse effects which should be considered for the main uses and the wider environment?
3. How do you differentiate between measures for achieving GES and measures for achieving GEP with regard to different key uses?
4. Can we differentiate benefits of the uses on different levels (from national to local)?
5. At what scale are significant adverse effects of measures assessed for the key uses in the context of HMWB designation and in the context of definition of GEP? Are large-scale issues and water body level issues particularly relevant for specific parts of the process or for specific types of uses?
6. How can the adverse effects of measures on the use or wider environment be quantified?
7. How to decide whether an adverse effect on use is significant or not? What is considered as a significant adverse effect on the use (versus just adverse effect) for specific sectors?
8. Which clusters of measures are frequently considered to have a significant adverse effect on use?
9. Can you provide examples/cases where a certain measure (e.g. a fish pass) has a significant adverse effect on the use and cases where it has no significant adverse effect on the use?
10. How do you assess significant adverse effects of measures on more than one use (multiple uses of the same water body)?
11. How do you distinguish in practice between significant adverse effects of measures on a use and costs of measures (linked to exemptions)?

Annex 1 – Specific information on significant adverse effects related to storage for hydropower

Previous CIS State exchange and recent work by the Ad-hoc Task Group on Hydromorphology on the inter-comparison of GEP have led to relevant insights on the significant adverse effects of measures on water storage for hydropower. The following summarises some of the key relevant conclusions from these processes.

Significant adverse effect by different measures for achieving GEP

As reported in the JRC report on mitigation measures for water storage in 2016,[18] and the technical annex to this report, significant effects on water use seem to be a common reason for ruling out flow measures and lake level measures in several countries. Overall nevertheless, most responding countries consider that many types of the key mitigation measures for GEP have no effect or low effect on the use of water storage. In addition, technical not possible to implement relevant measures for GEP is reported to be a more widely used reason for ruling out key measures (e.g. continuity measures, mitigation of impoundments and as as common for mitigating lake level alteration and rapid flow change). Adverse effect on the wider environment from mitigation measures is not a common reason for ruling out; actually only SE and PT partly considered this as a common reason.

The key measure types for which "a significant adverse effect on water storage" is more frequently used as a reason for ruling out mitigation measures were reported as being:

- Measures for mitigation of low flow (especially providing additional flow to river) (7 out of 10 countries)
- Mitigation flows for fish migration (5 out of 7 countries)
- Measures for mitigation of variable flows (especially actively delivered flow variability, e.g. timed release from dam) (6 out of 8 countries)
- Measures for mitigation of lake level change (especially limit level variation by reducing abstraction during ecologically sensitive periods) (4 out of 5 countries)
- Measures for mitigation of sediment alteration (especially introduction of mobilizing flows) (4 out of 7 countries).

For measures related to upstream and downstream continuity for fish, "a significant adverse effect on water storage" is rarely used as a reason for ruling out measures, as shown as an example in the figure for downstream continuity measure (from the technical annex to the JRC report from 2016).

[18] JRC technical report on common understanding of using mitigation measures for reaching Good Ecological Potential for heavily modified water bodies (2016); see http://publications.jrc.ec.europa.eu/repository/bitstream/JRC110957/jrc110957_online_flood_gep_jan202018_jrc20technical20report_final_clean.pdf

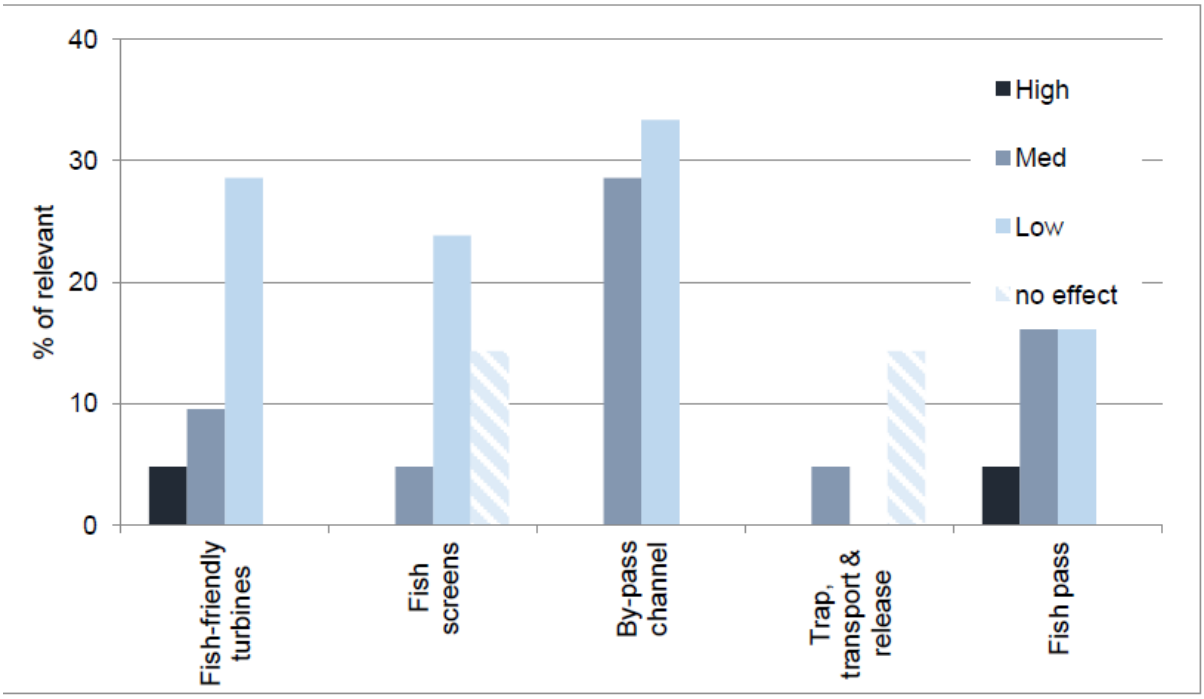


Figure: Relative effect on water storage from continuity measures (for downstream), based on respond from 15 countries. Source: Technical annex to JRC report 2016.

Ruling out a technical mitigation measure due to significant adverse effects on use may also include cases whereby safety is endangered (this may also be the case for mitigation measures considered for HMWBs designated due to their use for flood protection).

The JRC report also highlighted that, to achieve the same standard for good ecological potential, countries where very limited mitigation was incorporated face a much larger relative effect on the benefits provided by their water storages schemes than do countries where considerable mitigation was embedded from the start. To avoid significant adverse effects, one of the recommendations of the report is that countries with an unfavourable starting point use the river basin planning process to decide where and how to prioritise improvements.

As few countries have defined a clear (biological) minimum requirement to GEP, and if the understanding of ruling out relevant meaures due to significant adverse effect differ between countries, it might be hard to differentiate less stringent objectives from ecological potential with no good ecological functionality in the water bodies. This is why a more common understanding of significant adverse effect methodology that is transparent is so critical for ensuring a comparable implementation of GEP and HMWBs.

Criteria and thresholds used by 2016

The JRC report on mitigation measures for water storage in 2016 highlights that:

- 5 out of 17 countries (29 %) have reported national framework criteria for determining significant effect of mitigation on hydropower. In NO, national assessment at policy level has been developed, that can apply as a guide on how to prioritise flow mitigation measures in catchments/river segments with highest potential benefits from mitigating impacts from hydropower.
- 12 out of 17 countries have no national framework criteria and in 5 of these countries, the assessment of significant effect on hydropower is done on case-by-case basis or expert evaluation.
- The framework criteria look at the national level in 5 countries and at the scheme level in 3 countries.
- In 3 countries, the criteria look at total production and in 2 countries at both total production and regulatory power. In SE, in specific, there are different criteria for significant effect on use

for production, balancing and frequency regulatory power, explained in a separate text box (part of chapter 14) in the JRC report.

- In 4 countries, the criteria relate to a percentage (%) against a fixed baseline. In SE, a fixed baseline is used but could be changed in an adaptive management. In 2 countries, the criteria do not relate to a percentage (%) but relate to specific case-by-case conditions. In FI, although a case specific assessment is practised, it was indicated that criteria on significant effect on use are often between 1-5 %.

The table below shows which countries reported the use of criteria (national or local) for determining significant adverse effects of mitigation on hydropower, based on CIS information exchange activities (workshops or templates) between 2011 and 2016.

Table: Countries reporting the use of national or local criteria for determining significant adverse effects on use. Source: JRC report on mitigation measures for water storage in 2016

Source	Yes (national or local criteria)	No	No information (no response)
2011 CIS Workshop on Hydropower and the WFD	(AT), FR, IT, LV, LT, NL, RO, ES, CH, IS	BG, DE, FI, LU, NO, PT, SE, UK, CZ, SI	BE, HU, PL
2016 Mitigation Measures Template	AT, NO, RO, SE, UK (national) IE (local)	DK, DE, LT, SK, IE, FI, PT, EE, ES, CY, FR, LT, HU, CZ	BE, BG, HR, EL, HU, IC, IT, LV, LU, MT, NL, PL, SI

During the CIS Workshop on GEP inter-comparison case studies on water storage in 2017, participants differentiated between the overall loss in production with an annual figure to compare (e.g. GWh/year) and the lost flexibility in altering short-term production (daily production, MW) and long-term production (seasonal, regulatory GWh).

There is evidence available suggesting that thresholds for considering effects as significant are very similar between countries, but depending on the countries starting point (e.g. demand for Eflow in old hydropower licenses). For example, in the case of effects on hydropower generation, they appear to be in the range 2% to 4% of the national output. These thresholds are usually applied for HPP above 10 MW.

Updates based on case studies submitted by March 2018

Additional information was recently collected through the case studies of the inter-comparison exercise on GEP definition (in 2017-2018), with contributions of 18 water storage cases from 12 countries (by end of March 2018). Four countries (Finland, France, UK-Scotland, Slovakia) provided cases with information on their interpretation of significant adverse effect on water storage use for hydropower. The table below presents their response. Overall:

- Most frequently used indicator is “production loss in base load (exact figure and compared to annual production) (e.g. by FI, FR, UK-Scotland, SK). Some thresholds are used by e.g. Austria (3% accepted loss of annual energy production) and Scotland (maximum of 2% hydropower production loss for whole country for each RBMP cycle).
    - Production loss is compared to renewable energy targets in FI and Scotland
    - Finland uses an interesting indicator: production loss compared to annual production of the whole river.
- Profit loss used in several countries (e.g.FI, FR, SK) but it is not considered as part of the assessment of significant adverse effects in others (e.g. UK-Scotland)
- Finland considers the loss of peak load production compared to available flexibility of whole river, at national level, and compared to amount of flexible hydropower in the country
- UK-Scotland may consider whether a dam spills frequently and could therefore accommodate mitigation flows by using up some spill volume rather than direct hydropower generation

Table: Criteria and thresholds reported by countries during the inter-comparison of GEP definition for water storage for hydropower

Criteria		Which countries used this criterion	Thresholds used (if any)
Production loss (base load)	**Exact figure (production, MWh)**	FI, FR, SK, UK-Scotland	
	Compared to annual production (%)	FI, SK, UK-Scotland	SK: Used threshold - Austrian 3% (study and assessment for Danubian region) or Romanian 5% - accepted loss of energy production UK-Scotland: maximum cap set across the whole country. All hydropower improvements across all RBMP cycles must not exceed a maximum of 100GWh (roughly 2% of overall hydropower generation)
	Compared to annual plant production (%)	FI, UK-Scotland	
	Compared to renewable energy targets (%)	FI, UK-Scotland	
	Compared to annual production of the whole river	FI	
Profit loss	**Exact figure (€)**	FI, FR, SK	
	Compared to annual plant profit (%)		
	Compared to annual plant owner/company profit (%)		
	Annual value of production (€)	FI	
Loss in regulatory power	**Compared to national level**		
	Compared to available flexibility of the whole river	FI	
Loss in peak load production	**Compared to available flexibility of the whole river**	FI	
	Compared to the amount of flexible hydropower	FI	

Annex 2 – Specific information on significant adverse effects related to storage for drinking water supply

The JRC report on mitigation measures for water storage in 2016 highlights that:

- Only 2 out of 17 countries have national framework criteria for determining significant effect of mitigation on water supply.
- 15 out of 17 countries have no national framework criteria and in 4 of these countries, the assessment of significant effect on water supply is done on case-by-case basis. In 5 countries, significant effect of mitigation on water supply is considered not relevant or to a limited extent, either because surface water is not used (extensively) for water supply or because water supply is not considered as a use for HMWB designation.
- 1 country (UK) indicates demand supply balance as criteria for determining significant effect of mitigation on storage for water supply (creating a negative supply/demand balance (after leakage reduction etc)).

Information was also collected through the case studies of the inter-comparison exercise on GEP definition (in 2017-2018). Three countries (Finland, Hungary, UK-England) provided cases with information on their interpretation of significant adverse effect on water storage use for drinking water supply. The table below presents their response. Overall:

- Finland indicates that they evaluate whether there are no or limited alternative supply options
- Similar observation is made by Hungary, which evaluates the significance of the water storage to supply settlements in the relevant area.
- If the mitigation measure leads to a mismatch between supply and demand in a particular water resource zone, authorities in UK-England evaluate whether “appropriate” measures can be implemented, which do not involve developing new reservoirs elsewhere or water resource transfers (between water resource zones). If no appropriate measure can be implemented, it is considered that the mitigation measure leads to significant adverse effect. The specific thresholds vary between water resource zones.

Table: Criteria and thresholds reported by countries during the inter-comparison of GEP definition for water storage for drinking water supply

Country	Criteria for assessing significant adverse effect on use
UK-England	The definition of significant adverse impact on use for HMWB designated for water supply and storage operated by water companies is the following. If the Water Resources Zone will go into a supply-demand balance deficit and this deficit cannot be returned to a supply-demand balance by the implementation of appropriate measures* secured through the water resource management plan process. Appropriate measures include new infrastructure to make better use of existing water resources within a water resource zone but exclude those to develop new resources or the use of mothballed assets. For example, they include the following options: • customer management (options affecting customer use and supply pipe losses); • distribution management (options targeted at activities between distribution and the point of consumption); • production management (options targeted at activities between abstraction and distribution input); It excludes resource management (options affecting deployable output, such as new reservoirs or resource transfers) with the exception of transfers and improved/more sophisticated conjunctive use within a water resource zone. The supply-demand balance varies between WRZs hence it is not possible to apply a percentage or unit value impact on yield definition. Water Resource Zone (WRZ) describes an area within which, managing supply and demand for water is largely self-contained (apart from bulk transfers of water); where the resource units, supply infrastructure and demand centre are linked such that customers in the WRZ experience the same risk of supply failure.

Hungary	The water supply of the whole precedent floodplain depends on the system, also settlements developed on flood protected floodplains (using flood free areas as domicile) during the last 170 years. This criterion was reported in relation to assessing significant adverse effect in relation to mitigation measures: in-channel habitat improvements, lateral reconnection, and restore lateral erosion processes.
Finland	No / limited alternative supply available