Water Use

Supporting Guidance (WAT-SG-21)

Environmental Standards for River Morphology

Version: v2.1

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Update Summary

Version	Description
v1.0	First issue for Water Use reference using approved content from the following documents: *WAT-SG-21 Operational Guidance for ES Tests v2.doc*
v1.1	Section numbering issues resolved
v1.2	Revision to values in Table 8, p43.
v2.0	Doc revised to reflect updates to WAT-RM-02, classification tools and survey methods.
v2.1	Figure 4 text updated. WAT-doc links direct to QPulse.

Notes

References: Linked references to other documents have been disabled in this web version of the document. See the References section for details of all referenced documents.

Printing the Document: This document is uncontrolled if printed and is only intended to be viewed online.

If you do need to print the document, the best results are achieved using Booklet printing or else double-sided, Duplex (2-on-1) A4 printing (both four pages per A4 sheet).

Always refer to the online document for accurate and up-to-date information.

Table of Contents

How to Use this Guidance Document

This document provides guidance on the Environmental Standards (ES) for River Morphology. The document is divided into three parts.

Part 1 provides:

- An overview of the principles underpinning the new Environmental Standards for River Morphology

- A summary of the process that staff should undertake to apply the Environmental Standards to new engineering authorisations.
  - Step 1: Establish existing morphological status of the water body
  - Step 2: Assess the activity(s) at the 500m scale
  - Step 3: Assess new activity(s) at water body scale

Included in Part 1 are simple step-by-step guides to help complete different aspects of the Environmental Standards Test. Each step-by-step guide includes *Quicklinks* to more detailed information held in Part 2 and Part 3 (Annexes).

Part 2 provides:

- An overview of the procedures used to carry out the steps identified in Part 1. This includes how to apply the different steps in different situations.
  - 2.1 Identifying the Channel Section
  - 2.2 Determining the Channel Type
  - 2.3 Gathering Data on Existing Engineering Pressures
  - 2.4 Guide to Using MImAS

Part 3 (Annexes) provides:

- Detailed information to help carry out individual procedures.
  - Annex A Description of River Types
  - Annex B SEPA River Type Database
  - Annex C River Type Field Survey Guidance
  - Annex D Using maps and photographs to identify morphological pressures

Staff should read Parts 1 and 2 of this document to familiarise themselves with the principles and processes that have been developed to allow staff to use environmental standards for river morphology. Once you are familiar with the basic process, the document can be treated as an interactive tool by using the *Quicklinks* to navigate around it. To use a *Quicklink*, place the cursor over the link, press ctrl and click on the left mouse button.

PART 1: Environmental Standards Test

1.1 Introduction

The Environmental Standards Test determines whether a proposed activity (or activities) will result in deterioration in morphological quality and WFD status. The assessment should be used to decide whether more detailed assessments are required, what mitigation should be sought and whether the proposal is likely to result in significant adverse impacts on the water environment.

The Environmental Standards (ES) test for rivers is undertaken using an impact assessment tool called MImAS (Morphological Impact Assessment System). MImAS is an Oracle-based application that is available internally to SEPA staff and it is also the tool used to produce the morphology WFD classification.

MImAS works by determining the likely morphological impact resulting from a single activity, or from combinations of activities within a given length of channel. Impacts are measured by how much 'system capacity (%)' they use up within two zones (channel zone and banks/riparian zone), the assumption being that rivers have a fixed amount of 'capacity' to absorb engineering pressures and different engineering activities consume different amounts of available capacity. In addition, the amount of capacity used by a pressure will vary depending on the channel's sensitivity, or type, with a pressure of a given size using less capacity in a lower sensitivity type than in a higher sensitivity type. To run MImAS, a user must enter information on engineering pressures, modifications to the riparian vegetation and channel type. Using this information, MImAS calculates how much system capacity has been used in each zone and predicts WFD status.

Environmental Standards (also referred to as Morphological Condition Limits or MCL) define permissible levels of impact on a systems available capacity within each zone (Figure 1 and BOX 1). It is believed that these limits, which are expressed as different percentages of total system capacity, are compliant with WFD status classification objectives, such that development beyond these limits could compromise ecological and/or morphological conditions and result in deterioration in status.

Figure 1   Summary of MImAS and link to morphological condition limits
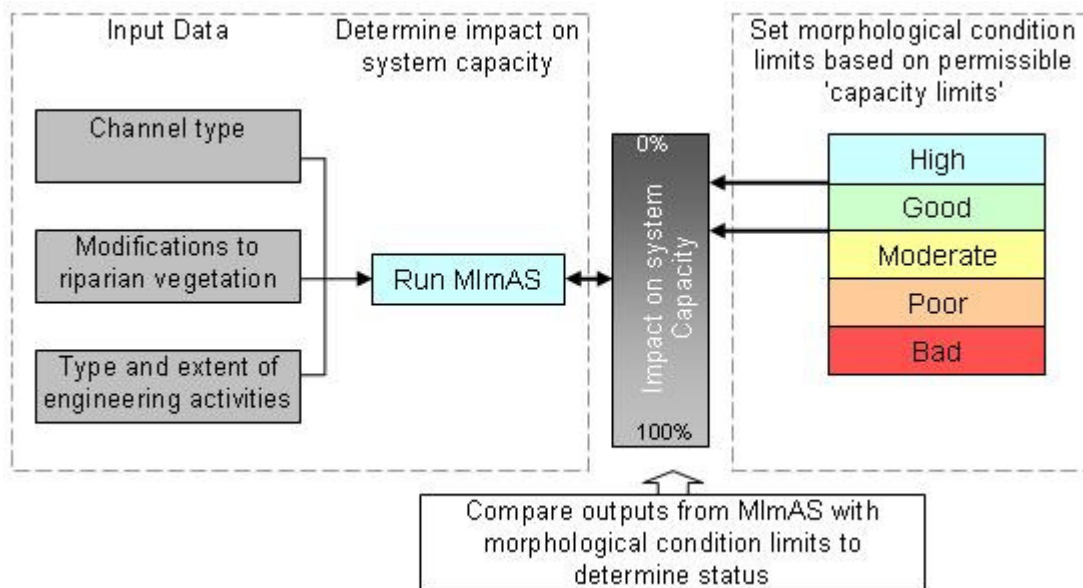
BOX 1   Overview of modules used in the MImAS tool

MImAS comprises a series of modules that are linked by a scoring system that measures impacts in terms of % capacity. Environmental Standards define permissible capacity limits for each WFD status boundary.

Module	Description
Module 1 - Eco-geomorphic attributes	Defines the morphological/ecological features that need to be protected
Module 2 - River Typology	Allows assessment of how features vary between and within rivers
Module 3 - Sensitivity Assessment	Predicts the sensitivity of features to impacts
Module 4 - Impact Assessment	Predicts the likelihood that an engineering activity will cause an impact

Capacity based scoring System

1.2 Summary of Environmental Standards Test

The screening of licence applications is a three step process (Figure 2 to Figure 4). All three steps can be applied to **Main Stem Rivers**. Step 2 is the only step that should be applied to **Minor Tributaries** and **Coastal Streams**.


BOX 2   Identifying Watercourses

- **Main Stem Rivers** are identified on SEPA's GIS Intranet in the "River Water Bodies (baseline)" layer of the "Rivers" theme. They are classified for morphology using MImAS.

- All other watercourses are either **Minor Tributaries** or **Coastal Streams**. This includes watercourses connected to Main Stem Rivers but not identified in the GIS layer (see above) and water bodies shown in the "Small River Water Bodies" layer of the "Rivers" theme. Minor Tributaries and Coastal Streams are not currently included in the morphology classification.

Detailed guidance on each of the three steps is provided in the following sections (Click on the steps outline below for a *Quicklink* to the relevant section).

- **Step 1: Main Stem Rivers Only**
  Establish the current morphological status of the water body.

- **Step 2: Main Stem Rivers, Minor Tributaries and Coastal Streams**
  Apply MImAS to the 500m section of channel surrounding the proposed activity to see whether or not the activity is sufficiently significant to downgrade this local section of channel.

- **Step 3: Main Stem Rivers Only**
  Check cumulative impact and Single Activity Limits at water body scale.

Environmental Standards Test Process Summary

Figure 2 Main Stem Rivers (longer than 5km and more than 2.5% from a Morphological Condition Limit)
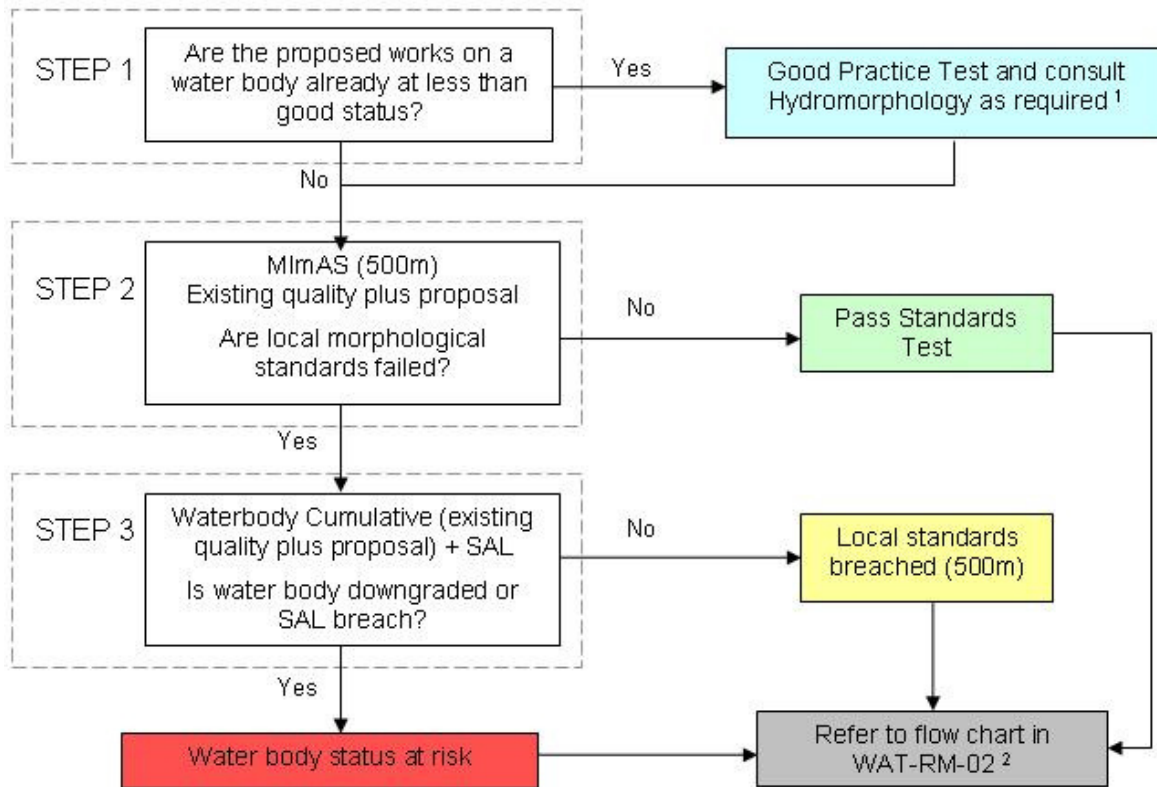
[1] See Figure 5

[2] See *WAT-RM-02*, Figure 2 *Summary of outcomes from the Environmental Standards test*
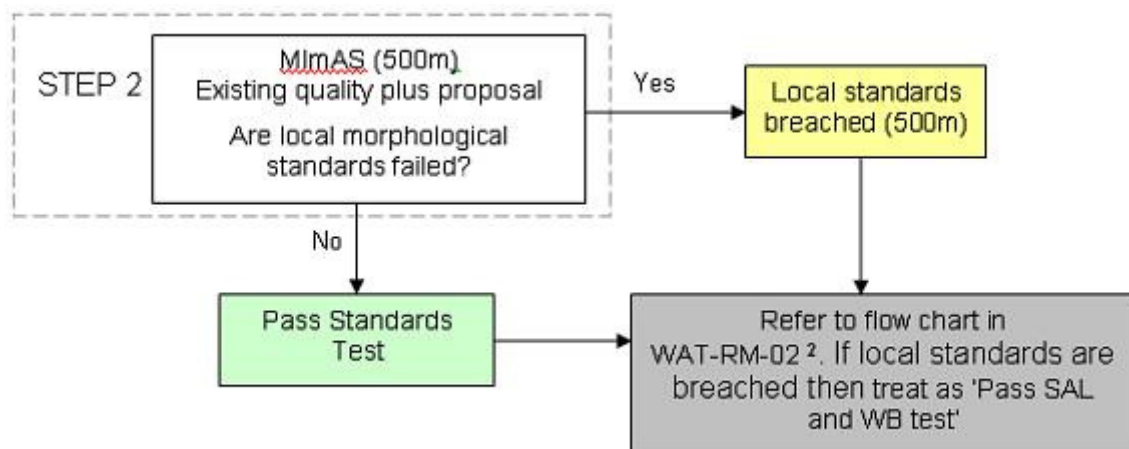
Figure 3   Main Stem Rivers (less than 5km long and/or within 2.5% of a Morphological Condition Limit)
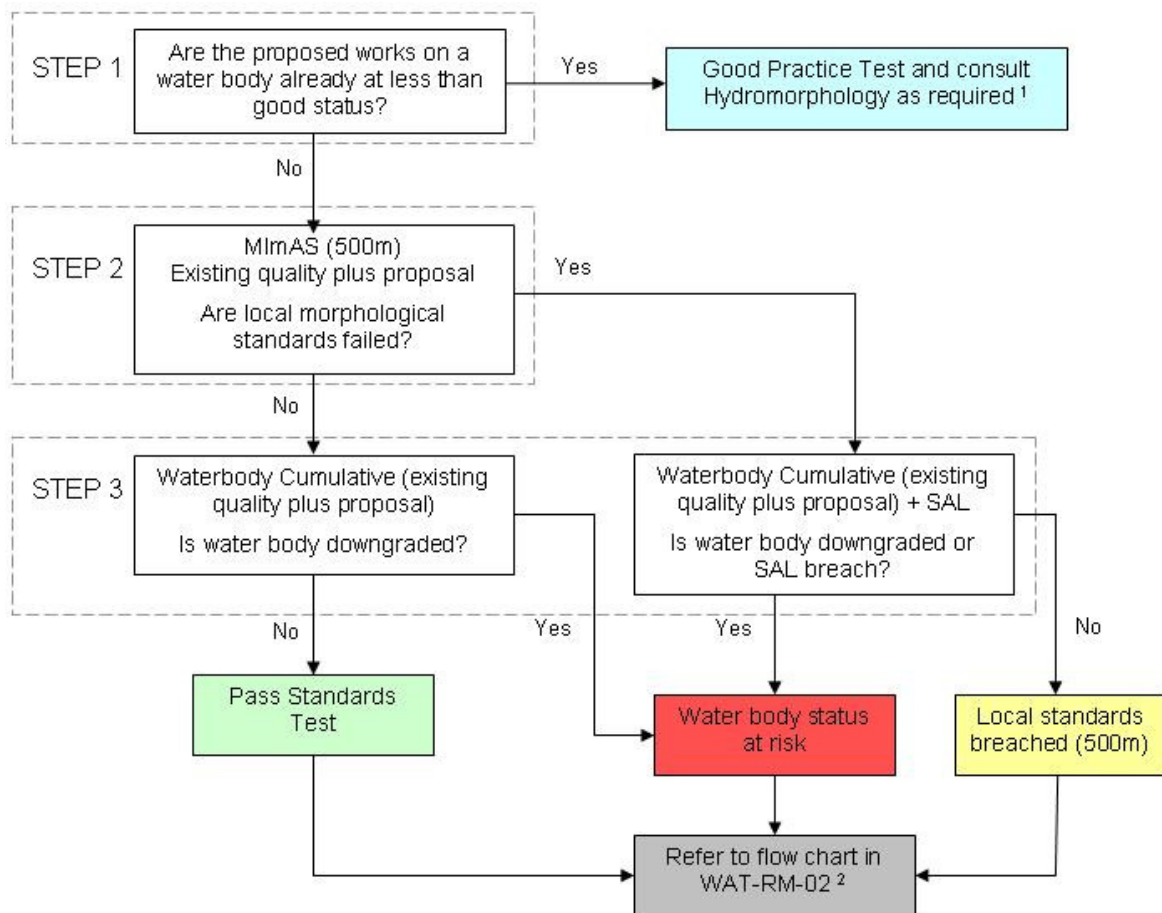
[1] See Figure 5

[2] See *WAT-RM-02*, Figure 2 *Summary of outcomes from the Environmental Standards test*

Figure 4   Minor Tributaries and Coastal Streams

[2] See *WAT-RM-02*, Figure 2 *Summary of outcomes from the Environmental Standards test*

Step 1 Establish existing morphological status of the water body

The existing morphological status of the water body on which the works are proposed can be found in the classification spreadsheet on Q-Pulse: *Morphology Classification Summary* (QP: ES-ECOL-S-01). Use the water body identification number to locate it in the spreadsheet then read across to find the status allocated (H=High, G=Good, M=Moderate, P=Poor and B=Bad).

IMPORTANT NOTE: The morphological status may be different from the overall status shown on the intranet GIS. For instance, the morphological status may be GOOD but the chemical status may be MODERATE.

If the existing morphological status of a Main Stem River is MODERATE, POOR or BAD then the application must also be subjected to the Good Practice test even if Step 2 results in a PASS. Further details of the Good Practice test can be found in *WAT-RM-02: Regulation of Engineering Activities*.

Where the existing morphological status is less than GOOD SEPA will have identified measures, through the river basin planning process, which aim to improve the status back to GOOD. Doing so could involve

- restoring previously straightened/realigned channels
- removing or setting back embankments
- removing or mitigating impounding structures
- improving riparian vegetation

These are the major pressures causing downgrades in Scotland. It is possible that new activities may compromise SEPA's ability to restore these water bodies but this can only be assessed on a case by case basis.

Therefore, where existing morphological status is less than GOOD and an application

- involves new channel realignments, embankments or impoundments and
- is on a water body where channel realignment, embankments or impoundments already exist

staff should consult Hydromorphology for further advice.

Where any other activity is proposed or the above are not present on the water body already then staff should proceed with the remainder of the Environmental Standards Test but undertake the Good Practice test regardless of the outcome.

It is also possible that proposed activities may not result in the downgrade of a 500m reach but would downgrade the waterbody. This may happen where there are few existing pressures in the 500m reach but the presence of pressures elsewhere on the water body are such that the capacity used is close to a Morphological Condition Limit. This is likely to be an uncommon situation and is more of an issue on short water bodies as they have less capability to absorb pressure.

For example, if you receive an application for 264m of hard bank protection on a type C river, and the 500m reach is at the very top end of the GOOD status band (5.1% capacity used), then this bank protection will use up an additional 19.8% of the capacity in that 500m reach before it will be downgraded to MODERATE. If the application was for 265m of hard bank protection (which would fail the 500m reach test), but the water body was long (say 15km), then this length of hard bank protection would only use up an additional 0.7% capacity at the waterbody scale. If, however, the water body was short (say 2km) and only just lay within the good status boundary (say 24% capacity was already used up), then the additional 265m of bank protection would use up 5% of capacity and downgrade the waterbody. This would be very serious and must be avoided.

In order to avoid this situation, when checking the classification spreadsheet, make a note of the highest capacity used on the water body. If the water body is less than 5km long **and/or** the current water body capacity used is within 2.5% of a morphological condition limit (e.g. between 22.5-25% for good/moderate boundary, 47.5-50% for moderate/poor boundary etc.) then you should undertake a water body assessment (Step 3) even if the 500m assessment (Step 2) does not result in a failure.

Figure 5   Water body classification check summary
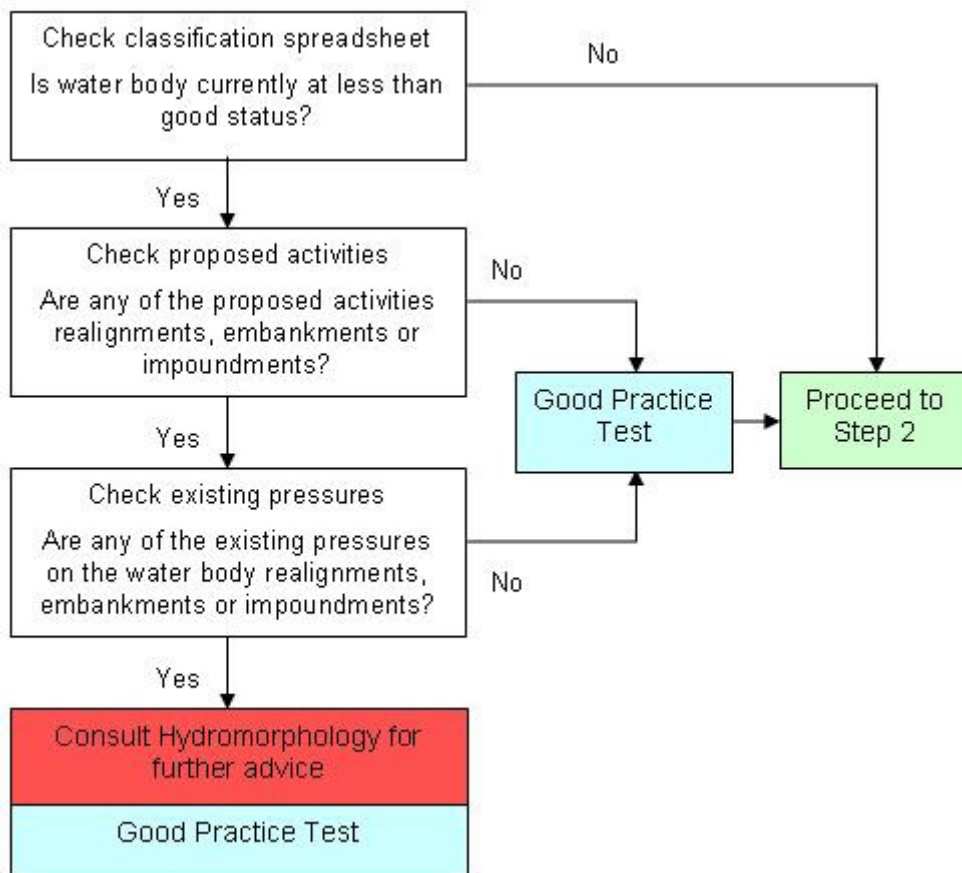
Step 2   Assess the activity(s) at the 500m scale

The 500 m assessment is an important step in the assessment procedure, since it helps to identify activities whose impacts are potentially significant at a local scale. The Oracle MImAS tool should be used to assess the impact of the proposed activity on the 500m section of channel on which the activity is centred, together with the impact of all the other pressures that currently exist in that 500 m reach.

BOX 3 contains a summary of the procedure with *Quicklinks* to more detailed procedures in Part 2.

BOX 3   Guide to Step 2 of the Environmental Standards test

1. Identify the section of channel over which the assessment will be undertaken.
   Quicklink: Identifying the Channel Section on which the 500m assessment should be performed

2. Determine the channel type
   Quicklink: Determining the Channel Type

3. Gather data on existing engineering pressures within the section of channel under assessment
   Quicklink: Gathering Data on Existing Engineering Pressures for input to MImAS

4. Enter data on existing pressures into MImAS and record the capacity used and the 'status' of each river zone. For sites at less than good status (shown as a 'fail' in MImAS), use Table 1 to determine current status.
   Quicklink: Guide to Using MImAS

5. Add the proposed activity or activities into MImAS and record capacity used and 'status' of each river zone (see *Guide to Using MImAS* for guidance)

6. Compare current status with predicted status to determine if deterioration is likely to occur:

   Refer to Table 1 for a summary of the Morphological Condition Limits.

In future, it is likely that procedures will be put in place that will almost completely automate the 500 m assessment by tapping into the existing classification status for the 500 m channel section. In the meantime, however, the collection of the information required to perform the 500 m assessment remains a manual process.

In summary, Step 2 requires an appraisal of the current status of the 500m reach centred on the proposed activity (or activities), followed by an assessment of whether the proposed activity (or activities) will result in a deterioration in status. Table 1 summarises the Morphological Condition Limits that should be applied.

Table 1   Morphological Condition Limits for 500m and Water Body Assessments

Zone	500m and Water Body Assessments			
	High/good	Good/mod	Mod/poor	Poor/bad
Channel	5%	25%	50%	75%
Banks and Riparian zone	5%	25%	50%	75%

Next step - Refer to Figure 2 to Figure 4

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Step 3   Assess new activity(s) at water body scale

Assessment of activity/activities at water body scale consists of two distinct checks.

- Cumulative impact

- Single Activity Limits (SAL)

If either of these checks results in a failure then there is a risk of significant impact on the quality of water environment.

NOTE: Where a water body scale assessment is being carried out but the 500m assessment has been passed, there is no need to carry out the SAL check.

Cumulative Impact

The process is similar to the 500m assessment except that the impact of existing pressures is derived from current morphological classification rather than manual calculation. Thus a manual MImAS calculation only needs to be carried out for the proposed activity(s).

BOX 4 contains a summary of the procedure with *Quicklinks* to more detailed procedures in Part 2.

Single Activity Limits

MImAS uses six channel types, A to F, although Type E (groundwater dominated) channels are not found in Scotland, and Single Activity limits have been defined for all these types (Table 2). Refer to *Determining the Channel Type* for guidance on how to determine what type of channel the activity is occurring in.

The limits are regarded as the maximum extent of an individual pressure which, in its own right, would cause a significant and long term impact on the water environment. This is calculated as the footprint of activity which uses up 25% capacity (good/moderate boundary) on a reach of river which is 900m long.

If a proposed activity exceeds the 'Single Activity Limit', then it should be recorded that a 'Single Activity Limit' has been breached. In this case SEPA must be sure that the environmental harm is outweighed by benefit to sustainable human development. This is done using *WAT-RM-34: Derogation Determination - Adverse Impacts on the Water Environment*.

If a proposed activity extends an existing pressure of the same type (e.g. hard bank protection is extended) then the total continuous length of the pressure (existing + proposed) should be compared against the Single Activity Limit.

BOX 4   Guide to Step 3 of the Environmental Standards test

7. Identify the waterbody length. This is the section of channel over which the assessment will be undertaken.
    Quicklink: Identifying the Channel Section on which the assessment should be performed.

8. Check the current morphological classification for the Water Body using the classification spreadsheet in Q-Pulse *Morphology Classification Summary* (QP: ES-ECOL-S-01). Make a note of the capacity used for each zone of the channel (i.e. bed and bank). **Important note**: Do not keep a local copy of this spreadsheet as it will be updated from time to time.

9. Determine the channel type at the site of the proposed activity(ies)
    Quicklink: Determining the Channel Type.

10. Enter data on proposed activity(ies), waterbody length and channel type into MImAS and record the capacity used in each river zone.
    Quicklink: Guide to Using MImAS

11. Add the capacity used by the proposed activity(ies) to the capacity reported in the classification. The capacities for each zone should be added separately (e.g., bank capacity usage from proposal + bank capacity from classification; bed to bed, etc). Use this combined capacity to determine the predicted status, referring to the Environmental Standards shown in Table 1.

12. Compare current status with predicted status to determine if deterioration is likely to occur

Refer to Table 1 for a summary of the Morphological Condition Limits.

* IMPORTANT: The MImAS tool is currently set-up to perform the 500m assessment. When running a Water Body assessment, the water body length must be set to the full water body length (see section 2.1 for details of how to identify water body length).

Next step - Refer to Figure 2 to Figure 4

Table 2   Water Body Single Activity Limits (m)

Activity	Type A	Type B	Type C	Type D	Type F
Riparian vegetation	7500	2500	1410	1410	2500
Sediment Removal	900	540	360	320	590
Dredging	540	340	250	210	390
Embankments & Floodwalls (excludes bank reinforcement)	1070	670	270	390	780
Set Back Embankments and Floodwalls	22500	11250	3460	5630	11250
Grey (Hard) Bank Protection	2810	1180	600	710	1180
Green (Soft) Bank Protection	7500	2370	1450	1450	2370
Bank Reprofiling	7500	2370	1450	1450	2370
High Impact Realignment (e.g. straightening)	680	390	140	190	450
Low Impact Realignment (e.g. re-meandering)	1730	1020	730	590	1180
Flood Bypass Channel	900	660	240	330	800
Open Culverts	460	230	100	130	260
Culvert with natural bed (e.g. arch culvert)*	540	340	140	190	390
Culvert with artificial bed (e.g. pipe or box culverts)	420	280	120	160	330
Croys, Groynes, Flow Deflectors (length of structure =)	1730	590	300	360	590
Bed Reinforcement	680	390	140	210	450
Impoundments (length of impounded water =)	540	340	140	190	390
Bridges (number of piers x river width)	1410	800	260	400	900

Notes- All values are based on length along channel or bank, except weirs (based on length of impounded water), bridge piers (based on number of piers and river width), and flow deflectors (based on total length protruding into channel).

* In CLAS and on the application form, culverts for land gain are separated from bridging culverts. For the ES Test, this distinction is not necessary and all culverts are treated the same.

PART 2: Detailed Procedures

The different sections in this part of the document provide an overview of how to perform the following procedures as part of the Environmental Standards Test:

- 2.1 Identifying the Channel Section

- 2.2 Determining the Channel Type

- 2.3 Gathering Data on Existing Engineering Pressures

- 2.4 Guide to Using MImAS

Part 2 is organised into four sections, with each section providing an overview of a specific procedure. Included at the end of each procedure are *Quicklinks* back to the relevant sections in Part 1, like this:

Quicklink: Step 1: Establish existing morphological status of the water body

Quicklink: Step 2: Assess the activity(s) at the 500m scale

Quicklink: Step 3: Assess new activity(s) at water body scale

Throughout the procedures there are also *Quicklinks* to more detailed information in Part 3 (Annexes) to help carry out the procedures.

Note that each section in Part 1 also includes *Quicklinks* to the relevant procedure overview in Part 2.

2.1 Identifying the Channel Section

The section of channel to be assessed should always be defined centred on the centre (NGR) of the proposed activity.

- If undertaking a 500m assessment, a default length of 500m should be defined around the proposed activity.

- If undertaking a Water Body assessment, the whole length of the Water Body should be used. This can be found by opening the "River Water Bodies (baseline)" layer under the "Rivers" theme in SEPA's Intranet GIS and using the "Identify" tool to click on the Water Body. The length will be shown in the box displayed below the map.

Some exceptions to these rules are provided in BOX 5, BOX 6 and BOX 7.

Once the length of channel has been determined, create an electronic copy of the map and save it for later use.

1. **Identify the stretch of channel to be assessed**
   To do this, you should open the SEPA intranet GIS application and zoom to the NGR supplied on the license application.
   TIP:

   - For 500m assessments set the radius to 0.5 km

   - For Main Stem River Water Body assessments set the radius to 2.5km and zoom to NGR. Switch on the 'River Water Body (baseline)' layer in the 'Rivers' theme, make the layer active and use the 'Select' tool to highlight the whole Water Body. The zoom tools and grid reference can then be used to zoom in and out as required

Figure 6   Identifying the location of the activity using a grid reference in GIS
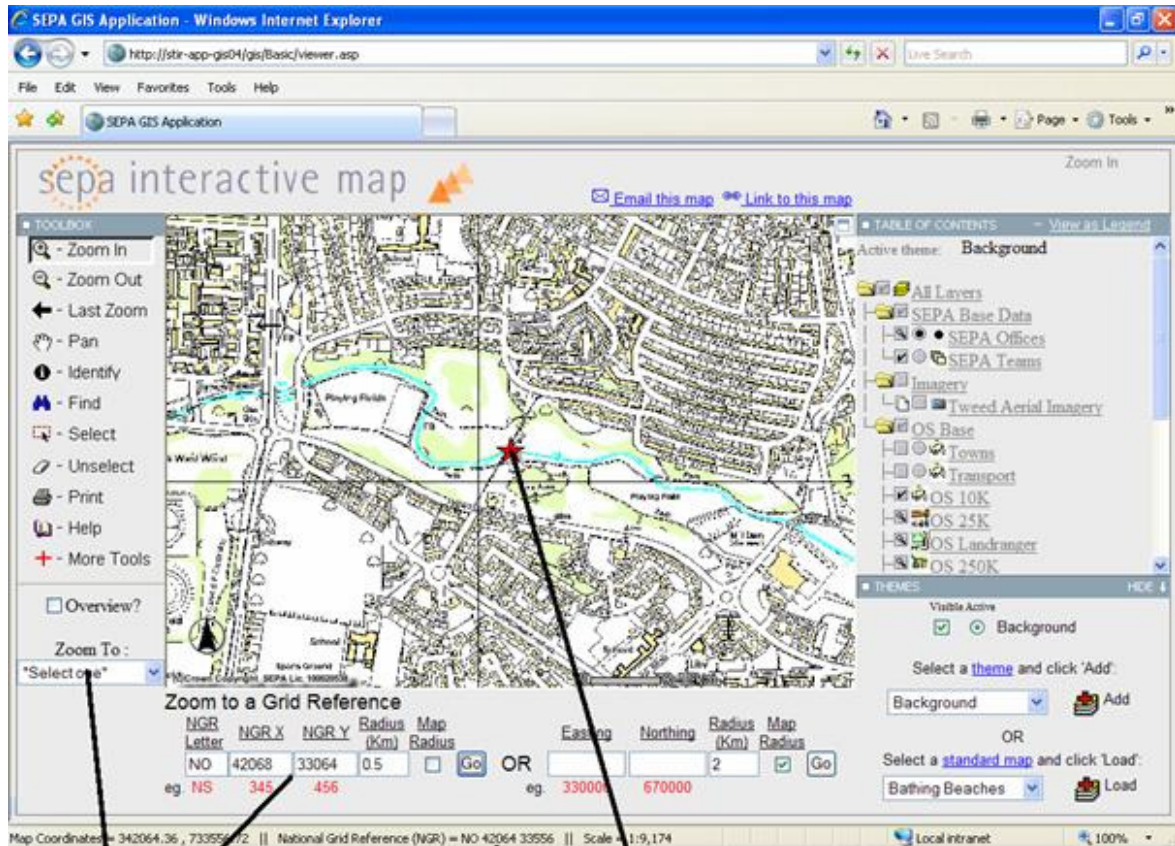
2. **Mark out the assessment length**
   For 500m assessments use the 'Measure' tool (click 'More Tools' to access) to measure 0.25km either side of the NGR location respectively. This will identify the upstream and downstream limits of the channel section to be assessed. Use the 'Graphics' tool to draw a line between the upstream and downstream ends of the channel section.

Figure 7   Identifying the length of channel to be assessed using GIS
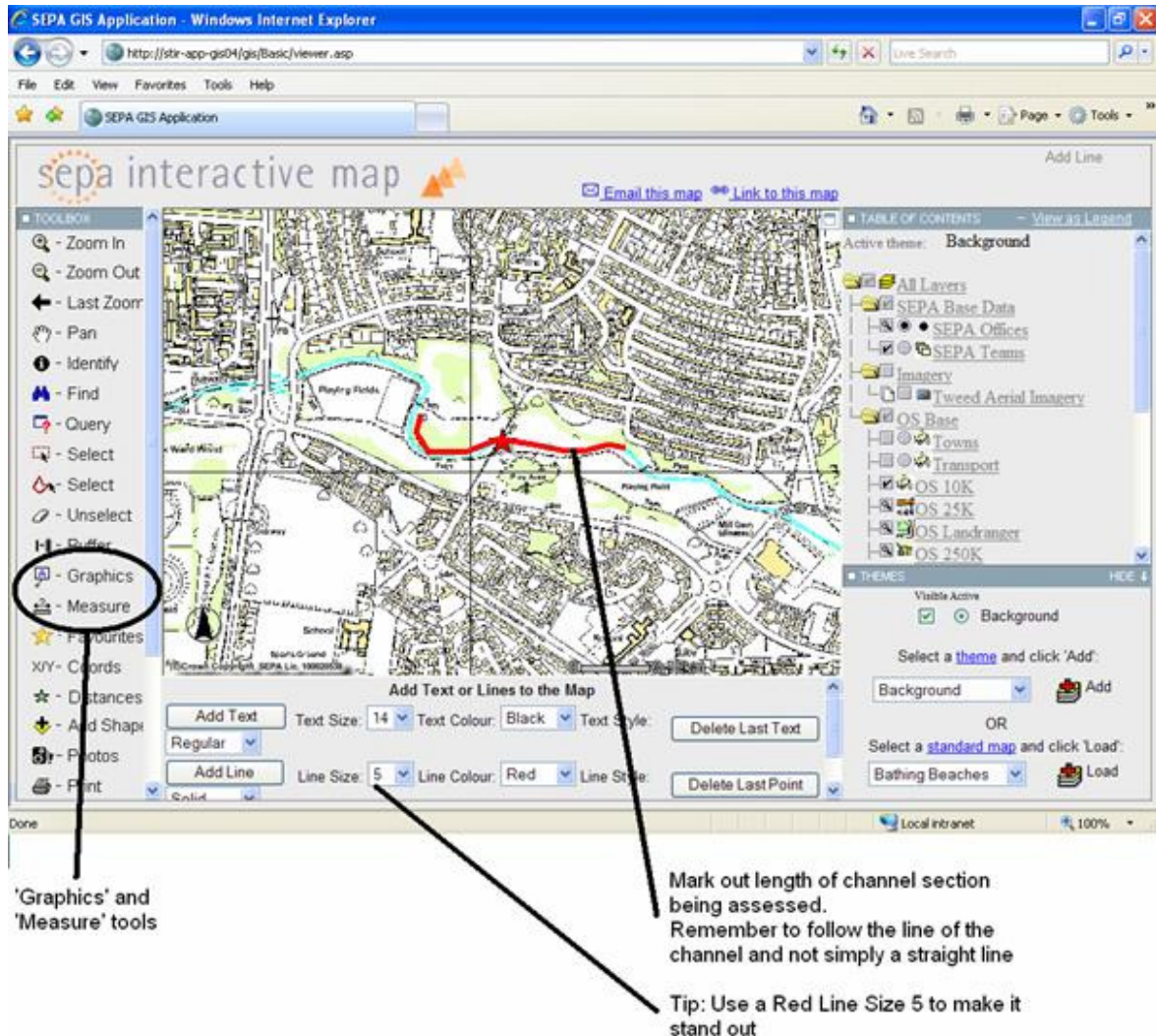
3. **Create a copy of the map**
   Create a MS Word copy of the map using the 'How to copy a map to MS Word' guidance under the 'Print Map' options under the map. Alternatively, press the 'Print Scrn' button on your keyboard, then paste the image into a word document. Save this to an appropriate folder for future reference.

BOX 5   Assessing activities > 500m long (for 500m assessment)

If an activity exceeds 500m in length and an assessment using the MImAS tool is required, the procedure outlined below should be followed:

1. Define an NGR that reflects the midpoint point of the proposed activity.

2. Extend the length of channel over which the assessment is being carried in increments of 500m until the entire activity is incorporated. Keep the midpoint of the proposed activity at the midpoint of the channel length being assessed.

3. Enter the correct length of channel over which the assessment is carried out into the MImAS tool (See *Guide to Using MImAS* for guidance on using the MImAS tool).

BOX 6   Assessing activities affecting multiple channels or activities within the vicinity of tributary junctions

If an activity affects multiple channels or is within the vicinity of a tributary junction (e.g., bank protection across a confluence where two waterbodies join), the procedure outlined below should be followed:

1. Identify each channel or waterbody affected by the activity. Remember that a tributary could be affected if it is within 250m of an activity centre point for a 500m assessment.

2. Identify what length of activity affects each channel or waterbody

3. Extend the assessment area to cover 500m on each affected channel or waterbody

4. Carry out the MImAS assessment separately on each channel or waterbody..

BOX 7   Assessing multiple activities

If there are multiple activities in an application the procedure outlined below should be followed:

1. For a 500m assessment where the activities are more than 500m apart separate 500m assessments should be carried out for each activity.

2. For a 500m assessment where the activities are less then 500m apart the length of channel assessed should be extended by 250m upstream of the furthest upstream activity and 250m downstream of the furthest downstream activity. The revised length of channel over which the assessment is carried out should be entered into the MImAS tool (See *Guide to Using MImAS* for guidance on using the MImAS tool).

Quicklink: Step 1: Establish existing morphological status of the water body

Quicklink: Step 2: Assess the activity(s) at the 500m scale

Quicklink: Step 3: Assess new activity(s) at water body scale

2.2 Determining the Channel Type

2.2.1 Overview of approach

MImAS has been developed to work on six commonly occurring UK channel types. For more information on the channel types see *Annex A*. A summary is given in Box 9 below.

SEPA now has a database of channel types for the whole Main Stem River network in Scotland. The database was developed using remotely sensed data i.e. using maps and digital ground models. It is a "prediction" of channel type. A more detailed explanation of how the database was developed and what to be aware of when using it is contained in *Annex B*. First time users MUST take time to read this supplemental information before using the database.

For Minor Tributaries and Coastal Streams a simplified method of typing channels has been developed. This method of typing channels only considers two of the most common channel types in Scotland: Type B and Type C. Of course, if you know the channel type already, you should use that.

In certain circumstances the allocation of river type should be checked using a field survey.

A summary of the procedure for determining channel type is given below with quick links to the relevant sections of this chapter.

Main stem rivers

1. Determine channel type(s) from SEPA River Type database (Section 2.2.2)
2. Verify database types using field survey as necessary (Section 2.2.4)

Minor tributaries and coastal streams

1. Determine channel type(s) using simplified desk assessment method (Section 2.2.3)
2. Verify findings of desk assessment using field survey as necessary (Section 2.2.4)

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BOX 8   Supplemental technical information on channel types

The channel types have been defined in consideration of the processes of sediment supply and transport, stream energy and channel sensitivity. 12 commonly occurring UK channel types have been grouped into 6 categories which are broadly similar in form and, more importantly, sensitivity to morphological pressures. The six types can be summarized as flows:

Type A: Bedrock channels and upland cascading channels

Type B: Step-pool channels and plane bed channels lacking sediment deposits (e.g. bars and riffles).

Type C: Plane-riffle (channels with poorly formed pools and riffles), braided and wandering channels.

Type D: Actively meandering channels (channels with well defined pools and riffles and often have eroding banks on the outside of meanders and sediment deposits on the inside of meanders).

Type E: Ground-water dominated channels. Not relevant to Scotland.

Type F: Lowland passive meandering channels. Lowland channels with a meandering planform that are no longer actively adjusting their planform through erosion, e.g. channels in carse environments.

</div>

2.2.2 Determining channel type from SEPA River Type database

As noted in the introduction above the River Type database is a prediction of river type based on computer modelling of remotely sensed data (maps and ground elevation models). The database will be progressively updated with the results of field survey.

It is therefore very important that users of this database have an understanding of how it was derived and what to bear in mind when using the results. A detailed explanation of this can be found in *Annex B* which staff MUST read before using the database.

To access the database, open SEPA's GIS Intranet and add the "Morphology" theme to the map. Make sure that the "River Type" layer is visible. Zoom to the location of the proposed activity using the grid reference or Water Body ID zoom tools. The river type will be displayed as a coloured line along the watercourse. Different line colours represent different river types and different line styles represent different "confidence" flags.
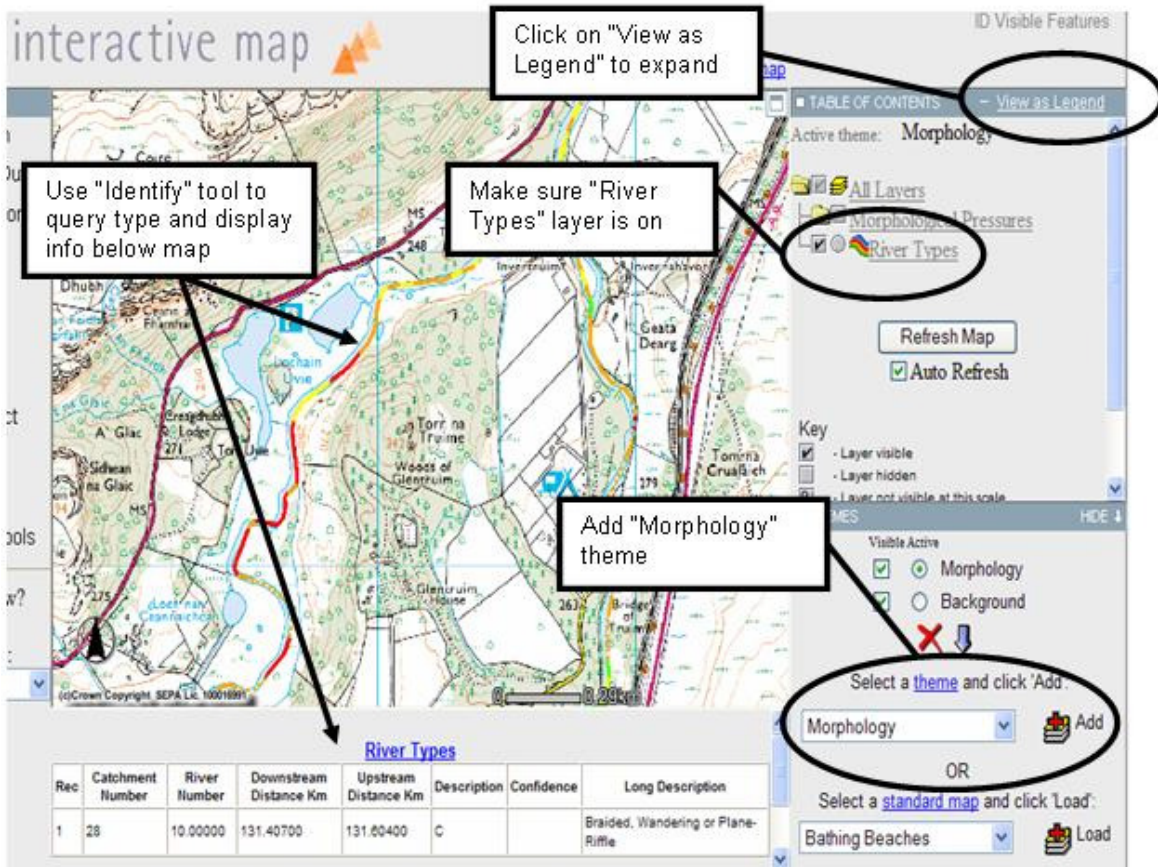
There are three "confidence" flag situations:

- **LC**
  indicates that the type was derived by prediction but for some reason

there is low confidence in the prediction (see Annex B for further details)

- ◼ **No flag** (or Standard Confidence)
  indicates that the type was derived by prediction

- ◼ **HC**
  indicates that the type was derived from field survey and so there is higher confidence that the type is accurate.

To view a legend for the river types click the "View as Legend" link at the top right corner of the Table of Contents box.
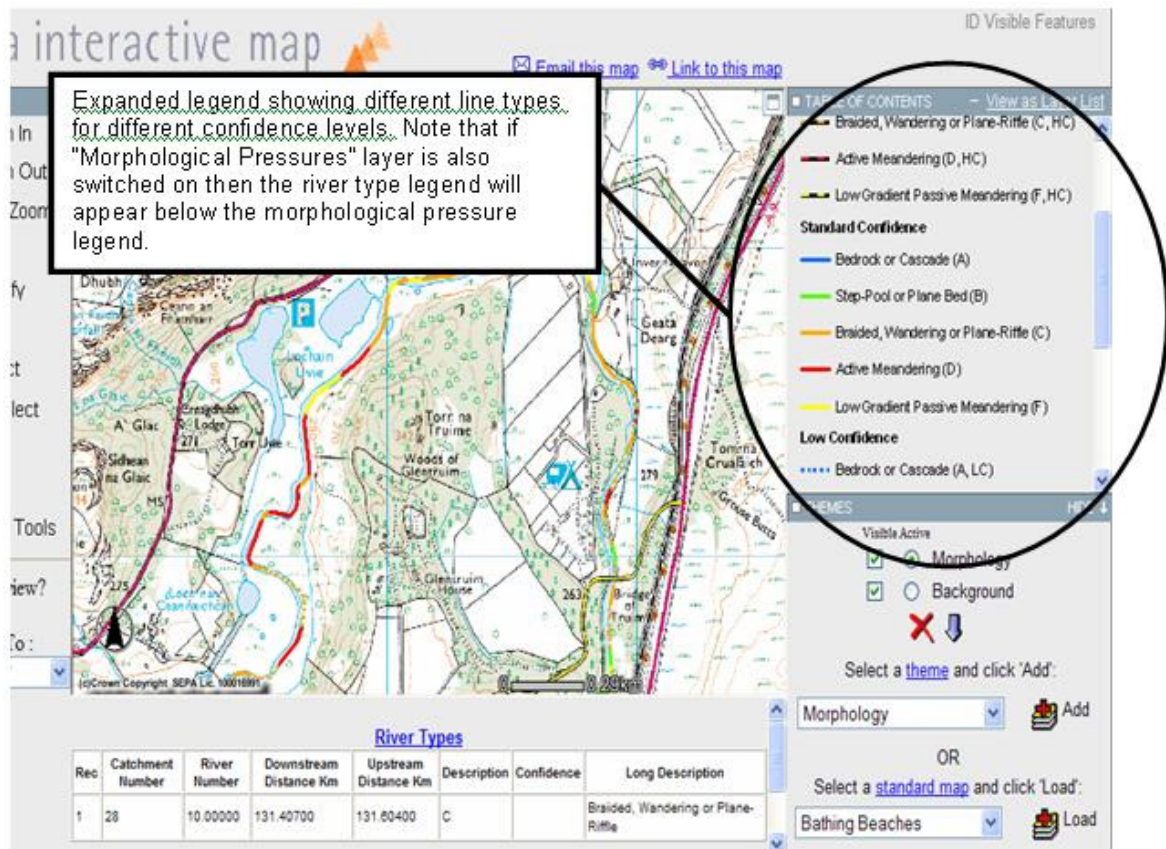
Figure 8   Viewing river type on GIS

Figure 9   Viewing river type legend on GIS

To undertake MImAS assessments simply use the river type shown on the map at the location of the proposed and/or existing activities. For line pressures (such as bank protection, embankments or realignment) that straddle more than one type separate MImAS calculations should be carried out using the proportion of each pressure in each type (see example in BOX 9 below).

BOX 9   Example of splitting pressures over different channel types
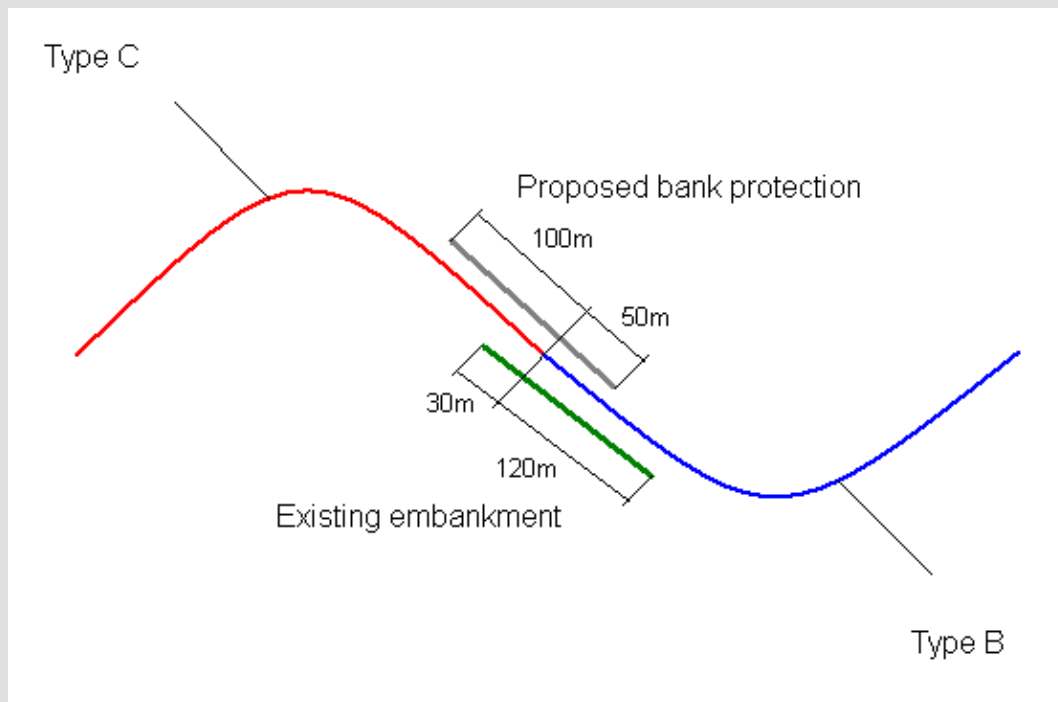
In the above example two MImAS calculations would be carried out.

- 100m bank protection + 30m embankment with Type C

- 50m bank protection + 120m embankment with Type B

The "capacity used" figures from both calculations would then be added to obtain the total capacity used on the length of river being assessed.

## 2.2.3 Determining channel type using the simplified method

This method should only be used where there is no typology information in the SEPA River Type database (i.e. minor tributaries and coastal streams) and where a field survey will not be carried out. Where no typology information is available in the database staff are strongly encouraged to use a field visit to identify channel type, whenever possible and practicable, rather than this simplified method. For further guidance on when a field survey should be carried out see Section 2.2.4 below.

The method only considers two of the channel types found in Scotland, Type B and Type C. These are the two most common types found in the database and they also represent two different channel sensitivities i.e. Type B represents a low sensitivity and Type C a high sensitivity.

To use the simplified method you must first calculate the gradient of the channel through the reach under consideration. A step by step guide to doing this is given below.

- Open SEPA Intranet GIS and zoom to the location of the reach

- Making sure that the OS 25K background map is displayed identify a contour line which passes through the channel at or close to the reach.

- Identify the next contour upstream or downstream and measure the distance between where the two contour lines cross the channel. The distance should be measured along the line of the channel. Where several contour lines cross the channel through the reach be careful to pick ones near the proposed activity and which are representative of the gradient at that point.

- Calculate the gradient in the form 1:X where X can be found by dividing the distance between the contours by the difference in height (upstream contour level minus downstream contour level).

- Where X is less than or equal to 80 then the channel should be assumed to be Type B. Where X is greater than 80 then the channel should be assumed to be Type C.

Figure 10 Using contours from GIS to calculate channel gradient
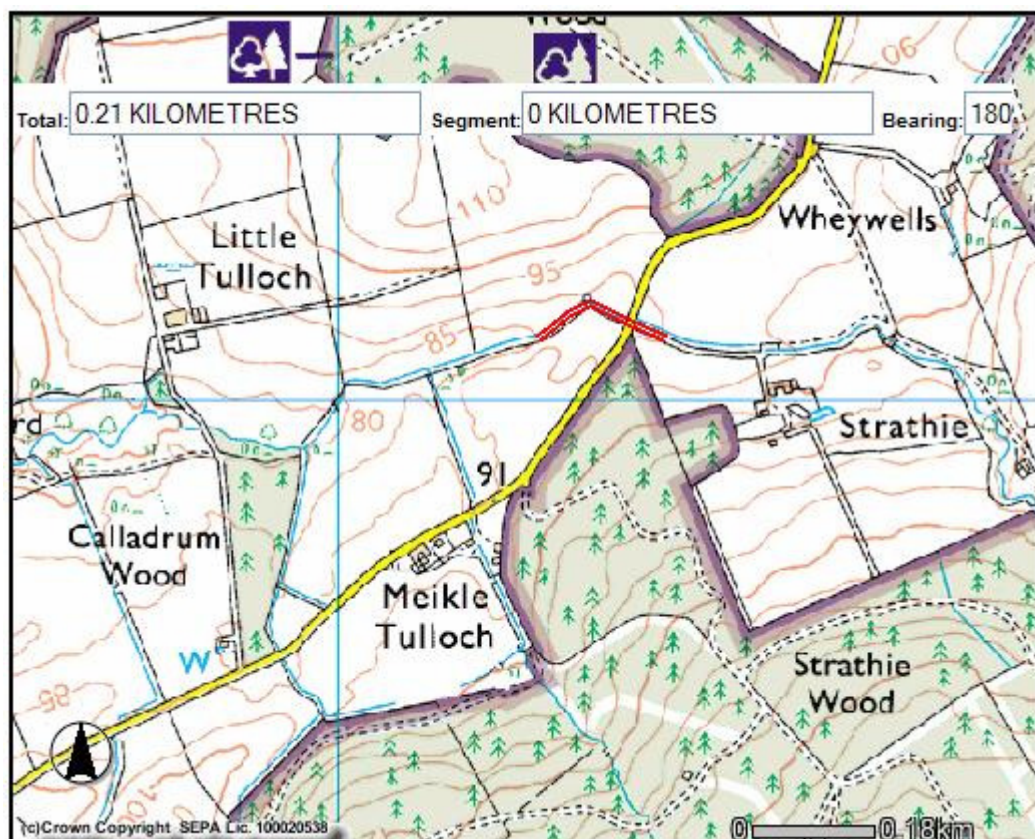
In the example above, the distance measured between the 90m and 85m contours is 210m. In this case X = 210/(90-85) = 42, so the gradient is 1:42. X is less than 80 so the channel is Type B.

2.2.4 When to use field survey to verify desk assessment of type

It is clear that there is generally more confidence in river type determined by field survey than from current desk-based assessment techniques. It is therefore obvious that if staff are visiting the site for any reason they should also make a note of the channel type(s) present in the reach being considered.

There are other circumstances where increased confidence in the channel type chosen for assessment is necessary. A summary of these circumstances is given below and should be used as a guide to decide when field survey is required

- Whenever staff visit the reach under consideration, even if this is for another reason.

- If the 500m MImAS assessment results in failure, i.e. status of 500m reach downgraded or is below good status.

- High risk or contentious applications.

- Where there is a "low confidence" in the typology noted in the database.

- Where current classification (link) shows that the Water Body is already close to a status class boundary (e.g. where existing capacity used is 24.5% this is very close to the 25% limit between Good and Moderate status). This only applies to Water Body assessments.

- Where examination of the background information suggests a different type to that derived from the database. For example, bedrock is present but the channel is not Type A; meanders and gravel bars are present but the channel is Type A or B). See *Annex A* for more guidance on indicators of channel type.

Guidance on identifying channel type by field survey is in *Annex C*.

Quicklink: Step 1: Establish existing morphological status of the water body

Quicklink: Step 2: Assess the activity(s) at the 500m scale

Quicklink: Step 3: Assess new activity(s) at water body scale

2.3 Gathering Data on Existing Engineering Pressures

2.3.1 Summary of pressures assessed by MImAS

MImAS can be used to assess a wide range of engineering pressures. A summary of the engineering pressures assessed in MImAS is provided in Table 3. Not all engineering activities can be directly assessed using MImAS and in some instances, e.g. box culverts and flood walls, it is necessary to combine two or more activities to create the desired engineering activity. See *Morphological Pressure Survey Guidance* (QP: ES-ECOL-P-WFD004) for further details.

IMPORTANT: Although MImAS has the ability to assess impacts to the sedimentary and hydrological regime, protocols for running these assessments are still being developed.

IMPORTANT: Data is entered into MImAS in the form of activity footprints. Prior to gathering data, it is important to understand what 'activity footprint' information is required to run MImAS. See *Morphological Pressure Survey Guidance* (QP: ES-ECOL-P-WFD004)for further details.

Table 3   Summary of Engineering Pressures Assessed using MImAS

Activity Type	Definition
Sediment removal (<50% channel width affected)	Removal of substrate from rivers. Does not extend greater than 50% of the channel width. If removing from >50% of channel width then record as dredging. Activity footprint = length of channel affected
Dredging (>50% channel width affected)	Removal of river substrate from more than 50% of the surface water width. Activity footprint = length of channel affected
Sediment introduction	Sediment imported from external source or re-introduced from other part of surface water after a period of storage. May be carried out as part of restoration activities. Activity footprint = length of channel affected
Sediment manipulation	Movement of sediment within a surface water. For example, for maintenance of fishing pools, where sediment is not removed but displaced in channel. Activity footprint = length of channel affected
Bank top embankments and floodwalls	Construction of an embankment within 10m or one channel width (whichever is greater) of bank top to protect adjacent areas from flooding. Includes land raising. Activity footprint = length of riverbank affected (note that this may be different from the length of the embankment/floodwall) Where floodwall forms the river bank enter as "embankment" and "bank reinforcement" in MImAS.

(Table 3 continued)	
Activity Type	**Definition**
Set-back embankments and floodwalls	Construction of an embankment or floodwall set back from the bank top a distance greater than 10m or one channel width (whichever is greater). Includes land raising. Activity footprint = length of riverbank affected (note that this may be different from the length of the embankment/floodwall)
Green bank reinforcement	This includes the use of vegetation and biodegradable geotextiles over the full height of the bank. Also includes the use of rip rap and log / timber restricted to the bank toe. The bank toe means roughly the lower third of the natural bank height and would therefore normally be submerged and not visible. Activity footprint = total length of bank affected (i.e. if both banks are reinforced then add the length of each bank)
Grey bank reinforcement	This includes the use of materials such as rip-rap over more than just the toe of the bank, gabion baskets, concrete, grouted stone, brick or block stonework, sheet piling, wood piling and non-biodegradable geotextiles. Activity footprint = total length of bank affected (i.e. if both banks are reinforced then add the length of each bank)
Bank re-profiling	Changing the slope of a bank/shore. Does not include heightening of bank or shore. Activity footprint = total length of bank affected
Open culverts	Channel bed and banks reinforced but with no top covering. Activity footprint = total length of channel affected Enter in MImAS as "bed reinforcement" plus "bank reinforcement"
Culverts with natural bed	This includes arch culverts and pipe or box culverts where the bottom of the pipe or box is buried such that the bed through the culvert is natural substrate. Activity footprint = total length of channel affected Enter in MImAS as "culverts"
Culverts with artificial bed	This includes pipe or box culverts where the bed of the channel through the culvert is artificial (e.g. concrete, gabion mattress, stone pitching). Activity footprint = total length of channel affected Unfortunately the MImAS tool cannot currently assess this pressure correctly so a manual calculation of "capacity used" must be performed using the spreadsheet *MImAS Capacity for Culverts with Artificial Bed* (QP: ES-ECOL-S-02).
High Impact Realignment	Any alteration to the planform, length or width of a river channel which reduces its naturalness, i.e. takes it to a less natural state. Activity footprint = total length of original channel affected

(Table 3 continued)	
Activity Type	**Definition**
Low Impact Realignment	Where channel is modified or moved but the natural state is maintained or improved. For example, restoration of a modified river to more natural channel pattern by re meandering. Can also include diverting a channel while maintaining its naturalness. This term can also be used to refer to a previously high impact realignment which has recovered some naturalness. Activity footprint = total length of original channel affected.
Bed reinforcement	Reinforcement of bed only using either artificial (i.e. gabions, concrete) or natural (i.e. rock) materials. Activity footprint = total length of channel affected
Croys, groynes, flow deflectors	Structures placed in-river or in-loch. Usually for fisheries enhancement or bank/shore protection. Manipulates flow and sediment movement. Activity footprint = length of structure projecting from bank
Bridges	Includes single span structures and span structures with piers (in stream supports). Activity footprint1 = number of piers x channel width Activity footprint2 = total length of abutments entered as grey bank reinforcement where applicable.
Impoundments and weirs	Man-made structures that extend across the entire width of a river channel and that impound flow. This includes accidental impoundments such as fords or pipe crossings that impound water or sediment. Activity footprint = height of impoundment x 50
Flood by-pass channel	Additional flow route, normally associated with flood management schemes.
Fords	River crossing but is not raised i.e. is at bed level. May be natural substrate or reinforced with artificial material. Activity footprint 1 = length of bed reinforcement as applicable Activity footprint 2 = total length of bank re-profiling/reinforcement as applicable
Pipeline/cable crossings	Pipeline or cable laid below the bed, submerged, or spanned across a river above the water surface. These can be treated as either bridges or impoundments as applicable. Activity footprint = as bridges
Boat slips	Reinforced structure impacting the bank/shore and sometimes the bed of rivers. Activity footprint 1 = length of bank reinforcement as applicable Activity footprint 2 = length of structure as flow deflector as applicable

2.3.2 Sources of data on morphology pressures

There are three main sources of data on morphology pressures:

- SEPA's Morphology Pressures Database (MPD), which is available on the intranet GIS under the 'Morphology Pressures' layer

- Field survey of morphology pressures (Morphology Pressures Survey (MPS))

- Other sources such as reports, maps and aerial photographs. Some guidance on using maps and aerial photographs to identify pressures on Minor Tributaries or Coastal streams is provided in *Annex D*.

You should begin your assessment by viewing the MPD.

2.3.3 Using the Morphology Pressures Database (MPD)

The MPD is a series of GIS layers that show where morphological pressures are and what data SEPA holds about them.

Before using the MPD, please note the following:

- The database covers all the Main Stem Rivers in Scotland, but not Minor Tributaries or Coastal Streams

- Some pressures are not fully recorded. In particular, hard bank protection and smaller embankments are often missed. In urban areas particularly there is likely to be much more bank protection and/or embankment than is shown in the database.

- The MPD does not contain information on riparian vegetation loss. This is held as a separate database that is not yet available on the intranet GIS.

To view the database, open SEPA's GIS intranet and zoom to the area you are interested in. Then click on the dropdown list next to Add Layer, select 'Morphology' and click on 'Add Layer'. Make sure the "Morphological pressures" layer is switched on. Next, click on View as Layer List to display a key to the pressures.

Figure 11 Viewing morphological pressures on GIS
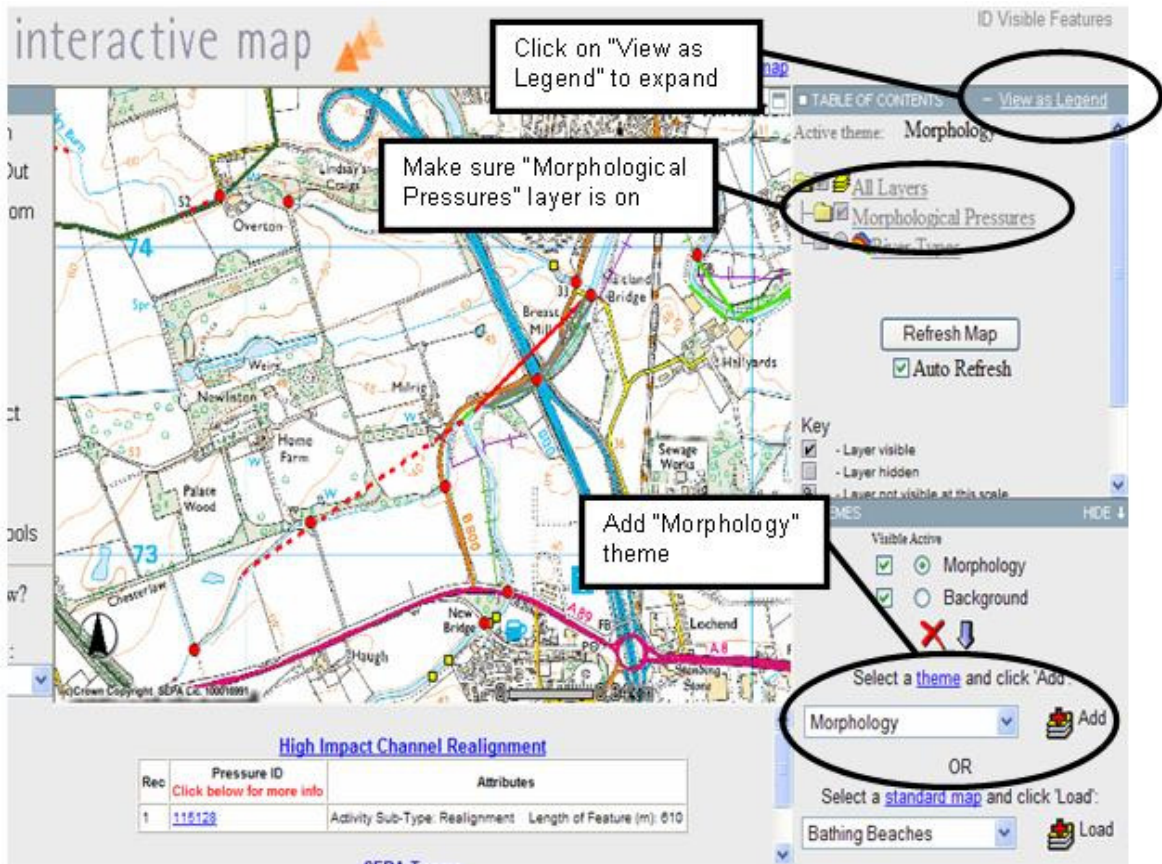
IMPORTANT: linear pressures are displayed as a straight line connecting the start and end points of a pressure. But the pressure itself may not be straight.

Figure 12 Identifying the length of embankments on GIS
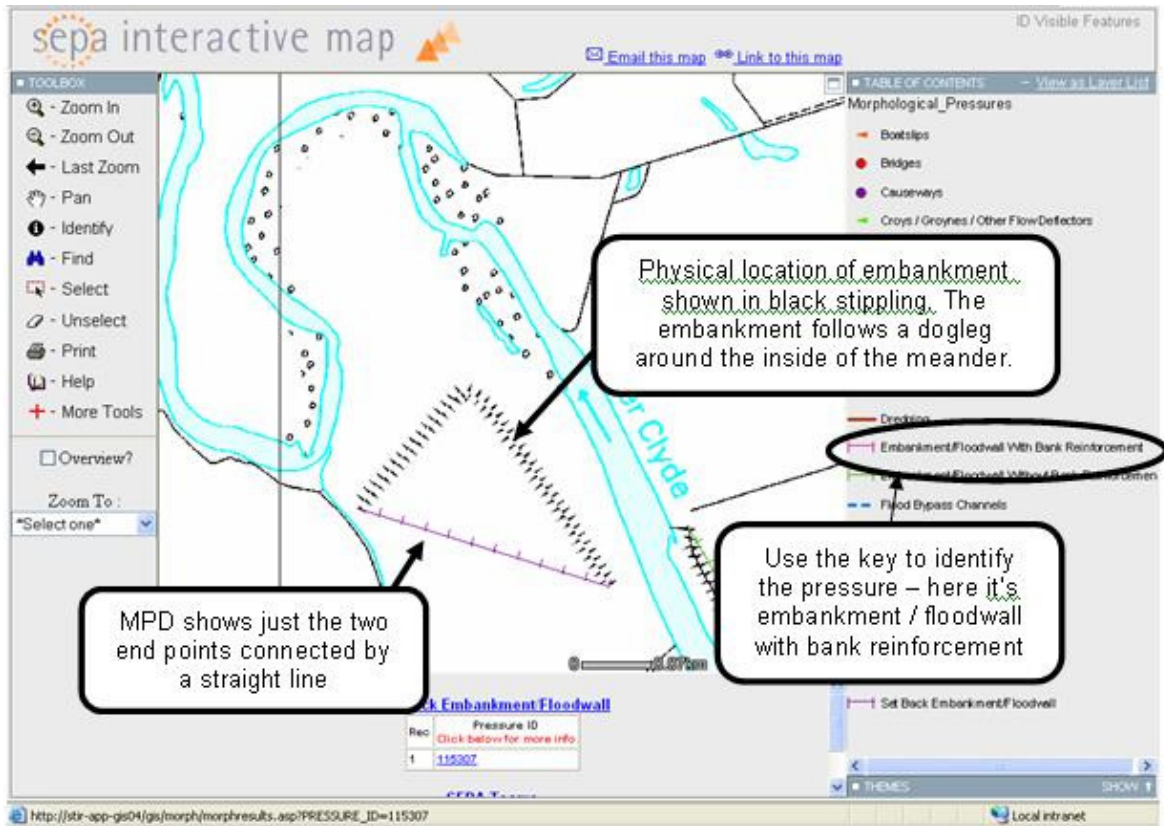
To find out the length of the pressure, click on the ❶ - Identify button in the toolbox, then click (carefully) on the pressure.

TIP: *Ensure that the radio button next to the morphology pressures layer is selected to make it the 'Active' layer (This is in the 'Themes' box in the lower right hand part of the screen).*

Then click on the blue number in the box at the foot of the page to bring up the relevant information:

Figure 13 Morphological Pressure Results

Attribute	Value
Activity ID	115307
Activity Sub-Type	Set back Embankment
Date	9999
Reason	unknown
Condition	Unknown
Length of Feature (m)	418
Width of Channel (m)	22
Height (m)	-99
Distance to Embankment (m)	143
Bank Affected	L

Make a note of the length of the pressure and what it is. Repeat this exercise for all the pressures present within the reach of interest.

2.3.4 Morphology Pressure Survey (MPS)

You should use the MPS method described in *Morphological Pressure Survey Guidance* (QP: ES-ECOL-P-WFD004) to gather data in the field.

The survey is carried out over a 500m length of channel. The survey takes around an hour to complete depending on site conditions and access to the channel.

To allow SEPA to store information on engineering pressures, the form requires the NGR of activities to be recorded. You should take a handheld GPS and camera when surveying.

A field survey form can be found on Q-Pulse in the *Morphological Pressure Survey Field Form* (QP: ES-ECOL-F-WFD004)] and detailed guidance is provided in the *Morphological Pressure Survey Guidance* (QP: ES-ECOL-P-WFD004).

Quicklink: Step 1: Establish existing morphological status of the water body

Quicklink: Step 2: Assess the activity(s) at the 500m scale

Quicklink: Step 3: Assess new activity(s) at water body scale

2.4 Guide to Using MImAS

2.4.1 Accessing the MImAS Tool

3. 1.Click on the red Oracle logo on the intranet homepage

4. 2.Click the 'Live' button then enter your username and password (if you do not have a username and password you can use username: browser, password: centralbrowser). The database is C01L.

5. 3.Open the SEPA Menu (drop down menu) and select MImAS Tool, as shown in Figure 14.

Figure 14 Selecting the MImAS tool from the SEPA Menu
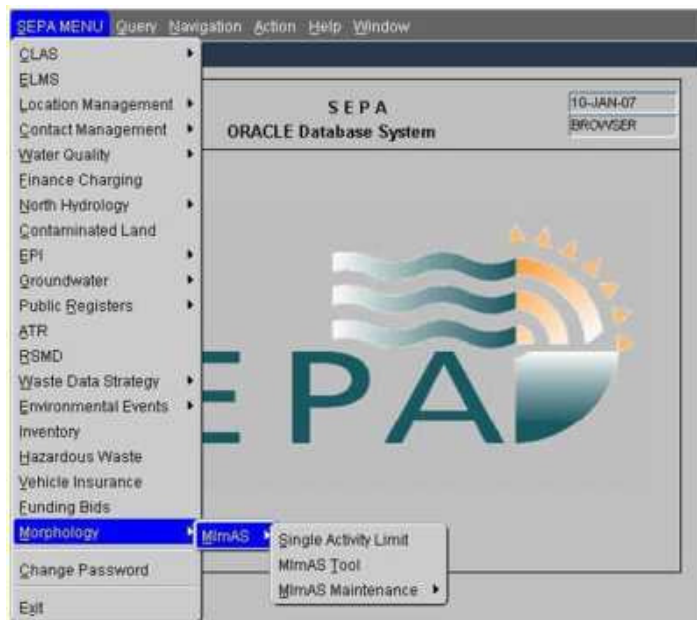
2.4.2 Using the MImAS Tool

The 'MImAS Tool' start window (Figure 15) is displayed when you open the tool.

(1) The user selects the 'Channel Type' from the drop down list (See *Determining the Channel Type*). Do not use the 'default' channel type as this represents the most sensitive river type for each of the different pressures i.e. will produce the highest capacity used in the results.

Figure 15 Start window after opening the MImAS tool
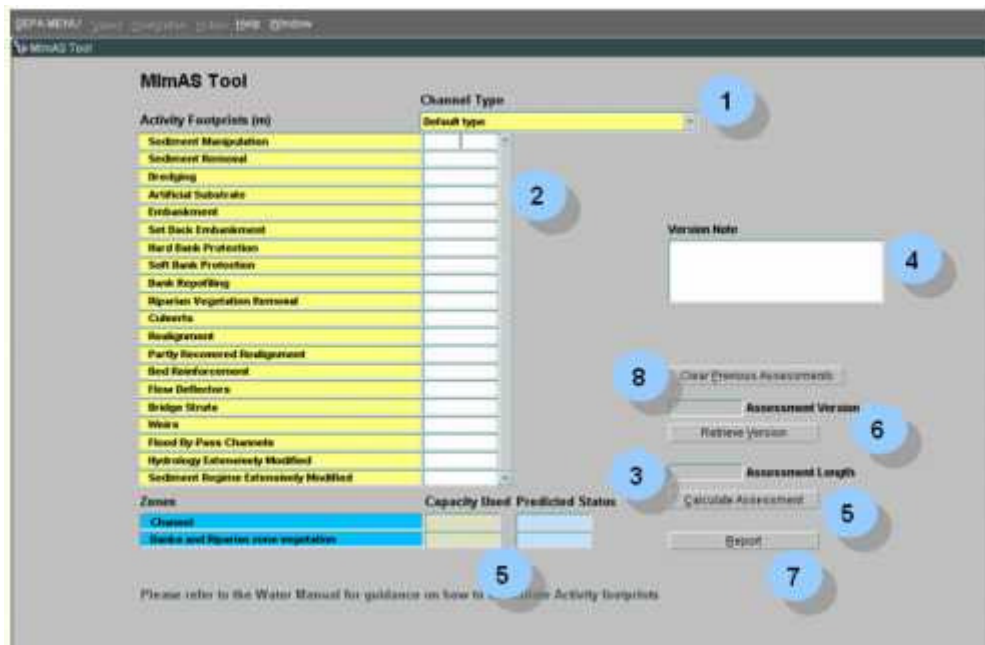
(2) The activity footprint values should be entered in the relevant box in the column with the white background.

(3) The default 'Assessment Length' value is 500m, though the user is able to change this by entering the new length (metres) in the appropriate item. The Water Body length should be used for a Water Body assessment on a Baseline Water Body.

(4) The 'Version Note' item is available for text input relating to the specific Assessment calculation that is to be performed. It is suggested that the Water Body ID and name are noted along with location details and the reason for the assessment e.g. '54321 Hill Burn between NV 654 321 and NV 123 456. Simple licence application for bank protection'

(5) The Assessment process is activated by selecting the 'Calculate Assessment' button. This will result in values being determined and then displayed in the 'Capacity Used' and the 'Predicted Status' items.

(6) Subsequent Assessment calculations can be performed, with the number of these indicated by the value of the 'Assessment Version' item. The user is able to retrieve previous Assessment calculations to the screen by entering the required version number in the 'Assessment Version' item and selecting the 'Retrieve Version' button.

(7) A report (PDF File) of the assessment calculations can be activated by selecting the 'Report' button. The report summarises all versions of the current assessment calculations and includes the information input into the version note box.

(8) To start a new assessment calculation process the user should select the 'Clear Previous Assessments' button.

2.4.3 Procedure Summary for Running MImAS

The process for running MImAS to assess whether a new activity, in combination with existing activities, threatens WFD status is summarised in Figure 16.

MImAS should be used to first assess the current status of the site.

Once this has been determined, the new activity(ies) should be entered to determine if a drop in status is likely to occur.

Figure 16 Summary of process for running MImAS
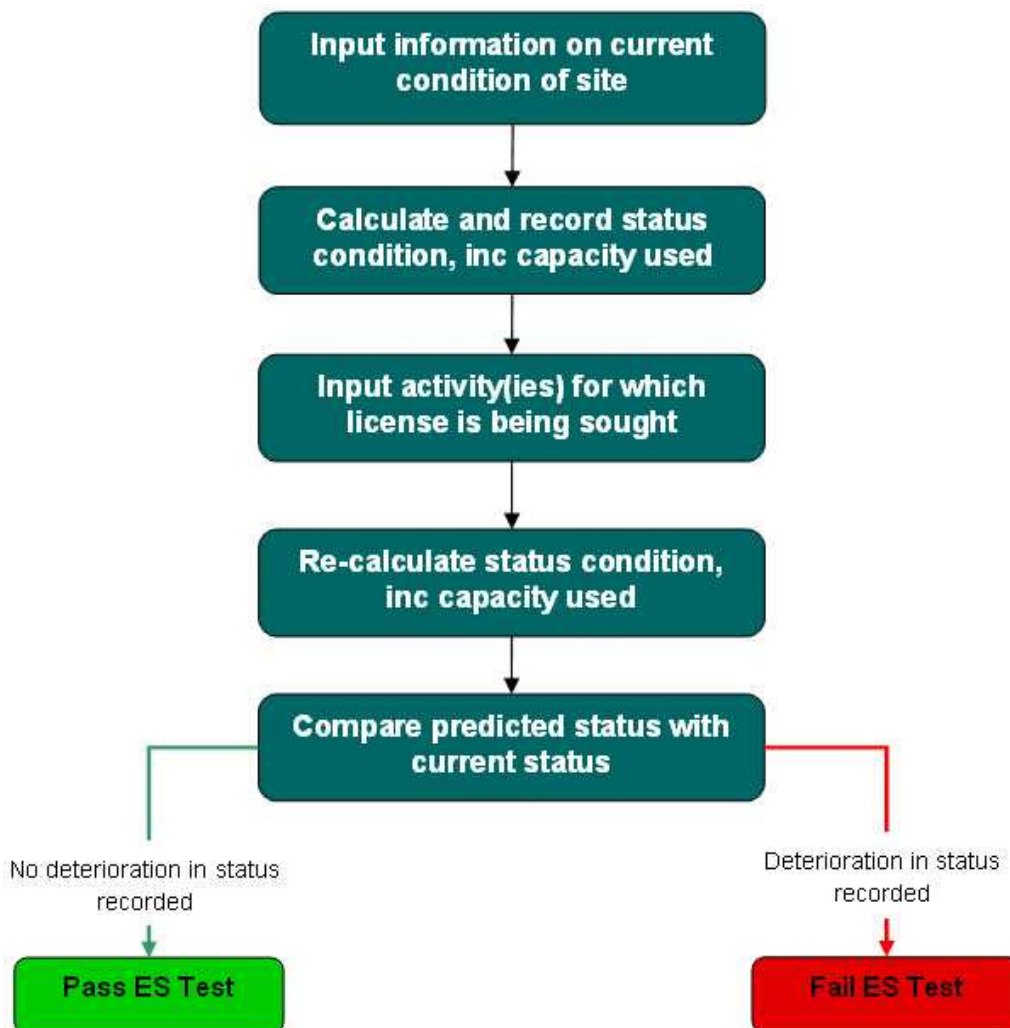
Step-by-step details

1. Select the assessment length. The default value is 500m. If undertaking a Water Body assessment, please enter the length of the water body for Main Stem Rivers (See *Identifying the Channel Section* for guidance).

2. Select the 'Channel Type' from the drop down list. Please ensure that the appropriate river type is selected and that it is not left at "default". (See *Determining the Channel Type* for guidance).

3. Insert appropriate information into the 'version notes' box. E.g. name, site name, current status, predicated status etc. This information will be displayed on any MImAS reports.

4. For a 500m assessment check current status by entering information on existing pressures in the relevant boxes in the column with the white background. Press the calculate button to complete the assessment. For a water body assessment check the classification spreadsheet.

5. Take a note of the current status and capacity used for Channel Zone and Bank and Riparian Zone. This information can be recalled using the retrieve function. Calculations which produce results that are very close to a morphological condition limit (e.g. within 0.3% capacity) should be carefully checked and advice sought from an engineering specialist or hydromorphologist.

6. For a 500m assessment check predicted status by inputting footprints for the activities for which a license is being sought as well as the existing pressures. Press the calculate button to complete the assessment. For a water body assessment calculate the capacity used by the proposed works only using MImAS then add this to the existing capacity from the classification spreadsheet to get the predicted capacity used. Check this against the Morphological Condition Limits in Table 1 to get the predicted status.

7. Take a note of the predicted status and capacity used for Channel Zone and Bank and Riparian Zone.

8. Compare the current status with the predicted status to determine if deterioration in status occurs. Remember that the assessment of current status can be retrieved using the 'Retrieve Version' function. Calculations which produce results that are very close to a morphological condition limit (e.g. within 0.3% capacity) should be carefully checked and advice sought from an engineering specialist or hydromorphologist.

9. Create a report (PDF File) of the assessment calculations by selecting the 'Report' button. The report summarises all versions of the current assessment calculations. Save and/or print PDF.

To start a new assessment, select the 'Clear Previous Assessments' button

> **BOX 10 Using MImAS to help identify mitigation measures**
>
> As described in *WAT-RM-02: Regulation of Engineering Activities*, the removal of structures and restoration of more natural riparian vegetation are two common mitigation measures that can be used to offset impacts from new activities. MImAS can be used to help identify how different mitigation measures may improve the quality of the reach.
>
> These assessments are undertaken by testing the pre- and post mitigation conditions by running MImAS with and without the mitigation measures. By running different combinations of measures, it should be possible to identify potential mitigation measures.
>
> IMPORTANTLY, these assessments are simple predictions of potential long-term recovery. Any form of mitigation would require a more detailed assessment to determine its suitability to site conditions and the likelihood that it will result in the desired improvements.

Quicklink: Step 1: Establish existing morphological status of the water body

Quicklink: Step 2: Assess the activity(s) at the 500m scale

Quicklink: Step 3: Assess new activity(s) at water body scale

PART 3: Annexes

Detailed information to help carry out individual procedures.

Annex A   Description of River Types

Rivers are a complex and diverse continuum of channel patterns and forms. This results from complex processes of sediment erosion, transport and deposition operating within the constraints imposed by the geology and terrain of the surrounding landscape. River channel typologies provide a basis for ordering physical features and processes into groups based on common characteristics.

SEPA's morphological river typology is based on the Montgomery & Buffington typology for mountain streams in North America. This has been modified to include the low gradient channels found in the UK. The typology is process based i.e. channel sub-types are grouped together according to the similar morphological processes present. As such the groupings have similar sensitivity to morphological pressures such as channel modifications. Other key features are that the types are natural, i.e. they assume the channel is unmodified, and that types exist at a reach scale, with individual reaches varying considerably in length.

Table 4 below shows a summary of the channel types and sub-types. The proceeding pages then give more details about each type/sub-type and the distinguishing characteristics of each. Type E has not been included in this guidance as it does not generally exist in Scotland.

Table 4   SEPA River Typology

SEPA River Type	Sub-types
A	Bedrock, Cascade
B	Step-pool, Plane Bed
C	Plane-riffle, Braided, Wandering
D	Actively Meandering
E	Groundwater Dominated
F	Low Gradient Passively Meandering

TYPE A: Bedrock & Cascade

- Generally a very high energy environment but quite stable

- Common in upland areas

- Bedrock outcrops in lowland areas (e.g. gorges)

- Generally very steep (particularly cascade reaches)

- Very little, if any, sand and gravel bed material present

- Bedrock channels are dominated by solid exposed rock on the channel bed and banks.

- Cascade channels are dominated by large cobbles and boulders on the channel bed and banks.

- Limited connection with the riparian zone.

Figure 17 Type A Cascade – Example 1

Figure 18 Type A Cascade – Example 2

Figure 19 Type A Cascade – Example 3

TYPE B: Step Pool

■ Discrete accumulations of large cobbles and boulders across the channel forming steps separated by pools.

■ Steps typically spaced 1-4 channel widths apart.

■ Steep gradient.

■ High energy environment but quite stable channel.

■ Generally confined by valley sides.

Figure 20 Type B Step Pool – Example

Figure 21 Type B Step Pool – Typical longitudinal profile
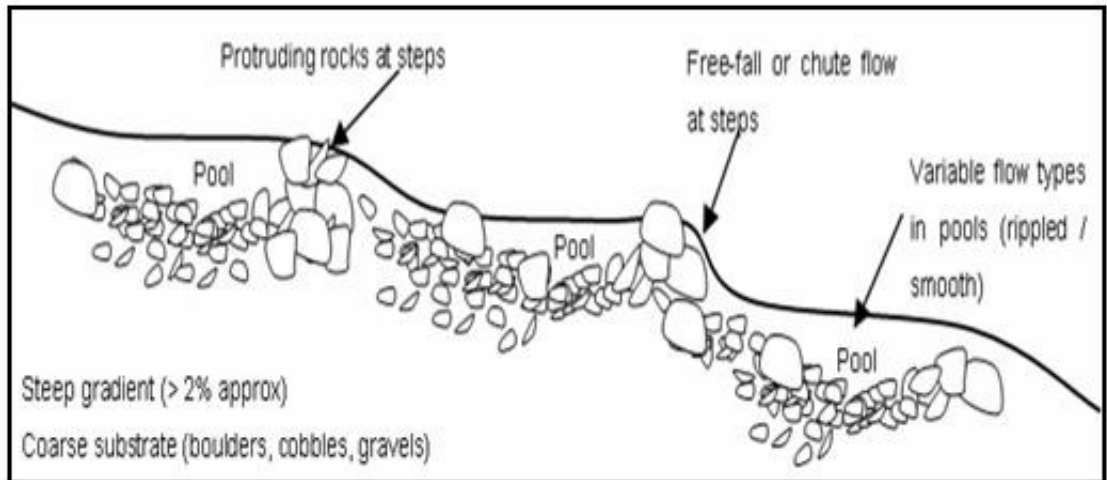
TYPE B: Plane Bed

- Featureless gravel/cobble bed often armoured (larger gravel and cobbles on surface protecting smaller gravels underneath from erosion).
- Moderate gradient.
- Generally stable banks resistant to erosion.
- Generally straight in confined or unconfined valleys.
- Can include glides, riffles or rapids.
- A transitional type between the higher energy cascade and step-pool channels to more dynamic/meandering channels (C, D and F).

Figure 22 Type B Plane Bed – Example

TYPE C: Plane Riffle

- Intermediate between plane bed (Type B) and meandering (Type D).
- Retain many features of meandering but less well defined pools, coarser bed and less extensive deposits.
- Often straight/gently curved planform.
- Banks generally stable and well vegetated.
- Bed substrate: cobbles and course gravel (may be armoured).
- Bars small and infrequent.

Figure 23 Type C Plane Riffle - Example

TYPE C: Braided

- Relatively high gradients but generally lower than Types A and B.
- Normally abundant bedload (input of sediment from upstream and/or bank erosion).
- Channel split into a number of threads around in-stream bars (gravel/cobble deposits).
- Bars often bare or with pioneer species.
- Poor bank strength.
- Unconfined.
- Highly dynamic: channels frequently change position.

Figure 24 Type C Braided - Example

TYPE C: Wandering

- Transition between braided and lowland meandering types.
- Exhibit characteristics of braided and meandering channels.
- Dynamic reaches.
- Extensive erosion at bends (typically >2m/year).
- Planform is mis-shaped/irregular meanders.
- Highly variable width (generally larger rivers).
- Susceptible to channel avulsion during high flows.
- Well developed floodplain with abandoned channels.

Figure 25 Type C Wandering - Example

TYPE D: Active Meandering

- Distinct bed morphology: undulations in bed create a REPEATING SEQUENCE of pools separated by riffles
- Regular sequence of bars
- Alternating side bars in straighter channels
- Point bars on inside of bends in more sinuous channels
- Bed material typically sands and gravels
- Fine sediment accumulations
- Channel typically unconfined by valley sides
- Bank material = sands and gravels therefore generally erodible
- Channels migrate slowly across floodplain (typically < 2m/year)
- Extensive floodplains and riparian zones

Figure 26 Type D Active Meandering – Example 1

Figure 27 Type D Active Meandering – Planform View
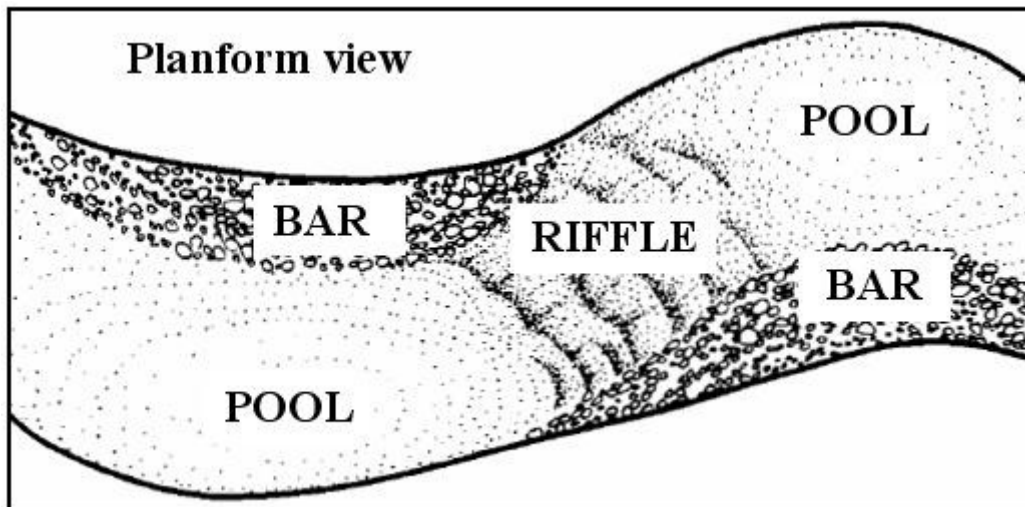
Figure 28 Type D Active Meandering – Example 2

TYPE F: Low Gradient Passively Meandering

- Low gradient and sinuous.
- Bed material typically sands and silts.
- Some small gravel deposits might be present.
- Typically lowland (high order).
- Generally deep laminar flows (glides) with runs at bends.
- Channel typically unconfined by valley sides.
- Very fine bank material (clays and carse deposits) = stable and resistant to erosion.
- Typically fixed planform.
- Often incised into floodplain.

Figure 29 Type F Low Gradient Passively Meandering – Example

Channel Type Bed Profiles

The bed profile of a channel is often a good indicator of the channel type. The diagram below highlights the main differences between bed profiles for some of the channel sub-types noted above.

Bed profiles for Type C wandering and braided channels tend to be much more chaotic.

Figure 30 Typical channel type bed profiles
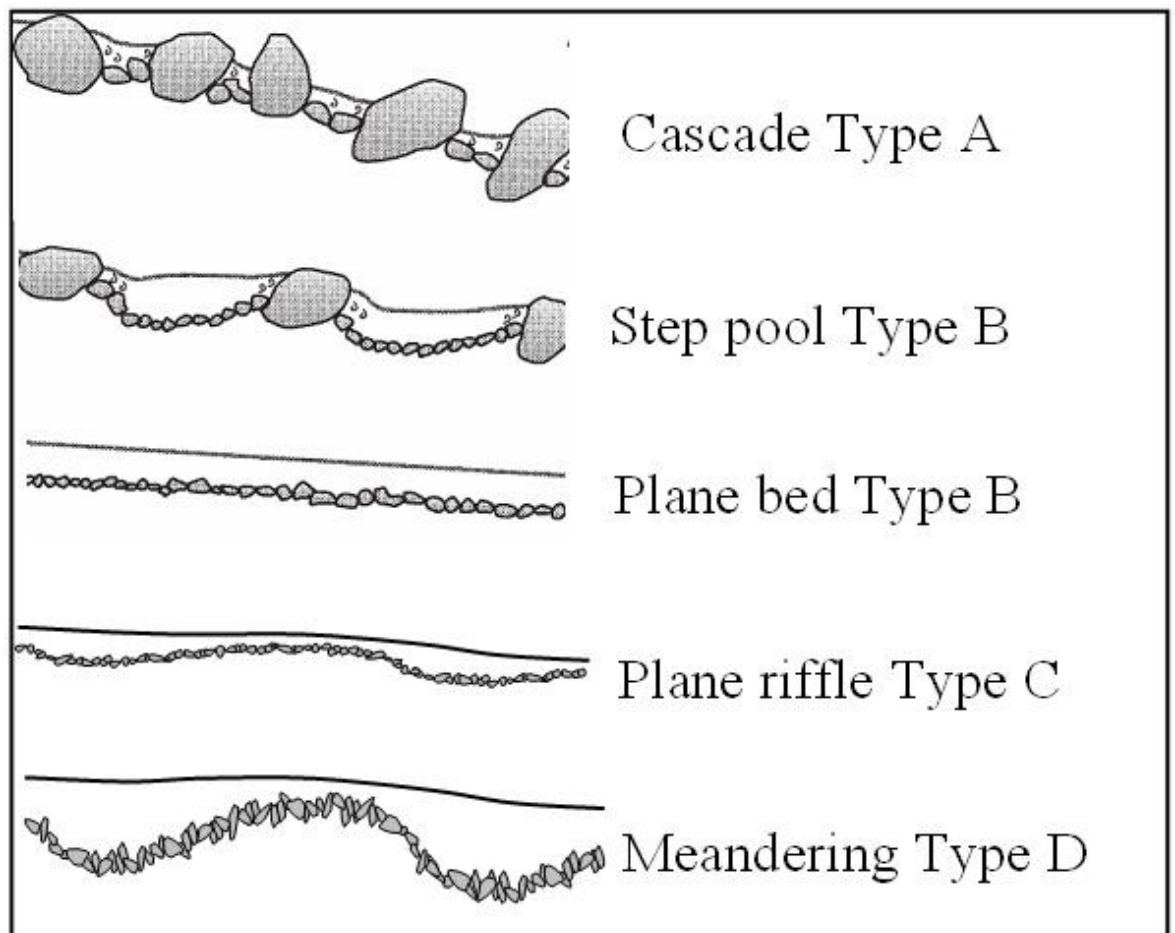
Annex B   SEPA River Type Database

The SEPA River Type database, covering a total of 25,000 km of river length, was derived using remotely sensed data.

The literature review of channel types, which led to the selection of the typology described in Annex A, suggests that channel type at any point on a watercourse can be predicted by analysing four key driving variables:

- Drift geology
- Channel slope
- Valley confinement
- Sinuosity

These driving variables can be derived from GIS datasets held by SEPA using GIS data manipulation and extraction techniques. The method used for each variable is summarised below.

- Drift geology was extracted directly from the British Geological Society Drift maps. These can be viewed on SEPA's GIS Intranet under the "Groundwater" theme.

- Channel slope was calculated using elevation data extracted from the NEXTMAP DTM and channel length derived from a channel centreline generated specifically for this project from OS Mastermap.

- Valley confinement is measured as a ratio of channel width to valley width. To calculate channel width a new dataset was generated that contained left and right bank lines in order that the distance between them could be calculated. Valley width was derived from polygons in the 200 year flood outline maps held by SEPA, where the extent of the 200 year flood was assumed to be the valley edge. Ratios were then categorised as confined, semi-confined or unconfined.

- Sinuosity is measured as the ratio of channel length between two points to the straight line distance along the valley centreline between the same two points. Channel length was derived from the channel centreline and valley centreline was derived using the flood outline maps.

Note: National coverage datasets for other variables such as stream power and bed sediment size are not currently available.

A GIS tool was designed to extract the chosen variables at 50m intervals along the entire SEPA Baseline Water Body network.

An algorithm was then constructed to use the extracted variables to predict channel type at each point. Adjacent sample points of the same type were then merged to show reaches of the same type within each water body. As expected, reaches are highly variable in length.

The algorithm (shown in the table below) was constructed using thresholds derived from a review of literature relating to the various river types, including some work on Scottish rivers. Allocation works from left to right and top to bottom i.e. start by assessing geology then slope, etc.

Table 5   River type algorithm

Geology	Slope		Sinuosity	Type
Bedrock	any		any	A
NOT Bedrock	> 0.1		any	A
	> 0.03	≤ 0.1	any	B
	> 0.005	≤ 0.03	≤ 1.1	B
			> 1.1	C
	> 0.001	≤ 0.005	any	C
	> 0.0005	≤ 0.001	≤ 1.4	C
			> 1.4	D
	> 0.0001	≤ 0.0005	any	D
	≤ 0.0001		any	F

Notes: In cases where some of the variables for a predicted river type were not within the thresholds usually associated with that river type, low confidence was assigned to the typology. The rules for this were as follows:

- Type F & D, Sinuosity < 1.1, Flag as "Potentially Modified"
- Type A, B & C, Sinuosity > 1.4, Flag as Low Confidence
- Type A, Confinement = UC, Flag as Low Confidence
- Type C, D & F, Confinement = C, Flag as Low Confidence

An extensive programme of dataset validation and updating is ongoing using data collected during routine survey work. This will replace the predicted data in the database and be shown as "high confidence" (HC).

The following issues had to be addressed in order to extract the predicted river typology from the map-based data:

Issue 1: Scale

This relates primarily to the distances over which channel slope and sinuosity data should be extracted from the maps. For example, slope measured over 1 or 2 km is likely to be different to the slope measured over 100 or 200 m. Rules based principally on location within the channel network were created to define the channel distances over which these variables should be extracted. Rivers at the upstream end of the channel network are small and changes in bed elevation are likely to be of a larger magnitude over shorter

channel distances. Calculations were thus carried out over shorter distances. In contrast, rivers towards the downstream end of the network are bigger and changes in bed elevation are likely to be of a smaller magnitude over longer channel distances. Calculations were thus carried out over longer distances.

Issue 2: Dataset resolution

The most accurate datasets available for each variable were often at varying resolutions. This meant that, for example, the river centreline sometimes did not pass through the lowest point in the digital elevation model, thus affecting slope calculations. Procedures were devised to overcome this issue as far as possible.

Issue 3: Overlapping variables

River types are generally dependant on different combinations of driving variable values. The values of these variables can sometimes be very similar but result in different types. The dominant variable seems to be channel slope, but there are quite large overlaps between the ranges of slope values at which individual types can exist. Large datasets of variable values for "real" rivers and national datasets for other variables, which may add accuracy to the analysis, are not yet available.

Issue 4: Threshold values

The thresholds at the upper and lower end of the range of variable values used in the allocation decision tree were taken from a review of the available literature. Although some of this information relates to Scottish rivers, it is limited in nature and more research is required.

SEPA will use periodic field survey to review and add to the quality of the river type database.

Annex C   River Type Field Survey Guidance

River type should be identified in the field primarily using the information contained in Annex A. This contains the fundamental characteristics of each river type and sub-type.

If necessary, Annex A can be printed and taken out during field survey. However, given the length of the Annex, a shorter one page summary has been produced below which can be taken instead. A flow chart has also been produced below to help identify channel type.

For the purpose of regulation, distinction between sub-types is not necessary although identifying sub-type will automatically identify the type. This means that it does not matter if there is doubt about the sub-type as long as there is no doubt about the type. For example, if you cannot decide whether the reach is step-pool or plane bed this does not matter because they are both Type B.

Useful hints and tips for identifying river type

- River type is dependent on the driving factors, i.e. the topographic setting of the channel, flow regime and underlying geology, which means that river type varies along a river with changes in the driving variables. The length of each reach between changes also varies considerably from hundreds of meters to several kilometres. Therefore, when identifying river type think at the reach scale rather than focussing on individual features at particular points.

- The complex nature of rivers means that there can be local variability. It can sometimes appear that a river has some features that are not consistent with those identified in the guidance in Annex A i.e. some features of one type and some of another. In this case try to focus on the dominant features and processes at work to decide which type it is.

- Often, a change in river type is not abrupt and therefore not always obvious. In some cases, as driving factors gradually change so too does the river type. There can therefore often be a (usually relatively short) reach between two different distinct types which has characteristics of both. In this case try to focus on the dominant features and processes at work to decide which type it is.

- Avoid focussing just on the area of proposed work. It is better to maintain a wider focus to try to understand the context of the reach being assessed. When approaching the reach (whether by vehicle or on foot) take the opportunity to observe the wider river setting. What is the river like upstream and downstream? Are there obvious changes in type upstream or downstream? How close are the valley sides to the river? Is there a floodplain?

- If possible walk upstream and downstream of the reach being assessed for an appropriate distance looking at river type. This may give you

more confidence in deciding what the type at the assessed reach should be.

- Bed profiles are often a good indicator of river type. Use the guidance at the end of Annex A to help confirm in your mind what the river type is.

- Try to think about what the river type should naturally be. Human modifications to rivers have often changed river characteristics and sometimes very significantly. Where there is obvious modification, such as straightening, bank protection, embankments etc, try to think about what the river might have looked like before it was modified. This can often be quite difficult but you can look for clues such as disconnected floodplain, old channels, bed sediment size and channel gradient. This can be supplemented by looking at historic maps. The best historic maps available, which pre-date most large scale river modifications are the *Roy Military Maps* from circa 1750.

Figure 31 River type summary sheet

Bedrock Sensitivity A

Few bars / little sediment storage

Steep & confined, floodplain absent

Flow types variable, often high energy. Pools / glides common locally.

Exposed rock

SEPA geomorphic river typology

The geomorphic type is described in words, e.g, bedrock, cascade, meandering, etc

The sensitivity class is a single letter - A, B, C, D or F

Cascade Sensitivity A

Boulders common

Disorganised bed

Fast flow types

Wandering Sensitivity C

Extensive, severe erosion

Highly dynamic

Abandoned channels in floodplain

Irregular meanders

Extensive sediment deposits

Step-pool Sensitivity B

Steep, distinct steps into pools

The front of each pool is constructed from boulders / cobbles

Plane-riffle Sensitivity C

Deeper, slower flow NOT A POOL

Repeated pattern of flow types eg glide-riffle-glide or run-rapid-run

Low sinuosity & lack of bars

Shallow, faster flow

Plane bed Sensitivity B

Uniform bed, fairly straight

Bars infrequent / absent

Bed armoured – hard to kick sample

Type B: Plane bed

Cobbles often jutting through water surface

Meandering Sensitivity D

Inner bank deposition

Outer bank erosion

Well-developed floodplain

Sinuous

Moderate erosion on outside of bends

Deposition on inside of bends

Braided Sensitivity C

Multiple channels

Bars bare or with pioneer species

Low-gradient passive meandering Sensitivity F

Sinuous stable planform

Stable, vegetated banks

Deep channel

Little / no erosion

## Figure 32 River type identification flow chart
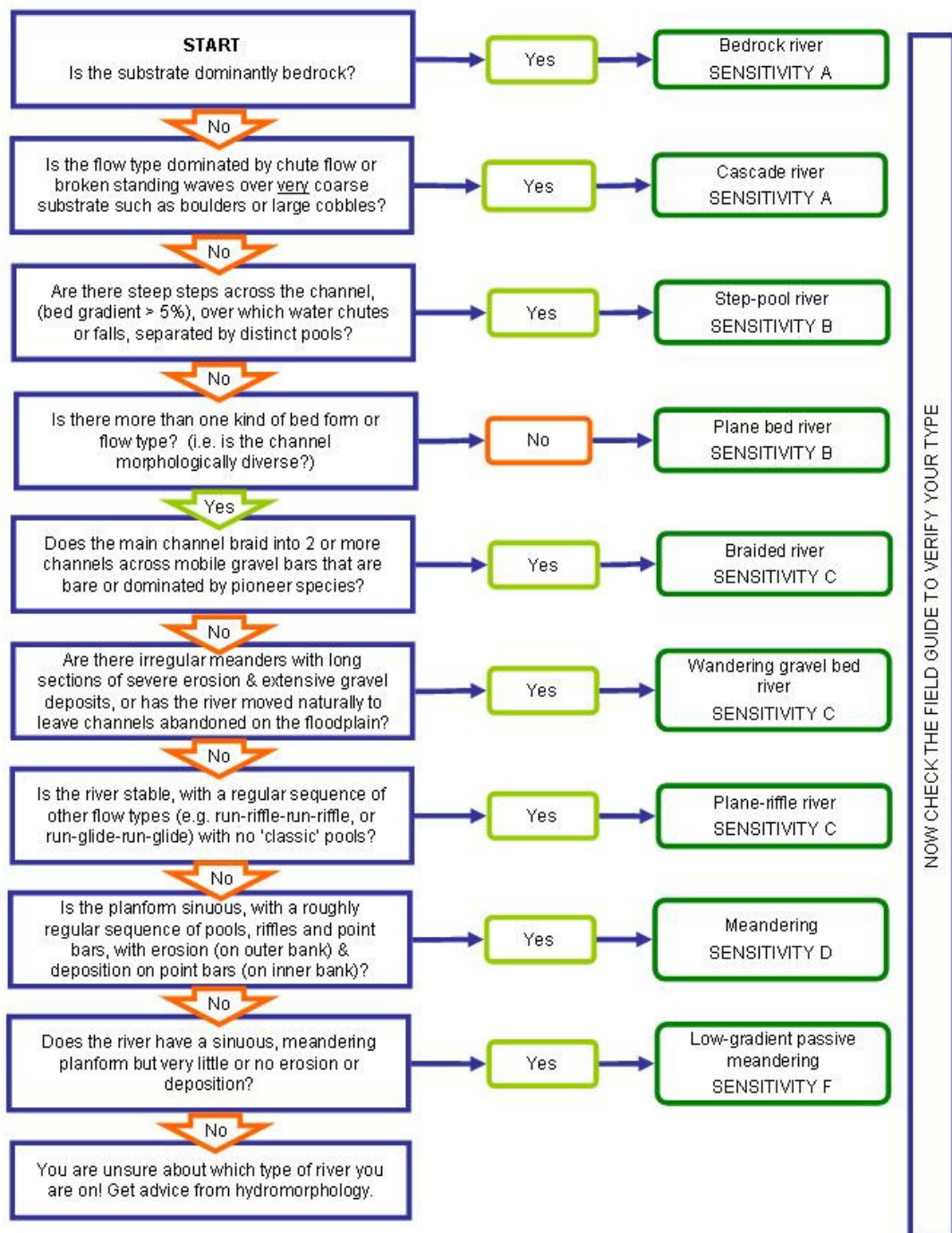
Annex D   Using maps and photographs to identify morphological pressures

This annex provides guidance on how to identify major engineering pressures on Minor Tributaries and Coastal Streams. These watercourses are normally small and as such the scale of maps and aerial photographs makes it hard to identify even significant pressures. It is therefore recommended that a field survey is carried out if possible to validate the results of a desk survey.

Channel realignment

A very straight channel is a good indicator of historic high impact realignment. It is usually not possible to tell from maps or aerial photos if the channel has recovered enough from the historic realignment to be considered low impact realignment. A field visit is normally needed to confirm this. It is, however, worth checking the aerial photos for signs of recovered sinuosity. A good source of aerial photos is the *Peoples Map* website.

Figure 33 Example of very straight channel upstream of houses - obvious historic high impact realignment
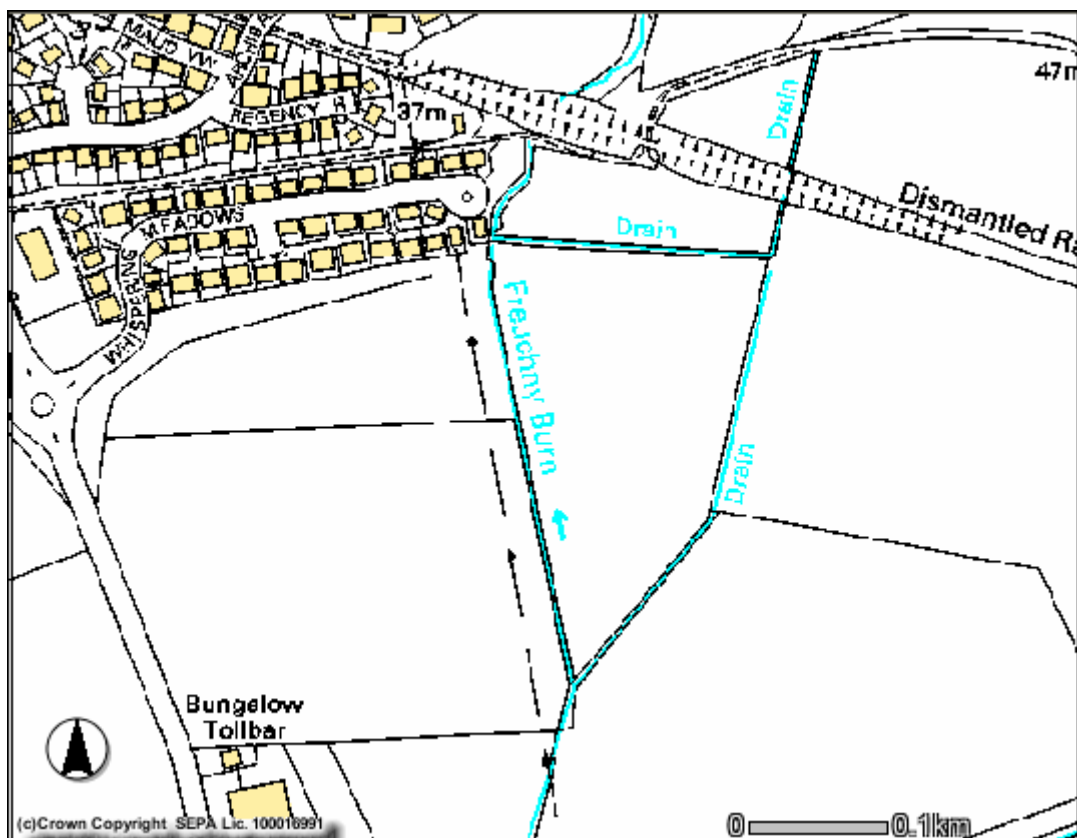
Another way of checking if a channel has been realigned is to look at old maps. The best old maps to use are the *Roy Military Maps* from circa 1750 and which are available on the National Library of Scotland website.

Bridges/Culverts

It can be quite difficult to distinguish between bridges and culverts on maps and aerial photos.

Short road, rail or track crossings can easily be either a bridge or a culvert. A field visit will normally be required to confirm this.

Where a road crossing is long or there is an obvious embankment between the edge of the road and the watercourse (a gap on the map where no water is shown) it is likely to be a culvert. The type of culvert can only be confirmed by field visit.

Figure 34 Gap between edge of road and water indicating that this is a culvert
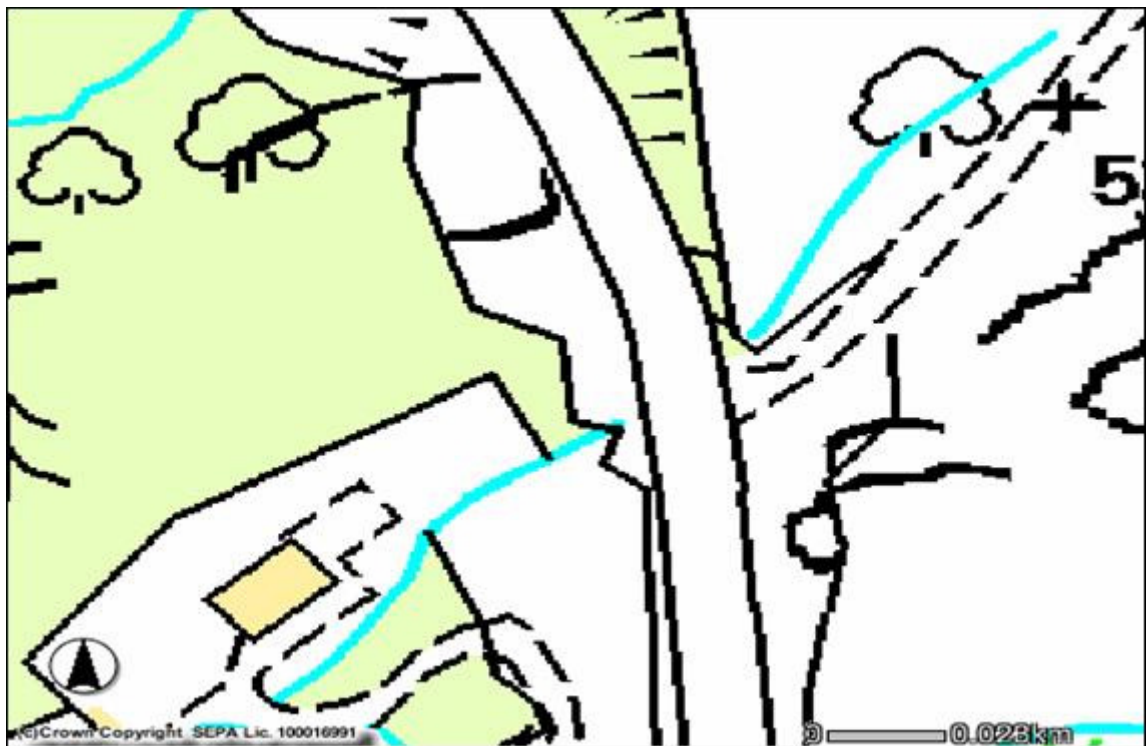
Embankments

Embankments can sometimes be identified from OS maps but these are normally large embankments with obviously sloping faces. OS maps typically represent embankments as small chevrons or triangles. Be aware that some embankments displayed on an OS map are natural landforms i.e. natural steep sloping surfaces such as valley sides.

REMEMBER: If an embankment is more than 10m or 1 channel width (which ever is greater), it should be classified as a 'set-back embankment'.

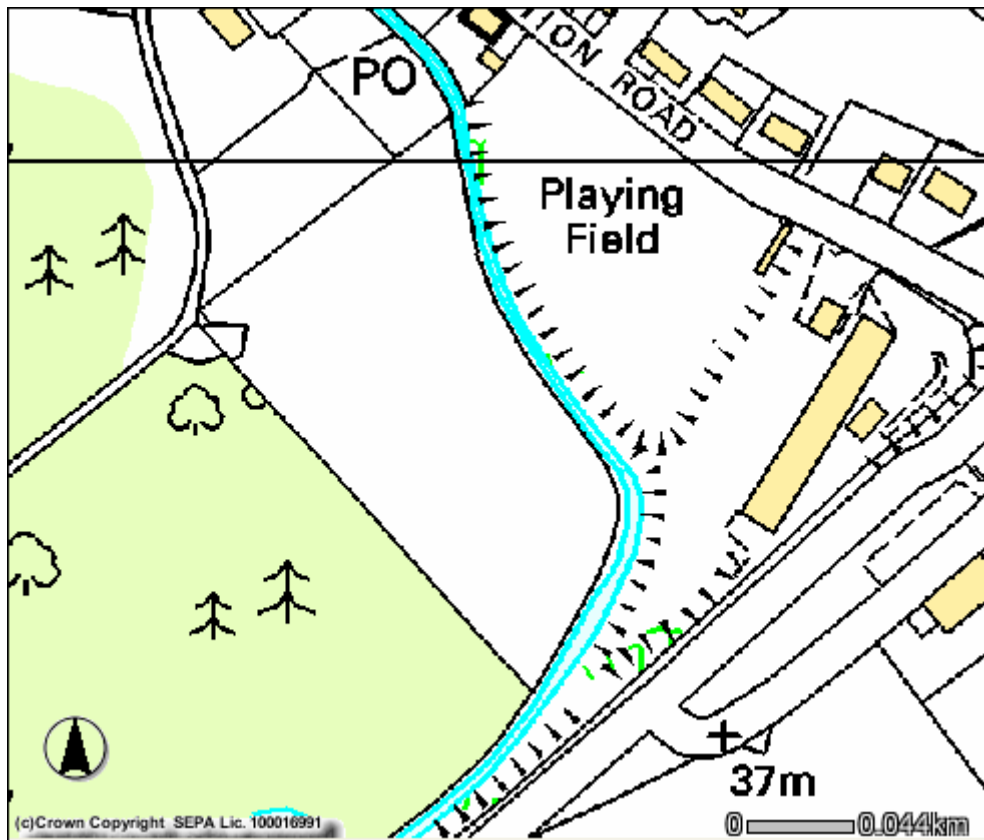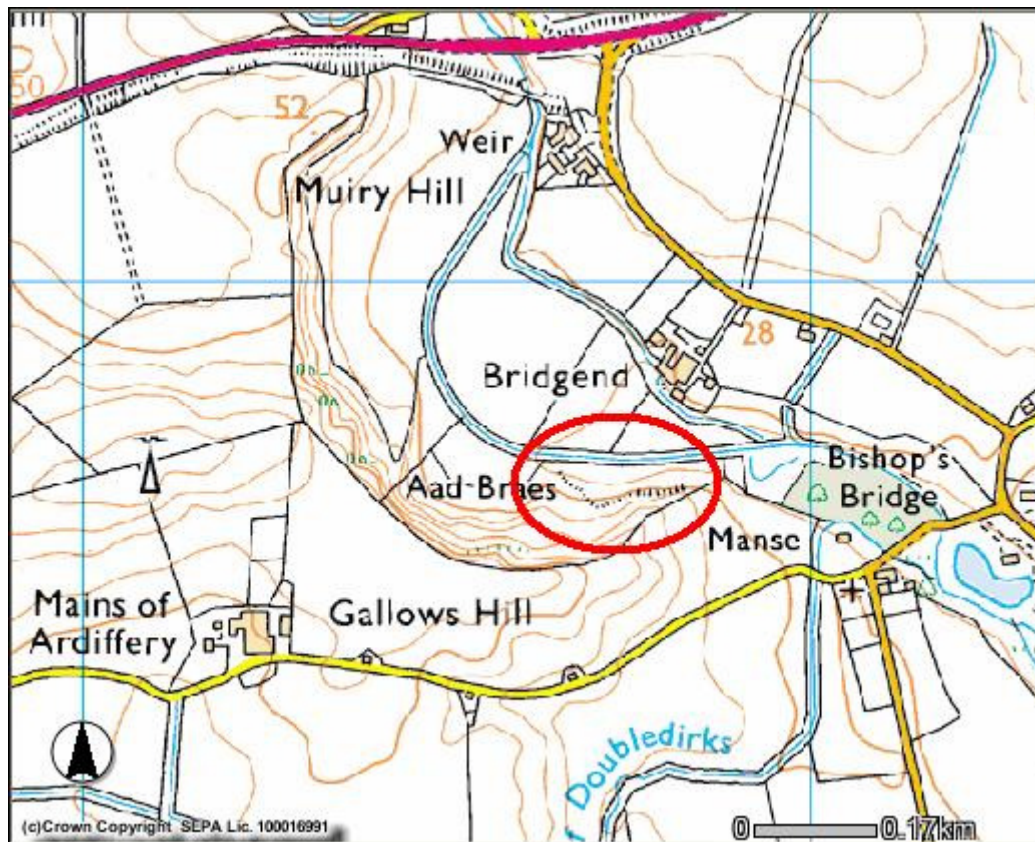**Figure 35 Triangles adjacent to watercourse indicating a steep slope and therefore probably an embankment**

Figure 36 Triangles indicating a steep slope but this time the contours and irregular alignment indicate that it is a natural slope


Impoundments

The location of impoundments can be determined form OS maps and/or aerial photos (see link above). However, the height of the weir can not be accurately determined from these sources. A field visit will normally be required to establish this if the applicant can not provide any details.

Impoundments noted on OS map. May also be called dam or sluice.

Figure 37 Indication of impoundments
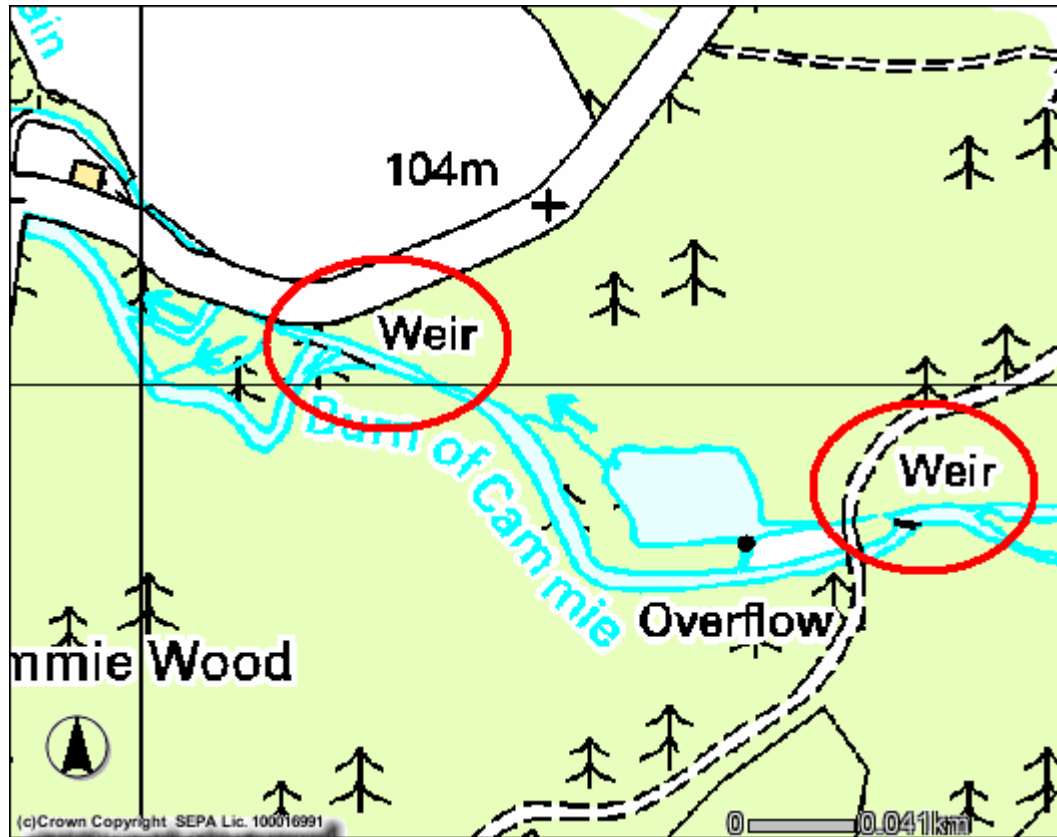
References

NOTE: Linked references to other documents have been disabled in this web version of the document.

See the Water >Guidance pages of the SEPA website for Guidance and other documentation (*www.sepa.org.uk/water/water_regulation/guidance.aspx*).

All references to external documents are listed on this page along with an indicative URL to help locate the document. The full path is not provided as SEPA can not guarantee its future location.

Key References

■ *WAT-RM-02: Regulation of Engineering Activities*

■ *WAT-RM-34: Derogation Determination - Adverse Impacts on the Water Environment*

Q-Pulse Documents

Use the doc number as a search string in Q-Pulse to find the document directly.

■ *MImAS Capacity for Culverts with Artificial Bed* (QP: ES-ECOL-S-02)

■ *Morphological Pressure Survey Field Form* (QP: ES-ECOL-F-WFD004)

■ *Morphological Pressure Survey Guidance* (QP: ES-ECOL-P-WFD004)

■ *Morphology Classification Summary* (QP: ES-ECOL-S-01)

Other References

■ *Annex 16: Surface water morphological condition limits - amendments to the 2007 Directions*, June 2008 (www.scotland.gov.uk/Publications/) (in *Implementing the Water Environment and Water Services (Scotland) Act 2003: Development of environmental standards and conditions limits - phase II: A Consultation*)

■ *Peoples Map* (www.peoplesmap.com)

■ *Roy Military Maps*, National Library of Scotland, Georeferenced maps and applications (http://geo.nls.uk/)

■ *The Environment Act 1995: The Scotland River Basin District (Surface Water Typology and Environmental Standards) (Scotland) Directions 2007*, October 2007 (www.scotland.gov.uk/Publications/)

- End of Document -