4. The geomorphological assessment

The geomorphological assessment is carried out firstly as a desk top exercise and secondly as a field exercise.

4.1 The desk top exercise

The desk top exercise is used to collect information relating to the location of the site and its geomorphological setting. This includes a reach analysis which defines the boundaries and characteristics of the reach within which the site is located. Using this information the reach is assigned to a zone class according to Table 1. The zone plus channel type (assessed in the field) are the main criteria used to classify the site geomorphology. The data is entered into a summary table (Appendix A).

The desk top exercise should also include an audit of catchment conditions as relevant to geomorphological change (erosion potential, flow modifications etc.). Aerial photographs should be examined for general conditions over the length of the reach as well as possible historical changes to the channel. A scale of 1: 10 000 is necessary if channel features are to be observed.

Table 1. Geomorphological Zonation of River Channels (after Rowntree and Wadeson, 1999).

Longitudinal zone	***Macro-reach characteristics***			***Characteristic channel features***
	Valley form	***Gradient class***	***Zone class***	
A. Zonation associated with a 'normal' profile				
Source zone	V10	not specified	S	Low gradient, upland plateau or upland basin able to store water. Spongy or peaty hydromorphic soils.
Mountain headwater stream	V1, V3	> 0.1	A	A very steep gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
Mountain stream	V1, V3	0.04 - 0.99	B	Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool. Approximate equal distribution of 'vertical' and 'horizontal' flow components.
Transitional	V2, V3, V4, V6	0.02 - 0.039	C	Moderately steep stream dominated by bedrock or boulder. Reach types include plain-bed, pool-rapid or pool riffle. Confined or semi-confined valley floor with limited flood plain development.
Upper Foothills	V4, V6	0.005 - 0.019	D	Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow flood plain of sand, gravel or cobble often present.
Lower Foothills	V8, V10	0.001 - 0.005	E	Lower gradient mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Reach types typically include pool- riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Flood plain often present.
Lowland river	V4, V8, V10	0.0001-0.001	F	Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed meandering pattern within a distinct flood plain develops in unconfined reaches where there is an increased silt content in bed or banks.
B. Additional zones associated with a rejuvenated profile				
Rejuvenated bedrock fall / cascades	V1, V4	>0.02	A/B/Cr	Moderate to steep gradient, confined channel (gorge) resulting from uplift in the middle to lower reaches of the long profile, limited lateral development of alluvial features, reach types include bedrock fall, cascades and pool-rapid.
Rejuvenated foothills	V2, V3, V4, V6	0.001 - 0.02	D/Er	Steepened section within middle reaches of the river caused by uplift, often within or downstream of gorge. Characteristics similar to foothills (gravel/cobble-bed rivers with pool-riffle/ pool-rapid morphology) but of a higher order. A compound channel is often present with an active channel contained within a macro channel activated only during infrequent flood events. A limited flood plain may be present between the active and macro-channel.
Upland flood plain	V8, V10	< 0.005	Fr	An upland low gradient channel, often associated with uplifted plateau areas as occur beneath the eastern escarpment.

4.2 The field survey

Field data is collected at two levels depending on the type of assessment (see Section 6.1). Channel transect or cross-section surveys are used to quantify the channel form in terms of a width-depth ratio and entrenchment ratio. Resurvey of these transects will also enable monitoring of channel change. A more rapid qualitative assessment of channel type and channel condition is undertaken using prescribed data forms. Data sheets for the field survey are given in Appendix B. Data collection is summarised below.

General information on the site and conditions at the time of the site visit are recorded on the first page (Sections 1-4). Basic site details (Section 1) are derived from a 1: 50 000 map (river name, altitude, lat. long.) or from a GPS (lat. long). Photographs should be taken to record the characteristics of the site (Section 2). Section 3 classifies the channel in terms of its flow regime: perennial, seasonal or ephemeral (storm runoff during heavy rains). Section 4 relates to the flow condition at the time of the survey: the level of flow and the clarity of the water. This information aids in the interpretation of certain evaluations. For example, if the flows are high, or the clarity of the water is low, it will be difficult to observe the condition of the stream bed.

The intrinsic geomorphological characteristics of the site required for classification are recorded in Sections 5 through to 12. Section 5 requires the observer to make a sketch of the channel plan. A good sketch map and cross-sections are invaluable when assessing change at some future date. A cross-section template is provided to assist the observer in identifying the main channel features (Section 6). The channel width dimensions should be recorded in the appropriate table (Section 7). More accurate data on the channel width and depth can be obtained from the cross section surveys.

The channel is assigned to a channel type in Section 8. Four channel types are recognised: bedrock, alluvial, mixed and fixed boulder. Bedrock channels are formed in solid rock, though there may be loose material present locally. Alluvial channels are formed in sand, gravel, cobbles or small boulders (the material should be able to move during floods). Mixed channels consist of alternating bedrock and alluvial sections. Fixed boulder bed channels are dominated by large boulders which are unlikely to move except during extreme flood events. Morphological units observed at the site are recorded in Section 9. These are the morphological features which make up the form of the channel and which determine the type of physical habitats that will be available to aquatic and riparian organisms. Bars, which are important depositional features, are recorded separately in Section 17. The assemblage of morphological units present in the site are used to assign a reach type from the list in Section 10. Where possible the observer should confirm this classification by considering the characteristics of the reach within which the site is located.

The composition of dominant material making up the bed and bank are recorded in Section 11 and 12. The bed and bank material are particularly important factors determining the stability of the channel form and its associated habitats. More detailed information on the composition of the channel bed can be recorded using the table in Section 18. Whilst the

entries in Section 11 and 12 will be used to classify the channels and assess potential stability, the size distribution of sediments as given in Section 18 can be used to monitor changes in bed condition over time.

Data recorded in Sections 13 to 18 relate to the condition of the channel and refer to more transitory characteristics that may change during the monitoring period. Riparian and in-channel vegetation are important factors controlling channel stability. Encroachment of vegetation on to channel bars is a good indication of long term channel change, or channel recovery from a major flood. Vegetation condition is recorded in Section 13. Channel modifications and bank impacts due to external disturbance are assessed used Section 14. Section 15 and 16 relate to the condition of the banks. Section 15 is used to assess the potential stability of the banks in terms of their height, slope, material composition and stratification and vegetation cover. Ratings for each of these factors is combined to derive a bank stability score. The observed erosion is entered in Section 16.

Channel bars are the main depositional features found within the channels. They represent local storage of sediment so that a change in the bar classification and bar material would indicate a significant change in the sediment dynamics of the reach. Channel bars are assessed using Section 17. Change in bed condition at a finer scale is assessed using Section 18. Bed packing can be used as an indicator of the stability of the bed in respect of erosion. Loosely packed beds tend to be mobile during floods and probably consist of recently deposited material. Tightly packed beds are stable under most flows. Embeddedness refers to the deposition of fine grains around coarse particles (sand around cobble) and indicates an environment conducive to deposition. It may be a transitory condition dependent on the balance of the supply of fine sediment and the competence of recent floods to disturb the larger material. Bed packing can be assessed by kicking the bed or attempting to move material by hand. Embeddedness is assessed by direct observation. The size distribution of the bed material requires a more time consuming assessment, but gives a good record against which change can be assessed. It is necessary to record the diameter of at least 100 randomly selected clasts (or fine deposits) for both the hydraulic control (riffle, rapid etc.) and the main bar type if present.

Available habitat is assessed using Section 19 using observations of the type of flow (depth and surface appearance) and the available cover (related to substrate, vegetation, bank shape or snags). This rapid assessment could be replaced by a more detailed assessment of hydraulic habitat using 3-d survey techniques that are being developed for application to the Ecological Reserve.