GUIDELINES ON ASSESSING RELIABILITY

Prepared by Mike Edwards April 1998

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1. Introduction

These guidelines were prepared to assist consultants assess the reliability of flood data captured for the flood data transfer project in a consistent and objective manner.

The reliability of the flood data relates to the confidence placed on the data. The exception is for levees, where their reliability will be assessed in terms of their ability to protect areas from flooding.

Two categories of data are considered - raw data and interpretative data.

Raw data includes historic flood levels, flood photography, soil maps, etc. They can also include flood maps and other interpretative data where these have been used as source material.

Interpretative data relates to the projection of the raw data to the 1% (or other) flood by the consultants.

Reliability assessment relates to point features (e.g. flood levels), arc features (e.g. flood extent lines) and polygons (areas flooded).

2. Raw Data

Reliability will be classified according to the different types of data. These are discussed below.

2.1 Soil Maps, Geology Plans and Geomorphology Plans

Although considerable effort might have gone into preparing these plans, their reliability is considered low with respect to flood extent mapping.

2.2 Flood Photography

The assessment of reliability relates to the confidence one has in distinguishing between flooded and non flooded areas at the time of the flood photography.

This can be defined in terms of confidence limits in determining the boundary between flooded and non flooded areas from the raw data. Refer Table 1.

Determining the confidence limits will require consideration of a number of factors:

a) the scale of photography relative to the scale of flood map (urban or rural);
b) whether it's black and white, colour, infra-red or other;

c) quality of the photography and its contents (contrast between flooded and non flooded areas, boundary fuzziness, light reflection, etc.);
d) how much of the boundary is obscured by clouds, tree cover, etc.; and
e) whether the photo is oblique or vertical or satellite.

If these factors vary across the photo (as would be expected from a satellite photo or photomosaic) reliability should be assessed on those parts of the photo that cover the flood boundary areas rather than the whole photo.

Table 1 Reliability Assessment for Flood Photography

	Confidence Limits	
Reliability	**Urban Map** **(1 in 5,000 to 1 in 10,000 scale)**	**Rural Map** **(1 in 25,000 scale)**
High	+/- 10 m	+/-50 m
Medium	+/- 20 m	+/-100 m
Low	more than +/- 20 m	more than +/- 100 m

2.3 Contour Information

Ground level contour information is not regarded as flood data. However, where it is used in conjunction with flood data to produce interpretative information, its reliability will need to be assessed (refer Section 3).

Ground level contour information is available in many forms. Typical contour intervals and scales are tabulated as follows:

Table 2 Types of Ground Level Contour Plans

Contour Interval	**Typical Scale**
75 to 100 mm	About 1 in 4,000
100 to 300 mm	About 1 in 5,000 to 1 in 20,000
300 to 500 mm	About 1 in 5,000 to 1 in 20,000
1000 mm	About 1 in 5,000 to 1 in 20,000
Greater than 1000 mm	Varies

Where the topography is sufficiently varied to enable flood boundaries to be well defined horizontally (+/- 10 m for urban areas and +/- 50 m for rural areas), a high reliability should be assigned to the ground level contour plans.

If this is not the case there are a number of things to consider (refer Table 3).

Table 3 Things to Consider When Assessing Reliability

Things to Consider	Comments
Who produced the plans?	If produced by a reputable organisation assume standards relating to survey control, checking of work, etc, have been followed and that information on the plans is accurate. If not, assume a low reliability.
What datum has been used?	Where a conversion to Australian Height Datum is required, any uncertainties in the accuracy of the conversion will need to be estimated or determined.
How accurate are the ground level contours?	Assume confidence limits of +/- one half the contour interval shown on the plans.

Assuming the plans have been produced by a reputable organisation the following limits (Table 4) are to be used as a guide in assigning reliability.

Table 4 Reliability Assessment for Ground Level Contour Plans

	Sum of: Confidence Limits When Converting to Australian Height Datum Plus One Half of the Contour Interval	
Reliability	**Urban**	**Rural**
High	+/- 0.05 m	+/- 0.3 m
Medium	+/- 0.2 m	+/-0.5 m
Low	greater than +/- 0.2 m	greater than +/- 0.5 m

2.4 River Survey Plans

These relate to survey plans of flood plains produced in the 1930s and 1940s. They generally show cadastral information, spot ground level heights, the edge of high ground or escarpments and a few flood levels. The scale is typically 1:7920 (0.5 miles per inch).

Reliability of this information relates to how distorted the plans are and the information captured.

2.4.1 Urban Areas

For urban maps the reliability is considered to be low. Given the age of the surveyed data it is likely that alterations to the topography have taken place.

2.4.2 Rural Areas

For rural maps, where the edge of high ground has been digitised it should be checked against more recent topographical and cadastral data, and photography if available. The following guidelines (Table 5) apply:

Table 5 Assessment of Reliability for River Survey Plans - Rural Areas

Reliability	Confidence Limits
High	Edge of high ground is an escarpment and comparison with more recent data indicates horizontal distortion is less than +/-50 m for 90% of the escarpment (i.e. +/- 2 mm on a 1 in 25,000 scale map).
Medium	Other data/observations confirm edge of high ground or escarpment is correctly shown to within +/- 75 m of the true location for 90% of its length.
Low	For all other cases

2.5 Flood Study, Detailed Design Report, or Levee Audit Report

These need to be considered on their own merits. Use Table 6 as a guide.

Table 6 Assessment of Reliability for Studies & Reports

Reliability	Type of Report/Study
High	Major report, well documented, supported by reliable survey data, hydrologic and hydraulic analyses; findings not in dispute.
Medium	Report of lesser scope than above but still considered to give credible results.
Low	Desk top study based on field inspection and a single flood level, or report where the findings are disputed or have been considerably updated by more recent information.

2.6 Hydrologic/Hydraulic Modelling

These will also need to be considered on their own merits. There are a number of factors to consider, including:

- the intent of the modelling (e.g. for a detailed study or a coarse model to show trends);
- the range (and distribution) of data used for calibration;
- how accurate the design flow rate is in view of current knowledge;
- the survey information used;
- the assessment of parameters used in the model(s);
- the accuracy of calibration; and
- the applicability of the model to the area (e.g. whether a 1D model should have been used in preference to a 2D model or vice versa).

Use Table 7 as a guide.

Table 7 Assessment of Reliability for Hydrologic & Hydraulic Models

Reliability	Type of Model
High	Well researched, well calibrated model based on adequate and accurate data, with results consistent with current knowledge.
Medium	Hydraulic model calibrated to a moderate (say 1 in 10 to 20 year ARI) flood, or a model where a shortage of survey data has led to assumptions being made in relation to cross sections used in the model. Hydrologic model where deficiencies in the model can be identified or where there is reason to doubt results.
Low	Model results are not consistent with current knowledge or a coarse model with little or no calibration.

2.7 File Note, Letter

These are generally obtained from correspondence files and include documentation of floods, hydraulic analyses to estimate flood levels, flood frequency analyses, etc.

Letters which provide estimated flood levels for specific sites, based on an interpretation of flood data, should not be quoted as source information unless substantial documentation is included as attachments. Data relating to historic flood levels should be treated under Section 2.11.

How the reliability of this type of information is classified depends on its type and source. Use Table 8 as a guide.

Table 8 Assessment of Reliability for File Notes & Letters

Reliability	Type of Information
High	Well documented information from a good source. E.g. internal study incorporating well calibrated hydraulic model or an accurate flood map on file of a historic flood.
Medium	Use when the information appears to be not good enough to assess as having a high reliability and is too good to assess as having a low reliability. For instance a 1 in 100,000 scale plan showing a flood extent for rural areas or a flood map based on low altitude oblique flood photography.
Low	Information that is widely disputed or where there are significant doubts on the accuracy of the information. E.g. a working plan of a historic flood recorded by driving around a number of days or weeks after a flood.

2.8 Working Plans

Working plans can broadly be classifed into 3 types:

- unregistered plans (no plan number) created for internal use;
- unregistered plans which have been used as an intermediate step in producing a registered plan; and
- copies of registered plans containing additional annotated data.

Generally, only those plans containing new information (i.e. not documented from another source) will be required to be digitised, unless doubts are raised about the accuracy of any registered plans produced from working plans.

Assessment for reliability will depend on the accuracy of the information presented. If it has involved interpretation of data (such as correlating flood levels with ground level contour information), assessment will depend on the level of data. As a guide Table 9 applies.

Table 9 Assessment of Reliability for Working Plans

Reliability	Type of Information
High	Well documented information that can be or has been verified as accurate. E.g. where a flood extent has been surveyed from a recorded flood level and delineated on a 1 in 1000 scale subdivision plan.
Medium	Plans which cannot be verified as accurate, either because of distortions in the maps or because the information or methodology used is not sufficient to be regarded as having a high reliability.
Low	Large scale (say 1 in 60,000 scale) flood extent plan derived from site inspection 7 days after a flood.

2.9 Schematic Maps

These are regarded as the type of maps produced for reports. They are not usually accurate. Therefore they should be assessed as having a low reliability.

2.10 Flood Maps Produced By Others

Assessment of reliability will require an assessment of the way raw data was used in the mapping. Section 3.4 provides further guidelines.

2.11 Levees (and Other Raised Banks)

Unlike reliability assessments of data relating to flood extents and heights (which generally relate to the accuracy of the source data) reliability assessments for levees require a consideration of the ability of the levee to protect land from flooding rather than how accurately the levee has been positioned.

The success of a levee in protecting areas against flooding depends on a number of factors, including:

- levee height;
- the Average Recurrence Interval corresponding to the level at which failure is imminent (which may be defined in different ways, for example the level of overtopping less 0.1 m to allow for surface cracks, or design level plus freeboard);
- standard of construction;
- materials used; and
- whether they are rural or urban levees.

For convenience, levees have been classified as urban or rural, and these are explained in further detail in the following sections.

2.11.1 Urban Levees

Levees protecting urban areas require a higher standard than rural levees. Most levees constructed from public funds have been subject to a recent levee audit: levee audit reports should be used to assess their reliability. Where audits have not been carried out, the following applies:

Table 10 Assessment of Reliability for Urban Levees

Criteria	Reliability
Levees which have a 1 in 100 year level of protection, have a minimum of 600 mm freeboard and are maintained by an authority	High
• Levees up to 1 m high, which have 0.3 to 0.6 m freeboard above the 1 in 100 year flood and are unlikely to fail unless overtopped; or • levees which would be classified as having a high reliability except that they are not maintained by an authority	Medium
All other urban levees	Low

2.11.2 Rural Standard Levees

For rural levees the expectations on the level of protection and standard of construction and maintenance are generally lower than for urban levees.

These guidelines assume that assignment of reliability is based on the Average Recurrence Interval (ARI) corresponding to the imminent failure level of the levee. The ARIs for levees are required to be specified as notes (which are covered in Look Up Tables attached to metadata standards) and they vary across the state.

A low height levee might have a high reliability rating purely because the ARI corresponding to its imminent failure level is low. In other words the levee performs well but overtops frequently.

Conversely a 2 m high levee which isn't overtopped unless floods are greater than 1 in 30 year ARI could be assigned a low reliability rating, even though it has a good record in protecting areas from minor and moderate flooding.

A few rural levees have been audited. In such cases, the results of the audit report should be used to assess the reliability.

Where levee audits haven't been carried out, Table 11 can be used as a guide. It is assumed that, *unless overtopped*, levees less than 0 to 0.5 m in height are highly unlikely to fail, levees 0.5 m to 1 m in height are unlikely to fail, and levees above 1 m in height will have an increasing risk of failure.

Table 11 Assessment of Reliability For Rural Levees

Reliability	**Average Height above Natural Surface Level**	**Comments**
High	All heights	Applies where long period of records (50 years or greater) show no evidence of prior failure for floods less than the imminent failure level
Medium	0 to 1 m	Applies where records show occasional levee failure for floods less than the imminent failure level
	1 to 1.5 m	Applies where levees are well maintained and records show occasional levee failure for floods less than the imminent failure level
Low	0 to 0.5 m	Applies where record of failure is frequent
	1 m plus	Applies where levees are poorly maintained

2.12 Flood Levels

Use Table 12 as a guide:

Table 12 Assessment of Reliability for Flood levels

Reliability	Criteria
High	Flood levels which are documented as being highly reliable (e.g. off survey book) and which correspond to the flood peak.
Medium	Flood levels which are documented as "good' or "reasonable" in source data, or where a surveyed level is considered to be accurate but there is uncertainty as to whether the level coincides with the flood peak
Low	Flood levels which are documented as "fair" or "poor", or where there are significant reasons for doubting their relevance to the flood peak (e.g. anecdotal advice).
Unknown	Where the reliability cannot be assessed.

3. Interpretative Data

Interpretative data arises when available flood data is extended by consultants using various techniques. An example of interpretative flood data is where margins between a historic flood event and a 1% flood event are estimated and used to produce a 1% flood extent polygon and/or 1% flood level isolines. The 1% flood data is regarded as being interpretative data.

3.1 Reliability of Interpretative Data

Reliability should relate to the confidence one has in the interpretative data, which therefore depends on the methodology employed to interpret and extend historic data.

3.2 Types of Interpretative Data

Interpretative flood data basically takes two forms: flood levels and flood extent. These are discussed further in the following sections.

3.3 Interpreted Flood levels

Interpreted flood levels generally relate to the 1 in 100 year ARI flood (usually in the form of isoline contours). However in some cases interpretative flood isoline contours of historic floods may be required. For example, isolines of historic floods might have previously been produced as part of a flood study, or insufficient hydrological or hydraulic information may be insufficient to estimate 1% flood levels.

If the interpreted flood levels have been determined from a flood study/flood model, the reliability of the levels should generally reflect the reliability assigned to the flood study/model.

If the levels have been determined using other methods, then assessment should be based on a qualitative assessment of the method used.

Table 13 should be used as a guide.

Table 13 Assessment of Interpreted Flood Levels

Reliability	
High	Where a detailed hydraulic/hydrologic analysis has been used to produce 1% flood flows and levels with considerable confidence (having regard for the length of flood records and other considerations) and where interpretative flood levels are estimated to be within +/- 0.1 m of these levels.
Medium	Where less rigorous methods of estimating interpretative flood levels have been used. Estimated confidence limits +/- 0.3 m.
Low	Where the available data and/or a steep flood profile results in estimated confidence limits more than +/- 0.3 m.

3.4 Interpreted Flood Extent

Metadata standards allow for reliability to be assessed for both arcs and polygons.

The former relates to flood extents for localised areas. The latter relates to more general areas. In a sense, polygons are defined by a set of arcs.

It follows that reliability assessments applicable to arcs will be more detailed than the reliability assessment applicable to polygons.

As flood maps will be divided into tiles, and each tile requires a “reliability diagram” to be assigned to it, it follows that polygons will be aligned with portions of map tiles. Each portion should be chosen according to the methodology and information used to estimate the interpreted flood extent.

The “generalised” reliability of each portion of a map tile will be shown on the hardcopies, and on digital maps. If more detailed information is required within an area, the reliability of specific arcs can be determined.

Where the term “reference flood” is used in the following sections it refers to the event for which the interpretative flood extent applies. This is either the 1% event, or a historic event.

3.4.1 Methodologies Employed

These guidelines assume that methodologies for deriving interpretative flood extents are based on flood studies, hydrologic/hydraulic analyses, flood photography, flood levels and contour information.

3.4.2 Flood Studies and Models

If the flood extent has been determined from a flood study or flood model, the reliability of the arc or polygon should be the same. If this isn’t the case then use Section 3.4.3 as a guide for Arcs and Section 3.4.4 as a guide for polygons.

3.4.3 Interpreted Flood Extent Arc

Unless Section 3.4.2 applies use Table 14 as a guide.

Table 14 Assessment of Reliability for Interpretative Flood Arcs

Reliability	Criteria
High	**If the reference flood is a historic extent:** Have either: • high reliability flood photography of the reference flood taken at the peak (refer Section 2.2 for reliability); Or: • high to medium reliability ground level contour information; plus • a good spread of historic flood levels related to the interpretative flood extent; and/or • high reliability flood photography and a means of estimating peak flood levels from the flood photo with confidence (+/- 0.1 m accuracy). **If the reference flood is the 1% flood extent, have:** • high to medium reliability ground level contour information; plus • a good spread of historic flood levels from which 1% flood levels can be estimated confidently (+/- 0.1 m accuracy); and/or • high reliability flood photography, and extrapolation of flood levels at the time of flood photography to 1% flood levels can be confidently achieved. (Refer Section 2.3 for reliability assessment of contour information)
Medium	Have either: • Flood photography of the reference flood which is close to peak; Or: • medium or low reliability ground level contour information; plus • enough flood levels of sufficient reliability to estimate flood levels for the reference flood to within +/- 0.1 to 0.3 m; and/or • medium to low reliability flood photography.
Low	Source information has a low reliability; and/or the confidence limits associated with estimating peak flood levels for the reference flood is below +/- 0.3 m.

3.4.4 Interpreted Flood extent Areas

Unless Section 3.4.2 applies reliability can be assessed by using either of two methods. They are:

- considering the data as a whole for each area; or
- analysing the reliability of the underlying arcs (excluding levees).

If an applications program can be developed which enables all arcs for a defined area to be displayed in the 3 separate categories (high, medium and low), it is suggested that the second method would be more appropriate.

1st method - General analysis of Data Used

For determining the reliability of *historic flood extent* (i.e. projecting data to the peak of a historic flood) refer to Table 15.

Table 15 Assessment of Reliability for Interpreted Flood Extent Areas Relating to Historic Flood General Analysis of Data

Reliability	Criteria
High	Flood extent is derived from a combination of: • flood photography of major floods taken near the peak • extensive historic flood levels or designated flood levels • detailed contour information • extensive and accurate hydrologic and hydraulic data
Medium	Flood extent derived from a combination of: • flood photography where the distinction between inundated and dry land is not clear • limited historic flood levels • limited terrain topographic information (including detailed contour information) • limited hydrologic and hydraulic data
Low	Flood extent derived from a combination of: • soil maps, geology maps • poor flood photography, aerial photography (non-flood) • low reliability ground level contour information

For determining the reliability of the *1% flood extent*, (i.e. projecting data to the peak of the 1% flood) an assessment of the methodology of projecting historic data to the 1% flood is required, along with the same sorts of considerations applicable to the *historic flood extent* case.

It is assumed that, apart from flood extents estimated from a flood study or model (in which case the reliability should coincide with the reliability assigned to the study or model), the methodology employed relates to estimating appropriate margins between a historic flood and the 1% flood and using ground level contour plans to estimate the flood extent for the 1% flood.

Use Table 16 as a guide.

Table 16 Assessment of Reliability for Interpreted Flood Extent Areas Relating to 1% Flood General Analysis of Data

Reliability	Criteria
High	If the underlying historic flood extent has a high reliability if Table 15 is applied, and the margins are considered to be good estimates, i.e. can be used with confidence (+/- 0.1m).
Medium	If the confidence limit for the 1% levels upon which the extent is derived is estimated to be between +/- 0.1 to 0.3 m, either because the method of determining margins is not as rigorous or robust as that applicable to a high reliability rating or because the underlying historic flood extent can be considered to have a medium reliability if Table 15 is applied.
Low	If the underlying historic flood extent has a low reliability or the method of estimating margins gives only approximate results.

2nd method - Assessment By Considering Reliability's Of Segments.

If the reliability of each individual arc defining a flood extent area has been assessed these can be used to assess the reliability of each flood extent area. Reliablity assessments applicable to levees are to be excluded from consideration. Details are as follows.

Step 1
Select the area for which the reliability is to be assigned. This is generally determined by the available information.

Step 2
Assign the portions of segments assigned high, medium and low reliability's, defined as follows:
H = portion defined as high reliability
M = portion defined as medium reliability
L = portion defined as low reliability
(H + M + L = 100% of the flooded area selected).

Step 3
Define the reliability for the chosen area, using Table 17 as a guide. Where more than one category applies to the chosen area the higher reliability rating should be assigned.

Table 17 Assessment of Reliability for Interpreted Flood Extent Areas By Considering Reliabilities of Segments

Reliability	**Criteria**
High	(H + M) is greater than 70% and H is at least 50%
Medium	Combinations of H, L & M which do not fit high or low reliability categories
Low	L is greater than 50%

3.4.5 Potential Conflicts In Reliability Assessments

In some cases an interpretative *1% flood extent* might have a lower reliability than the underlying *historic flood extent*. If this occurs the 1% case should be shown but a note should be included on the flood maps qualifying the underlying data used and its reliability.