Manual

Road Drainage
Chapter 4: Data Collection

September 2019
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4 Data collection

4.1 Introduction

In this chapter, general guidance is provided on how to source and collect data and how to conduct site surveys/assessments to assist in the planning and design of road drainage infrastructure. This data is required to quantify the design requirements as described in Chapter 2.

The various forms of data used in the planning and design of drainage infrastructure are broadly categorised as either ‘strategic data’ or ‘project data’.

Designers should ensure that collected data is appropriately stored for easy retrieval, not only during the preconstruction activities of the project, but also in the future.

This chapter discusses:

a) types of data
b) the importance and sources of strategic data
c) types of project data, sources and application
d) the importance of site surveys and assessments to an overall project
e) methods for collecting and recording data.

4.2 Types of data

Data is progressively collected, analysed and used throughout all preconstruction activities at a level of detail that is appropriate for the purpose being considered. Data that is collected and used for network planning and the development of Road Route Strategies (TMR 2008a) is strategic and regional in nature. The data may become more focused and geographically-specific as the strategies are used to prepare Road Link Plans (TMR 2008a). Data collected for these purposes is defined as ‘strategic data’.

In the development of specific project proposals, the strategic data needs to be reviewed and expanded with the introduction of more detailed, project-specific data. As a project proposal progresses through various preconstruction activities, refinement of data occurs through various investigations and studies and as new design specific data is obtained.

During the construction activities, more data is collected, usually as as-constructed detail. Once a project is completed and becomes operational, further data regarding the operations and maintenance of the road should be recorded as part of the asset management process.

Data collected during preconstruction, construction and operational/maintenance activities is defined as ‘project data’.

Both strategic and project data, with respect to drainage, is useful not only to the department, but also to others who are interested in information such as flood levels and so on. Local authorities, developers and consultants may refer to the department for assistance in providing observed flood levels and so on in areas of interest and this assistance should be given where relevant/appropriate.

Data that has been obtained from various sources for use in planning and design work should be retained as part of the documentation for the project.
4.2.1 Strategic data

Strategic data is usually regional in nature and is required for network planning and the preparation of Road Route Strategies/Road Link Plans. It may also be required for the planning and design of drainage infrastructure. It can be considered in four types of information:

Type 1 – planning instruments such as:
- regional strategic land-use plans
- statutory and advisory land-use management plans
- land-based and marine national parks
- land-based and marine estuarine environmental protection and management plans
- other land and water-based management plans
- Australian Government planning instruments
- local authority town planning schemes
- urban and rural drainage management plans, initiated under Queensland Government legislation.

Type 2 – naturally occurring events such as:
- storm event data
- flooding event data
- abnormal highest astronomical tide event data
- storm surge event data.

Type 3 – drainage and water management infrastructure such as:
- specific drainage infrastructure
- water catchment storages (such as aquaculture, fish)
- irrigation schemes.

Type 4 – Private or Public Utility Plant (PUP) such as:
- communications systems
- municipal services
- trunk distribution systems for oil, gas, water and effluent
- electricity transmission lines
- state and interstate railways and industry narrow gauge rail systems.

4.2.1.1 Planning instruments

The department may be a participant in the planning processes that create some of these instruments to ensure appropriate road service delivery is provided through Queensland. However, planners and designers need to work within the overall statutory and advisory planning framework when developing various strategic network plans and when planning and designing specific projects.
As these instruments may change over time, it is not advisable to attempt to store this type of data, but rather obtain current information at the start of each new project and review the currency of this information as the phases of a project progress.

Land-use planning is one form of data that can change within the department’s planning and design time frame. In rapidly developing urban areas, upstream and downstream land-uses could change through:

- issue or the review of a regional land-use plan
- amendments to the planning scheme, or
- the completion of a new planning scheme.

All relevant Department of Transport and Main Roads regional and district offices need to be part of the regional planning and local authority planning processes to ensure that drainage infrastructure is consistent with land-use planning.

### 4.2.1.2 Naturally occurring events

Section 4.9.1 of the Austroads *Guide to Road Design* – Part 5 is accepted for this section.

### 4.2.1.3 Drainage and water management infrastructure

Local authorities and various statutory authorities manage urban and rural drainage systems that are designed for:

- existing and future land-uses in the catchment
- specific hydrological and environmental parameters
- local drainage parameters.

Planners and designers need to obtain data relating to the design of these facilities so that the department’s drainage infrastructure is compatible with local authority planning and design.

Drainage infrastructure located in the catchments of existing or planned municipal water storages may need to conform to requirements of the relevant catchment authority, particularly in matters of water quality and erosion and sediment control. Planners and designers should consult with the catchment management authority to ascertain requirements for drainage in the catchment under review.

Authorities managing irrigation schemes may have similar requirements for drainage infrastructure to municipal catchment management authorities and these requirements should be obtained. Details of existing irrigation infrastructure should be confirmed by survey and any expansion plans obtained from the authority.

### 4.2.1.4 Private/Public Utility Plant

As the department generally approves the location of service infrastructure within the road corridor, documentation associated with these approvals provides an initial source of data for new drainage projects. This data needs to be verified with the agency involved and any information supplied should be confirmed with site measurements and ground survey.

Existing services in the vicinity of drainage infrastructure needs to be located by survey to ensure:

- that the service installation does not impair drainage performance
• maintenance of drainage infrastructure can be completed without damage to the service or the drainage
• the extent of any PUP relocation requirements to enable drainage to be correctly installed can be determined.

4.2.2 Project data

Project data is more relevant to the planning and design of specific projects and largely relates to the physical characteristics of a site and the surrounding catchment. It may be collected or measured at varying times in the different phases of the planning process and at different levels of detail.

Project data includes:

• land-use
• topographic information
• catchment information
• rainfall data
• stream flow and flooding information
• stream flow patterns
• tidal information
• waterway characteristics and stability
• water quality
• sedimentation issues
• soils data
• erosion history
• vegetation constraints
• acceptable time of inundation
• fauna habitats
• downstream conditions
• service installations
• obstructions.

Specific project and routine maintenance inspections provide opportunities to obtain data and to review the in-service performance of the infrastructure. Inspections should have similar objectives to those outlined in Section 4.9.1 of the Austroads Guide to Road Design – Part 5 for inspections following extreme events, and the findings recorded in the district database.

The quality of data collected has a direct bearing on the successful design and implementation of drainage infrastructure and is strongly linked to an effective site assessment and planning process. It is important that adequate data is collected in the early stages of a project and that it is stored in a readily available format for use in all subsequent phases.
For example, the collection of soils data at the planning or design phase of a project will facilitate the selection of appropriate erosion and drainage controls and the preparation of an appropriate Erosion & Sediment Control Plan (ESCP) for the construction phase.

Site assessment is also strongly linked to risk assessment. A thorough site assessment, where data is added at each stage of the project, will lead to a reduced risk of adverse impacts to the surrounding environment or to the road itself. This, in turn, will lead to reduced costs in the long term.

The identification of special environmental characteristics of a project site is a key requirement while undertaking a site assessment, though it is expected that most such characteristics will be identified as part of the environmental assessment process. Knowledge of special conditions and factors which influence sensitive environments facilitates environmentally responsible drainage design as defined in subsequent sections of this manual.

### 4.2.3 Sources of data

Different phases and steps during the preconstruction process may use the same data. This data may be obtained from field investigations, studies and recorded information in various forms such as:

- existing field inspection records
- topographic maps
- documentation obtained during the environmental assessment process
- existing design drawings
- geotechnical investigations
- survey records
- land resource manuals
- aerial photographs
- published references (such as *Australian Rainfall and Runoff (ARR 2019)*)
- previously published reports and investigations (being feasibility studies)
- concept and link studies
- acid sulphate soils (ASS) maps
- vegetation maps
- flood maps
- various electronic data sources (such as geospatial data, mapinfo, Queensland Globe). The department’s Geospatial Technologies Unit can assist with this.

Data is available from various departmental sources, from land owners and organisations, such as:

- Bureau of Meteorology (federal)
- Department of Environment and Heritage Protection (state)
- Department of State Development, Infrastructure and Planning (state)
- Department of Natural Resources and Mines
- Queensland Rail
• historical societies
• local authorities
• port authorities
• industry organisations
• environmental groups, including catchment management groups and river trusts.

Table 4.3.1 has been prepared to indicate the type of data available from each of these external organisations.

4.3 Environmental assessment

For every infrastructure project, the department has a responsibility to consider the project’s potential environmental effects and/or impacts and to then develop appropriate mitigating measures as necessary. Therefore, an environmental assessment for the project is required and this assessment should be undertaken as early as possible in a project’s development.

4.3.1 Vegetation

The vegetation surrounding a project site reduces raindrop impact on the soil, as well as stabilising the soil. These factors are important in erosion control. The vegetation also filters runoff containing sediment. Knowledge of the vegetation characteristics of the project site:

• assists in the determination of the existing degree of disturbance (if any) of the site and its potential for erosion
• enables the protection of species with conservation significance
• guides the selection of species for revegetation
• assists in determining roughness (Manning’s Equation’s ‘n’)
• contributes to the determination of the coefficient of runoff
• assists in the identification of constraints to drainage design.

The collection of vegetation data, both terrestrial and aquatic, is an important process. This data is then used in other assessment and design processes referred to in this manual.

The environmental assessment for a project should gather the following data (with mapping) where possible:

• extent and location of all vegetation types (terrestrial, littoral, intertidal, aquatic, trees, shrubs, vines and grasses) in and around the road environment
• description and location of any vegetation corridors that traverse the road environment
• description of the conservation significance of vegetation communities within the study area
• description of any rare or endangered species
• extent and location of any cleared vegetation and incidence of exotic species and weeds
• description and location of flora used traditionally for food, spiritual and/or cultural purposes.
### Table 4.3.1 – Data sources

<table>
<thead>
<tr>
<th>Data type</th>
<th>External organisation</th>
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</thead>
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<tr>
<td>Flood levels (historic)</td>
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<td>Soil information</td>
<td>2, 11</td>
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<tr>
<td>Flora and fauna</td>
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<tr>
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<td>2, 3, 5, 6, 8, 9</td>
</tr>
<tr>
<td>Aerial photography</td>
<td>2, 5, 10</td>
</tr>
</tbody>
</table>

Notes:
1. Bureau of Meteorology
2. Relevant State Departments
3. Queensland Rail
4. Historical societies
5. Local authorities
6. Port authorities
7. Environment groups
8. Local residents
9. Service providers
10. Web-based data sites
11. Department of Transport and Main Roads geographic information systems
12. Department of Transport and Main Roads (Maritime Safety Queensland)

### 4.3.2 Fauna

Recognition of the impacts of road corridor development on fauna populations has led to modifications in the way that roads are now designed. Fauna can influence drainage design significantly.

Research has been undertaken on developing practices that help facilitate fauna movement through passages in the road corridor via drainage structures in a way that minimises fauna mortalities on the road. The provision of fauna passage is important and may influence the physical dimensions of a drainage structure.

The location of drainage structures and discharge points may also affect fish or bank-dwelling species such as platypus.

Again, the environmental assessment for a project should gather the following data (with mapping) where possible:

- species diversity and abundance for terrestrial, littoral, intertidal and aquatic and avifauna
- description and location of any rare or endangered species
• fish habitat/passage requirements
• occurrence, distribution and requirements for migratory species
• species important for traditional, recreational and/or commercial fisheries
• any local terrestrial, aquatic or avifauna used traditionally for food, spiritual and/or cultural purposes.

Appendix 4A provides further information on data collection and site assessment for fauna passage through drainage infrastructure.

4.4 Forms and checklists
To assist in the collection and retention of data, the department has prepared a number of pro formas for use in data collection. These forms should be used as they provide:

• a checklist to ensure all relevant data has been obtained
• media to record data while on site.

Forms currently in use by the department include:

• Bridge Hydraulics Design Summary (Form HYD5).

An overall checklist for the collection of data is provided as Appendix 4A.

4.5 Field inspections
Field inspections of catchments, existing drainage and possible sites within a proposed project area are essential for the planning of major drainage works and for the design of all drainage systems.

Field inspections provide opportunities to understand the site and to assist in formulating the risk profile for the project. Where possible, field inspections by the designer should be organised to be completed in conjunction with field survey, soil and environmental investigations to provide a more integrated data collection process.

More specifically, site inspections allow the designer to:

• obtain an appreciation of the site and its constraints
• validate the reliability and currency of existing records and information (including anecdotal information)
• verify characteristics and parameters that are to be used in the drainage planning and design process
• speak to landowners regarding site issues, drainage and flooding history
• identify and photograph site features that may impact on the selection of future drainage infrastructure.

In particular, field inspections should focus on obtaining an understanding of:

• drainage patterns
• waterway characteristics
• evidence of flooding through existence of debris levels
• evidence of erosion or deposition
• soil types
• extent and type of vegetation including vegetative communities
• potential sources of debris
• existing infrastructure
• location and level of adjacent buildings
• locations for future controls (such as retardation or sediment basins).

The department’s Surveying Standards Part 2 Chapter 2 – Bridge Surveys – provides a thorough guide to the collection of data.

Data contained in each of these forms has been combined and included in the checklist in Appendix 4A.

4.6 Rainfall

The duration and intensity of rainfall are major components with respect to the determination of runoff and of erosivity potential. Both vary with geographic position and with the time of year. Thus, rainfall distribution, seasonality and intensity must be considered in order to determine flow rates and the potential for erosion. For more detailed explanations, reference may be made to the latest release of *Australian Rainfall and Runoff, A Guide to Flood Estimation* 2019.

a) Rainfall distribution

The distribution of median annual rainfall across Queensland is shown in Figure 4.7. The rainfall isolohyets shown in Figure 4.7 are generally parallel to the coast, except where topographic features modify the pattern. In particular, significantly higher rainfall occurs between Ingham and Cooktown, Proserpine and Sarina, and north and south of Brisbane where there are high ranges aligned perpendicular to the main onshore winds.

b) Rainfall seasonality

Rainfall is summer dominant throughout the state, but the volume of rain that falls during the other months varies considerably between regions. South of the Tropic of Capricorn and east of a line between Emerald and Mitchell, there is a significant winter peak in many years.

c) Rainfall intensity

Rainfall intensity varies with the type of rainfall event (such as advective, cyclonic or frontal), but is generally higher during the summer months than the winter months.

4.7 Flood data

While the majority of structures are sized using statistically derived flows, the collection of historic flood data can also provide valuable information. Flood data can consist of:

• gauging station records
• recorded peak levels
• mapping of flow patterns
• debris marks
• water stains
• photographs or videos
• anecdotal evidence.

Sources of historic flood data can include landowners, local authorities, Queensland Rail (for example, design drawings often highlight peak flood levels), Department of Natural Resources and Mines and the Bureau of Meteorology.

All data obtained must be evaluated for accuracy and correlated across different sources where possible. This is particularly true with respect to anecdotal evidence of flood heights provided by individuals as:

• the observations did not coincide with flood peak
• there was a lack of visibility (night time flood)
• a significant time (years) has elapsed since the observation
• personal observations can change as time passes.

*Figure 4.7 – Annual median rainfall for Queensland*

To be useful, it is essential that all flood height information be related to a recognised level datum.
For large scale and some urban projects, historic flood data may be used for the calibration of mathematical models. Information should also be sought in relation to flood gradients, rates of rise or fall, velocities and flow patterns (directions of flow).

For smaller projects, flood data is often scarce and, hence, may only provide an indication of historic peaks, with no means available to estimate the average exceedance probability (AEP) of the flood event.

4.8 Drainage and flow patterns

An understanding of drainage and flow patterns is required to help ensure that adequate provisions are made for upgraded or future drainage infrastructure. This is particularly important at sites where there is no existing drainage infrastructure.

While flow patterns may be simple to ascertain in waterways, careful consideration is required in relation to overland or floodplain flow.

Drainage and flow patterns may be determined through the review of available topographic maps and aerial photography, and through field inspection. For many sites, all three techniques should be used.

Elements that need to be considered include:

- direction of flow particularly in flat areas
- width of flow
- possible backwater from downstream impacts, such as rivers or weirs
- potential for spill into or from adjacent flow paths
- obstacles to flow.

4.9 Waterway characteristics

The characteristics of a waterway may be considered in terms of geometry, hydraulics and the environment.

Geometric characteristics are based on the physical dimensions of the waterway and include:

- channel width and depth
- cross-section
- bed slope
- channel form.

Channel form relates to the geomorphic characteristics of the channel and notes should be made of the following issues:

- Is the waterway straight or meandering?
- Is the channel clear or obstructed by banks or islands?
- Are there sequences of pools and riffles?
- Is there a clear distinction between channel and floodplain?
- Is the stream in a pristine state or has it been degraded?
- Are the banks steep?
• Are the banks stable?
• Is there any evidence of current or past bank slumping?
• Are there any other signs of erosion or deposition of material? If so, what type of material is evident?
• Does the waterway appear to be stable in location?
• Is the low flow channel likely to alter in location?
• Is the waterway consistent in appearance, or are there pool and riffle sequences?

Hydraulic characteristics relate to the actual flow within the waterway. It is important to note that most field inspections occur during times of little or no flow and, hence, the data collected is unlikely to provide a good indication of flood characteristics. Hydraulic characteristics include:

- flow depth
- velocity (note locations where velocities show variation)
- backwater effects (that is, inundation by downstream water levels, which may drown out or control upstream water levels)
- nature and state of vegetation within channel/floodplain.

The environmental characteristics of a waterway may also be characterised by its water quality, soils and vegetation. These are discussed in subsequent sections.

### 4.10 Water quality data

Water quality data may be required in those instances where:

- proposed works will be discharging runoff into a waterway defined as sensitive
- major works are constructed across a waterway
- there is a need to design pollution control measures.

Therefore, while the collection of water quality data will not be required for all projects, water quality should always be a consideration. The extent of this consideration should be dependent both on the sensitivity of the waterway and on the scale of the project.

In some cases, reports on water quality investigations will be provided through the mechanisms of the environmental assessment process.

Existing water quality data within the study area provides an indication of the health of the aquatic ecosystem. This data is useful for identifying potential changes which may be brought about by the proposed project, and in particular, how runoff and drainage may cause adverse impacts on the existing characteristics.

On the lowest level, the assessment of water quality may be as simple as noting the condition of the water at the time of the inspection (such as stagnant, brackish, colour, turbidity, odour, and so on).

For many waterways, water quality monitoring may be in place. For major projects, specific water quality monitoring may be required. Typically, monitoring should occur both upstream and downstream of the site, so that background levels of pollution can be recorded, and impacts of drainage works monitored.
Chapter 4: Data Collection

*Australian Runoff Quality – A guide to Water Sensitive Urban Design* (EA 2006) is a design guideline that provides an overview of current best practice in the management of urban stormwater in Australia.

### 4.11 Topography

The collection of topographic data is relevant to the assessment of both flow and the potential for erosion. Topographic information is required to allow catchment definition and, in the absence of survey, an assessment of the longitudinal gradient of waterways.

Topographic data is normally obtained from digital terrain models. These are based on aerial laser survey and photography and are often held by relevant state and local authorities or created for specific projects. In the absence of any accurate topographic data, less accurate information from the Shuttle Radar Topography Mission (SRTM) can be used to delineate catchment boundaries and estimate stream slopes.

### 4.12 Soils

Section 3.6.1 of the Austroads *Guide to Road Design* – Part 5 is accepted for this section.

#### 4.12.1 Natural soils

Information on the distribution and description of soils within Queensland is available from the Department of Transport and Main Roads, the Department of Environment and Heritage Protection and CSIRO.

Soil information may be available, from these organisations, in the following formats:

- printed hardcopy maps produced following soil surveys of specific study areas
- published soil survey reports that accompany the maps and describe the soil mapping units in more detail – some of these reports also contain chemical and physical analytical data for samples taken from soil profiles representing the major soils present within the study area
- digital GIS soil maps of specific study areas, most commonly provided as either ArcInfo Export, ArcView/ArcMap Shape or MapInfo TAB files
- digital GIS databases associated with the maps and often providing additional information such as landform, geology, dominant soils within each mapping unit, associated soils and the proportion of the mapping unit that each covers
- digital ACCESS databases that contain additional information for the mapping units
- digital ACCESS databases that provide soil profile information for all sites recorded as part of the soil survey.

Specific soil maps and associated reports have also been produced for selected transport corridors. Care should be taken when using published soils information as the quality of the data may vary due to:

- original purpose of the survey
- mapping scale (or level of intensity) of the survey information
- methodology used in the survey.

Any associated chemical laboratory methods may vary over time and should be checked before proceeding with data interpretation.
4.12.2 Acid sulphate soil information

The Department of Environment and Heritage Protection is the lead agency for information and advice on acid sulphate soil (ASS), and is continually developing ASS risk maps that show areas dominated by actual (AASS) and potential (PASS) ASS. These maps present information on presence or ‘depth to’ AASS horizons and presence or ‘depth to’ PASS horizons. They are available in hard copy and electronic forms at a range of scales.

For more information and mapping:

- access the Department of Transport and Main Roads geographic information systems (GIS) (mapinfo)
- access the Department of Natural Resources and Mines’ fact sheets, such as Acid sulfate soils in Queensland on its website
- contact the Queensland Acid Sulphate Soils Investigation Team (QASSIT), Department of Natural Resources and Mines
- access CSIRO and the National Committee for Acid Sulphate Soils (NatCASS) soil databases.

4.13 Existing infrastructure

At all locations, it is important to identify existing infrastructure and PUP, which may act as constraints to the design and location of future drainage measures. At all sites, it is important to note the location and existence of:

- adjacent dwellings or other buildings with floor levels
- existing culverts and bridges
- infrastructure associated with the supply of services such as communications, gas, water supply, sewerage
- industrial pipelines
- irrigation infrastructure.

The existence of infrastructure may exert a strong influence on the design of hydraulic structures. Constraints can include:

- maximum allowable upstream water levels (for example, based on potential for flooding of existing buildings and infrastructure)
- obstructions to flow
- diversion of flow
- need to maintain pedestrian safety.

For larger projects, it may also be necessary to obtain details of major infrastructure, such as dams or weirs.

4.14 Survey

In obtaining survey for a project, reference should be made to the current departmental surveying standards. In particular, reference should be made to the relevant geomatic survey section, as well as the general information section. These standards are available on the department’s intranet and internet sites. The geomatic type ‘Bridge Surveys’ provides comprehensive details as to the
requirements for bed levels, bed gradient and channel cross-sections. Reference is also made to the need to identify additional information as described in other sections of this chapter.

When specifying requirements for survey, it is important to ensure that cross-sections are surveyed perpendicular to the direction of flow, both within the channel and on the floodplain.

The most appropriate and cost-effective method of data capture should be assessed for each project. Options include traditional ground survey, photogrammetry and Airborne Laser Scanning /Light Detection and Ranging. Also, any existing geographical data (within GIS) should be reviewed.

For advice and/or additional information, refer to the regional or district survey manager and/or Geospatial Technologies Unit within the Engineering and Technology Branch.

4.14.1 Aerial imagery

Aerial imagery is a valuable source of information for the design and assessment of drainage infrastructure, though it is important to be aware of the dates and times at which the image was captured. Aerial imagery may be used to determine, at the time of capture:

- extent, density and patterns of vegetation
- delineation of overland flow paths
- locations of active erosion (such as meanders)
- waterway dimensions where access is poor
- land use.

Historical photographs and imagery can also be a valuable source of information in relation to assessing historic flood heights, flow patterns, and waterway characteristics.

Care must be taken in the assessment, where the date and time of the capture is not known. Field inspections should be used to confirm the currency of existing information.
4A Appendix: Data collection checklist

Data collection checklist

<table>
<thead>
<tr>
<th>Region/district:</th>
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<td>Contract/project number:</td>
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Each section must be considered for applicability to project. Sub-components should be checked when data is collected or noted as not applicable to the project.

**Table 4A.1 – Environmental assessment**

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<th>Item</th>
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<td>Has vegetation and fauna data been obtained from an environmental assessment?</td>
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**Table 4A.2 – Vegetation coverage**

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<td>Have aerial photographs been sought?</td>
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<td>Has a field assessment of vegetation coverage been undertaken?</td>
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**Table 4A.3 – Other forms and checklists**

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</tbody>
</table>

**Table 4A.4 – Field inspections**

<table>
<thead>
<tr>
<th>Item</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing land use</td>
<td>✔</td>
</tr>
<tr>
<td>Evidence of flooding – indications of flood heights (debris, etc.)</td>
<td>✔</td>
</tr>
<tr>
<td>Evidence of erosion or deposition</td>
<td>✔</td>
</tr>
<tr>
<td>Potential sources of debris</td>
<td>✔</td>
</tr>
<tr>
<td>Potential sites for future control measures</td>
<td>✔</td>
</tr>
<tr>
<td>Extent and nature of vegetation (refer also Table 4A.2 in this Appendix)</td>
<td>✔</td>
</tr>
<tr>
<td>Drainage and flow patterns (refer also Table 4A.7 in this Appendix)</td>
<td>✔</td>
</tr>
<tr>
<td>Waterway characteristics (refer also Table 4A.8 in this Appendix)</td>
<td>✔</td>
</tr>
<tr>
<td>Water quality (refer also Table 4A.9 in this Appendix)</td>
<td>✔</td>
</tr>
<tr>
<td>Soil characteristics (refer also Table 4A.11 in this Appendix)</td>
<td>✔</td>
</tr>
<tr>
<td>Building infrastructure (refer also Table 4A.12 in this Appendix)</td>
<td>✔</td>
</tr>
<tr>
<td>Drainage and other infrastructure (refer also Table 4A.12 in this Appendix)</td>
<td>✔</td>
</tr>
</tbody>
</table>
### Table 4A.5 – Rainfall

<table>
<thead>
<tr>
<th>Item Check</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has the following rainfall data been obtained?</td>
<td></td>
</tr>
<tr>
<td>• Statistical data</td>
<td>☐</td>
</tr>
<tr>
<td>• Historical records</td>
<td>☐</td>
</tr>
</tbody>
</table>

### Table 4A.6 – Flood data

<table>
<thead>
<tr>
<th>Item Check</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have gauging station records been obtained?</td>
<td>☐</td>
</tr>
<tr>
<td>Have recorded peak water levels been obtained?</td>
<td>☐</td>
</tr>
<tr>
<td>Have debris marks, water stains, etc., been identified?</td>
<td>☐</td>
</tr>
<tr>
<td>Has anecdotal evidence been obtained?</td>
<td>☐</td>
</tr>
<tr>
<td>For large-scale projects, has historical flood data been sought?</td>
<td>☐</td>
</tr>
<tr>
<td>Has flood data been assessed for accuracy? (surveyed or anecdotal)</td>
<td>☐</td>
</tr>
</tbody>
</table>

### Table 4A.7 – Drainage and flow patterns

<table>
<thead>
<tr>
<th>Item Check</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verify direction of flow (particularly important in flat terrain)</td>
<td>☐</td>
</tr>
<tr>
<td>Width of flow (including low and high banks)</td>
<td>☐</td>
</tr>
<tr>
<td>Potential for overflow into or from adjacent flow paths</td>
<td>☐</td>
</tr>
<tr>
<td>Identify obstacles to flow</td>
<td>☐</td>
</tr>
<tr>
<td>Existing and potential drainage patterns</td>
<td>☐</td>
</tr>
</tbody>
</table>

### Table 4A.8 – Waterway characteristics

<table>
<thead>
<tr>
<th>Item Check</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have the following geometric characteristics been obtained?</td>
<td></td>
</tr>
<tr>
<td>• Channel width and depth</td>
<td>☐</td>
</tr>
<tr>
<td>• Cross-section</td>
<td>☐</td>
</tr>
<tr>
<td>• Bed slope</td>
<td>☐</td>
</tr>
<tr>
<td>• Channel form</td>
<td>☐</td>
</tr>
<tr>
<td>Have the following geomorphic characteristics been considered?</td>
<td></td>
</tr>
<tr>
<td>• Is the waterway straight or meandering?</td>
<td>☐</td>
</tr>
<tr>
<td>• Is the channel clear, or obstructed by banks or islands?</td>
<td>☐</td>
</tr>
<tr>
<td>• Is there a clear distinction between channel and floodplain?</td>
<td>☐</td>
</tr>
<tr>
<td>• Are the banks steep?</td>
<td>☐</td>
</tr>
</tbody>
</table>
### Chapter 4: Data Collection

#### Table 4A.9 – Water quality data

<table>
<thead>
<tr>
<th>Item</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are the banks stable?</td>
<td>☐</td>
</tr>
<tr>
<td>Is there any evidence of current or past bank slumping?</td>
<td>☐</td>
</tr>
<tr>
<td>Are there any other signs of erosion or deposition of material?</td>
<td>☐</td>
</tr>
<tr>
<td>If so, what type of material is evident?</td>
<td>☐</td>
</tr>
<tr>
<td>Does the waterway appear to be stable in location?</td>
<td>☐</td>
</tr>
<tr>
<td>Is the low flow channel likely to alter in location?</td>
<td>☐</td>
</tr>
<tr>
<td>Is the waterway consistent in appearance, or are there pool and riffle sequences?</td>
<td>☐</td>
</tr>
</tbody>
</table>

**Have the following hydraulic characteristics been obtained?**

<table>
<thead>
<tr>
<th>Item</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow depth</td>
<td>☐</td>
</tr>
<tr>
<td>Velocity (note locations where velocities show variation)</td>
<td>☐</td>
</tr>
<tr>
<td>Backwater effects (that is, inundation by downstream water levels, which may drown out or control upstream water levels)</td>
<td>☐</td>
</tr>
</tbody>
</table>

#### Table 4A.10 – Topography

<table>
<thead>
<tr>
<th>Item</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevant State Departments</td>
<td>☐</td>
</tr>
<tr>
<td>MRTS16 Landscape and Revegetation Works</td>
<td>☐</td>
</tr>
<tr>
<td>Local authorities</td>
<td>☐</td>
</tr>
<tr>
<td>Will onsite water quality monitoring be required?</td>
<td>☐</td>
</tr>
<tr>
<td>Has the presence of acid sulphate soils been checked?</td>
<td>☐</td>
</tr>
</tbody>
</table>

#### Table 4A.11 – Soils

<table>
<thead>
<tr>
<th>Item</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevant soil maps and reports including TMR Soil Group</td>
<td>☐</td>
</tr>
<tr>
<td>Relevant State Departments or CSIRO soil database</td>
<td>☐</td>
</tr>
<tr>
<td>MRTS16 Landscape and Revegetation Works</td>
<td>☐</td>
</tr>
<tr>
<td>Field investigations at each site</td>
<td>☐</td>
</tr>
</tbody>
</table>
**Table 4A.12 – Existing infrastructure**

<table>
<thead>
<tr>
<th>Item</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has the existence and location of the following been identified?</td>
<td></td>
</tr>
<tr>
<td>• Adjacent dwellings/buildings – where flooding could be a sensitive issue, include floor levels or other control points etc.</td>
<td>☐</td>
</tr>
<tr>
<td>• Existing drainage infrastructure (e.g. bridges, culverts, subsoil drains, pipelines, environmental/water quality devices)</td>
<td>☐</td>
</tr>
<tr>
<td>• Private/Public Utility Services (e.g. communications, gas, power, water, sewerage etc.)</td>
<td>☐</td>
</tr>
<tr>
<td>• Industrial pipelines</td>
<td>☐</td>
</tr>
<tr>
<td>• Irrigation infrastructure</td>
<td>☐</td>
</tr>
</tbody>
</table>