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# SECTION 206 STRUCTURAL DESIGN

The Principal will appoint a Bridge Engineer to be the liaison officer for the Project. To ensure the Project fully meets the Principal's requirements this officer shall be kept fully informed on all matters and aspects of the work.

## 206.1 Foundation Investigation

The Consultant shall determine and carry out all foundation investigation considered necessary for the design of the Works including any testing required, either in‑situ or laboratory.

Foundation Investigation for bridge works shall be carried out in accordance with Part 3 of AS 5100 Bridge Design Code.

Borehole logging shall be carried out by an experienced engineering geologist or geotechnical engineer.

Borehole Information Drawings shall be prepared to present the results of the foundation investigation and shall be included in the Contract Documents as "Information for Tenderers" (refer Section 209 **Tender Documentation**).

The results of all foundation investigation work shall be made available to the Principal’s Representative. The core samples must be kept safely for a period of 5 years minimum and be accessible to the construction tenderers.

## 206.2 Waterways Investigation for Major Crossings

*<MRWA Project Manager to seek advice from Waterways Section to complete Section 206.2>*

### Introduction

Waterways investigation shall be in accordance with “Australian Rainfall and Runoff Guidelines 2019” and:

for bridges “AS 5100” and “Austroads Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures”.

for culverts and floodways “MRWA Supplement to Austroads Guide to Road Design Part 5B: Drainage-Open Channels, Culverts and Floodway Crossings” and “Main Roads Floodway Design Guide”

### 206.2.2 Hydrology

The Consultant shall carry out flow estimation for Annual Exceedance Probabilities (AEP) of 50%, 20%, 10%, 5%, 2% and 1%. Flows up to 0.05% AEP may be required for the purposes of informing ULS forces on the bridge, and in these scenarios, a pragmatic estimation approach should be taken.

*<Note: ULS forces typically occur when water level is at or just above bridge deck. If bridge is known or shown to be submerged in the 2% AEP to 1% AEP flood event, then flow estimation up to 0.05% AEP may not be critical>*

Acceptable flow estimation techniques, including computer modelling, shall be used. Design flows are to be checked against historical flood events and relevant data or requirements (e.g. from Water Corporation or Department of Water and Environmental Regulation), if available. Where the waterways are gauged, flood frequency analysis techniques are to be used. Before commencement of the analysis, the Consultant shall obtain from the Principal’s Representative any available flood data or other relevant information at the site, and clarify the scope of hydrological work with Main Roads Waterways Section.

*<Amend as appropriate:*

* *The suggested hydrological methods are:*
	+ *RFFE;*
	+ *ARR87;*
	+ *FFA;*
	+ *Runoff Routing (ARR 1987 and/or ARR 2019); and*
	+ *Other (e.g. Flavell).*
* *Notable information to be aware of:*
	+ *Add relevant waterways reports*
	+ *Add relevant historical flood information>*

### 206.2.3 Hydraulics

Hydraulic analysis shall be carried out on the existing waterways structure and options to compute the following:

* bridge/culvert/floodway size, type and configuration;
* stage/discharge and backwater curves;
* velocities in the natural channel, through the structure and on floodway batters (where applicable);
* estimated depth of scour (typically for preferred bridge option only);
* scour protection (if required);
* dimensions, locations and sizes of guide and levee banks and other associated works;
* possible modes of failure under overtopping conditions.

The serviceability for Highways and Main Roads shall consider “AS 5100”, “MRWA Supplement to Austroads Guide to Road Design Part 5: Drainage-General and Hydrology Considerations”, “MRWA Supplement to Austroads Guide to Road Design Part 2: Design Considerations” and “Main Roads Floodway Design Guide”, and shall be confirmed by Principal’s Representative for any site specific requirements. In general, bridges shall at minimum pass the 2% AEP flow and culverts and floodways at minimum pass the 5% AEP flow.

Climate change considerations shall be in accordance with “Australian Rainfall and Runoff Guidelines 2019”. A pragmatic approach considering risk is recommended.

Before commencement of the analysis the Consultant shall contact Main Roads Waterways Section to clarify the scope of hydraulic work. For quality assurance, Main Roads Waterways Section shall also be contacted after hydrology is complete and the existing waterways structure analysed (prior to options being analysed).

*<Amend as appropriate:*

* *Specific hydraulic considerations are:*
	+ *Suggest 1D or 2D hydraulic modelling approach;*
	+ *Add whether site visit is considered mandatory or not;*
	+ *Add any further guidance on serviceability;*
	+ *Add any further guidance on replacement structure type preferences;*
	+ *Add any notes about available survey;*
	+ *Add any further guidance on climate change (if appropriate);*
	+ *Add any notes regarding anecdotal performance or scour (if known);*
	+ *Add possible flood impact checks (if known);*
	+ *Add possible flood behaviour description (if known); and*
	+ *Final report to present X number of viable replacement options.>*

### 206.2.4 Waterways Investigation Deliverables

The Consultant shall prepare a Waterways Report incorporating all details of the literature review, site visit (where applicable) and survey, hydrology, hydraulics and recommendations. Information required to complete the waterways criteria on the [Design Criteria Sheet](https://www.mainroads.wa.gov.au/globalassets/technical-commercial/technical-library/structures-engineering/structure-design/technical-design-guidelines/bridge-design-criteria-form.docx) shall be determined. The final hydrology and hydraulic models shall be submitted to Main Roads.

## 206.3 Bridge Design

### 206.3.1 Introduction

The proposed bridge will cross ................................................................................ The proposed superstructure will be ............. metres wide between kerbs and will be in the order of ............. metres long.

The design Consultant must satisfy the requirements of the “Eligibility To Tender” Special Conditions of Tendering Clause 1. The design requires the involvement of suitably qualified and experienced personnelin an office in Perth, Western Australia, to facilitate technical review by the Principal's Representative for the duration of the design contract.

<Complete to suit>

<If any drilling already carried out, insert suitable reference, and provide

details in suitable format, and where information is located>.

The scope of the bridge design work to be carried out under this Commission shall include:

* Preliminary design.
* Final design.
* Design verification.
* Submission of design reports.
* Design summary and load rating.
* Minor works contracts.

<Example only - amend as required>

The Principal’s Representative will provide to the Consultant, in both hard copy and electronic form, copies of standard details and standard designs as appropriate for this Project. Refer also to Structures Engineering Branch’s Document No. 3912/02/01-17, *Bridge Branch Design Information Manual*, and Document No. 3912/03/00, *Bridge Branch Design Manual*.

### 206.3.2 Structural Design Standards

(i) The bridge shall be designed in accordance with the Australian Bridge Design Code AS5100 (Code), the Bridge Branch Design Information Manual (Document No 3912/02; attention is drawn to Section 2) and the modifications below.

(ii) The clause numbers below refer to clause numbers as used in the Bridge Code. For example: BDC 1 - 13.11 refers to Bridge Code Part 1, Clause 13.11.

**BDC 1 - SCOPE AND GENERAL PRINCIPLES**

**BDC 1 - 13.3 Bridges Over Navigable Waterways**

Dimensional clearances for the bridge are XX m horizontal and XX m vertical.

**BDC 1 - 13.4 Road Bridge Carriageway Widths**

The bridge width must be based on the following minimum configuration:

 No. of lanes: XX

 Cross section: XX m shoulder + XX x XX m lanes + XX m median +

 XX x XX m lanes + XX m shoulder

 Shared path: XX m on XX side of bridge

 Footpath: XX m on XX side of bridge

**BDC 1 - 13.11 and 13.13 Pedestrian Bridges And Bicycle Paths**

The clear width between handrails must be XX m. Vertical clearance over roadways, with due allowance for settlement and for the addition of a further 50 mm asphalt, must not be less than XX m.

Design of shared path bridges must cater for the disabled in accordance with Main Roads’ *Disability Service Plan* and AS1428 *Design for Access and Mobility*.

**BDC 1 - 13.12 Pedestrian Subways (Dual Use Underpasses)**

Design of shared path underpasses must have a clear width of at least XX m at the base, a height of not less than XX m, a width at the widest part of not less than XX m and a cross sectional area of not less than XX m2. Design must also cater for the disabled in accordance with Main Roads’ *Disability Service Plan* and AS1428 *Design for Access and Mobility*.

**BDC 1 -20 Utilities (Services)**

The Contractor must obtain the agreement of the relevant Authority or private owner in writing to the conditions contained in [Utility Services in Road Reserves - Policy and Guidelines](http://standards.mainroads.wa.gov.au/NR/rdonlyres/2856D7E8-36EA-43C0-BB25-DC9826CD3C47/0/e80414_20070312130406077.PDF) available from the Roads and Traffic Engineering Standards section of Main Roads’ website.The Consultant or Project Manager must obtain the service owner signature on the MRWA Standard Conditions for Attachment of Services to Existing Structures.

**BDC 2 - DESIGN LOADS**

**BDC 2 - 14.3.2 Earthquake Forces - Bridge Classification**

Earthquake effects shall be considered given the bridge classification BEDC-X.

**OTHER STRUCTURAL DESIGN REQUIREMENTS**

Refer to the Bridge Branch Design Manual (Document No 3912/02) Section 2.

### 206.3.3 Design Process

Refer to Bridge Branch Design Information Manual (Document No 3912/02; attention is drawn to Section 2).

### 206.3.5 Design Verification

Prior to signing and submission of final drawings an independent check of all aspects of the structural design shall be carried out by a suitably qualified and experienced Engineer who was not involved in the design.

The Principal may also arrange for a proof check of the design either by the Structures Engineering Branch or an independent authority appointed by the Principal.

### 206.3.6 Lighting Design

The Consultant shall design lighting to the bridge carriageway and/or walkways in accordance with Main Roads' standards and utilising standard Main Roads' components. Refer to Section 205.9 **Street Lighting**.

### 206.3.8 Bridge Drawings

All Bridge Design Drawings shall be produced at A1 size using Structures Engineering Branch’s Standard Titleblocks. Drawings shall be produced in accordance with Structures Engineering Branch Document No. 3912/04, *Drafting Information and Practices Manual*. Drawings shall conform to the CAD standards, requirements and prototype details as detailed in Structures Engineering Branch Document No. 6706-02-2228, *Guidelines on Presentation and Format of Drawings*. The current edition of “Drafting Information and Practices Manual” will be made available to the Consultant as an uncontrolled copy upon request to the Principal’s Representative. The “Guidelines on Presentation and Format of Drawings” is available on-line.

The final Drawings for the Project shall be signed in the "Approved" box by a Director of the Principal's staff, a Partner or other senior member of the Consultant's staff to certify that the design and an independent design check have been carried out in accordance with this Brief.

Phase 1 – Preliminary Design

Where bridge designs are included in the commission, General Arrangement Drawings shall be prepared for all alternatives considered.

Phase 2 – Detailed Design

The drawings shall include the following:

* Contract Cover sheet.
* Index Sheet.
* General Arrangement.
* Earthworks and Services (May be included in General Arrangement).
* Bore Information.
* Geometric Data.
* Reinforced Concrete drawings.
* Prestress Drawings.
* Bearing Data and Installation details.
* Beam Fabrication and Installation details.
* Traffic Barrier, Parapet Panel and Parapet railing details.
* Piling details.
* Expansion Joints and Approach Slabs details.
* Construction Sequence.
* Design Summary (For refurbishments - may be included in the General Arrangement).

<Example only - amend list as required>

Phase 3 – Final Submission

The principal of the company who is authorised to take responsibility for the technical content shall sign and date the drawings at this time.

### 206.3.9 Design of Temporary Works

Where applicable, the design of temporary works shall be in accordance with AS 3610 - "Formwork for Concrete" and the Work Health and Safety Act 2022.

No temporary restriction to existing vertical clearances or temporary reduction in the load carrying capacity for heavy vehicle movements is permitted.

### Structural Design Models

Electronic copies of all structural design models used in the analysis shall be provided in accordance with Survey and Mapping Section’s Guideline “Data Lodgement” Document No. 67-08-119.

### 206.3.11 Onsite Design Check

The Consultant shall peg the apron design levels of culverts and the abutment locations of new bridges for inspection by the Principal’s Representative.

## 206.4 Retaining Walls

All retaining walls not covered by the Bridge Code as defined in AS 5100.1, Clause 1 must be designed in accordance with AS 4678 Earth Retaining Structures.

The footings of any retaining wall located on a boundary must be located completely outside the abutting property. Such footings must be designed and located such that the face of the wall is as close as practicable and parallel to the boundary.

Materials and appearance of retaining walls on private property boundaries must be approved by the property owner.

## 206.5 Sign Gantries and Cantilever Signs

The surface finish colour must be 'Brunswick Green'.

GUIDANCE NOTES

***DELETE GUIDANCE NOTES FROM FINAL DOCUMENT AFTER USING FOR REFERENCE***

All edits to downloaded Briefs shall be tracked (most word processing software allows this to be done automatically). Deletions shall be struck through e.g. ~~example~~. Insertions shall be in italics e.g. *example*. If **all** information relating to a clause is deleted then the clause number should be retained and the words "**NOT USED**" should be inserted.

The proposed documents with tracked changes shall be submitted to Main Roads for review, prior to printing the final batch of documents. When this final printing is carried out, changes are saved and the tracked changes option is to be **turned off**.

The Custodian of this section of the Brief is Mr Adam Lim (Structural Design & Standards Engineer) ph: 9323 4457.

1. **Clause 206.3.5 Design Verification**

If the optional **Design Verification** Clause 101.2.2.6 is included in the Brief then Clause 206.3.5 **Design Verification** needs to be amended accordingly.