Drafting and Design Presentation Standards
Volume 3: Structural Drafting Standards

Chapter 11: General Arrangement Drawings

December 2020

Queensland Government

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Chapter 11 Amendments

Revision register

Issue/Rev No.	Reference Section	Description of Revision	Authorised by	Date
1	-	First Issue	Manager (Structural Drafting)	Apr 2011
2	-	Document name change	Manager (Structural Drafting)	Nov 2011
	11.7	Threaded rod option added		
3	-	General Revisions Updated Appendix sample drawings	Senior Designer	Dec 2020

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11 General Arrangement Drawings

11.1 Glossary of terms

For a complete glossary of terms refer Chapter 1 *Introduction*.

General Arrangement drawings are informally referred to as GA's as they will be in this chapter. On all drawings they are to be referred to with the full description and shall not be abbreviated.

11.2 Figures and examples shown in this volume

The figures and examples shown in this volume are for presentation purposes only, and may contain some details that are now superseded. These details have been included for ease of reference, to illustrate typical solutions, and to show the required standard of drafting presentation, as such, details are shown for PSC Deck Units and PSC Girders. The supplied details are not to be used without an engineering check and certification by a Structural RPEQ to confirm that the details are appropriate for the specific project.

11.3 Consistency in presentation

As stated in Chapter 1 – *Introduction*, the purpose of this volume is to standardise the presentation of structural drawings, particularly departmental bridges, to achieve uniformity in appearance and detail for structural drawings.

This is important, particularly when drafting GA drawings, which can be drawn so that similar information is displayed consistently. For example:

- plan and elevation on the first sheet (multiple first sheets if the bridge is too long to fit on one drawing)
- bench mark / permanent survey mark information is always shown in the top left-hand corner of the first GA drawing along with a legend regarding foundation bore holes
- the catchment area is to be shown at the bottom right-hand side of the Plan view, and
- the notes are to be shown at the bottom right-hand side of the drawing.

11.4 Types of GA drawings

GA drawings give an overall representation, at various phases of the project, of the bridge to be constructed. These phases are:

- concept design (15% complete)
- preliminary design (50% complete), and
- detailed design (85% / 100% complete)

The level of detail provided at each phase will increase as the project progresses from concept through to detailed design.

11.5 Concept design GA drawings

The information available at the concept stage of the project can be limited. These drawings are used to provide different options that may be appropriate for the particular site and road design.

The following views shall be provided:

- plan
- elevation
- section deck
- horizontal curve alignment (if available)
- vertical curve alignment (if available)
- concept drawing stamp (with issue date), and
- title block (if various options are provided each drawing is to be clearly marked with the appropriate option, for example Option A, Option B etc.).

Each of these views shall provide all information available at that time.

Generally, there will be one drawing, however depending on the overall length of the bridge there may be multiple drawings. Concept GA drawings are usually used to indicate the anticipated type of structure for the Region's Business Case.

Refer Appendix A - Example Concept GA Drawings.

The following sections will explain each view in detail and look at some of the aspects to be addressed:

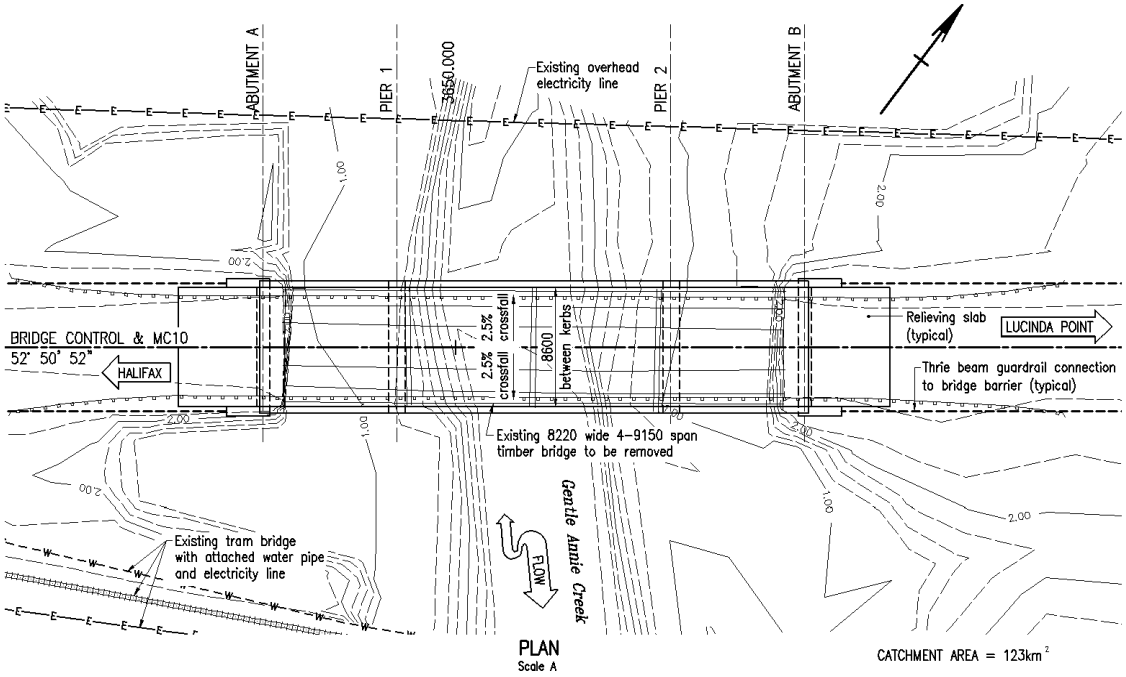
Plan

- Outline of the structure
- Waterway name
- Crossfall or superelevation
- Width between kerbs
- Major towns (in each direction)
- Contours of the existing surface, at 0.25 m intervals with Heights marked at 1 m intervals
- Property boundaries and fences
- Public utilities and services, labelling any services to be relocated, including if it is in or out of the contract
- Abutments and Pier(s) centrelines
- Relieving slabs
- Approach and departure guardrail / extruded concrete barriers
- Stream flow, including tidal stream flow when appropriate
- North point
- Road control line and chainages
- The Road Control is to be shown on the left hand side of the Plan view along with the Bridge Control. The horizontal alignment, bearing or radius, shall also be shown.

- Existing structures, to be shown in a dashed line, and with details such as span lengths, bridge width and composition and existing nominal deck Height. This is important particularly when a new bridge is being built on or near the same alignment as the existing bridge. Ensure the new piles are well clear of the existing piles taking into account any rake on new or existing piles and the maximum theoretical out of position tolerance or existing 'As Constructed' information.

Refer Figure 11.5(a) - Concept GA Drawing - Plan.

Figure 11.5(a) - Concept GA Drawing - Plan



Elevation

- Outline of the structure
- Individual span lengths and overall length of the structure between abutments
- Excavation to clear waterway
- Minimum vertical clearances for overpass bridges
- Existing surface cross section taken along the Control Line
- Existing structures
- Datum Height
- Table of grade Heights and vertical alignment details. Heights shall be shown at abutments and piers.
- Table of surface Heights. Show Heights at major changes in grade and at abutments and piers centrelines.
- Table of chainages. Show chainages for each surface Height and at abutment and pier centrelines, and
- Hydraulic information including flood velocities and flood immunity Heights.

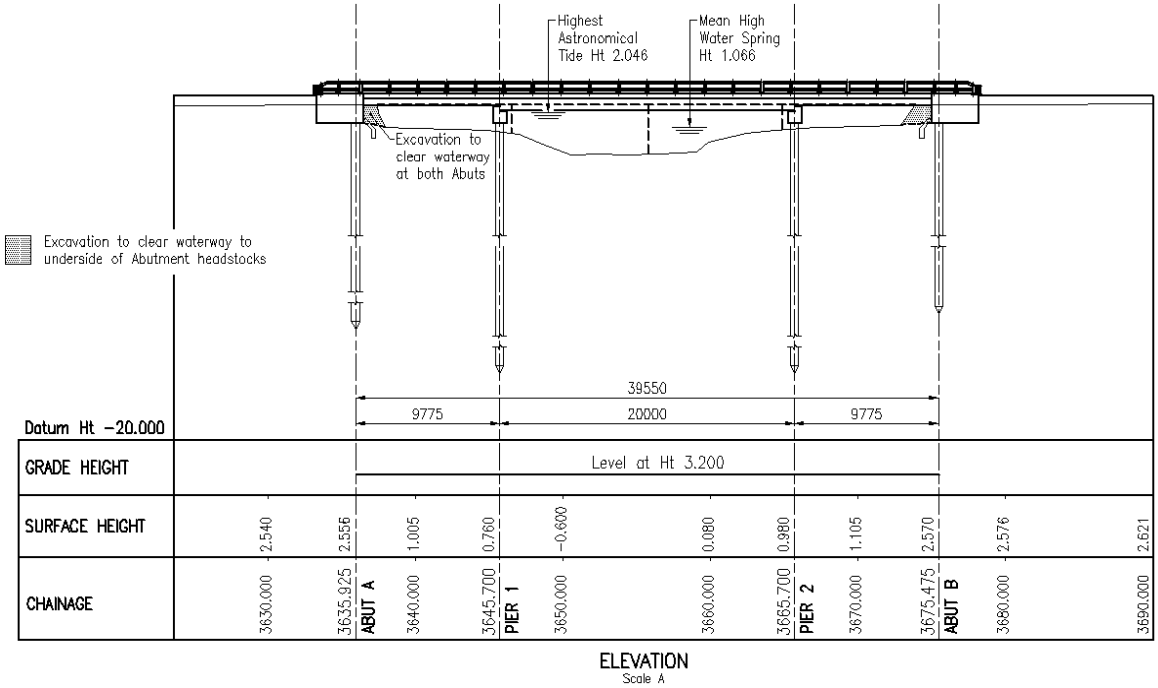
To obtain the relevant permits, the following additional hydraulic information shall be shown when the bridge spans a navigable waterway:

- Mean high water spring – The long term average of the Heights of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of tide is greatest, at full and new moon.
- Mean low water spring – The long term average of the Heights of two successive low waters during those periods of 24 hours (approximately once a fortnight) when the range of tide is lowest, at full and new moon.
- Highest astronomical tide – The highest level that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions. This level will not be reached every year. Storm surges may cause considerably higher levels to occur.
- The clear span between abutments and piers.
- The clearance between the Highest Astronomical Tide and the underside of the deck units / girders.

The Elevation view can become complex on skewed bridges. The view may be replaced with a Sectional Elevation where there are no specific advantages to a projected elevation. Where available, the plan and elevation may also be supplemented (not replaced) by a 3D view, to assist in visualising complex bridge features.

Refer Figure 11.5(b) - Concept GA Drawing - Elevation.

Figure 11.5(b) - Concept GA Drawing - Elevation



Section deck

The section deck is a typical cross section taken through the bridge superstructure. Components that may be shown include, but are not limited to:

- Bridge control
- Deck units / girders, nominal gaps between the deck units / girders
- Transverse stressing units
- Reinforced Concrete (RC) deck
- Grade Height
- Deck Wearing Surface (DWS) and bituminous waterproof membrane
- Crossfall or superelevation
- Width between kerbs (overall width and dimensions to the Bridge Control)
- Width of footways
- Flow arrow
- Scuppers and drainage
- Barriers, and
- Jacking points for girder bridges.

Refer Figure 11.5(c) - Concept GA Drawing - Typical Section Deck and Figure 11.5(d) - Concept GA Drawing - Typical Section Girders.

Figure 11.5(c) - Concept GA Drawing - Typical section deck units

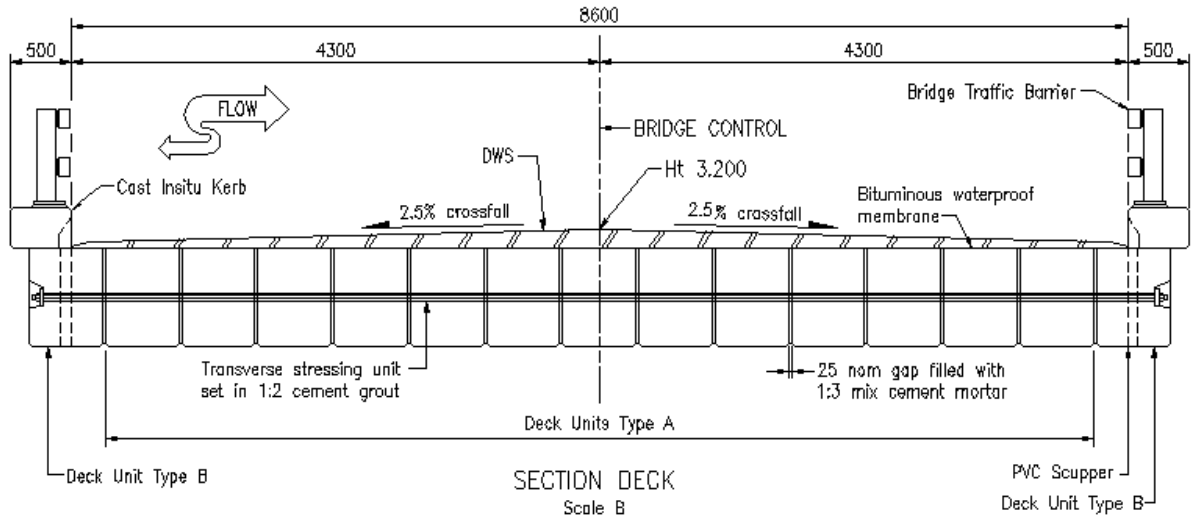
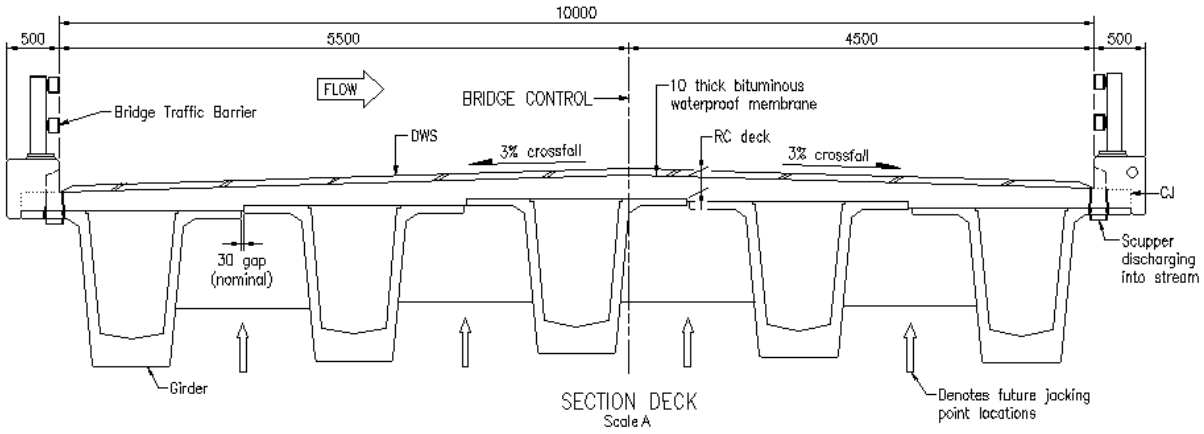


Figure 11.5(d) - Concept GA Drawing - Typical section girders



Stability of PSC girders and deck units

The following text shall be shown on the GA drawing besides the section deck detail 'THE CONTRACTOR SHALL SUBMIT A CONSTRUCTION PROCEDURE TO THE SUPERINTENDENT WITH REGARD TO ENSURING THE STABILITY OF PSC GIRDERS DURING CONSTRUCTION'

Drilling of holes into deck units and girders

The following text shall be shown on the GA drawing besides the section deck detail 'DRILLING INTO THE DECK UNITS (or PSC GIRDERS) IS NOT PERMITTED. ALL FERRULES / ATTACHMENTS MUST BE CAST-IN'

Alignment details

All bridge scheme drawings shall contain adequate alignment information to define the bridge site alignment independently of road design or survey drawings.

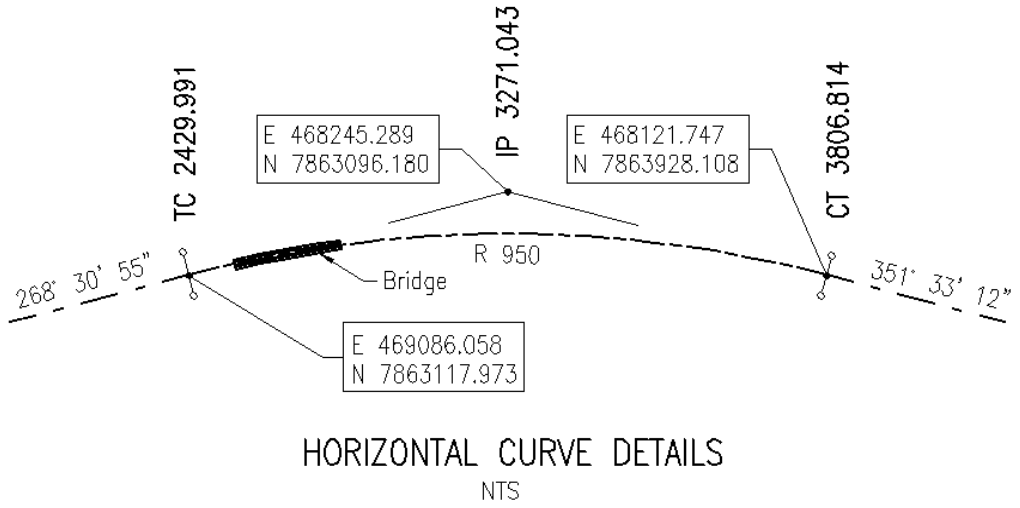
The horizontal and vertical curve details illustrate possible implications on the structure, for example a horizontal curve within 200 m of the bridge may have implications on the superelevation of the structure or possible implications on the width of the structure.

Horizontal curve alignments

Where a bridge is on a horizontal curve the following information is to be shown on a Horizontal Curve detail, Refer Figure 11.5(e) - Horizontal Curves:

- bearings before and after the curve
- radius of the curve
- tangent points (including chainage and co-ordinates)
- intersection points (including chainage and co-ordinates)
- location of the bridge in relation to the curve, and
- any other curve that may have an impact on the structure (within approximately 200 m of the abutments).

Figure 11.5(e) - Horizontal curve detail

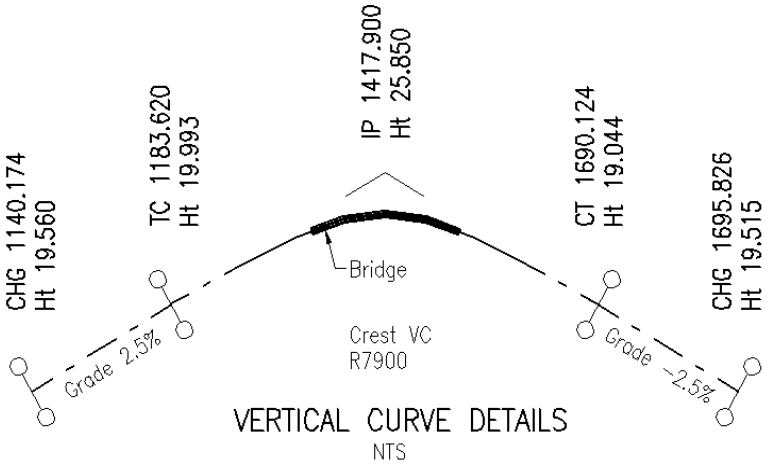


Vertical curve alignment

Where a bridge is on a vertical curve the following information is to be shown on a Vertical Curve detail, Refer Figure 11.5(f) - Vertical Curve Details:

- grade before and after the curve
- radius of the curve and direction of the curve (sag or crest)
- tangent points (including chainage and Heights)
- intersection points (including chainage and Heights)
- location of the bridge in relation to the curve, and
- any other curve that may have an impact on the structure (within approximately 200 m of the abutments).

Figure 11.5(f) - Vertical curve detail



11.6 Preliminary design GA drawings

At the preliminary design phase more information becomes available, which may include final horizontal and vertical alignments, preliminary geotechnical data, hydraulic design etc.

The span length of the bridge will be fixed, as will the width between kerbs. Bridge Fixing is when the design team, hydraulics team, Transport and Main Road's structures and the region, sign off on the length, width, vertical alignment and type of bridge.

More detailed GA drawings can now be prepared. The concept drawings, if available, can be updated with the current information. Views included on the Preliminary GA include, but are not limited to:

- Outline of the abutment spillthroughs and the embankment slopes. Also note if the new embankments intrude into the traffic lanes of the existing road. When they do, solutions including stage construction of the new bridge, temporary retaining walls for the embankments, or side tracking of the bridgeworks, shall be shown.
- Preliminary drawing stamp (with issue date).
- Type Abutments and Piers showing the anticipated structure (this is only required when a preliminary cost estimate is requested by the client). The Type Abutments and Piers views show the type of substructure that the estimate is based on. For example, if the estimate includes driven piles then the views should indicate driven piles because this type of substructure is substantially less expensive than cast in place piles. For drawing requirements refer Section 11.7 – *Detailed Design GA Drawings*.

A table showing the co-ordinates of the proposed bore hole locations may be required (if bore holes have not already been drilled). Refer to the *Geotechnical Design Standard - Minimum Requirements* for an explanation of the number and position of bore holes required at each abutment and pier. The proposed bore holes shall be shown in the Plan view. The co-ordinates shall be rounded to the nearest 0.1 m. The Preliminary Design GA drawing/s may be used with a fixing letter for review and agreement with key stakeholders on the bridge location, spans etc. Once agreement is reached the Preliminary Design GA may be used to inform geotechnical investigations

Refer Appendix B - Example Prelim Design GA Drawings.

11.7 Detailed design GA drawings

At the detailed design phase, all necessary information should be available to draft the final GA drawings for the project. Refer Appendix C - Example Detailed Design GA Drawings.

The Preliminary Design GA drawings can be updated with all final information to create the Detailed Design GA drawings. In addition to views on the Preliminary Design GA drawings, other views shall be added. These may include, but are not limited to:

- note 'Embankments to be in place prior to pile driving. Prebore with …. dia auger to natural surface Height' to be placed in a box on the left hand side of Abutment A
- deck unit anchorage details
- deck unit construction sequence
- pile identification and setting out diagram
- deck unit or girder layout diagram (unless shown on unit or girder drawings)
- type abutments and piers
- limits of HLP vehicle diagram
- table of Standard drawings

- pier design flood force data, including flood velocities and immunity Heights
- notes
- staged construction diagrams and erection procedures, and
- actual borehole locations.

The following sections will explain each view in detail and look at some of the aspects to be addressed.

Plan

All text is to be clear and concise when read at A3 drawing size. If text is placed over features of the drawing, for example contour lines, embankment lines, hatched areas etc., these features are to be blocked out. (In AutoCAD this is referred to as a wipeout or textmask).

It is not necessary to show abutment and pier chainages in this view, but the Plan view must be aligned vertically above the Elevation view below.

In addition to the features previously listed for concept and preliminary GA, additional features may include, but are not limited to:

- Two Bench Marks or Permanent Survey Marks shall be shown in the top left-hand corner along with the type of survey mark, its co-ordinates, Height and Height datum, for example PSM 166915, Star Picket, E274125.225, N2329910.650, Ht 3.970 AHD.
- Existing fences and property boundaries. Note any conflict that bridge components, such as embankment spillthroughs, may have on property boundaries.
- Catchment area in the bottom right-hand side of the Plan view.
- All services such as electricity cables above or below ground, water mains, telecommunication cables etc. Particular reference shall be made for any service that may have an impact on the construction of the bridge. Clearly nominate the services and how they are treated, for example de-energised, relocated etc.
- Actual (not proposed) bore hole locations as detailed in the Geotechnical Report.
- Define excavation to clear waterway by hatching. For maintenance and inspection requirements a minimum clearance of 1200 mm is required between underside of deck units / girders and the ground surface at the abutments. The resulting embankment slopes from the excavated area up to the natural surface shall be a maximum gradient of 1 on 2. Refer Chapter 13 – Provision for Bridge Jacking, Inspection and Maintenance, Section 13.7 - Abutment Protection.

Elevation

The elevation gives details of Grade Heights, Surface Heights and Chainages along the Road Control. If this view is shown along any other alignment the line of section is to be clearly noted.

In addition to the features previously listed for Concept and Preliminary GA, additional features may include, but are not limited to:

- Services above or below the natural surface.
- Heights to PSC pile tips, toe of steel liners, toe of cast in place piles, soffit of pilecaps and footings.

- Preboring requirements. Show a boxed note describing the location, size of auger and give a Height at the toe of prebore. Generally, the diameter of the auger is 50 mm less than the nominated size of the PSC pile.
- Maximum reported flood Height and date.
- Recent water Height and date.
- Articulation of the bridge. Fixed bearing, continuous joint or expansion bearing shall be shown at the centreline of the abutments and piers along with an explanation of the symbols used as shown below (placed on the left of the view):

  F denotes Fixed Bearing

  E denotes Expansion Bearing

  C denotes Continuous Joint.

Section deck

In addition to the detail previously mentioned regarding Concept and Preliminary Design GA drawings, show the mass of DWS and the conduit details (if required).

Anchorage details

For Deck Unit bridges anchorage details at abutments and piers shall be shown on the GA drawings. For girder bridges these details are typically shown on the Miscellaneous Details drawing. Refer to Chapter 14 – *Prestressed Concrete Girders*, for further information.

Anchorage details show the assembly details at abutments and piers. Features may include, but are not limited to:

- Abutment and pier headstocks, deck units, girders, relieving slabs, RC deck, DWS etc.
- Detail of the anchorage system used, for example, dowels, threaded rod or holding down bolts on deck unit bridges or restraint mechanism on girder bridges.
- Additional corrosion protection details for holding down bolts.
- Provision for future jacking.
- Positioning of jacks for future bridge maintenance.
- Limits of mortar seating and its nominal thickness.
- Bearings and recesses for bearings. Note that when deck units/girders are supported by bearings at fixed abutment joints, an approved small movement joint shall be provided in the DWS. Refer Chapter 17 – *Cast Insitu Kerbs and Decks*, Appendix A - Deck Design Sketches – Sheet 2.
- Areas to be grouted, or left clear of grout.
- Expansion joints, and
- Compressible filler.

Refer Figure 11.7(a) - Deck Unit Anchorage Detail - No Provision for Jacking and Figure 11.7(b) - Deck Unit Anchorage Detail - Provision for Jacking.

Figure 11.7(a) - Deck unit anchorage detail - No provision for jacking

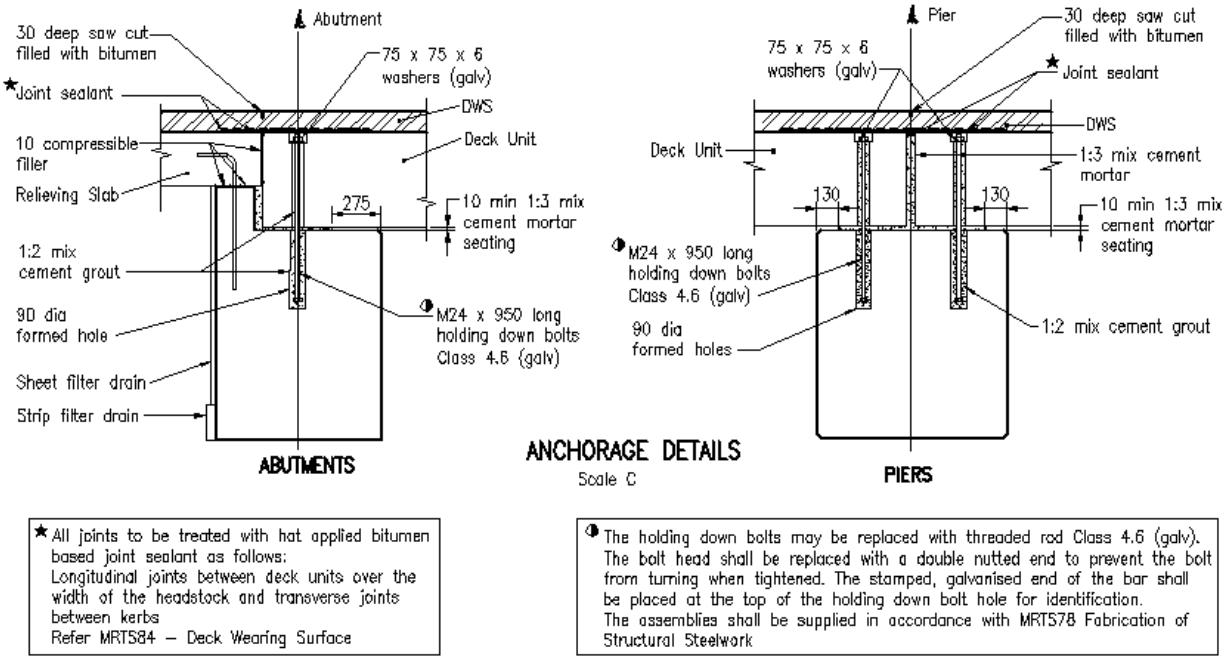
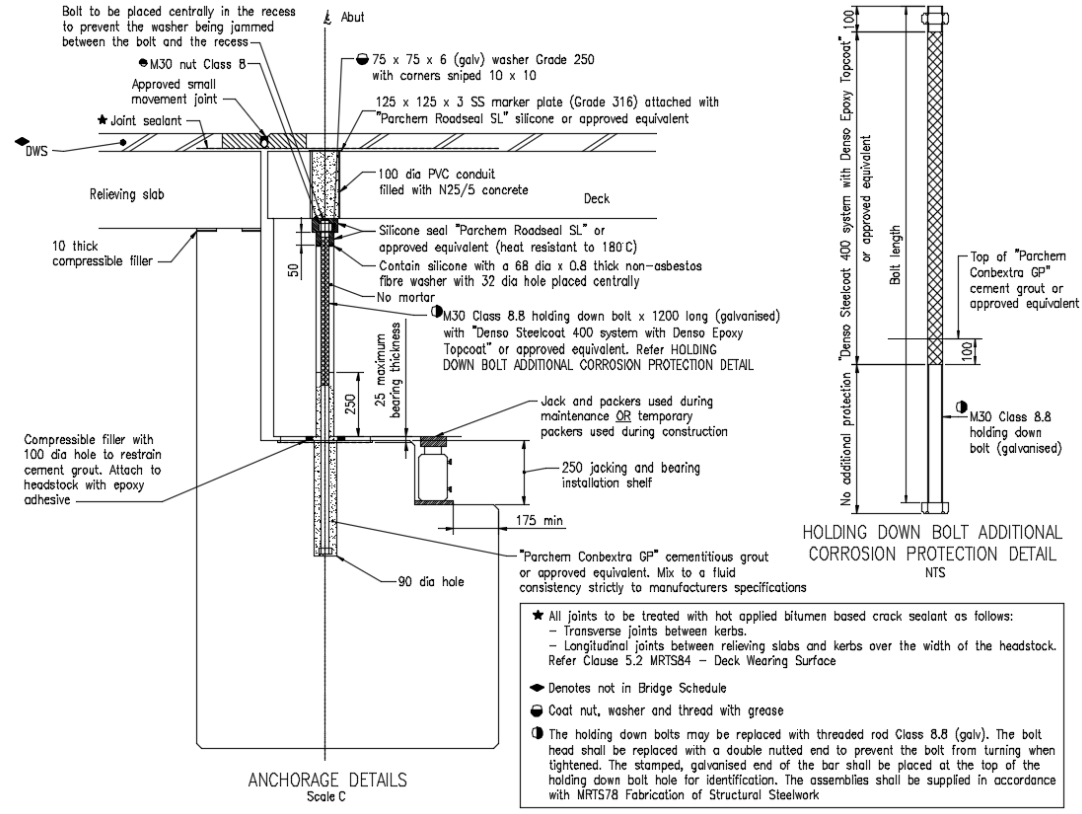


Figure 11.7(b) - Deck unit anchorage detail - Provision for jacking



Deck unit erection construction sequence

When precast deck units are erected on elastomeric bearings, the erection procedure notes and appropriate diagram are shown. Refer Chapter 13 – *Provision for Bridge Jacking Inspection and Maintenance*, Section 13.5 – *Deck Unit Erection Construction Sequence*.

Pile identification and setting out diagram

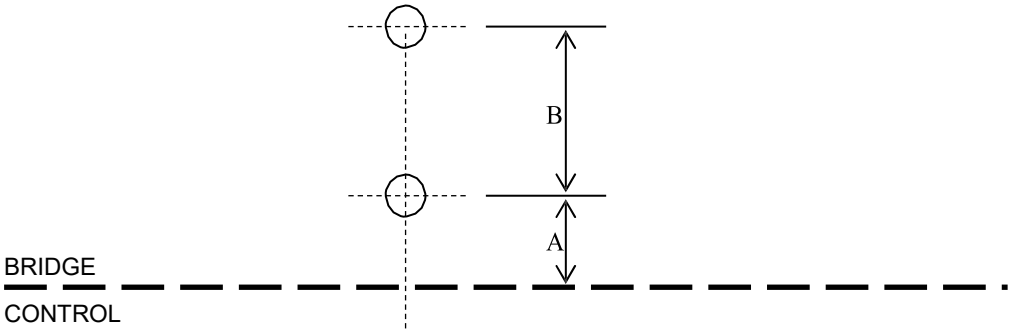
The pile identification and setting out of the piles shall be shown on the GA drawings. The Pile Identification and Setting out Diagram is generally not drawn to scale, but it shall have reasonable proportions and shall show the following details:

- bridge control and its bearing, or the radius of the horizontal curve
- the centreline of the pile group at abutment and piers shall be defined by a bearing and the intersection with the Bridge Control line shall be identified by a co-ordinate
- pile identification number for each individual pile
- dimensions to locate each pile
- relationship of footings to Bridge Control and abutment and pier centrelines, and
- relationship of stage construction to Bridge Control.

All piles shall be identified by a Pile Identification Number shown adjacent to the pile it represents. The format of the number is @/# where:

- @ = an alphanumeric character or number that represents the element of the bridge, for example A for Abutment A, B for Abutment B and one for Pier one
- # = a sequential number given to each pile counting from the left-hand side of the bridge.

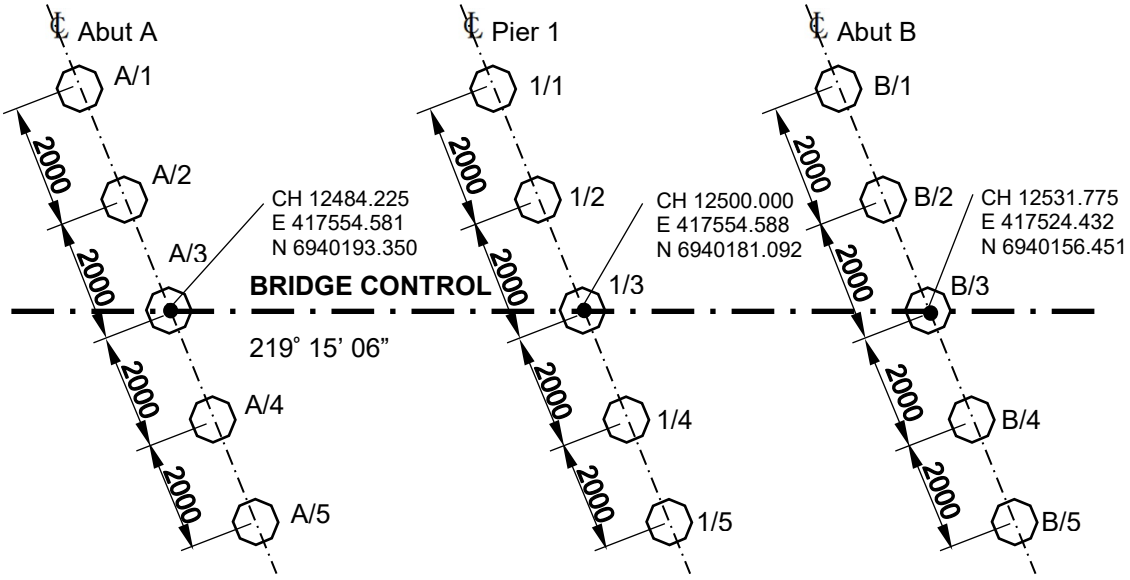
The spacing of the first pile from the Bridge Control along the centreline of the group of piles shall be dimensioned from the Bridge Control line, Dimension A. The spacing of each subsequent pile along the centreline of the group of piles shall be dimensioned from the previous pile, Dimension B.



Where raked piles are used, a note shall be added to the drawing stating that the location shown is at the underside of the headstock / pilecap into which the pile is bonded. Raked piles are also to have the slope of the rake noted together with an arrow showing the direction of the rake.

Refer Figure 11.7(c) - Pile identification and setting out diagram.

Figure 11.7(c) - Pile identification and setting out diagram



Abutments and Piers parallel on bearing 109° 15' 06"

PILE IDENTIFICATION AND SETTING OUT DIAGRAM

NTS

Deck unit or girder layout diagram

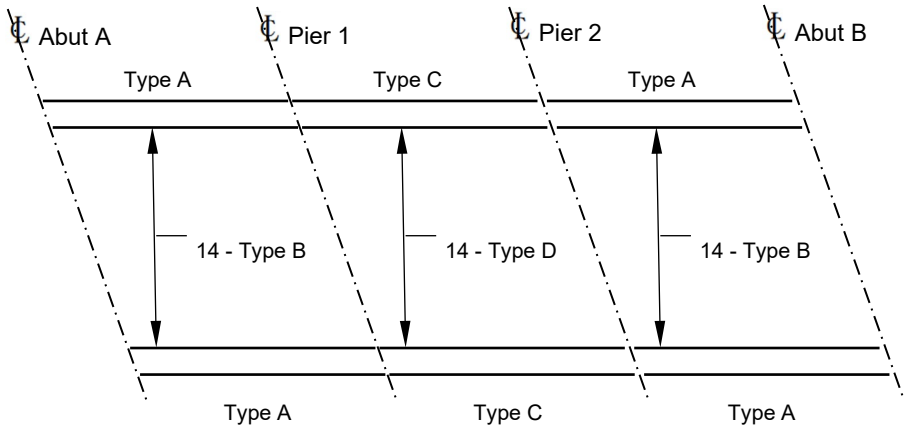
The Layout Diagram is generally not drawn to scale, but it shall have reasonable proportions.

Layout Diagrams may be shown either as part of the GA drawings or as part of the unit or girder drawings. Type names such as A/B/C and so on shall be consistent with the naming conventions used in the unit or girder drawings elevation and plan views.

For a simple layout where each span has the same deck unit or girder types, they can be identified on the Section Deck. Refer Figure 11.5(c) - Concept GA Drawing - Typical section deck units.

When deck unit types vary from span to span, due to expansion joints, continuous deck joints and so on, a pictorial plan view of all bridge spans shall be shown with the deck unit types clearly identified. Refer Figure 11.7-4 - Deck unit layout diagram.

Figure 11.7(d) - Deck unit layout diagram

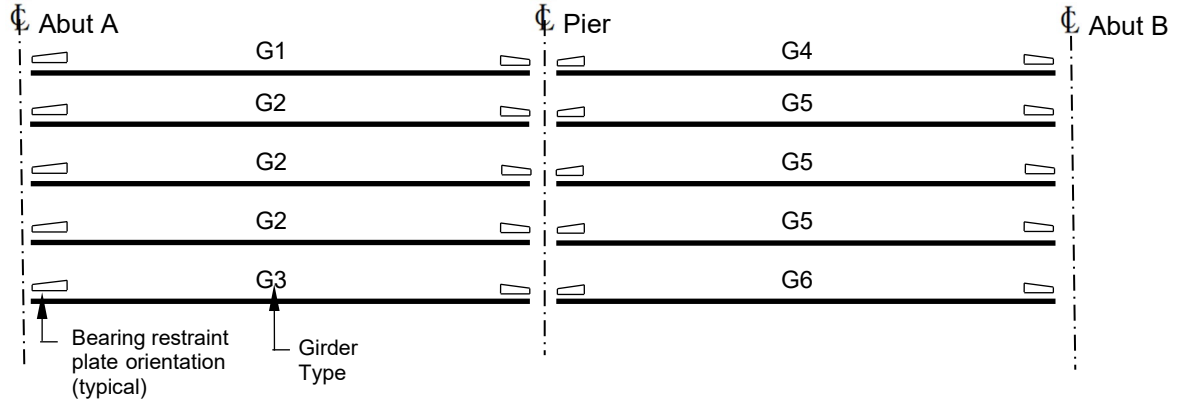


DECK UNIT LAYOUT DIAGRAM

NTS

For girder bridges these details are shown on the Miscellaneous Details drawing when the diagram is used to layout steelwork (bearing restraint plates) as well as the girders. Refer Figure 11.7(e) - Girder layout diagram.

Figure 11.7(e) - Girder layout diagram



LAYOUT DIAGRAM FOR GIRDERS AND BEARING RESTRAINT PLATES

NTS

Note: Bearing restraint plates are tapered to ensure girders may be supported on level bearings. Depending on the grade of the bridge, the orientation of the restraint plates may change. Refer to girders chapter for further information.

Type abutments and piers

Type Abutments and Piers are to show the typical features for each substructure element. Where there is more than one type each unique type is to be shown. Refer Figure 11.7(f) - Type Piers and Figure 11.7(g) - Type Abutments for basic examples. These views give a pictorial view of each structure and shall show:

- Elevation and section (or end elevation as appropriate).
- Number, type and size of piles supporting each structure, or reference to a pile drawing.
- Outline of the headstock.
- A clear delineation between new work and the existing bridge, including broken back areas. No dimensions are required in this view but may be added where appropriate.
- Abutment Protection type, in accordance with the following Standard drawings. (Project specific design features are to be shown where applicable):

  a) Type 1 - Rock Spillthrough refer Transport and Main Road's Standard Drawing 2232 or 2233. If the protection conforms to a standard drawing only the toe wall dimensions need to be detailed. If the protection is non-standard, all off the non- standard details shall be detailed and all other details shall be referenced back to the standard drawing.

  b) Type 2 - Reinforced Concrete Over Spillthrough refer Transport and Main Road's Standard Drawing 2234 or 2235. If the protection conforms to a standard drawing only the toe wall dimensions need to be detailed. If the protection is non- standard, all off the non-standard details shall be detailed and all other details shall be referenced back to the standard drawing.

c) Type 4 - Rockwork Over Spillthrough refer Transport and Main Road's Standard Drawing 2236 or 2237. If the protection conforms to a standard drawing only the toe wall dimensions need to be detailed. If the protection is non- standard, all off the non-standard details shall be detailed and all other details shall be referenced back to the standard drawing.

d) Rock Masonry refer Transport and Main Road's Standard Drawing 2238. All rock masonry details shall be shown on the Type Abutments view. The standard drawing shows the details required. Refer Figure 11.7(h) - Type Abutments with Rock Masonry. (Note: Rock masonry is only recommended for bridge widenings of structures with existing rock masonry protection.)

e) Type 7 – Rock Filled Gabion Protection - Height up to 6 m refer Transport and Main Road's Standard Drawing 2241.

f) Type 8 - Rip Rap protection – Height up to 6 m refer Transport and Main Road's Standard Drawing 2242.

Figure 11.7(f) - Type piers

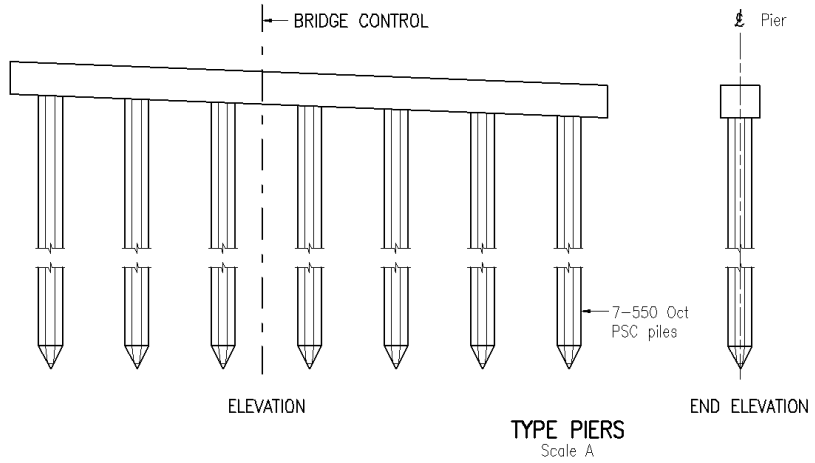


Figure 11.7(g) - Type abutments

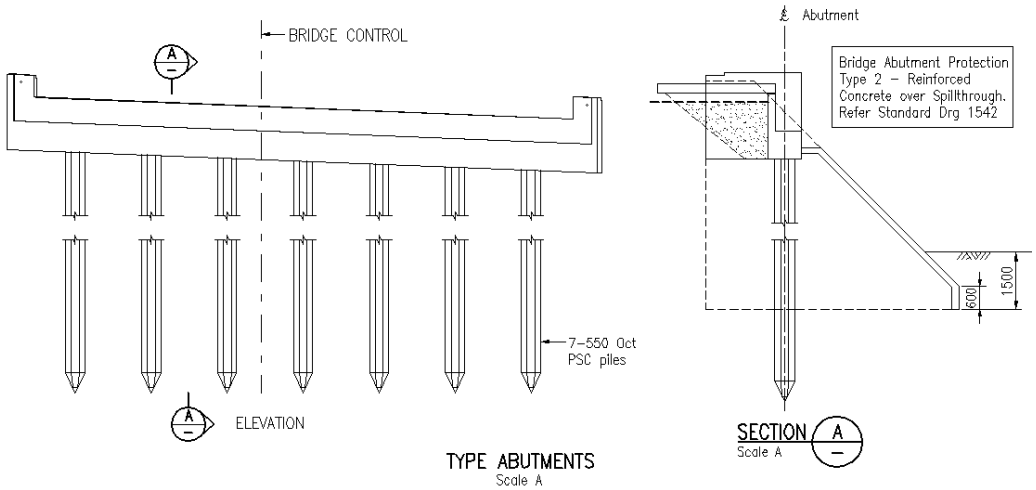
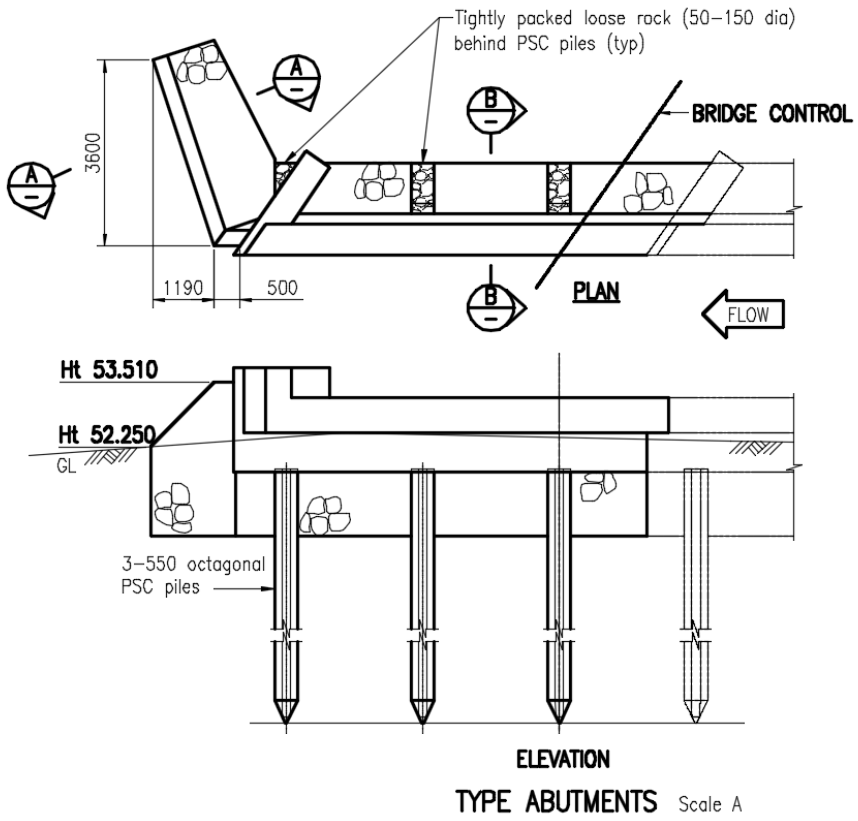
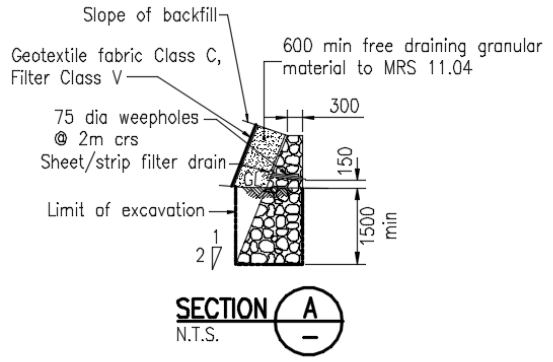
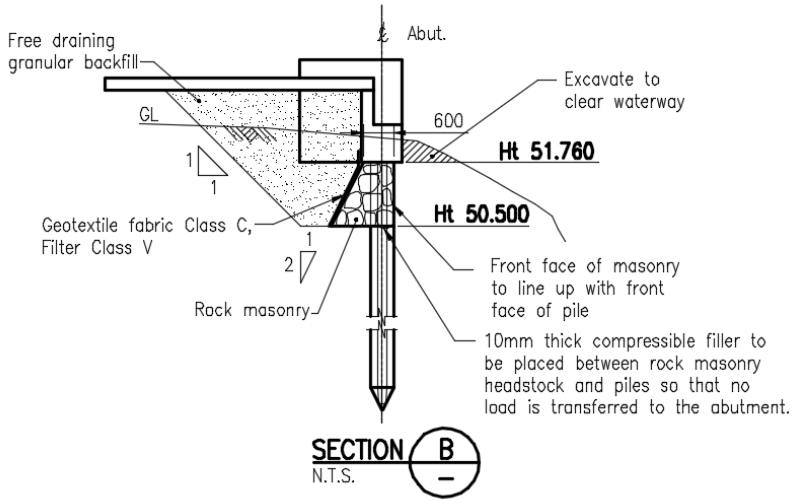


Figure 11.7(h) - Type abutments with rock masonry







Limits of HLP vehicle diagram

All bridges designed with Heavy Load Platform (HLP) capability shall display a diagram showing the allowable deviation of the position of the HLP vehicle on the bridge.

Show the following details:

- pictorial cross section of deck
- allowable HLP dimensions from the Bridge Control to the outside of vehicle, and
- minimum clear distance from the HLP to the kerb face.

The limits of the lateral position of the HLP vehicle is defined in the *Design Criteria for Bridges and Other Structures*.

Minimum clear distances to kerbs shall be shown.

The width of HLP 320 vehicle is 3600 and the width of HLP 400 vehicle is 4500.

Figure 11.7(i) - Limits of HLP vehicle

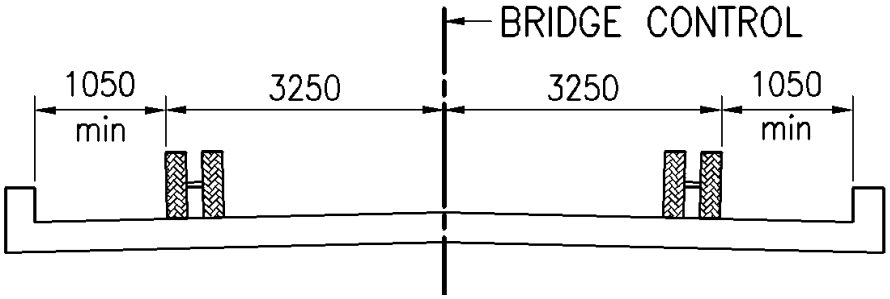


Table of Standard Drawings

Tabulate all standard drawings associated with the project. These drawings shall be marked 'included' in the Standard Documents List in the contract documents.

A sample Table 11.7(j) is shown below. The version date shall be the current published version of the relevant standard drawing.

Table 11.7(j) - Standard Drawings

Drg No	Version	Description
SD1043	03/18	REINFORCING STEEL - STANDARD BAR SHAPES
SD1044	03/18	REINFORCING STEEL – LAP LENGTHS
SD2005	07/16	STANDARD BRIDGE DATE PLATE
SD1145	08/02	STANDARD PVC SCUPPER
SD2255	11/19	BRIDGE APPROACHES – RELIEVING SLAB 3 METRE SPAN
SD2256	11/19	BRIDGE APPROACHES – RELIEVING SLAB 6 METRE SPAN

Design loading notes – Flood forces

Designers are to include key design parameters for flood forces within the project notes, which are to include the following:

- Design event
- Heights
- Velocities
- Scour Heights / depths, and
- Debris depth.

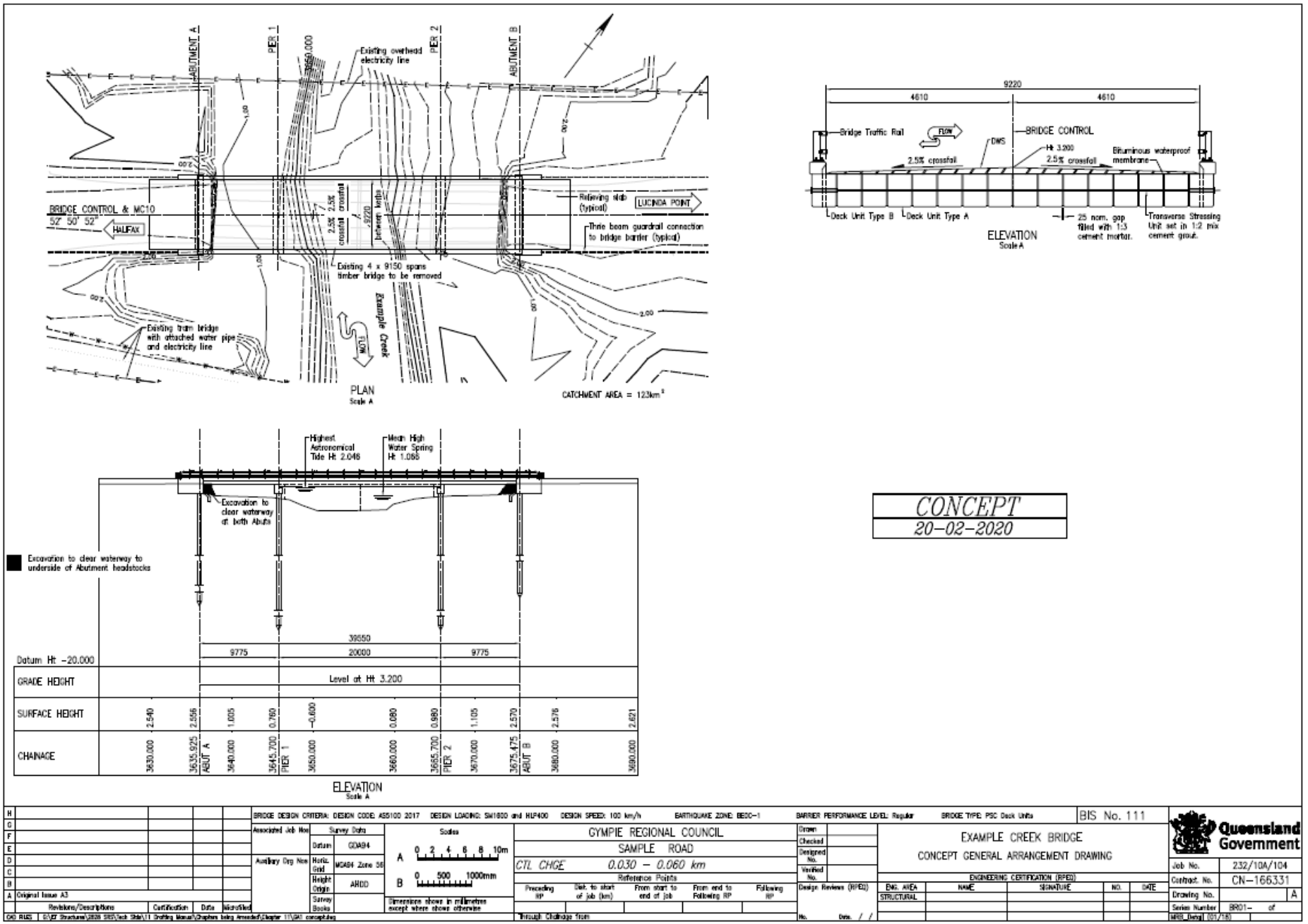
Notes

Notes shall be placed in the bottom right-hand corner of the first GA drawing. If they don't fit there, they shall be moved to another GA drawing. Refer Chapter 5 – *Notes*.

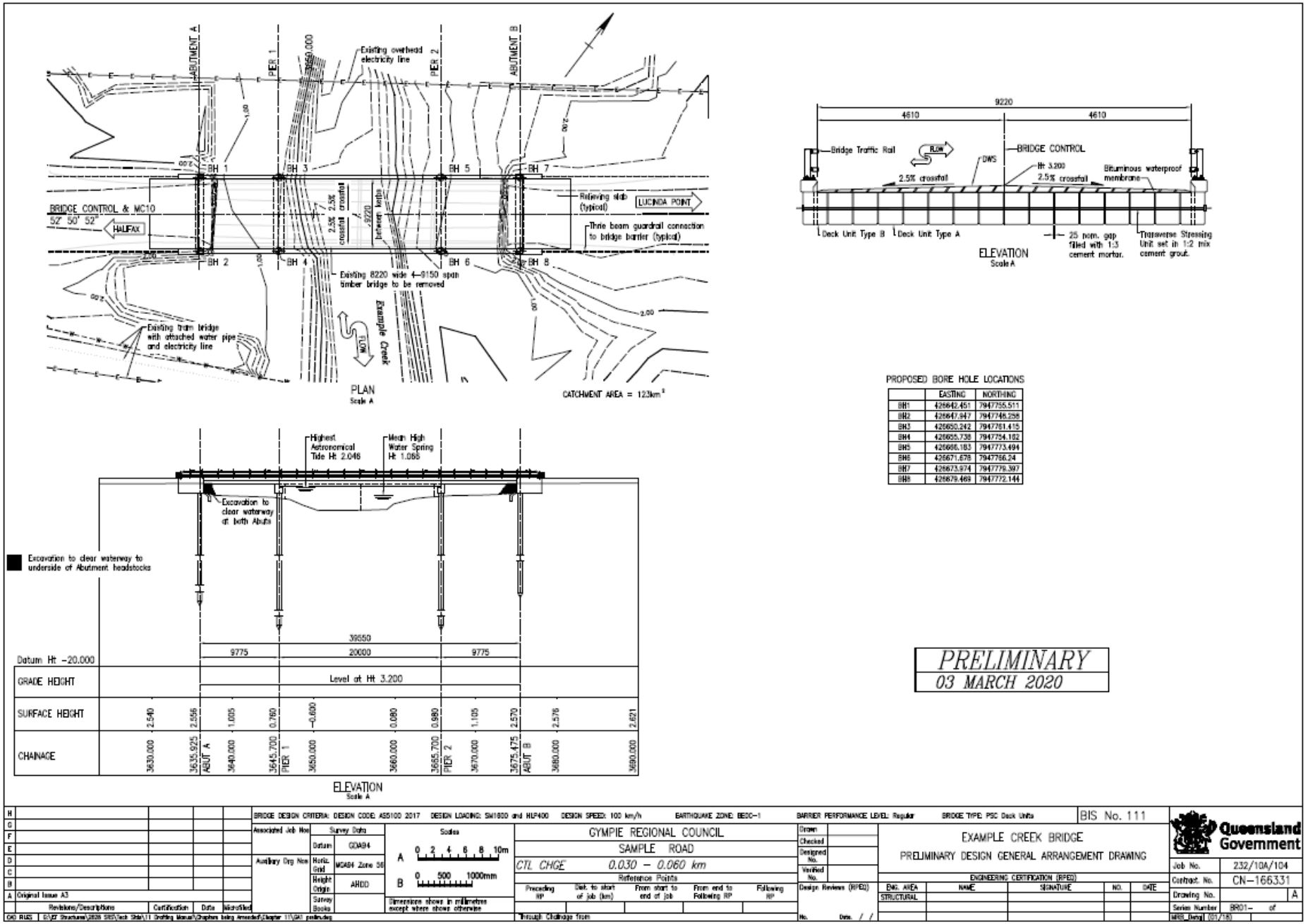
Procedures

Where the design requires stage construction or where the safety and constructability of the project is contingent on an erection or construction procedure, the process shall be documented on the drawings. Enough information shall be provided to clearly explain the steps required to achieve the design intent. This may include detailed procedures, sketches and notes. These details may be included on the GA or on the specific drawings relevant to the process.

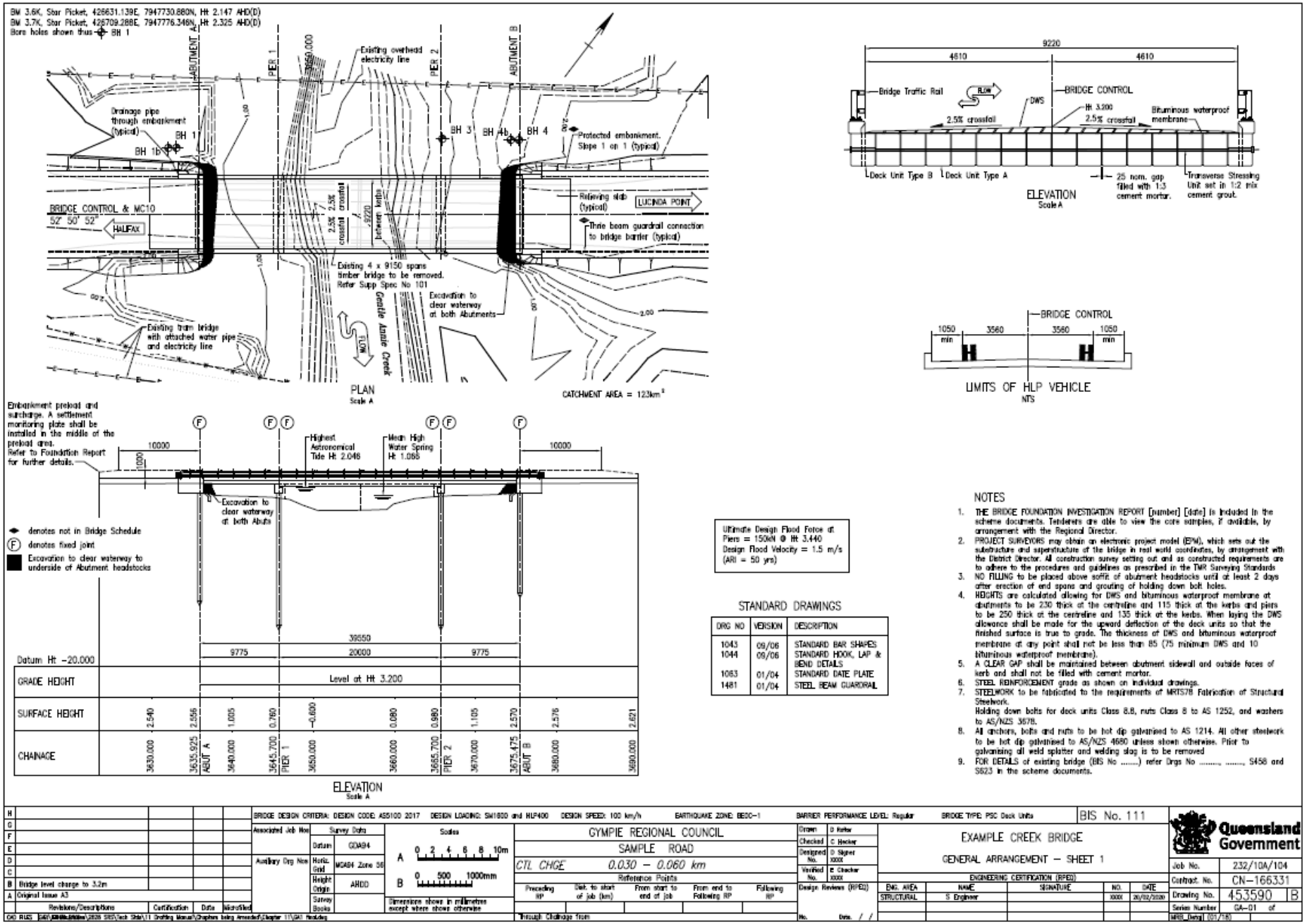
Appendix A - Example Concept GA Drawings



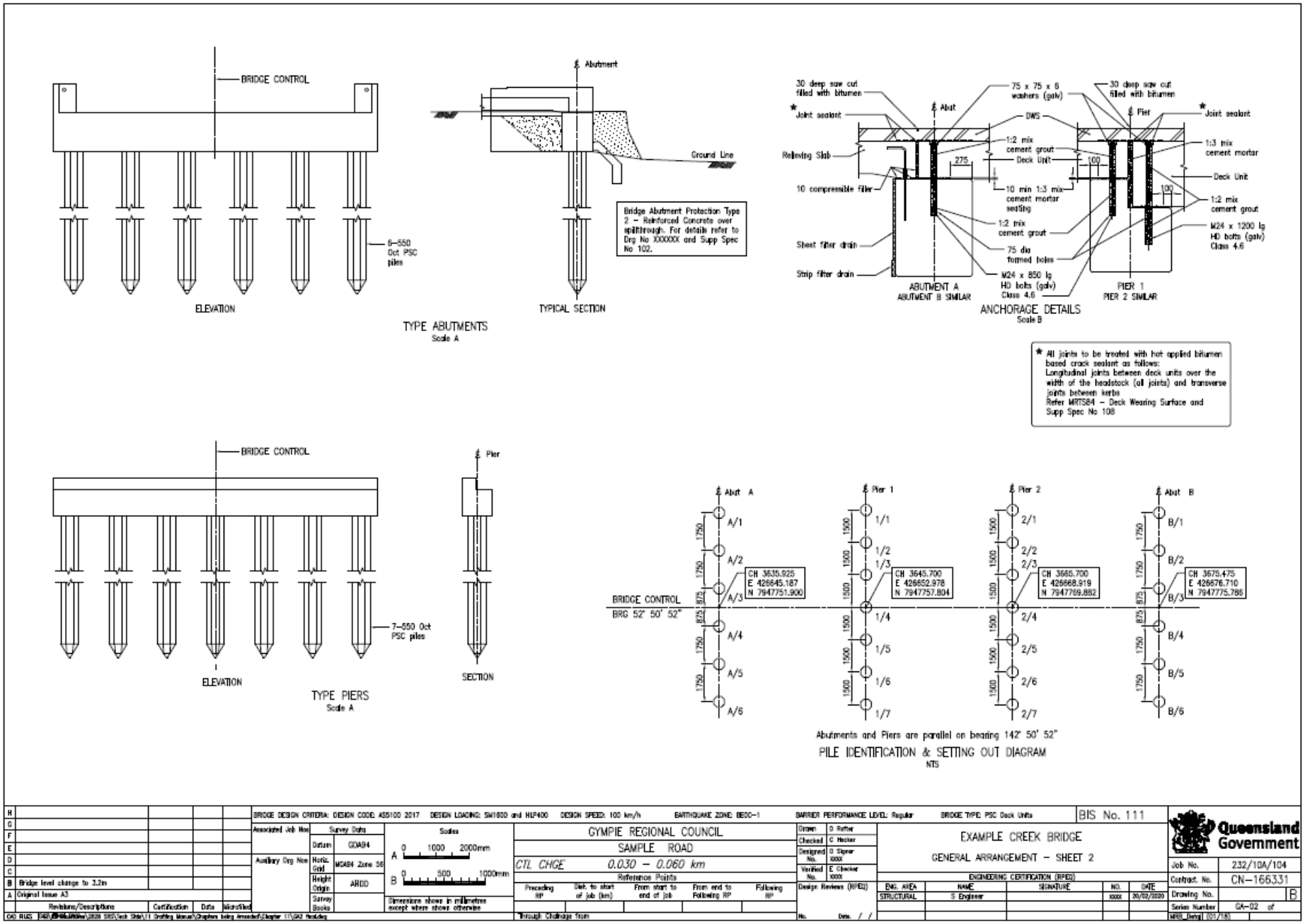
Appendix B - Example Prelim Design GA Drawings



Appendix C - Example Detailed Design GA Drawings – Sheet 1



Appendix C - Example Detailed Design GA Drawings – Sheet 2



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