Technical Specification

MRTS56 Construction Surveying

July 2020

Queensland Government

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1 Introduction

This Technical Specification applies to the surveying requirements for specific construction types such as; earthworks, pavements, road furniture, underground assets and bridges and structures during civil construction Works for the Department of Transport and Main Roads. For further detailed information on these construction types, refer to the *TMR Surveying Standards*. Construction surveying enables the construction of design elements in the correct location, meeting conformance requirements and undertaking and delivering an As Constructed Survey.

If a region or district does not have a Principal Surveyor, then all enquiries to the Principal Surveyor shall be made through: TMR_Spatial_Enquiry@tmr.qld.gov.au.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

2 Definition of terms

The terms and symbols used in this Technical Specification shall be as defined in Clause 2 of MRTS01 *Introduction to Technical Specifications* and in Table 2 below.

Table 2 – Definition of terms

Term	Definition
As Constructed Survey	As Constructed Surveys are detailed site survey measurements that accurately record details of completed Works. They represent the true shape and size of the real world constructed objects depicting surface shapes in either two or three dimensions (3D) in geospatially referenced location. They also provide descriptive attribute information. The As Constructed Survey can be represented by hard copy drawings and/or in three dimensional (3D) electronic models.
Cadastral Reference Survey Marks	Cadastral Reference Survey marks are part of the property boundary cadastre.
Control Survey	A Spatial Reference System. A more expansive definition is specified in *Standard for the Australian Survey Control Network – SP1 Ver. 2.1* (www.icsm.gov.au/).
Culvert	A culvert is a structure that allows water to flow under a road, railway or similar obstruction from one side to another. These can include: • pipe culverts, and/or • box culverts
Drainage system	An underground drainage system can include an underground network system of pipe culverts and/or box culverts connecting between field inlets, gully pits and access chambers that is designed to drain away excess stormwater and ground water. These can include: • access chambers • gullies / field inlets • pipe culverts, and • box culverts.
Permanent Survey Mark	Permanent Survey Marks are substantial marks. The installation and maintenance of Permanent Survey Marks is regulated under the Survey and Mapping Infrastructure Regulation 2014.

Term	Definition
Secondary Control Mark	Secondary Control Marks are marks that consist of survey marks and reference marks placed by traversing between survey control marks.
Survey Control Mark	As defined in the *Standard for the Australian Survey Control Network – SP1 Version 2.10*, a Survey Control Mark is a monument that provides a physical realisation of one or more datums. They are used for survey control networks and Permanent Survey Marks are the preferred type of marks used for Survey Control Marks.
Survey Mark	Survey mark means a survey peg, reference mark, level mark or any other mark for the purpose of setting out, checking or measuring work Under the Contract.

3 Referenced documents

Table 3 lists documents referenced in this Technical Specification.

Table 3 – Referenced documents

Reference	Title
MRTS03	*Drainage, Retaining Structures and Protective Treatments*
MRTS04	*General Earthworks*
MRTS05	*Unbound Pavements*
MRTS07A	*Insitu Stabilised Subgrades using Quicklime or Hydrated Lime*
MRTS07B	*Insitu Stabilised Pavements using Cement or Cementitious Blends*
MRTS07C	*Insitu Stabilised Pavements using Foamed Bitumen*
MRTS08	*Plant-Mixed Heavily Bound (Cemented) Pavements*
MRTS09	*Plant-Mixed Pavement Layers Stabilised using Foamed Bitumen*
MRTS10	*Plant-Mixed Lightly Bound Pavements*
MRTS14	*Road Furniture*
MRTS15	*Noise Fences*
MRTS30	*Asphalt Pavements*
MRTS32	*High Modulus Asphalt (EME2)*
MRTS38	*Pavement Drains*
MRTS39	*Lean Mix Concrete Sub-base for Pavements*
MRTS40	*Concrete Pavement Base*
MRTS50	*Specific Quality System Requirements*
MRTS61	*Gantries and Support Structures for Road Signs, Tolling Systems and ITS Devices*
MRTS62	*Bridge Substructure*
MRTS63	*Cast-In-Place Piles*
MRTS63A	*Piles for Ancillary Structures*
MRTS64	*Driven Tubular Steel Piles (with reinforced concrete pile shaft)*
MRTS65	*Precast Prestressed Concrete Piles*
MRTS66	*Driven Steel Piles*

Reference	Title
MRTS70	*Concrete*
MRTS73	*Manufacture of Prestressed Concrete Members and Stressing Units*
MRTS74	*Supply and Erection of Prestressed Concrete Deck and Kerb Units*
MRTS75	*Supply and Erection of Prestressed Concrete Girders*
MRTS76	*Supply and Erection of Steel Girders*
MRTS77	*Bridge Deck*
MRTS84	*Deck Wearing Surface*
MRTS91	*Conduits and Pits*
MRTS92	*Traffic Signal and Road Lighting Footings*
MRTS93	*Traffic Signals*
MRTS94	*Road Lighting*
MRTS140	*Horizontal Directional Drilling (HDD)*
MRTS141	*Microtunnelling and Pipe Jacking*
MRTS142	*Thrust Boring and Auger Boring*
SP1 Ver. 2.1	*Standard for the Australian Survey Control Network (*www.icsm.gov.au/*)*
-	*Survey and Mapping Infrastructure Act,* 2003
-	Survey and Mapping Infrastructure Regulation, 2014
TN163	*Third Party Utility Infrastructure Installation in State Controlled Roads Technical Guidelines*
TN165	*Survey Marks (Transport and Main Roads Surveying Standards – February 2016)*
TMR Surveying Standards (February, 2016)	*TMR Surveying Standards Part 1 – General Information*
	TMR Surveying Standards Part 2 – Geomatic Survey Types
	Schedule 1 – Codes, Linestyles and Examples

4 Quality system requirements

4.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

There are no Milestones defined.

The Hold Points and Witness Points applicable to this Technical Specification are summarised in Table 4.1.

Table 4.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
6	1. Validation of survey information		
7.1	2. Validation of existing survey control prior to Works		

Clause	Hold Point	Witness Point	Milestone
7.2.5	3. Submission of survey control		
7.3		1. Disturbance or destruction of survey marks	
7.3.2		2. Report historical mark	
7.3.3	4. Cadastral survey reference mark protection prior to noise fence construction		
	5. Cadastral survey reference mark protection prior to retaining wall construction		
	6. Cadastral survey reference mark protection prior to excavations or trenching		
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11.2.2	9. Survey bottom of excavation for cuttings		
11.2.3	10. Survey excavation area of unsuitable material		
	11. Survey after backfill		
11.2.4	12. Survey bottom of excavation area for end structures		
11.2.5	13. Survey top of embankment including batters		
11.2.6	14. Survey top of subgrade		
11.3.1	15. Survey top of every pavement layer (non-concrete)		
11.5.1	16. Survey of drainage system and culverts		
11.5.2	17. Survey of gullies		
11.5.3	18. Survey of access chambers		
11.5.4	19. Survey of subsoil drains		
11.5.5	20. Survey of vertical drains		

Clause	Hold Point	Witness Point	Milestone
11.6.1	21. Survey bottom of retaining wall pad / strip excavations		
	22. Survey top of retaining wall pad / strip footings		
11.6.3	23. Survey bottom of noise fence pile / spread excavation		
	24. Survey top of noise fence pile / spread footing		
11.6.4	25. Survey bottom of traffic signal and road lighting footing excavation		
11.6.5	26. Survey load bearing footing excavations		
11.6.6	27. Survey of concrete masonry / crib wall footing excavations		
11.7	28. Survey of TETS conduits and pits		
11.11	29. Survey of 3rd party underground assets – including Public Utility Plant (PUP)		
13	30. Survey of existing underground assets		
15.0		4. Deliverables handover	

5 Surveyor competency

The Contractor:

a) Must employ a Contractor's Surveyor who must:

   i. meet the competency requirements as specified in the relevant categories under Section 2.4.3 of the *TMR Surveying Standards*, *Part 1*, and

   ii. have the minimum years of experience as specified in the relevant categories under Section 2.4.3 of the *TMR Surveying Standards, Part 1*.

b) The Contractor's Surveyor must direct and supervise all surveys and must be authorised to discuss and resolve technical surveying related issues on Site.

6 Receipt of survey information

The Surveyor is to check that enough information to enable undertaking survey Works has been received prior to undertaking any survey Works. This can include the Ground and Feature Model (GFM), 12d model or digital model, survey control, plans, drawings, construction specifications, contract documents, annexures, standards and schedules and notice of such validation provided to the Administrator. **Hold Point 1**

7 Survey control

7.1 Validation of existing survey control prior to Works

Where existing survey control is provided by the department of Transport and Main Roads, then before construction commences the Contractor must check all survey control marks for height, any disturbance since installation, and obtain any additional survey data necessary for their design and any other purposes and notice of such Works provided to the Administrator. **Hold Point 2**

7.2 Establishing survey control

7.2.1 Survey control for roads and associated Works

If survey control is not provided by the Principal or if new survey control is to be established that is fit for purpose for construction surveying, then the following applies:

a) All survey heights and horizontal co-ordinate systems must match the project coordinate values as listed in the contract drawings. Refer Section 6.4 of *TMR Surveying Standards*, *Part 2.*

b) Control survey for the Contractor's work must be conducted in accordance with the recommended survey, and reduction practices specified in *Standard for the Australian Survey Control Network – SP1 Ver. 2.1* and its relevant guidelines (www.icsm.gov.au/).

c) For the Contractor's work, height control requires that existing Permanent Survey Marks must be supplemented by new Temporary Bench Marks such that the spacing between the Permanent Survey Marks and Temporary Bench Marks is a maximum of 500 metres. The practice for installing Temporary Bench Marks is prescribed in Section 6.5 of *TMR Surveying Standards*, Part 1. Levelling procedure and accuracy of Temporary Bench Marks is specified in Section 6.6 of *TMR Surveying Standards, Part 1*.

7.2.1.1 Resections

Once validation of existing control and/or establishment of survey control has been completed, there are often instances during construction Works where it is acceptable to establish in-fill control by resection methodology. Resection methodology for establishing in-fill control is acceptable under the following conditions:

- Physical marks or remote prism (for example, bolted in a wall or stable structure) must be placed or established. They can be less robust marks than survey control marks (for example, pegs, nails in concrete and so on), but must be stable, semi-permanent and fit for purpose.
- Observations to a minimum of three survey or secondary control marks on both faces must be measured.
- Angular geometry needs to be sound. Small measurement errors increase the resultant error ellipse rapidly on very narrow angle geometry. Angles less than 10° must not be used.
- Tripod mounted traverse prisms should be used on all survey or secondary control marks.
- Once resected coordinates are calculated, use these values to set out the survey or secondary control marks and compare resultant differences. Accept only if coordinate residuals are within +/- 5 mm, and
- Other resected marks must not be used as part of a resection.

7.2.1.2 Survey control accuracy

Survey control accuracy requirements are specified in Table 7.2.2.1.2.

The Contractor must verify and accept the construction project survey control for the Contractor's work.

i. Survey Control Marks – project reference frame marks are the primary on site reference marks for each project. They primarily consist of Permanent Survey Marks (PSM's) and shall have a minimum spacing of 500 metres between each other:

   - Horizontal accuracy – unless specified in the drawings or documentation, Survey Uncertainty (SU) of < 0.015 metre at 95% confidence level. This value takes precedence over the *TMR Surveying Standards.*
   - Vertical accuracy - unless specified otherwise in the drawings or documentation, the accuracy requirements are as specified for Survey marks in Table 1.3.1.4b, *TMR Surveying Standards, Part 2.*

ii. Construction project survey control (Secondary control) – construction project survey control shall use as datum, where available, the projects underlying survey control network used to create the project design (that is, the pre-design survey). The preferred method of estimating the Survey Uncertainty (SU) for construction project survey control marks is by applying a minimally constrained adjustment of the construction project survey control network. Minimum spacing and density between placed construction project control marks should be fit for purpose for the lot under construction and maximum spacing should not exceed 150 metres.

   - Horizontal accuracy - unless specified in the drawings or documentation, Relative Uncertainty (RU) < 30 ppm (linear misclose ratio) between individual marks.
   - Vertical accuracy - unless specified in the drawings or documentation, the allowable misclose (in millimetres) as determined by reciprocal level runs must not be greater than 6mm * √k where 'k' is the distance in kilometres.

7.2.2 Bridge construction survey control

There are other exceptions where plan coordinates are based on a plane system rather than a map projection system. These can apply to bridges and structures where the combined scale factor can have a significant impact on construction tolerances. The best practice to adopt in these cases including resections is specified in Section 6.6 Bridge Construction Survey, *TMR Surveying Standards, Part 2*.

7.2.2.1 Bridge survey control accuracy

7.2.2.1.1 Horizontal

The preferred method of estimating the Survey Uncertainty (SU) for bridge survey control marks is by applying a minimally constrained adjustment of the bridge survey control network. Examples of bridge network geometry and measurement criteria can be found in Section 6.6 *TMR Surveying Standards, Part 2*. SU values are specified in Table 7.2.2.1.2.

7.2.2.1.2 Vertical

Independent two way level runs are required on all Bridge Survey Control Marks. The allowable misclose for this level run is 6mm * √ km. In addition, the maximum Relative Uncertainty (RU) for heights between adjacent Bridge Survey Control Marks is 1.5 mm.

Table 7.2.2.1.2 - Survey accuracy control requirements

Clause	Survey Accuracy	Work activity	Hz Accuracy SU (mm) @ 95% Confidence Level (CL)	Hz Accuracy RU ppm (linear misclose ratio)	Height Accuracy RU (mm) @ 95% Confidence Level (CL) between individual marks	Height Accuracy misclose
7.2.1.2	Survey Control Accuracy	Survey Control Marks	< 15	-	10	12mm*√k
		Construction Project Survey Control Marks (Secondary Control Marks)	-	30	3	6mm*√k
7.2.2.1	Bridge Survey Control Accuracy	Bridge Survey Control Marks	≤ 2	-	1.5	6mm*√k
7.2.1.1	Resections	Resections (Road Construction Survey Control)	≤ 15	-	-	-
7.2.2	Bridge Construction Survey Control	Resections (Bridge Survey Control)	≤ 3	-	-	-

7.2.3 Ongoing validation and maintenance

Ongoing validation and maintenance of survey control is essential during the construction process, especially after rainfall events and nearby construction activities.

7.2.4 Naming and coding of survey marks

Refer to TN165 *Survey Marks (Transport and Main Roads Surveying Standards – February 2016)* for standardised naming and coding for the different types of survey marks.

7.2.5 Submission of survey control

Submission of survey control validation results are to be provided to the Administrator and Transport and Main Roads region / district's Principal Surveyor prior to commencement of Works. **Hold Point 3**

If a region or district does not have a Principal Surveyor, then all enquiries to the Principal Surveyor shall be made through: TMR_Spatial_Enquiry@tmr.qld.gov.au.

Subsequent to the survey control validation check, if any errors are found with the supplied survey control, then contact the above.

7.3 Protection of survey marks

The Contractor shall keep in their true positions all survey marks specified in the Contract or as supplied by the Administrator.

Prior to undertaking Works, the Contractor shall identify and notify the Administrator of any such survey marks that are at risk of being disturbed or obliterated.

If a survey mark is disturbed or obliterated, the Contractor shall within one business day notify the Administrator and, unless the Administrator otherwise directs, the Contractor shall reinstate the survey mark. **Witness Point 1**

If the disturbance or obliteration of survey marks is caused by a person referred to under Site access for the Principal and others in the C7830 *General Conditions of Contract*, other than the Contractor, the cost incurred by the Contractor in reinstating the survey mark shall be valued under variations in the C7830 *General Conditions of Contract*. The Contractor's attention is directed to the possible existence of survey marks within or near the Site. Survey Control Marks are placed at approximately one kilometre intervals and have the highest order of accuracy. These are defined in Section 6.4 of the *TMR Surveying Standards, Part 1*. Destruction, maintenance, and replacement of these marks are controlled under Survey mark protection and by the Survey Control Marks Register as specified in Section 6.4.1 and Section 6.4.2 of the *TMR Surveying Standards, Part 2*.

7.3.1 Survey control marks and benchmarks

Survey Control Marks and Benchmarks are significant survey marks that are placed at regular intervals throughout the project. The Contractor must avoid where reasonably possible disturbance of Survey Control Marks and Benchmarks and must re-establish any Survey Control Marks and Benchmarks disturbed or affected by the Contractor's work. Prior to the commencement of work, the Contractor must inform in writing to the Administrator and Transport and Main Roads region / district's Principal Surveyor of any:

i. proposed changes to any Survey Control Marks or Benchmarks, or

ii. proposed destruction of any Survey Control Marks or Benchmarks.

Survey Control Marks (in particular, permanent survey marks) may also be regulated by the *Survey and Mapping Infrastructure Act,* 2003.

The minimum standard for a qualified Surveyor to re-establish Survey Control Marks must be registered with the Surveyors Board of Queensland (SBQ) as a Surveyor or supervised by a Surveyor as prescribed under Section 15(2) of the Survey and Mapping Infrastructure Regulation, 2014.

7.3.2 Secondary control marks

Secondary Control marks consist of survey marks and reference marks placed by traversing between survey control marks. Destruction, maintenance, and replacement for these marks are controlled under Survey Mark Protection and by the Survey Control Marks Register Section 6.4.1 and Section 6.4.2 of the *TMR Surveying Standards, Part 2*. Reference marks in urban areas require additional care.

The Contractor must report historical survey marks (protected under the *Survey and Mapping Infrastructure Act,* 2003) such as blazed trees or bench marks to the Administrator who will obtain and provide management guidance that the Contractor must implement. **Witness Point 2**

7.3.3 Cadastral reference mark protection

Destruction, maintenance, and replacement for these marks are controlled under Survey Mark Protection and by the Survey Control Marks Register Section 6.4.1 Survey Mark Protection and Section 6.4.2 Survey Control Register of the *TMR Surveying Standards, Part 2*.

An assessment is to be undertaken to identify cadastral marks that may need protecting prior to excavations for:

a) Footings to be undertaken in accordance with MRTS15 *Noise Fences,* and notice of such Works provided to the Administrator and Transport and Main Roads region / district's Principal Surveyor. **Hold Point 4**

b) Construction of retaining walls undertaken in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments.* If the assessment deems it necessary, a survey for identifying and protecting cadastral survey marks shall be undertaken as specified in Table 7.3.3 and notice of such Works provided to the Administrator. **Hold Point 5**

c) Earthwork cuttings or trenching Works undertaken in accordance with MRTS04 *General Earthworks.* If the assessment deems it necessary, a survey for identifying and protecting cadastral survey marks shall be undertaken as specified in Table 7.3.3 and notice of such Works provided to the Administrator. **Hold Point 6**

Enquiries regarding assessments can be obtained through Transport and Main Roads region / district's Principal Surveyor.

Table 7.3.3 - Cadastral reference mark protection

Clause	Cadastral reference mark protection survey	Work Activity
7.3.3	Noise Fence footings	Identification and protection of cadastral reference marks shall be undertaken by a Cadastral Surveyor prior to excavation Works as directed by Transport and Main Roads region / district's Principal Surveyor
	Retaining wall footings	
	Excavation Works for cuttings or trenching	

7.4 Relocation of survey control marks

If the Contractor wishes to relocate an existing Survey control mark, the Administrator shall be notified in writing at least five business days prior to such intended relocation. **Witness Point 3**

The notice shall include a description of the proposed method for coordinating and levelling the new survey mark. If another Authority's survey mark is involved, the Contractor shall also obtain written approval from the other Authority and submit a copy of such approval to the Administrator and to Transport and Main Roads region / district's Principal Surveyor.

7.5 Identification markers

The Contractor shall place identification markers at a minimum of 100 metres spacing along each control line for road centrelines and adjacent to each tangent point. Such markers shall show the chainage and any other relevant information. All identification markers must be placed as specified unless directed otherwise by the Administrator.

8 Validation of existing ground surface prior to Works

Prior to breaking ground, if the Contractor wishes to dispute the existing ground surface terrain model in accordance with MRS04 *General Earthworks*, they must provide a suitable a terrain model / points.

Should these points exceed the values specified in Table 1.3.1.4c Interpolated heights of the *TMR Surveying Standards, Part 2*, the Contractor shall advise the Administrator in writing for the issue to be resolved prior to construction activities. All validation surveys must meet the *TMR Surveying Standards* requirements.

Failure to undertake a validation of existing ground surface and adequately resolve any discrepancies prior to Works will result in the Contractor's acceptance of the supplied original ground surface model.

8.1 Survey accuracy

The Contractor must verify and accept the accuracy of the existing ground surface types for the Contractor's work as follows:

i. Horizontal - must meet accuracy requirements as specified for the various ground surface types in Table 1.3.1.4a, *TMR Surveying Standards, Part 2*, and

ii. Vertical – must meet accuracy requirements as specified for the various ground surface types in Table 1.3.1.4b, *TMR Surveying Standards, Part 2.*

8.2 Metadata

All survey information / data that is captured and provided to Transport and Main Roads must provide metadata (as per *TMR Surveying Standards Schedule 1 – Codes, linestyles and examples*).

9 Setting out the Works

9.1 General

Setting out of all items shown on the drawings or listed in the Contract is the responsibility of the Contractor.

9.2 Errors in setting out

If the Contractor discovers an error in the position, level, dimensions or alignment of any work under the Contract, the Contractor shall within one business day notify the Administrator and, unless the Administrator otherwise directs, the Contractor shall rectify the error. **Hold Point 7**

If the error has been caused by incorrect survey marks supplied by the Administrator, the cost incurred by the Contractor in rectifying the error shall be valued under variations in C7830 *General Conditions of Contract*.

9.3 Earthworks

All setting out activities for earthworks including survey accuracy are specified in Table 9.3.3.

9.3.1 Stripping of topsoil area

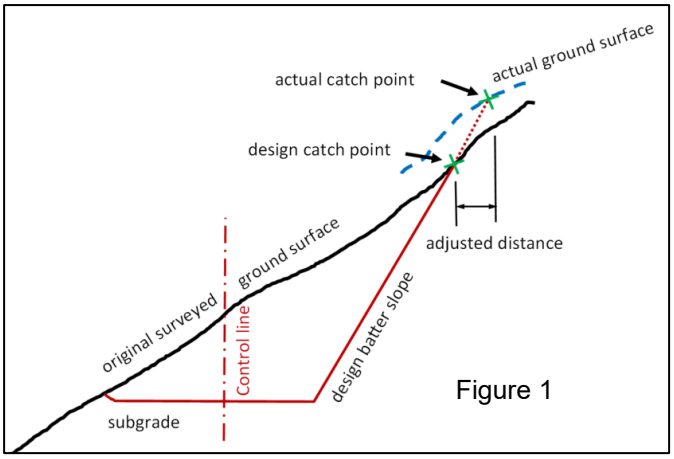
The stripping of topsoil area shall be set out in accordance with the shapes, lines, and other requirements shown on the drawings and in accordance with MRTS04 *General Earthworks*.

9.3.2 Excavations

Excavations shall be set out in accordance with the shapes, lines, dimensions and other requirements shown on the drawings and in accordance with MRTS04 *General Earthworks*. If the ground height at the location of the design batter interface (catch point) does not match the actual ground height, the catch point shall be adjusted accordingly (by multiplying the height difference by the batter slope gradient).

If the batter slope is higher (that is, exceeding the values specified in Table 1.3.1.4c Interpolated heights of the *TMR Surveying Standards, Part 2*) than the design location (see Figure 9.3.2), then notice of such shall be provided to the Administrator.

Figure 9.3.2 – Excavation catch point



9.3.3 Embankments

Embankments shall be set out in accordance with the shapes, lines, dimensions and other requirements shown on the drawings and in accordance with MRTS04 *General Earthworks*. If the ground height at the location of the design batter interface (catch point) does not match the actual ground height, the catch point shall be adjusted accordingly (by multiplying the height difference by the batter slope gradient). If the batter slope is lower (that is, exceeding the values specified in Table 1.3.1.4c Interpolated heights of the *TMR Surveying Standards, Part 2*) than the design location (see Figure 9.3.3), then notice of such shall be provided to the Administrator.

Figure 9.3.3 – Embankment catch point

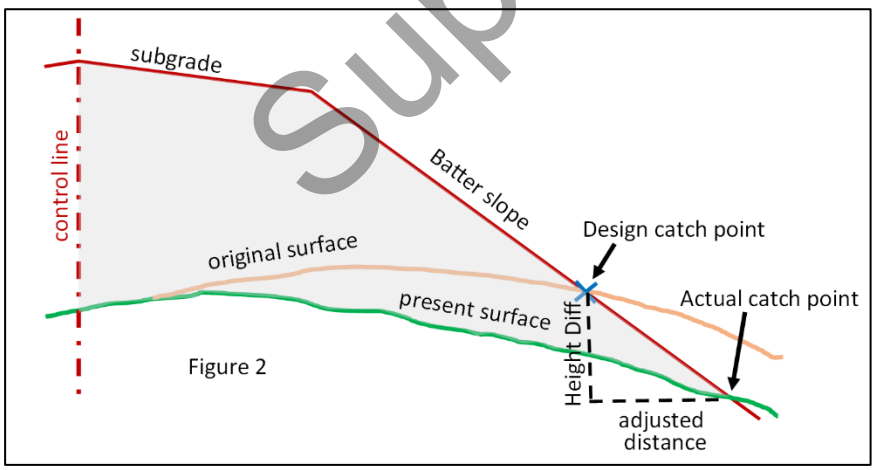


Table 9.3.3 – Setting out requirements for earthworks

Clause	Setting out	Work activity	Accuracy Hz & Vt (mm)
9.3.1	Topsoil stripping area	As per marked out on the drawings at minimum of 20 metre intervals. Or if undertaken by machine guidance then using Global Navigation Satellite Systems (GNSS) is acceptable	± 50
9.3.3	Excavations	Includes: Control lines, toe of batter at subgrade level and batter interfaces (catch points) and all at minimum of 20 metre intervals including tangent points and as specified on the drawings. Or if Works undertaken by machine guidance, undertake independent checks using alternative measurement techniques to achieve ± 25 mm accuracy at minimum 100 metre intervals	± 25
9.3.4	Embankments		

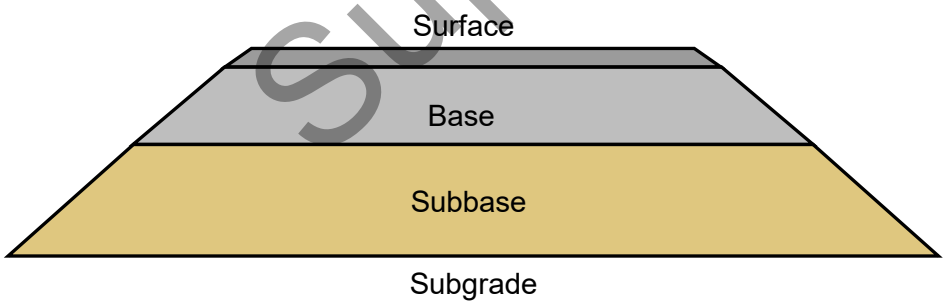
9.4 Pavement, pavement drains, kerbs, channels and kerb and channel

All setting out activities for pavement layers, pavement drains, kerb, channel and kerb and channel including survey accuracy are specified in Table 9.4.4.

9.4.1 Pavement layers

All pavement layers for the construction of subbase, base and pavement surface shall be set out in accordance with the shapes, lines, dimensions and other requirements shown on the drawings and in accordance with MRTS05 *Unbound Pavements*, MRTS07B *Insitu Stabilised Pavements using Cement or Cementitious Blends*, MRTS07C *Insitu Stabilised Pavements using Foamed Bitumen*, MRTS08 *Plant-Mixed Heavily Bound (Cemented) Pavements*, MRTS09 *Plant-Mixed Pavement Layers Stabilised Using Foamed Bitumen,* MRTS10 *Plant-Mixed Lightly Bound Pavements*, MRTS30 *Asphalt Pavements,* MRTS32 *High Modulus Asphalt (EME2)*, MRTS39 *Lean Mix Concrete Sub-base for Pavements* and MRTS40 *Concrete Pavement Base.*

Figure 9.4.1 – Pavement layers



9.4.2 Kerb, channel and kerb and channel

Kerbs, channels and kerb and channel shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.4.3 Footpath including pram crossings

Footpaths shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings and documentation and in accordance with hand-placed concrete paving in MRTS03 *Drainage, Retaining Structures and Protective Treatments.*

9.4.4 Pavement drains

Pavement drains shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings and in accordance with MRTS38 *Pavement Drains.*

Table 9.4.4 - Setting out requirements for pavement, pavement drains, kerb, channel and kerb and channel

Clause	Setting out	Work activity	Accuracy Hz (mm)	Accuracy Vt (mm)
9.4.1	Insitu Stabilised Pavements using Cement or Cementitious Blends	Use horizontal and vertical geometry of control alignments and as specified on the drawings to set out at a minimum of 20 m intervals all edges, changes in grade, crown, crests and dips in vertical geometry including tangent points. If using Machine Guidance, independent setting out of shoulder pegs should be installed at a minimum of 200 m intervals for height control checks	± 25	-2 and +5
	Insitu Stabilised Pavements using Foamed Bitumen			
	Plant-Mixed Pavement Layers Stabilised Using Foamed Bitumen			
	Lean Mix Concrete Sub-base for Pavements	Use horizontal and vertical geometry of control alignments and as specified on the drawings to set out at a minimum of 20 m intervals all edges, changes in grade, crown, crests and dips in vertical geometry including tangent points. If using Machine Guidance, independent setting out of shoulder pegs should be installed at a minimum of 200 m intervals for height control checks	± 10	± 5
	Unbound pavement	Use horizontal and vertical geometry of control alignments and as specified on the drawings to set out at a minimum of 20 m intervals all edges, changes in grade, crown, crests and dips in vertical geometry including tangent points. If using Machine Guidance, independent setting out of shoulder pegs should be installed at a minimum of 200 m intervals for height control checks	± 25	± 5
	Plant-Mixed Heavily Bound (Cemented) Pavements			
	Plant-Mixed Lightly Bound Pavements			
	Asphalt Pavements			
	High Modulus Asphalt (EME2)			
	Concrete Pavement Base		± 10	-2 and +10

Clause	Setting out	Work activity	Accuracy Hz (mm)	Accuracy Vt (mm)
9.4.2	Cast-in-Place Concrete kerb, Channel, and Kerb and Channel	Use horizontal and vertical geometry of control alignments (in particular, the kerb lip line), including tangent points and as specified on the drawings. Set out in sufficient detail to suit site conditions. And set out marks adjacent to proposed traffic and road lighting footings to ensure tolerances are met for height clearance of hold down bolts	± 5	± 5
	Precast Concrete Kerb, Channel, and Kerb and Channel			
9.4.3	Footpaths including Pram Crossings	Use horizontal and vertical geometry of control alignments, including tangent points and as specified on the drawings. Set out in sufficient detail to suit site conditions.	± 10	± 5
9.4.4	Pavement Drains	Use horizontal and vertical geometry as specified on the drawings (invert). * Gradient shall not be less than 0.5%	± 25	± 15*
		Use horizontal and vertical geometry as specified on the drawings (upper surface of drain)	± 25	± 5

9.5 Road furniture

All setting out activities for road furniture including survey accuracy are specified in Table 9.5.8.

9.5.1 Concrete road safety barrier

Concrete road safety barriers shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings and in accordance with MRTS14 *Road Furniture*.

9.5.2 Steel beam guardrail

Steel beam guardrails including posts and guardrail shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings and in accordance with MRTS14 *Road Furniture*.

9.5.3 Proprietary barrier system

Proprietary barrier systems shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings and in accordance with MRTS14 *Road Furniture*.

9.5.4 Wire rope barrier

Wire barrier systems shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings and in accordance with MRTS14 *Road Furniture*.

9.5.5 Road signs

Road signs shall be set out in accordance with the location details, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS14 *Road Furniture*.

9.5.6 Guide posts

Guide posts shall be set out in accordance with the location details, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS14 *Road Furniture*.

9.5.7 Fences

Fences shall be set out in accordance with the location details, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS14 *Road Furniture*.

9.5.8 Gates

Gates shall be set out in accordance with the location details, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS14 *Road Furniture*.

Table 9.5.8 - Setting out requirements for road furniture

Clause	Setting out	Work activity	Accuracy Hz (mm)	Accuracy Vt (mm)
9.5.1	Concrete Road Safety Barrier	Horizontal and vertical geometry of control alignments as specified on the drawings and documentation	± 25	
9.5.2	Guard Rail Posts	As specified on the drawings and documentation	± 25	
	Steel Beam Guardrail	Horizontal and vertical geometry of control alignments as specified on the drawings and documentation	± 25	± 5
9.5.3	Proprietary Barrier Systems	Use horizontal and vertical geometry of control alignments, and as specified on the drawings and documentation	± 25	± 5
9.5.4	Wire Rope Barrier	As specified on the drawings and documentation	± 25	
9.5.5	Road Signs / Project Signs	As specified on the drawings and documentation	± 25	
9.5.6	Guide Posts	As specified on the drawings and documentation	± 25	
9.5.7	Fencing	As specified on the drawings and documentation	± 25	
9.5.8	Gates	As specified on the drawings and documentation	± 25	

9.6 Drainage

All setting out activities for drainage including survey accuracy are specified in Table 9.6.5.

9.6.1 Drainage systems and culverts

Drainage systems and culverts shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.6.2 Gullies

Concrete gullies and precast concrete side inlet gullies shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.6.3 Access chambers

Access chambers shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.6.4 Subsoil drains

Subsoil shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.6.5 Vertical drains

Vertical drains shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

Table 9.6.5 - Setting out requirements for drainage Works

Clause	Setting out	Work activity	Accuracy Hz (mm)	Accuracy Vt (mm)
9.6.1	Drainage Systems and Culverts	Set out location of culverts	± 50	-
		Set out invert of culvert *provided that grade shall not depart from those specified by more than 1%	-	± 5*
9.6.2	Concrete Gullies	Set out horizontal location of concrete gullies in direction of construction centreline	± 50	-
		Set out horizontal location of concrete gullies at right angles to construction centreline	± 25	-
		Set out invert of concrete gullies	-	± 25
		Set out heights at top of back-units, grates and frames	-	± 5
9.6.2	Precast Concrete Side Inlet Gullies	Set out location of concrete side inlet gullies	± 5 *	± 5 *
		* Notwithstanding that alignments of side inlet gully shall have smooth lines		
9.6.3	Insitu Concrete Access Chambers and Precast Concrete Access Chambers	Set out horizontal location of insitu concrete access chamber	± 50	-
		Set out invert of insitu concrete access chamber * provided that it joins neatly to existing drainage structures and are at heights compatibility with other adjacent structures	-	± 25 *
		Set out heights on tops of frames, surrounds and covers	-	± 5
9.6.5	Vertical Drains	Set out location of vertical drains	± 100	-

9.7 Subsurface footings and pile caps

All setting out activities for Subsurface Footings including survey accuracy are specified in Table 9.7.7.

The Surveyor should also check that any proposed footings do not clash with any existing or proposed underground assets (for example, subsequent drainage Works).

9.7.1 Retaining wall pad / strip footings

Retaining wall pad / strip footings shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.7.2 Ancillary structure pile footings

Ancillary structure footings used for such applications as sign gantries, retaining walls, road barriers, pad footings, light poles, masts, hoardings, advertising boards and other ancillary structures shall be set out in accordance with the details specified in the drawings, documentation and in accordance with MRTS63A *Piles for Ancillary Structures.*

9.7.3 Noise fence pile / spread footings

Noise fence pile / spread footings shall be set out in accordance with the details specified in the drawings, documentation and in accordance with MRTS15 *Noise Fences.*

9.7.4 ITS technologies traffic signal and road lighting footings

ITS Technologies traffic signal and road lighting footings shall be set out in accordance with the details specified in the drawings, documentation and in accordance with MRTS92 *Traffic Signal and Road Lighting Footings.*

9.7.5 Load bearing footings

Excavation detail for Load Bearing Footings shall be set out in accordance with the dimensions and depths shown on the drawings and in accordance with MRTS04 *General Earthworks*.

9.7.6 Concrete masonry / crib wall footings

Concrete masonry / crib wall footings location shall be set out in accordance with the details specified in the drawings, and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.7.7 Pile caps for ancillary structures

The location and dimensional requirements for pile caps shall be set out in accordance with the details specified in the drawings, and in accordance with MRTS63A *Piles for Ancillary Structures* and MRTS70 *Concrete*.

Table 9.7.7 - Setting out requirements for subsurface footings and pile caps

Clause	Setting out	Work activity	Accuracy Hz (mm)	Accuracy Vt (mm)
9.7.1	Retaining Wall Pad / Strip Footings	Set out location, dimensions and height of pad / strip footings	± 5	± 10
9.7.2	Ancillary Pile Structure Footing	Set out location of footing. Set out height location once constructed	± 35	± 3

Clause	Setting out	Work activity	Accuracy Hz (mm)	Accuracy Vt (mm)
9.7.3	Noise Fence Pile / Spread Footings	Set out location of pile / spread footings and dimensions of spread footings. Ensure centre to centre distance between posts meets horizontal accuracy requirements. Top of footing must be higher than ground level	+5 and -0	± 10
9.7.4	ITS Technologies Traffic Signal and Road Lighting Footings	Set out for traffic signal and road lighting footings	± 10	-
		Set out holding down bolts of traffic signal and road lighting footings as per appropriate Standard Drawing	-	± 3
9.7.5	Load Bearing Footings	Set out location, and dimensions for excavation Works.	± 25	± 10
9.7.6	Concrete and Masonry Retaining Wall Footings	Set out location & height of footings	± 5	± 10
9.7.6	Crib Wall Footings	Set out location & height of footings	± 10	± 10
9.7.7	Pile Caps for Ancillary Structures	Set out location and dimensions of pile caps	± 10	± 5

9.8 Traffic Engineering Technology and Systems (TETS) conduits and pits

All setting out activities for TETS Conduits and Pits including survey accuracy are specified in Table 9.8.2.

9.8.1 Conduits

Prior to setting out of conduits, setting out of allocated corridors, design surface heights and design subgrade surface heights and geometric design of other geometric design (for example, drainage and pole footings) shall be undertaken in accordance with the section on Underground Assets, Part 2 *TMR Surveying Standards*. This work is undertaken to ensure construction conformance requirements and identify potential clashes.

Conduits shall be set out in the locations shown on the standard drawings or described elsewhere in the Contract. Generally, locations of conduits are indicative only and set out best to suit site conditions and in accordance with MRTS91 *Conduits and Pits*. Generally, setting out of conduits is not required to be set out by a Surveyor. There is a Hold Point in MRTS91 *Conduits and Pits* once setting out is done.

9.8.2 Pits

Pits shall be set out in the locations shown on the standard drawings or described elsewhere in the contract. Generally, locations of pits are indicative only and set out best to suit site conditions and in accordance with MRTS91 *Conduits and Pits*.

Table 9.8.2 - Setting out requirements for conduits and pits (TETS)

Clause	Setting out	Work activity	Accuracy Hz (mm)	Accuracy Vt (mm)
9.8.1	Allocated corridors, design surface heights and other geometric designs	Set out allocated corridors, design surface heights and design subgrade surface heights and geometric design of other geometric design (for example, drainage and pole footings)	± 10	± 50
9.8.1	Conduits	Generally, locations of conduits shown on the Standard Drawings are indicative only and set out to best suit site conditions including within allocated corridors and avoiding clashes with other geometric designs	N/A	± 50
9.8.2	Pits	Set out pits in the locations shown on the standard drawings or described elsewhere in the contract. And to suit site conditions including previous set out constraints	± 10	-
9.8.1	Allocated corridors, design surface heights and other geometric designs	Set out allocated corridors, design surface heights & design subgrade surface heights and geometric design of other geometric design (for example, drainage & pole footings)	± 10	± 50

9.9 Retaining walls (above ground)

All setting out activities for retaining walls, soil nailing, passive rock dowels and active rock bolts including survey accuracy are specified in Table 9.9.6.

9.9.1 Concrete retaining walls

Concrete retaining walls shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.9.2 Crib walls

Crib walls shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.9.3 Boulder walls

Boulder walls shall be set out in accordance with the lines, dimensions and other requirements shown on the drawings, documentation and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.9.4 Soil nailing

Soil nailing shall be set out in the locations and in accordance with the details specified in the drawings and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.9.5 Active rock bolts

Rock bolts shall be set out in the locations and in accordance with the details specified in the drawings and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

9.9.6 Passive rock dowels

Rock dowels shall be set out in the locations and in accordance with the details specified in the drawings and in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

Table 9.9.6 - Setting out requirements for retaining walls (above ground) and soil nail walls

Clause	Setting out	Work activity	Accuracy Hz (mm)	Accuracy Vt (mm)
9.9.1	Concrete Retaining Walls	Set out location on top of concrete retaining wall	± 5	-
		* except where it is required to join neatly to adjacent structures	-	± 10 *
9.9.2	Crib Walls	Set out location on alignment of crib wall	± 10	
		* except where it is required to join neatly to adjacent structures	-	± 10 *
9.9.3	Boulder Walls	Set out location on front face of wall	± 75	-
9.9.4	Soil Nailing	Soil nails shall be set out in the locations and, if required, in accordance with the details specified in the drawings to ensure that the front end of the soil nails and rock bolts meet tolerance requirements	Drawing specific	Drawing specific
9.9.5	Active Rock Bolts	Active rock bolts shall be set out in the locations and in accordance with the details specified in the drawings	Drawing specific	Drawing specific
9.9.6	Passive Rock Dowels	Passive rock dowels shall be set out in the locations and in accordance with the details specified in the drawings	Drawing specific	Drawing specific

9.10 3rd Party underground assets – Public Utility Plant (PUP)

Setting out requirements for 3rd party assets is generally undertaken by the relevant utility authorities and is out of scope in this document.

9.11 Bridges

Abutments and piers shall be set out on the site by a surveyor experienced in bridge construction in accordance with MRTS62 *Bridge Substructure.*

All setting out activities for bridges including survey accuracy are specified in Table 9.11.10.

9.11.1 Piles

Piles shall be set out in accordance with MRTS62 *Bridge Substructure*, MRTS63 *Cast in Place Piles*, MRTS64 *Driven Tubular Steel Piles (with reinforced concrete pile shaft)*, MRTS65 *Precast Prestressed Concrete Piles* or MRTS66 *Driven Steel Piles* and other requirements shown on the drawings and documentation.

9.11.2 Pile caps

Pile caps shall be set out in accordance with accordance with MRTS62 *Bridge Substructure* and MRTS70 *Concrete* and other requirements shown on the drawings and documentation.

9.11.3 Columns

Columns shall be set out in accordance with MRTS62 *Bridge Substructure* and MRTS70 *Concrete* and other requirements shown on the drawings and documentation.

9.11.4 Abutments and headstocks

Abutments and headstocks shall be set out in accordance with MRTS62 *Bridge Substructure* and MRTS70 *Concrete* and other requirements shown on the drawings and documentation.

9.11.5 Coreholes

Coreholes shall be set out in accordance with MRTS62 *Bridge Substructure* and MRTS70 *Concrete* and other requirements shown on the drawings and documentation.

9.11.6 Pedestals / plinths

Pedestal / plinths shall be set out in accordance with MRTS62 *Bridge Substructure* and MRTS70 *Concrete* and other requirements shown on the drawings and documentation.

9.11.7 Girders / deck units

Girders / deck units shall be set out in accordance with MRTS70 *Concrete*, MRTS74 *Supply and Erection of Prestressed Concrete Deck and Kerb Units*, MRTS75 *Supply and Erection of Prestressed Concrete Girders* and MRTS76 *Supply and Erection of Steel Girders* and other requirements shown on the drawings and documentation.

9.11.8 Deck

The deck shall be set out in accordance with MRTS70 *Concrete*, MRTS77 *Bridge Deck* and MRTS84 *Deck Wearing Surface* and other requirements shown on the drawings and documentation.

9.11.9 Kerbs and parapets

Kerbs and parapets shall be set out in accordance with MRTS70 *Concrete* and MRTS77 *Bridge Deck* and other requirements shown on the drawings and documentation.

9.11.10 Relieving slabs

The relieving slabs shall be set out in accordance with MRTS70 *Concrete* and MRTS77 *Bridge Deck* and other requirements shown on the drawings and documentation.

Table 9.11.10 - Setting out requirements bridges

Clause	Setting out	Work activity	Accuracy Hz (mm)	Accuracy Vt (mm)
7.2.2	Bridge Survey Control & Pier Control lines	Refer to Clause 7.2.2	SU ≤2 mm @95% CI	RU 1.5 mm @ 95% CI
9.11.1	Piles	Set out from Bridge Survey Control and Pier Control lines	± 35	± 5
9.11.2	Pile Caps	For best practice, set out Pile caps, Abutments, Headstocks and Core holes as recommended in Clause 6.6.9.4 and 6.6.9.5 as prescribed in the *TMR Surveying Standards, Part 2*	± 10	± 5
9.11.3	Columns		± 3	± 3
9.11.4	Abutments and Headstocks		± 3	± 3
9.11.5	Core Holes		± 3	-
9.11.6	Pedestals / Plinths		± 3	± 1.5

Clause	Setting out	Work activity	Accuracy Hz (mm)	Accuracy Vt (mm)
9.11.7	Girders / Deck Units	Set out from Bridge Survey Control and Pier Control lines	± 3	-
9.11.7	Deck	Set out from Bridge Survey Control line	± 3	± 3
9.11.8	Kerbs and Parapets	Set out from Bridge Survey Control line	± 3	-
9.11.8	Relieving Slabs	Set out from Bridge Survey Control line	± 5	± 5

10 Compliance / conformance testing

This clause refers only to mandatory compliance / conformance testing requirements specified in Transport and Main Roads Technical Specification documents.

10.1 Earthworks and subgrade treatments

All compliance testing activities including geometric tolerance specifications for earthworks and subgrade treatments shall be in accordance with MRTS04 *General Earthworks* and MRTS07A *Insitu Stabilised Subgrades using Quicklime or Hydrated Lime* and/or other requirements shown on the drawings and documentation. These activities typically include:

- stripping top soil
- subgrade treatments
- bottom of excavations
- bottom of excavations for culverts and/or end structures
- bottom of excavations for channels and drains
- earth fill material in subgrade
- earth fill material – other than in backfill, subgrade or verge, and
- verge.

10.2 Pavement layers

All compliance testing activities including geometric specifications for pavement layers shall be in accordance with MRTS05 *Unbound Pavements*, MRTS07B *Insitu Stabilised Pavements using Cement or Cementitious Blends*, MRTS07C *Insitu Stabilised Pavements using Foamed Bitumen*, MRTS08 *Plant-Mixed Heavily Bound (Cemented) Pavements*, MRTS09 *Plant-Mixed Pavement Layers Stabilised Using Foamed Bitumen*, MRTS10 *Plant-Mixed Lightly Bound Pavements*, MRTS30 *Asphalt Pavements* and MRTS32 *High Modulus Asphalt (EME2)*, MRTS39 *Lean Mix Concrete Sub-base for Pavements* and MRTS40 *Concrete Pavement Base* and/or other requirements shown on the drawings and documentation. These activities include the subbase, base and surface layers.

10.3 Kerb, channel and kerb and channel

All compliance testing activities including geometric specifications for kerbs, channels and kerb and channel shall be in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* and/or other requirements shown on the drawings and documentation.

10.4 Pavement drains

All compliance testing activities including geometric specifications for pavement drains shall be in accordance with MRTS38 *Pavement Drains* and/or other requirements shown on the drawings and documentation.

10.5 Noise fences

All conformance requirements for the constructed noise fence must meet the tolerance specifications as specified in MRTS15 *Noise Fences* and/or other requirements shown on the drawings and documentation.

10.6 Drainage

All compliance testing activities including geometric specifications for drainage shall be in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* and/or other requirements shown on the drawings and documentation. These activities include:

- culverts
- gullies
- inlet gullies
- access chambers
- subsoil drains, and
- vertical drains.

10.7 Conduits and pits

All conformance requirements for installed conduits as specified in MRTS91 *Conduits and Pits* must meet these requirements as specified in Section 6.7.4 of the *TMR Surveying Standards, Part 2*, or as required in the construction drawings and documentation.

10.8 Retaining wall footings

All conformance requirements for the constructed elements must meet the tolerance specifications as specified in MRTS03 *Drainage, Retaining Structures and Protective Treatments* and/or as required in the construction drawings and documentation.

10.9 Bridges

All conformance requirements for the constructed elements must meet the tolerance specifications as specified in MRTS63 *Cast in Place Piles*, MRTS65 *Precast Prestressed Concrete Piles* or MRTS66 *Driven Steel Piles*, MRTS70 *Concrete* and MRTS77 *Bridge Deck* and/or as required in the construction drawings and documentation.

10.10 Ancillary structure footings

All conformance requirements for the constructed elements must meet the tolerance specifications as specified in MRTS63A *Piles for Ancillary Structures* or as required in the construction drawings and documentation.

11 As Constructed Survey

11.1 Survey at practical completion

As a condition precedent to the issue of the Certificate of Practical Completion, the Contractor must carry out and provide the Administrator with the As Constructed Survey deliverables of the Project Works that details the actual location of the new infrastructure, including underground infrastructure and demonstrates that the Project Works are within the Site.

11.2 Earthworks

As Constructed Survey methodologies and accuracy requirements for earthworks are specified in Table 11.2.7. They also must be in accordance with associated drawings and contract documents.

11.2.1 Topsoil stripped area

After stripping of topsoil has been completed in accordance with MRTS04 *General Earthworks*, no further work over the stripped area shall be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 8**

11.2.2 Bottom of excavation

After excavation has reached subgrade level in accordance with MRTS04 *General Earthworks*, no further work over the excavated area shall be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 9**

11.2.3 Excavated area of unsuitable material

After excavation of unsuitable material has been completed in accordance with MRTS04 *General Earthworks*, no backfilling of the excavated area shall be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 10**

After backfilling of the excavated are has been completed, an As Constructed Survey must be undertaken and notice of such Works provided to the Administrator. **Hold Point 11**

11.2.4 Bottom of excavated areas for end structures

After excavation for end structures has been completed in accordance with MRTS04 *General Earthworks*, no placement of precast concrete items shall be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 12**

11.2.5 Top of embankment (including batters) prior to construction of the subgrade

After completion of earthworks to subgrade level and proof rolling in accordance with MRTS04 *General Earthworks*, no construction of pavement Works shall be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 13**

11.2.6 Top of subgrade

After completion of the subgrade in accordance with MRTS04 *General Earthworks*, MRTS07A *Insitu Stabilised Subgrades Using Quicklime or Hydrated Lime*, MRTS07B *Insitu Stabilised Pavements Using Cement or Cementitious Blends* and MRTS10 *Plant-Mixed Lightly Bound Pavements* no covering of a subsequent layer shall be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 14**

11.2.7 Bottom of excavations for channels and drains

After completion of excavations for channels and drains have been completed, an As Constructed Survey shall be undertaken.

Table 11.2.7 - As Constructed Survey – Earthworks (includes excavations, embankments, subgrade, channels and open drains)

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.2.1	Stripped area	Full extent of stripped area. 10m x 10m grid minimum. Include dips and mounds and changes in grade	± 25
11.2.2	Bottom of excavation	All edges and interfaces. 10 m cross section minimum. Includes cut batters, crown, change in grade and at crests and dips in vertical curve geometry	± 25
11.2.3	Bottom of excavated area of unsuitable material	All edges and interfaces. 10 m x 10 m grid minimum. And sufficient density of points to provide shape to interpolated average accuracy ± 25 mm Hz & Vt	± 15
11.2.4	Bottom of excavated areas for end structures	Full extent of excavated area for end structures. And sufficient density of points to provide shape to interpolated average accuracy ± 25 mm Hz & Vt	± 15
11.2.5	Top of embankment (including batters) prior to construction of the subgrade	10 m cross sections minimum. Including bottom of batters, the crown, longitudinal breaklines, change in grade and at crests and dips in vertical curve geometry	± 25
11.2.6	Top of subgrade	10 m cross sections minimum. Includes crown, longitudinal breaklines, change in grade and at crests and dips in vertical curve geometry	± 10
11.2.7	Bottom of excavations for channels and drains	Full width and at minimum 10 m intervals and changes in direction (both horizontal and vertical)	± 25

11.3 Pavements, pavement drains, kerb, channel and kerb and channel

As Constructed Survey methodologies and accuracy requirements for pavements (non-concrete), pavement drains, kerb, channel and kerb and channel are specified in Table 11.3.6. They also must be in accordance with associated drawings and contract documents.

Using 3D laser scanning technology can be an acceptable methodology of undertaking an As Constructed Survey if all the requirements including accuracy can be achieved as prescribed in Table 11.3.6(a). Data extraction from the point cloud can then be applied to produce a 3D model.

In addition, to check the accuracy of the point cloud an alternative method of measuring cross sections using alternative measurement techniques shall be undertaken and data supplied. A minimum of three cross section checks is required at maximum 100 m intervals.

11.3.1 Top of every pavement layer (non-concrete)

After completion of every pavement layer in accordance with MRTS05 *Unbound Pavements*, MRTS07B *Insitu Stabilised Pavements using Cement or Cementitious Blends*, MRTS07C *Insitu Stabilised Pavements using Foamed Bitumen*, MRTS08 *Plant-Mixed Heavily Bound (Cemented)*

Pavements, MRTS09 *Plant-Mixed Pavement Layers Stabilised Using Foamed Bitumen*, MRTS10 *Plant-Mixed Lightly Bound Pavements*, MRTS30 *Asphalt Pavements* and MRTS32 *High Modulus Asphalt (EME2)* no covering of a subsequent layer shall be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 15**

11.3.2 Kerb, channel and kerb and channel

An As Constructed Survey shall be undertaken after kerb, channel and kerb and channel Works has been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

11.3.3 Footpaths and pram crossings

An As Constructed Survey shall be undertaken after footpath Works have been completed in accordance with hand-placed concrete paving in MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

11.3.4 Pavement drains

An As Constructed Survey shall be undertaken after pavement drainage Works have been completed in accordance with MRTS38 Pavement Drains.

11.3.5 Lean mix concrete sub-base and concrete pavement base

Surveying requirements for the substrata for lean mix concrete and top of lean mix concrete sub-base are to be in accordance with MRTS39 *Lean Mix Concrete Sub-base for Pavements* and are specified in Table 11.3.6(a).

11.3.6 Concrete pavement base

Surveying requirements for the invert level of the subbase and top of the subbase and base of concrete pavements are to be in accordance with MRTS40 *Concrete Pavement Base* and are specified in Table 11.3.6(b).

For As Constructed Survey requirements for Lean Mix Concrete Sub-base pavement and Concrete Pavement Base pavement, refer to MRTS39 *Lean Mix Concrete Subbase for Pavements* and MRTS40 *Concrete Pavement Base* which have detailed surveying requirements and Hold Points.

Note: MRTS40 Appendix D.2.1. If a survey procedure is adopted which produces an as built level model of the top of both the subbase and base, each with comparison to the design model, this model may be accepted by the Administrator.

Table 11.3.6(a) - As Constructed Survey – Pavement layers (non-concrete), pavement drains, kerb, channel and kerb and channel

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.3.1	Top of every pavement layer	10 m cross sections minimum that includes full width, crown*, longitudinal breaklines, change in grade, top / toe edge of pavement layer and at crests and dips in vertical curve geometry *Due to rounding of crown, capture 0.5 m either side of crown	± 10
11.3.2	Kerb and channel top of kerb back, top, invert and lip	Must include the full shape of the kerb and channel. (Use design dimensions if required for bottom of kerb). Minimum at 10 metre intervals, changes in grade, direction and over and under verticals at crests and dips in vertical curve geometry	± 5
11.3.3	Footpath and Pram Crossings	Must include the full shape of the footpath and pram crossing. (Use design dimensions if required for bottom of footpath). Minimum at 10 metre intervals, changes in grade, direction and over and under verticals at crests and dips in vertical curve geometry	± 5
11.3.4	Pavement Drain	Full width and at minimum 10 m intervals and changes in direction (both horizontal and vertical)	± 10 Hz ± 5 Vt

Table 11.3.6(b) - As Constructed Survey – Pavement layers (lean mix and concrete base)

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.3.5	Top Substrate	As per requirements under survey at the top of the substrate prescribed in MRTS39 *Lean Mix Concrete Sub-base for Pavements*	± 10 Hz ± 3 Vt
	Top of Lean Mix Concrete Sub-base	As per requirements under survey at the top of the sub-base prescribed in MRTS39 *Lean Mix Concrete Sub-base for Pavements*	± 10 Hz ± 3 Vt
11.3.6	Top of Base Invert Level	As per requirements for determining base invert level in MRTS40 *Concrete Pavement Base*	± 10 Hz ± 3 Vt
	Top of Concrete Pavement Sub-base	As per requirements under Base level surveys prescribed in MRTS40 *Concrete Pavement Base*	± 10 Hz ± 3 Vt
	Top of Concrete Base	As per requirements under Base level surveys prescribed in MRTS40 *Concrete Pavement Base*	± 10 Hz ± 3 Vt

11.4 Road furniture

As Constructed Survey methodologies and accuracy requirements for road furniture are specified in Table 11.4.11. They also must be in accordance with associated drawings and contract documents

11.4.1 Concrete road safety barriers

An As Constructed Survey shall be undertaken after the concrete road safety barrier has been completed in accordance with MRTS14 *Road Furniture*.

11.4.2 Guard rails

An As Constructed Survey shall be undertaken after the guard rail barrier has been completed in accordance with MRTS14 *Road Furniture*.

11.4.3 Wire rope barrier

An As Constructed Survey shall be undertaken after the wire rope barrier has been completed in accordance with MRTS14 *Road Furniture*.

11.4.4 Road signs / Project signs / Variable message signs

An As Constructed Survey shall be undertaken after road signs, project signs and variable message signs has been completed in accordance with MRTS14 *Road Furniture*.

11.4.5 Fences

An As Constructed Survey shall be undertaken after fence construction has been completed in accordance with MRTS14 *Road Furniture*.

11.4.6 Gates

An As Constructed Survey shall be undertaken after gate construction has been completed in accordance with MRTS14 *Road Furniture*.

11.4.7 Field cabinets

An As Constructed Survey shall be undertaken after the construction of field cabinets that can include telecommunication and electrical cabinets has been completed in accordance with MRTS14 *Road Furniture*.

11.4.8 Road light poles and road light poles with mast arms

An As Constructed Survey shall be undertaken after the construction of road light poles and road light poles with mast arms has been completed in accordance with MRTS94 *Road Lighting*.

11.4.9 Traffic signal poles and traffic signal poles with mast arms

An As Constructed Survey shall be undertaken after the construction of traffic signal poles and traffic signal poles with mast arms has been completed in accordance with MRTS93 *Traffic Signals*.

11.4.10 Electricity poles and electricity poles with road lighting mast arms

An As Constructed Survey shall be undertaken after the construction of electricity poles and electricity poles with road lighting mast arms has been completed in accordance with the requirements of the utility provider.

11.4.11 Overhead wires

Upon completion of overhead services (primarily electrical and aerial telecommunications), an As Constructed Survey shall be undertaken.

Table 11.4.11 - As Constructed Survey – Road furniture

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.4.1	Concrete Road Safety Barrier	At minimum of 10 metre intervals, change in direction and as per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
11.4.2	Guard Rail Posts	Top centre of posts	± 25
	Steel Beam Guardrail	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
11.4.3	Wire Rope Barrier	Top of wire at minimum 10 metre intervals, change in direction and as per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
11.4.4	Road Signs / Project Signs	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
	Variable Message Signs	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
11.4.5	Fences	At minimum of 20 metre intervals, change in direction and as per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
11.4.6	Gates	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
11.4.7	Field Cabinets	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
11.4.8	Road Light Poles	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
	Road Light Poles with Mast Arm	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
11.4.9	Traffic Signal Poles	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
	Traffic Signal Poles with Mast Arm	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
11.4.10	Electricity Poles	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
	Electricity Poles with Road Light Mast Arm	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 25
11.4.11	Overhead Wires	As per codes and examples of the *TMR Surveying Standards – Schedule 1*. Also record ambient air temperature and atmospheric description (for example, bright / sunny, partly cloudy / overcast) including estimated wind speed and direction	± 50

11.5 Drainage

As Constructed Survey methodologies and accuracy requirements for drainage are specified in Table 11.5.5. They also must be in accordance with associated drawings and contract documents.

11.5.1 Drainage systems and culverts

After installation of drainage systems and culvert Works have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, backfilling shall not be

undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 16**

11.5.2 Gullies

After installation of concrete gullies or precast concrete side inlet gullies have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, placement of grates shall not be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 17**

11.5.3 Access chambers

After installation of precast concrete or insitu concrete access chambers have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, placement of concrete top slabs shall not be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 18**

11.5.4 Subsoil drains

After installation of subsoil drains have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, backfilling of the trench shall not be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 19**

11.5.5 Vertical drains

After installation of vertical drains have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, subsequent construction of pavement layers shall not be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 20**

Table 11.5.5 - As Constructed Survey – Drainage

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.5.1	Drainage System	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2*	± 10
	Culverts under Roadway including End Structures (head walls, wing walls & aprons)	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2* including the *TMR Surveying Standards – Schedule 1* for culvert end structure	± 10
11.5.2	Concrete or Precast Concrete Side Inlet Gullies	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2*	± 10
11.5.3	Precast Concrete or Insitu Concrete Access Chambers	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2*	± 10
11.5.4	Subsoil Drains	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2*	± 10
11.5.5	Vertical Drains	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2*	± 10

11.6 Subsurface footings

As Constructed Survey methodologies and accuracy requirements for subsurface footings are specified in Table 11.6.6. They also must be in accordance with associated drawings and contract documents.

11.6.1 Retaining wall pad / strip footings

After excavation and formwork of the retaining wall footings have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, the concrete pour shall not be undertaken until an As Constructed Survey of the excavated area has been met and notice of such Works provided to the Administrator. **Hold Point 21**

After concrete pour of the retaining wall footings have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, backfilling shall not be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 22**

11.6.2 Ancillary structure pile footings

After construction Works of ancillary structure for pile caps such as sign gantries, retaining walls, light poles, masts, hoardings and advertising signs have been completed in accordance with MRTS63A *Piles for Ancillary Structures*, an As Constructed Survey shall be undertaken.

11.6.3 Noise fence pile / spread footings

After excavation of pile / spread footings have be completed in accordance with MRTS15 *Noise Fences*, placement of the posts shall not be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 23**

After construction noise fence pile / spread footings have been completed in accordance with MRTS15 *Noise Fences*, no further work shall not be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 24**

11.6.4 ITS Technologies– Traffic signal and road lighting footings

After excavation of the footings have been completed in accordance with MRTS92 *Traffic Signal and Road Lighting Footings*, placement of the anchor cage shall not be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 25**

After construction Works of the footings have been completed in accordance with MRTS92 *Traffic Signal and Road Lighting Footings*, an As Constructed Survey shall be undertaken.

11.6.5 Load bearing footings

After excavation of load bearing footings have been completed in accordance with MRTS04 *General Earthworks*, covering of the foundation surface shall not be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 26**

After construction of the load bearing footings have been completed in accordance with associated drawings and documentation, an As Constructed Survey shall be undertaken.

11.6.6 Concrete masonry / Crib wall footings

After construction of concrete masonry / crib wall footings have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, no further work shall not be undertaken until the As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 27**

Table 11.6.6 - As Constructed Survey – Subsurface footings

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.6.1	Concrete Retaining Wall Pad / Strip Footing	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2*	± 5 Hz ± 10 Vt
11.6.2	Ancillary Structure Pile Footing	Survey the centre and invert location of the footing excavation. After installation, survey the top perimeter of the footing	± 10
	Ancillary Structure Pile Footing Cap	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2*	± 10
11.6.3	Noise Fence Pile / Spread Footings Excavation	Survey the centre and invert location of the footing or extent of spread footing excavation. After installation, survey the top perimeter of the footing	± 10
	Constructed Noise Fence Pile / Spread Footings	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2*	± 10
11.6.4	Traffic and Road Lighting Footings	Survey the centre and invert location of the excavation. After installation, survey the top perimeter of the footing	± 10
11.6.5	Load Bearing Footings	Full extent of excavated area for load bearing footings. After installation, survey the top perimeter of the footing	± 10
11.6.6	Concrete Masonry Wall Footings	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2*	± 10
	Crib Wall Footings		

11.7 Traffic Engineering Technology and Systems (TETS)– Conduits and pits

As Constructed Survey methodologies and accuracy requirements for conduits and pits are specified in Table 11.7. They also must be in accordance with associated drawings and contract documents.

After construction Works of the Traffic Engineering Technology and Systems (TETS) conduits and pits have been completed in accordance with MRTS91 *Conduits and Pits*, backfilling of trenches shall not be undertaken until the Conformance and As Constructed Survey requirements have been met and notice of such Works provided to the Administrator. **Hold Point 28**

Table 11.7 - As Constructed Survey – Conduits and pits (TETS)

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.7	Conduits and Pits	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2*. Also includes a minimum requirement to provide conformance results for location within allocated alignment corridors, depth of cover and below the subgrade in road crossing	± 10

11.8 Retaining walls (above ground)

As Constructed Survey methodologies and accuracy requirements for above ground retaining wall are specified in Table 11.8.6. They also must be in accordance with associated drawings and contract documents.

11.8.1 Concrete retaining walls

After construction of the concrete retaining wall has been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, or associated drawings and documentation, an As Constructed Survey shall be undertaken.

11.8.2 Crib retaining walls

After construction of the crib retaining wall has been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, or associated drawings and documentation, an As Constructed Survey shall be undertaken.

11.8.3 Boulder retaining wall

After construction of the boulder retaining wall has been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, or associated drawings and documentation, an As Constructed Survey shall be undertaken.

11.8.4 Soil nails

After the installation of the soil nails have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, or associated drawings and documentation, an As Constructed Survey shall be undertaken.

11.8.5 Active rock bolt

After installation of active rock bolts have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, or associated drawings and documentation, an As Constructed Survey shall be undertaken.

11.8.6 Passive rock dowels

After installation of passive rock dowels have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, or associated drawings and documentation, an As Constructed Survey shall be undertaken.

Table 11.8.6 - As Constructed Survey – Retaining walls (above ground)

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.8.1	Concrete Retaining Wall	As prescribed in Underground Assets in the TMR Surveying Standards, Part 2	± 10
11.8.2	Crib Retaining Wall	As per codes and examples of the TMR Surveying Standards – Schedule 1	± 10
11.8.3	Boulder Retaining Wall	As per codes and examples of the TMR Surveying Standards – Schedule 1	± 10
11.8.4	Soil Nail	Centre of installed soil nail	± 10

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.8.5	Active Rock Bolts	Centre of installed active rock bolt	± 10
11.8.6	Passive Rock Dowels	Centre of installed passive rock dowel	± 10

11.9 Noise fences

As Constructed Survey methodologies and accuracy requirements for noise fences are specified in Table 11.9.

An As Constructed Survey shall be undertaken after the noise fence has been completed in accordance with MRTS15 *Noise Fences* and associated drawings and contract documents.

Table 11.9 - As Constructed Survey – Noise fences

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.9	Noise Fences	As per codes and examples of the *TMR Surveying Standards – Schedule 1*	± 10

11.10 Horizontal directional drilling, microtunnelling and thrust boring and auger boring

As Constructed Survey methodologies and accuracy requirements for horizontal directional drilling, microtunnelling and thrust boring and auger boring are specified in Table 11.10.3. They also must be in accordance with associated drawings and contract documents.

11.10.1 Horizontal directional drilling

After horizontal directional drilling Works are completed in accordance with MRTS140 *Horizontal Directional Drilling (HDD)* an As Constructed Survey is to be undertaken as specified in Table 11.10.3.

11.10.2 Microtunnelling and pipe jacking

After microtunnelling and pipe jacking Works are completed in accordance with MRTS141 *Microtunneling and Pipe Jacking* an As Constructed Survey is to be undertaken as specified in Table 11.10.3.

11.10.3 Thrust boring and auger boring

After thrust boring and auger boring Works are completed in accordance with MRTS142 *Thrust Boring and Auger Boring* an As Constructed Survey is to be undertaken as specified in Table 11.10.3.

The sonde at the bottom of the hole assembly (BHA) transmits a signal showing location, depth and direction and the all important angle of the drill head. A second person uses a receiver above ground to follow the sonde and track it for the operator.

Table 11.10.3 - As Constructed Survey – Horizontal directional drilling, Microtunnelling and Thrust boring and auger boring

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.10.1	Horizontal Directional Drilling	Survey the marked locations and depths on the ground surface from the sonde at intervals determined by the length of the drill rod and at minimum 10 metre intervals	± 50
11.10.2	Microtunnelling and Jacking		
11.10.3	Thrust / Auger boring		

11.11 3rd Party underground assets – including Public Utility Plant (PUP)

Where the relevant utility provider is required to adjust, modify, relocate, enhance or provide utility infrastructure and after construction Works have been completed to the relevant utility providers specification and meeting TN163 *Third Party Utility Infrastructure Installation in State-Controlled Roads Technical Guideline* requirements, an As Constructed Survey must be undertaken as prescribed in Table 11.11 prior to backfilling of trenches and notice of such Works provided to the Administrator. **Hold Point 29**

Table 11.11 - As Constructed Survey – Underground assets (3rd party)

Clause	As Constructed Survey	Methodology (Includes using appropriate codes as per the *TMR Surveying Standards* – Schedule 1)	Accuracy Hz & Vt (mm)
11.11	• Electricity Conduits • Electricity Inspection Chambers and Pits • Fuel Lines • Fuel Inspection Chambers • Gas Lines • Gas Valves • Gas Inspection Chambers and Pits • Thrust Blocks • Oil Lines • Sewer Lines • Sewer Valves • Sewer Chambers and Pits • Water Main Lines • Water Main Hydrants, Valves and Meters • Water Main Inspection Chambers and Pits, and • Envelopers	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2.* Check for meeting all conformance requirements for installed conduits and clash avoidance with subsequent construction of other assets.	± 10

11.12 Bridges

As Constructed Survey methodologies and accuracy requirements for bridges are specified in Table 11.12.8. They also must be in accordance with associated drawings and contract documents.

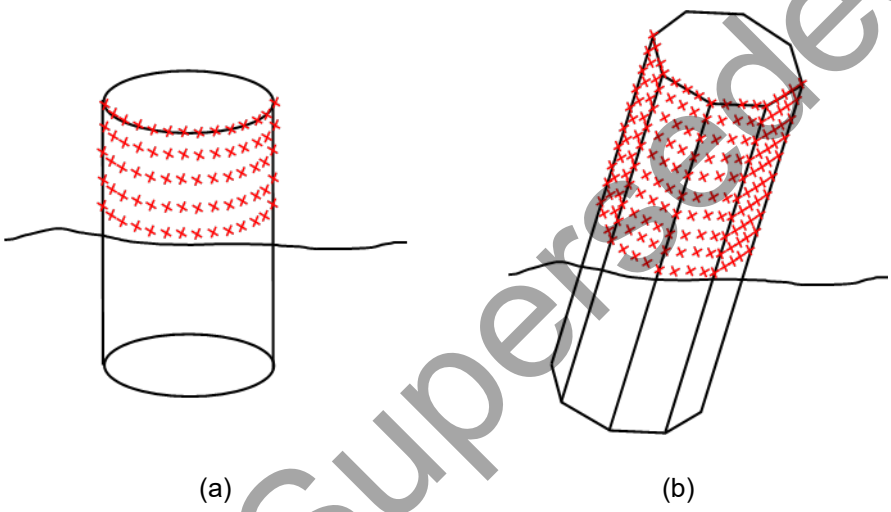
11.12.1 Piles

After pile Works have been completed in accordance with MRTS63 *Cast in Place Piles*, MRTS64 *Driven Tubular Steel Piles (with reinforced concrete pile shaft)*, MRTS65 *Precast Prestressed Concrete Piles* or MRTS66 *Driven Steel Piles* or associated drawings and documentation, an As Constructed Survey shall be undertaken

Measure the location, vertical direction and shape of piles by direct angular and distance measurement (for example, a Total Station or Robotic Total Station) or by scanning the surface of the pile as in Figure 11.12.1 (a and b). Full shape and location of the entire pile can be extrapolated in its direction from the measured data and known lengths of the piles prior to boring or pile driving.

If direct measurement to a circular pile by a Total Station or Robotic Total Station is used a minimum of six points should be measured around the perimeter to determine the centroid of the pile.

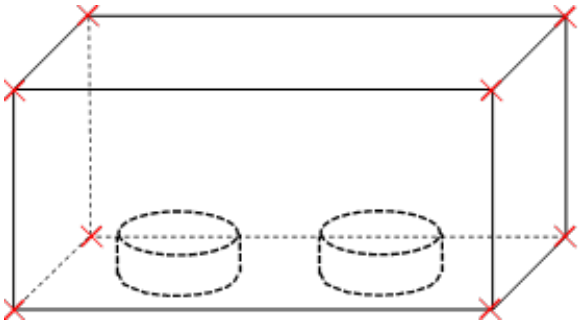
Figure 11.12.1 – As Constructed Survey of piles



11.12.2 Pile caps

After pile caps Works have been completed in accordance with MRTS70 *Concrete* or associated drawings and documentation, an As Constructed Survey shall be undertaken by measuring location, and shape of pile caps by direct measurement or by scanning techniques. See Figure 11.12.2(a).

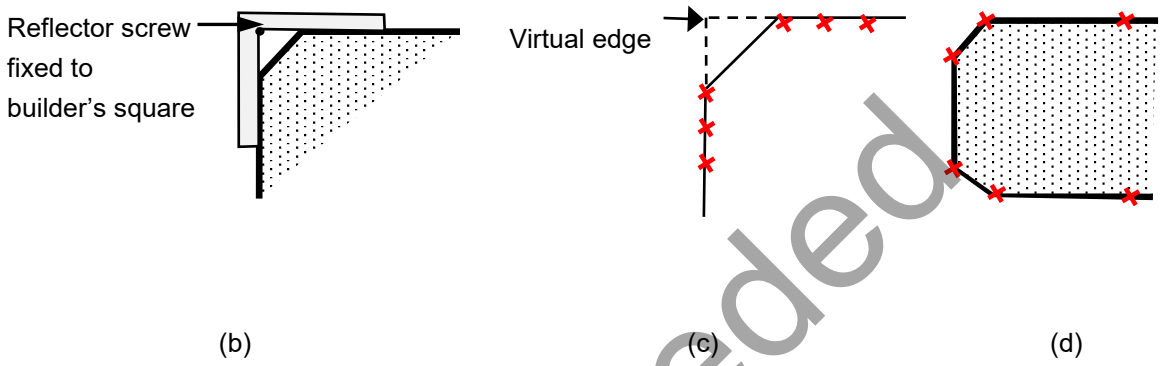
Figure 11.12.2(a) - As Constructed Survey of pile caps



Note: For compliance testing measurement the resulting virtual edge derived from the intersection of the adjacent projected chamfered faces is required. This can be achieved by using a reflector fixed to a builder's square (see Figure 11.12.2(b)) or measuring the offset distance from the chamfered edge or constructing the edge from the measured adjacent faces (see Figure 11.12.2(c)).

For As Constructed Survey purposes, the virtual edge (Figure 11.12.2(c)) or the chamfered edges (Figure 11.12.2(d)) on the concrete elements can be used for the As Constructed Survey Model.

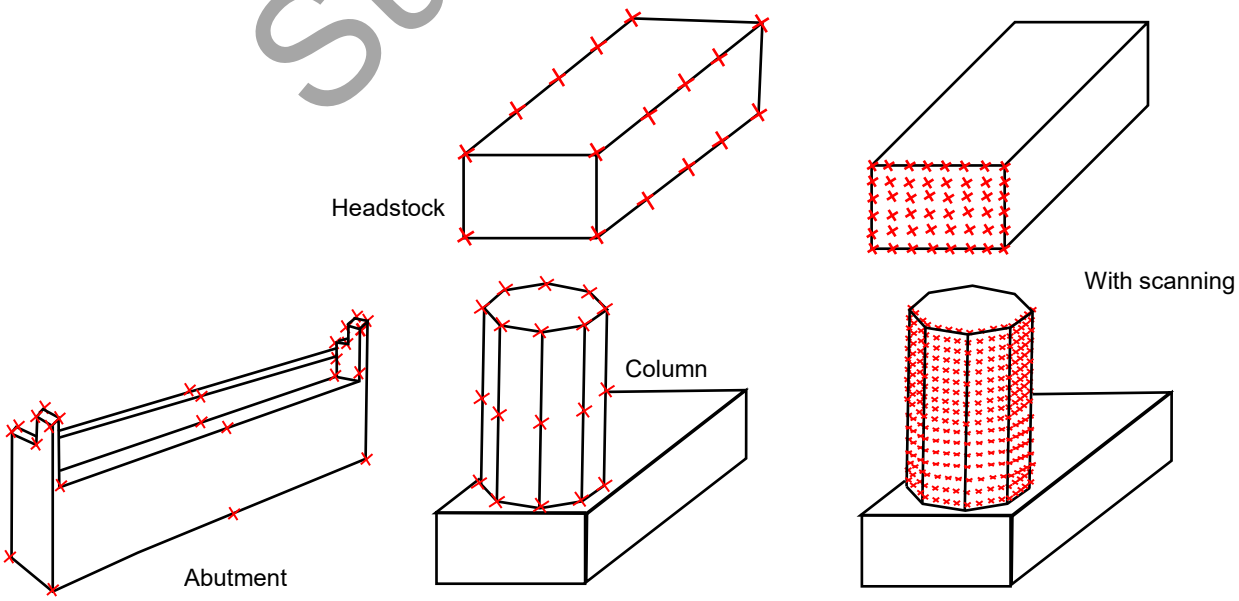
Figure 11.12.2(b), (c), (d) - As Constructed Survey of chamfered edges



11.12.3 Columns, abutments and headstocks

After columns, abutments and headstock Works have been completed in accordance with MRTS62 *Bridge Substructure* and MRTS70 *Concrete* or associated drawings and documentation, an As Constructed Survey shall be undertaken by measuring location, and shape of abutments, columns and headstocks by direct measurement or by scanning techniques. See Figure 11.12.3.

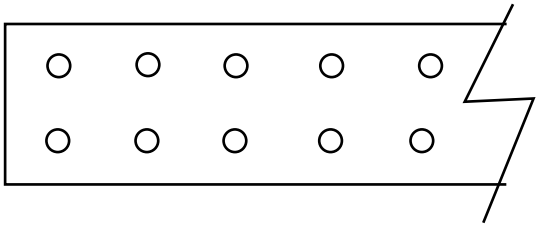
Figure 11.12.3 - As Constructed Survey of columns, abutments and headstocks



11.12.4 Coreholes

An As Constructed Survey shall be undertaken by measuring the centre locations of abutments / headstock coreholes. See Figure 11.12.4.

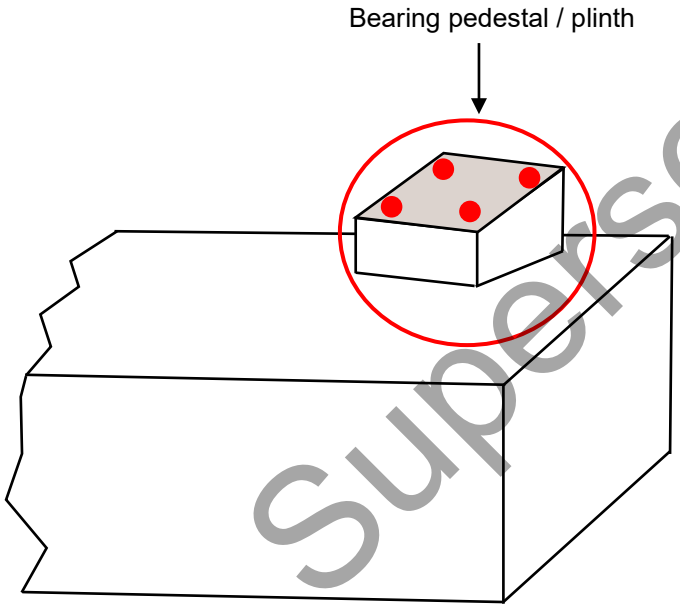
Figure 11.12.4 - As Constructed Survey of coreholes



11.12.5 Bearing pedestal / plinth

An As Constructed Survey shall be undertaken by measuring the location and shape of the bearing pedestal / plinth.

Height of the pedestal / plinth corners should be measured with a calibrated level and staff.



11.12.6 Girders / deck units

After girders / deck units have been placed in accordance with MRTS70 *Concrete* and MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units* or associated drawings and documentation, an As Constructed Survey shall be undertaken by measuring location, and shape of the girders / deck units by direct measurement or by scanning techniques. See Figure 11.12.6. The minimum measurement locations should be at the end of units, ¼ span, mid-span and ¾ span.

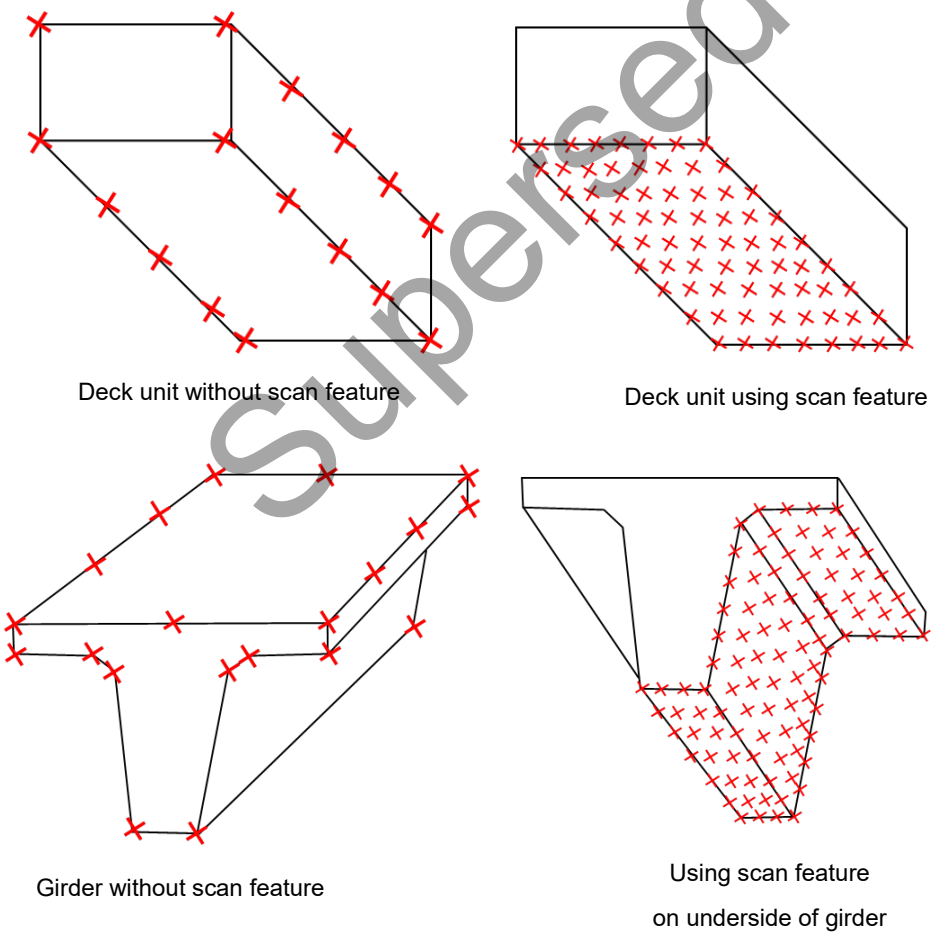
When a deck is poured onto deck units / girders the mass of the concrete deck will cause the hog in the beams to reduce.

This is known as pre-camber. Its effect can be measured directly on the underside of the deck units / girders during three separate phases:

- deck unit / girder placement
- insitu construction of the deck, and
- construction of the Deck Wearing Surface (DWS).

Once the deck units / girders have been placed, additional measurement points along the edges / face along the deck unit / girder will provide an accurate reference line / face to measure the pre-camber effect once the deck slabs have been poured and the final Deck Wearing Surface (DWS) has been placed. This can be done by conventional Total Station and prism, however, the scanning functionality of the Total Station would be far more practical. If possible, carry out measurements on the underside of deck units / girders. It is preferable to use the underside measurements of the deck units / girders as a reference line / surface during each phase. Temperature variation between the top and bottom side of the girder / deck unit can cause a measurable flexing effect. For this reason, camber measurements should be taken at the same times of day, preferably early morning when the effect of temperature variation is at its lowest. This procedure should eliminate or minimise the temperature variation effect between the top and bottom sides of the girders / deck units.

Figure 11.12.6 - As Constructed Survey of deck units / girders



11.12.7 Deck

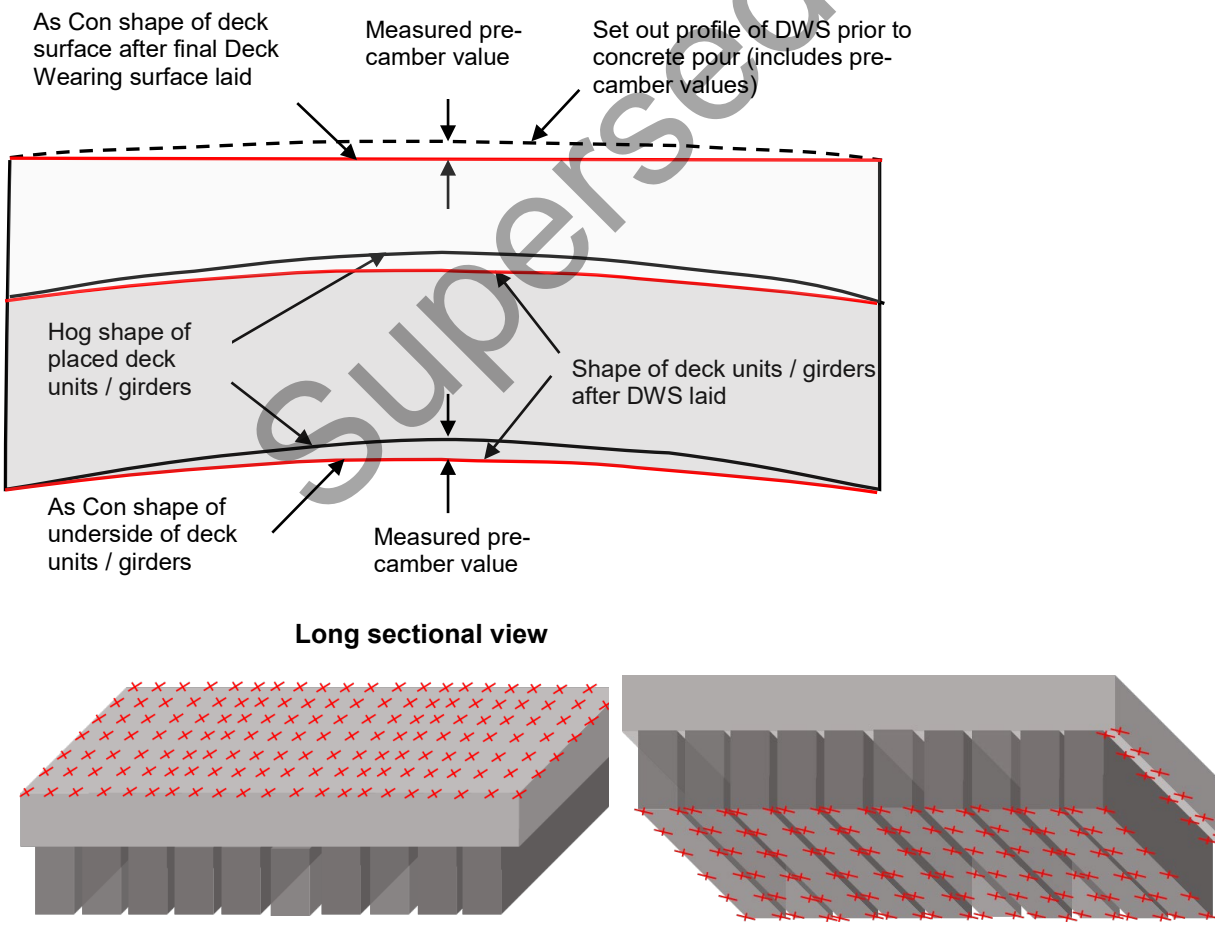
After deck Works have been completed in accordance with MRTS70 *Concrete* and MRTS77 *Bridge Deck* or associated drawings and documentation, an As Constructed Survey shall be undertaken on the top of the concrete deck slab and again on the top of the Deck Wearing Surface (DWS). Measurements should be in similar locations as measured on the girders / deck units.

If possible, carry out measurements in the same locations on the underside of girders / deck units once the concrete deck slab has been constructed. These camber measurements should be taken at the same times of day as the previous measurements prior to the deck pour. This should ensure that any height differences due to temperature variation movement on the underside of the girder / deck unit should be very minimal.

If possible, carry out same measurements on the underside of girders / deck units once the Deck Wearing Surface (DWS) has been laid.

Note: These final measurements can be used to produce a 3D electronic As Constructed Model elements for the deck units / girders.

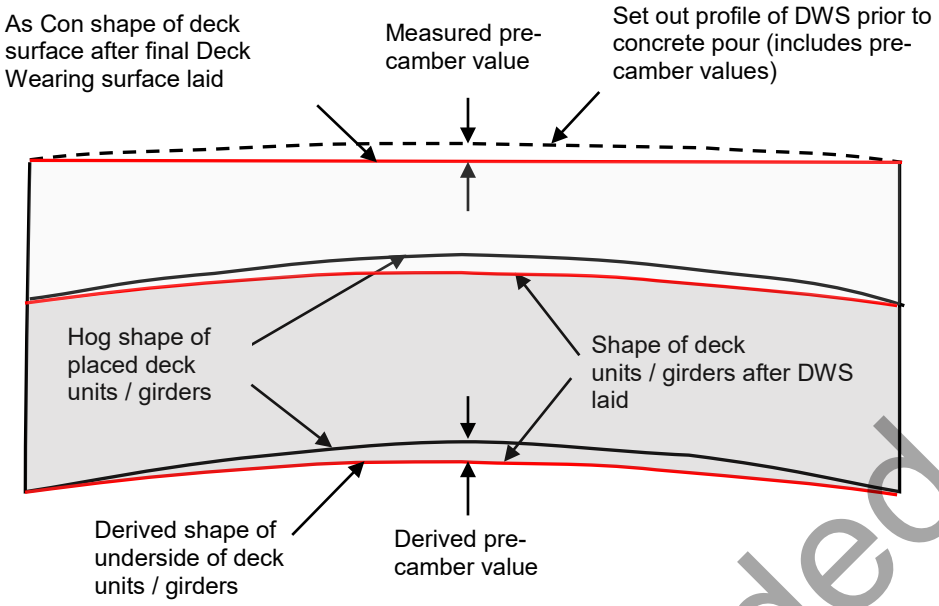
Figure 11.12.7(a) - As Constructed Survey of deck surface and underside of deck units / girders



If unable to measure the underside of the girders / deck units, calculate the pre-camber values from the differences between the set out height deck surface and As Constructed deck surface height

values. Use the same pre-camber values and dimensions of the girders / deck units to derive the underside shape of the girders / deck units.

Figure 11.12.7(b) - As Constructed Survey of deck surface only



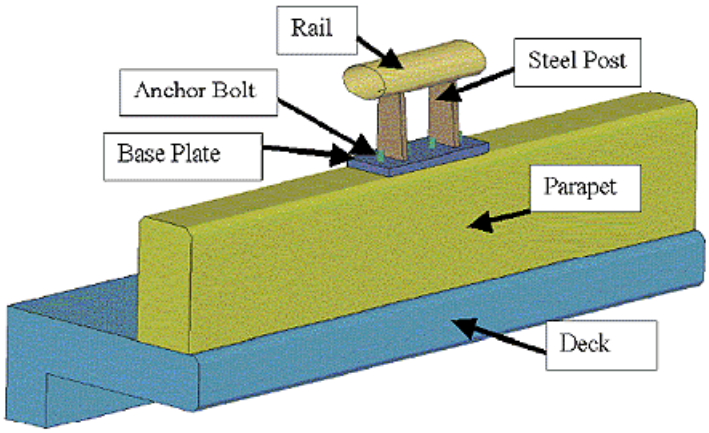
11.12.8 Kerbs, parapets and relieving slabs

After kerbs, parapets and relieving slab Works have been completed in accordance with MRTS77 *Bridge Deck* or associated drawings and documentation, an As Constructed Survey shall be undertaken. An as constructed model of the kerbs / parapets can be constructed from an As Constructed Survey.

A sufficient number of capture points along the edges of the kerb / parapet will enable the construction of a 3D electronic model for this component.

Guard rail and post detail are ancillary components of the bridge and require as constructed positional capture to meet current *TMR Surveying Standards* requirements. Unless the detail of these components is captured by a 3D Laser Scanning device, it is not a requirement to include them as part of the 3D As Constructed Survey model.

Figure 11.12.8(a) - As Constructed Survey of kerbs and parapets



An As Constructed Model of the relieving slabs can be constructed from an As Constructed Survey.

The relieving slab is usually constructed as part of road contract Works. As the relieving slab is poured insitu, an As Constructed Survey of the prepared surface is required before the concrete pour to create the underside shape of the relieving slab.

Figure 11.12.8(b) - As Constructed Survey of relieving slabs

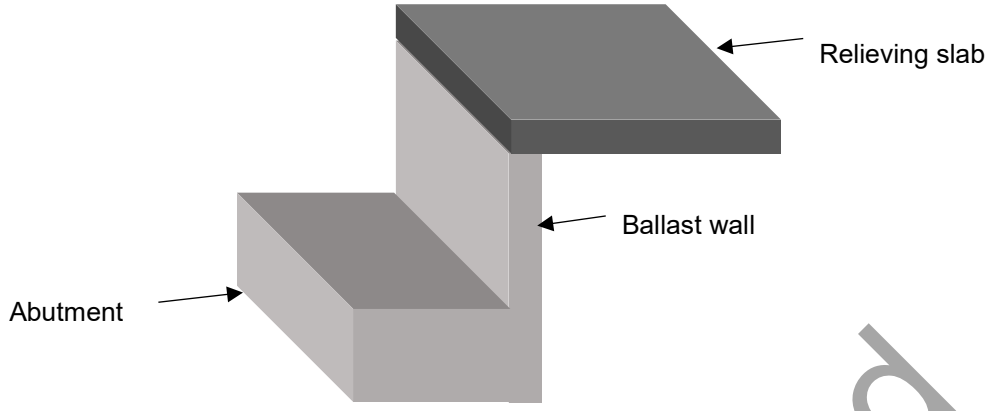


Table 11.12.8 – As Constructed Survey - Bridges

Clause	As Constructed Survey	Methodology	Accuracy Hz (mm)	Accuracy Vt (mm)
11.12.1	Piles	Perimeter at top of pile and at least one further perimeter below top of pile at sufficient length to determine verticality / rake of pile. Measure marked 1 metre section/s on pile (if marked on piles) and top of pile after final cut-off work completed	± 10	± 10
11.12.2	Pile Caps	All top edges including corners at minimum 2.5 metre intervals	± 10	± 5
11.12.3	Abutments, Columns and Headstocks	All top & bottom edges including corners at minimum 2.5 metre intervals	± 3	± 3
11.12.4	Coreholes	Centre of corehole	± 3	-
11.12.5	Pedestals / Plinths	Minimum location points at top corners Use calibrated level and staff for height on corners of pedestal / plinth	± 5	± 1
11.12.6	Deck Units / Girders	At minimum, all top edges at minimum 2.5 metre intervals along girder/headstock	± 10	± 3
11.12.7	Deck	All top edges and across deck surface at minimum 2.5 metre intervals	± 10	± 3
11.12.8	Kerbs, Parapets and Relieving Slabs	Along top edges at minimum 2.5 metre intervals	± 5	± 5

11.13 Gantries and support structures

For As Constructed Survey requirements for the base plate heights refer to MRTS61 *Gantries and Support Structures for Road Signs Tolling Systems and ITS Systems* which have detailed surveying requirements and a Hold Point.

12 Compliance / Conformance reporting results

There are no prescribed methods of how conformance results should be represented. The examples shown under this clause may be accepted by the Administrator.

Note: If 3D laser scanning techniques have been used to undertake an As Constructed Survey of the constructed objects throughout the construction process then conformance reporting results to produce heat mapping techniques using surveying and design software may be used as an additional visual tool to compare between the As Constructed Survey surface and the Design surface or creating isopach maps (contours) of the height differences (the thickness) between two surfaces.

12.1 Earthworks

Conformance reporting results to compare against the positional, height and relative tolerances for earthworks must meet the requirements in accordance with MRTS04 *General Earthworks*, associated drawings and contract documents.

12.1.1 Topsoil stripping area

After topsoil stripping Works have been completed in accordance with MRTS04 *General Earthworks* or associated drawings and documentation, the measured results for clearing limits are to be derived from the As Constructed Survey and drawings. There are no tolerance requirements for the clearing limits or prescribed methods of how the clearing limit results should be represented.

12.1.2 Bottom of excavations

After excavation Works have been completed in accordance with MRTS04 *General Earthworks* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

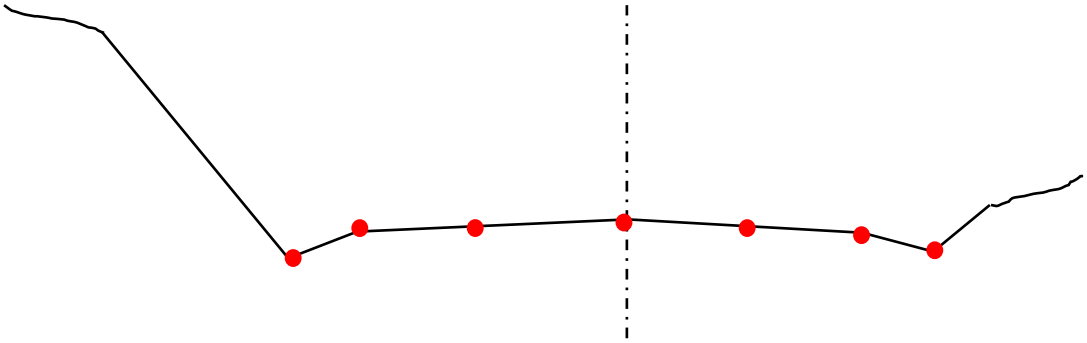
The minimum requirement is to provide conformance results for location and height of the excavated area.

An example of typical location and height conformance results can be shown in tabular form as shown in Table 12.1.2.

Table 12.1.2 - Example of typical location and height conformance results for excavated areas

Location and height conformance results from As Constructed (AsCon) survey bottom of excavation					**In tolerance** / **Out of tolerance**	
Ch	**Design O/S**	**As Con O/S**	**Diff O/S**	**Design Height**	**As Con Height**	**Height Diff**
130200	-10.000	-10.200	0.200	94.700	94.718	0.018
130200	-7.500	-7.450	-0.050	95.525	95.517	-0.008
130200	-3.750	-3.748	-0.002	95.638	95.645	0.007
130200	0.000	0.030	-0.030	95.750	95.755	0.005
130200	3.750	3.720	0.030	95.638	95.635	-0.002
130200	7.500	7.498	0.002	95.525	95.505	-0.020
130200	10.000	9.953	0.047	94.700	94.685	-0.015

Figure 12.1.2 - Typical cross section of As Constructed Survey and conformance locations for excavated area



12.1.3 Excavations for unsuitable material

After excavation Works for unsuitable material have been completed in accordance with MRTS04 *General Earthworks* or associated drawings and documentation, the conformance results for location and height are to be derived from the As Constructed Survey and associated drawings.

An example of typical location and height conformance results can be shown in tabular form as shown in Table 12.1.2.

12.1.4 Excavation areas for end structures

After excavation Works for areas for end structures have been completed in accordance with MRTS04 *General Earthworks* or associated drawings and documentation, the conformance results for location and heights are to be derived from the As Constructed Survey and associated drawings.

An example of typical location and height conformance results can be shown in tabular form as shown in Table 12.1.2.

12.1.5 Embankments prior to construction of the subgrade

After embankment Works have been completed prior to construction of the subgrade in accordance with MRTS04 *General Earthworks* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

An example of typical location and height conformance results can be shown in tabular form as shown in Table 12.2.1.

12.1.6 Stabilised subgrades

After stabilisation Works for the subgrade have been completed in accordance with MRTS04 *General Earthworks* and MRTS07A *Insitu Stabilised Subgrades using Quicklime or Hydrated Lime* or associated drawings and documentation, the conformance results for location and heights are to be derived from the As Constructed Survey and associated drawings.

An example of typical location, height and subgrade thickness conformance results can be shown in tabular form as shown in Table 12.2.1.

12.1.7 Excavation for channels and drains

After excavation Works for channels and drains have been completed in accordance with MRTS04 *General Earthworks*, MRTS03 *Drainage, Retaining Structures and Protective Treatments*

and MRTS38 *Pavement Drains* or associated drawings and documentation, the conformance results for location and height are to be derived from the As Constructed Survey and associated drawings.

An example of typical location and height conformance results can be shown in tabular form as shown in Table 12.1.2.

12.2 Pavement, pavement drains, kerb, channel and kerb and channel

Conformance reporting results to compare against the positional, dimensional and relative tolerances for pavement layers must meet the requirements in accordance with all the relevant Transport and Main Roads Technical Specification documents, associated drawings and contract documents.

12.2.1 Pavement layers

After pavement layer Works have been completed in accordance with MRTS05 *Unbound Pavements*, MRTS07B *Insitu Stabilised Pavements using Cement or Cementitious Blends*, MRTS07C *Insitu Stabilised Pavements using Foamed Bitumen*, MRTS08 *Plant-Mixed Heavily Bound (Cemented) Pavements*, MRTS09 *Plant-Mixed Pavement Layers Stabilised Using Foamed Bitumen*, MRTS10 *Plant-Mixed Lightly Bound Pavements*, MRTS30 *Asphalt Pavements* and MRTS32 *High Modulus Asphalt (EME2)* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

The minimum requirement is to provide conformance results for location, height, crossfall and pavement thickness of the constructed pavement layers.

An example of typical location, height conformance and pavement thickness results can be shown in tabular form as shown in Table 12.2.1.

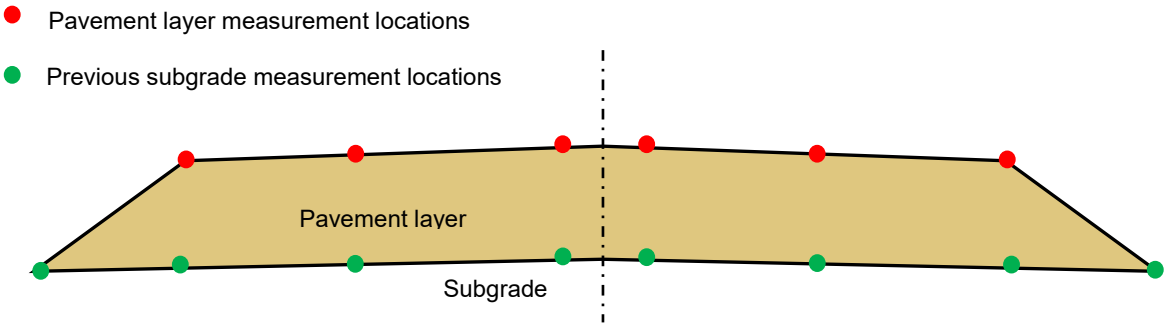
Graphical representations for turnouts intersections including roundabouts maybe more suitable.

Table 12.2.1 - Example of typical location and height conformance results for pavement layers

Location and height conformance results from As Constructed (AsCon) survey of a typical pavement layer									**In tolerance**	
									Out of tolerance	
Ch	**Design O/S**	**As Con O/S**	**Diff O/S**	**Design height**	**As Con height**	**Height diff**	**Design cross fall**	**Diff in cross fall**	**Subgrade height**	**Pavement thickness**
130200	-7.900	-7.940	0.040	94.700	94.720	0.020				
130200	-7.000	-7.050	0.050	95.000	95.011	0.011	3.00%	-	94.702	0.309
130200	-3.500	-3.450	-0.050	95.105	95.102	-0.003	3.00%	-0.47%	94.800	0.302
130200	-0.500	-0.505	0.005	95.195	95.193	-0.002	3.00%	0.09%	94.887	0.306
130200	0.500	0.550	-0.050	95.195	95.197	0.002	3.00%	-	94.899	0.298
130200	3.500	3.550	-0.050	95.105	95.102	-0.003	3.00%	-0.17%	94.803	0.299
130200	7.000	7.005	-0.005	95.000	94.997	-0.003	3.00%	-0.04%	94.699	0.298
130200	7.900	7.960	-0.060	94.700	94.68	-0.020				

Figure 12.2.1 - Typical cross section of As Constructed Survey and conformance locations for pavement layers

Measurement locations should always be taken at the same chainage and offset dimensions to ensure accurate thickness results



12.2.2 Kerb, channel and kerb and channel

After kerbs, channel and kerb and channel Works have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* the conformance results for location and tolerances are to be derived from the As Constructed Survey.

The minimum requirement is to provide conformance results for location and height kerb top or kerb lip or top of kerb and kerb lip of the constructed kerbs, channel and kerb and channel.

12.2.3 Footpath and pram crossing

After footpath and pram crossing Works have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* the conformance results for location and tolerances are to be derived from the As Constructed Survey.

The minimum requirement is to provide conformance results for location, dimensional and height of the constructed footpath and for pram crossings, the location, dimensional and the ramp gradient.

12.2.4 Pavement drains

After pavement drain Works have been completed in accordance with MRTS38 Pavement Drains the conformance results for location and tolerances are to be derived from the As Constructed Survey.

The minimum requirement is to provide conformance results for location and height of the constructed pavement drain.

12.3 Drainage

Conformance reporting results to compare against the positional and height tolerances for drainage Works must meet the requirements in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, associated drawings and contract documents.

12.3.1 Drainage systems and culverts

After installation Works for drainage systems and culverts have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

The minimum requirement is to provide conformance results for location and heights of the installed drainage.

An example of typical location and height conformance results can be shown in tabular form as shown in Table 12.3.1.

Table 12.3.1 - Typical example of location and height conformance results for a drainage system

Location and height conformance results of drainage system								In tolerance Out of tolerance	
Drain Design Chainage	**As Con Chainage**	**Chainage Diff**	**Offset**	**As Con offset**	**Design height top pipe**	**As Con height top of pipe**	**Height Diff**	**Design Gradient**	**Diff in gradient**
1.00	0.950	-0.050	0.000	0.070	10.056	10.050	-0.006		
5.00	4.950	-0.050	0.000	0.053	10.036	10.032	-0.004	-0.50%	-0.05%
15.00	15.005	0.005	0.000	0.036	9.986	9.983	-0.003	-0.50%	-0.01%
19.00	19.015	0.015	0.000	0.020	9.966	9.964	-0.002	-0.50%	-0.03%

12.3.2 Gullies

After installation Works for gullies have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

The minimum requirement is to provide conformance results for location and heights of the installed gullies.

An example of typical location and height conformance results can be shown in tabular form as shown in Table 12.3.2.

Table 12.3.2 - Typical example of location and height conformance results for gullies

Location and height conformance results of gullies										In tolerance Out of tolerance	
Road Chainage	**As Con Chainage**	**Chainage Diff**	**Offset**	**As Con offset**	**Diff**	**Design invert**	**As Con invert**	**Diff**	**Design frame Height**	**As Con fame Height**	**Diff**
10200.00	10200.085	0.085	6.850	6.808	-0.042	10.050	10.021	-0.029	10.950	10.955	0.005

12.3.3 Access chambers

After installation Works for access chambers have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

The minimum requirement is to provide conformance results for location and heights of the installed access chambers.

12.3.4 Subsoil drains

After installation Works for subsoil drains have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

12.3.5 Vertical drains

After installation Works for vertical drains have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

12.4 Subsurface footings

Conformance reporting results to compare against the positional and height tolerances for drainage Works must meet the requirements in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, MRTS63A *Piles for Ancillary Structures*, MRTS15 *Noise Fences*, MRTS92 *Traffic Signal and Road Light Footings* and associated drawings and contract documents.

12.4.1 Retaining wall pad / strip footings

Conformance reporting results to compare against the positional and heights for retaining walls must meet the tolerances in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, associated drawings and contract documents.

After installation Works have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* or associated drawings and documentation, the conformance results for location and heights are to be derived from the As Constructed Survey and associated drawings.

An example of typical location and height conformance results can be shown in tabular form as shown in Table 12.4.1(a) and (b).

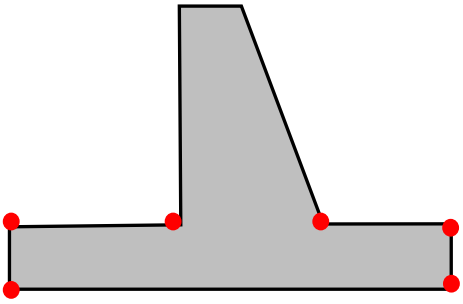
Table 12.4.1(a) - Example of typical location and height conformance results of excavated footing area

Location and height conformance results of excavated footing area					**In tolerance**	
					Out of tolerance	
Ch	**Design O/S**	**As Con O/S**	**Diff O/S**	**Design Height**	**As Con Height**	**Height Diff**
130200	-10.000	-10.004	0.004	92.050	92.058	0.008
130200	-12.000	-11.995	-0.005	92.050	92.053	0.003

Table 12.4.1(b) - Example of typical location and height conformance results of constructed footing

Location and height conformance results of footing					In tolerance Out of tolerance	
Ch	**Design O/S**	**As Con O/S**	**Diff O/S**	**Design Height**	**As Con Height**	**Height Diff**
130200	-10.000	-9.995	-0.005	92.250	92.255	0.005
130200	-10.500	-10.505	0.005	92.250	92.249	-0.001
130200	-11.500	-11.505	0.005	92.250	92.248	-0.002
130200	-12.000	-12.003	0.003	92.250	92.251	0.001

Figure 12.4.1 - Typical cross section of As Constructed Survey and conformance locations of concrete retaining wall



Cross section view

12.4.2 Ancillary structure pile footings

After installation of ancillary pile footings has been completed in accordance with MRTS63A *Piles for Ancillary Structures* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

The minimum requirement is to provide conformance results for location and heights of the installed pile footings.

12.4.3 Noise fence footings

After excavation Works and installation noise fence footings has been completed in accordance with MRTS15 Noise Fences or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

The minimum requirement is to provide conformance results for location, depth and top of the installed footings.

12.4.4 Traffic signal and road lighting footings

After excavation Works and installation of traffic signal and road lighting footings have been completed in accordance with MRTS92 *Traffic Signal and Road Lighting Footings* or associated drawings and documentation, the conformance results for tolerances are to be derived from the As Constructed Survey and associated drawings.

The minimum requirement is to provide conformance results for required location, depth and top of the installed footing.

12.4.5 Load bearing footings

After excavation Works for load bearing footings has been completed in accordance with MRTS04 *General Earthworks* or associated drawings and documentation, and installation of the load bearing footings have been completed, the conformance results for tolerances are to be derived from the As Constructed Survey and associated drawings.

The minimum requirement is to provide conformance results for required location, depth and top of the installed footing.

12.4.6 Concrete masonry / Crib wall footings

After construction of concrete masonry / crib wall footings have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* or associated drawings and documentation, the conformance results for tolerances are to be derived from the As Constructed Survey and associated drawings.

The minimum requirement is to provide conformance results for required location, depth and top of the installed footing.

12.5 Conduits and pits

After installation of the conduits have been completed in accordance with MRTS91 *Conduits and Pits* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

The minimum requirement is to provide conformance results for location requirements within allocated alignment corridors, depth of cover and below the subgrade in road crossings.

12.6 Retaining walls (above ground)

Conformance reporting results to compare against the positional and heights for retaining walls must meet the tolerances in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments*, associated drawings and contract documents.

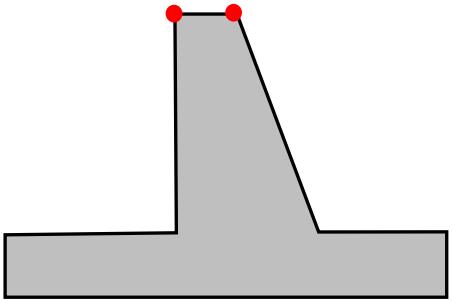
After installation Works have been completed in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* or associated drawings and documentation, the conformance results for location and heights are to be derived from the As Constructed Survey and associated drawings.

An example of typical location and height conformance results can be shown in tabular form as shown in Table 12.6.

Table 12.6 - Example of typical location and height conformance results of top of retaining wall

Location and height conformance results of top wall					**In tolerance**	
					Out of tolerance	
Ch	**Design O/S**	**As Con O/S**	**Diff O/S**	**Design Height**	**As Con Height**	**Height Diff**
130200	-11.000	-11.008	0.008	94.250	94.235	-0.015
130200	-11.500	-11.501	0.001	94.250	94.237	-0.013

Figure 12.6 - Typical cross section example of As Constructed Survey and conformance location for top of retaining wall



Cross section view

12.7 Bridges

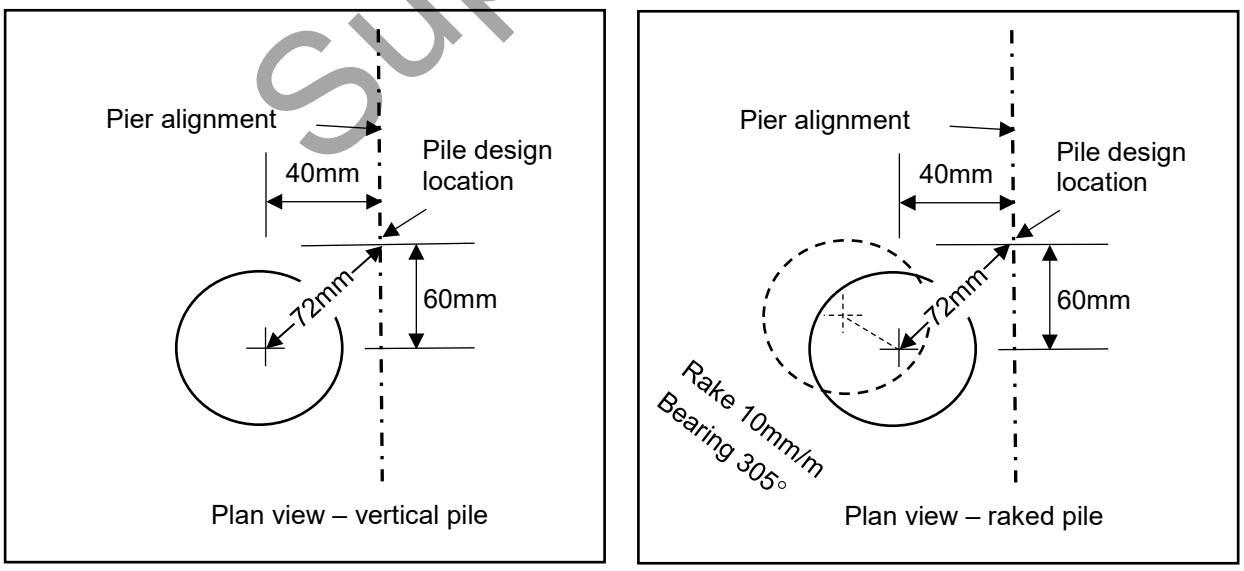
Conformance reporting results to compare against the positional, dimensional and relative tolerances for bridges must meet the requirements in accordance with all the relevant Main Roads Technical Specification documents, associated drawings and contract documents.

12.7.1 Piles

After pile Works have been completed in accordance with MRTS63 *Cast in Place Piles* or MRTS65 *Precast Prestressed Concrete Piles* or MRTS66 *Driven Steel Piles* or associated drawings and documentation, the conformance results for location are to be derived from the As Constructed Survey and associated drawings.

Conformance results can be represented by tables or graphically by calculating the vector between the pile design location coordinates and the As Constructed Survey location coordinates. And then calculating the departure offset dimensions from the bridge pier alignment. See examples in Figure 12.7.1(a) and (b).

Figure 12.7.1 - Example of As Constructed Survey and conformance results of piles



(a) (b)

12.7.2 Pile caps, pier columns, abutments and headstocks

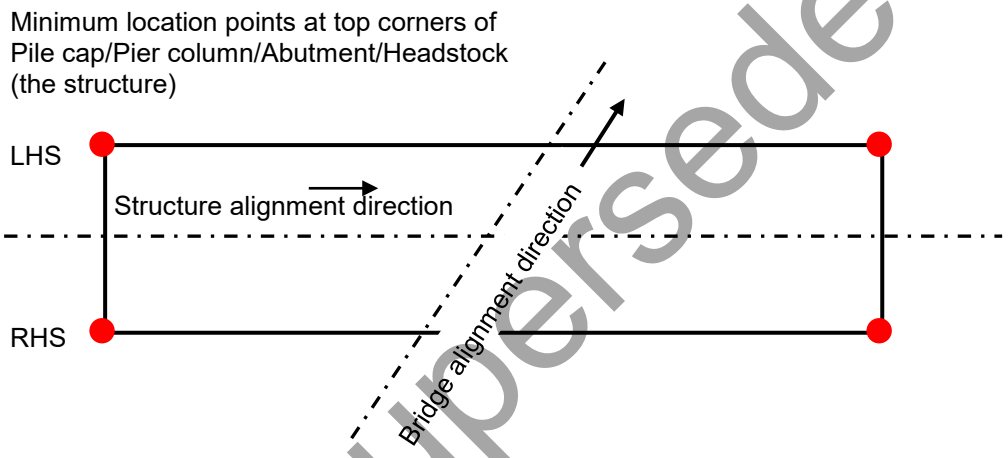
After pile caps, pier columns, abutments and headstock Works have been completed in accordance with MRTS70 *Concrete*, MRTS62 *Bridge Substructure* and MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

The minimum requirement is to provide conformance results for location, height, dimensional and linearity or planarity (shape) of the constructed elements.

For circular pier columns determine the centre of the pier from the As Constructed Survey and represent the positional location in the same manner for piles as shown in Clause 11.12.1.

12.7.2.1 Conformance positional and height location results

Figure 12.7.2.1 - Example of As Constructed Survey and conformance locations of pile caps / pier columns / abutments and headstocks



An example of typical location and height conformance results can be shown in tabular form as shown in Table 12.7.2.1.

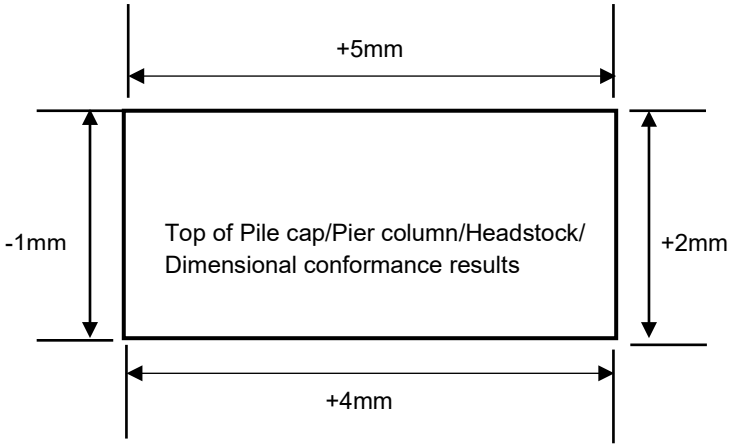
Table 12.7.2.1 - Example of typical location and height conformance results of headstock

Location and height conformance results from As Constructed (AsCon) survey (Structure chainage is in the direction as shown on the drawings and assumed to be 0.000 at intersection of structure and bridge alignments)								**In tolerance** / **Out of tolerance**	
	Design Ch	**As Con Ch**	**Ch Diff**	**Design O/S**	**AsCon O/S**	**O/S Diff**	**Design Height**	**As Con Height**	**Height Diff**
LHS	-7.500	-7.492	-0.008	-0.750	-0.746	-0.004	145.554	145.552	-0.002
	+7.500	+7.513	+0.013	-0.750	-0.746	-0.004	144.954	144.955	+0.001
RHS	-7.500	-7.496	-0.004	+0.750	+0.753	+0.003	145.554	145.553	-0.001
	Line measurement on Face			+0.750	+0.757	+0.007	145.640	145.641	+0.001
	+7.500	+7.508	+0.008	+0.750	+0.756	+0.006	144.954	144.956	+0.002

The same approach can be applied at bottom corners of the constructed element.

For compliance testing measurement, the resulting edge derived from the intersection of the adjacent projected chamfered faces is required. See Clause 11.12.2.

12.7.2.2 Conformance dimensional results



Dimensional conformance results in Table 12.7.2.2 can be derived from Table 12.7.2.1.

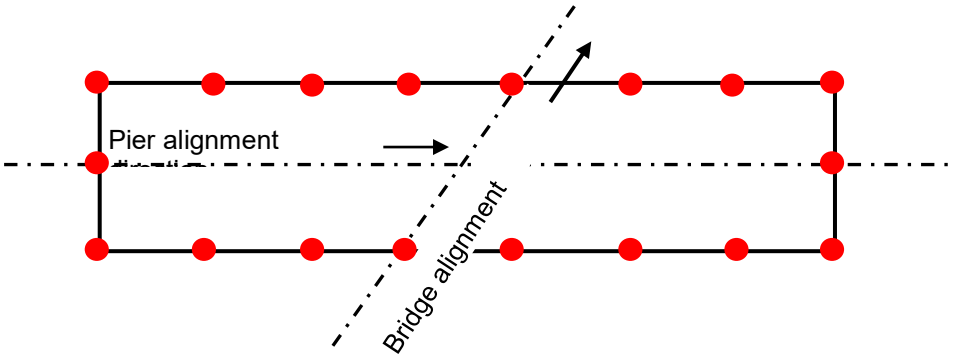
Table 12.7.2.2 - Example of dimensional conformance results of pile cap / pier column / headstock

Dimensional conformance results			In tolerance / Out of tolerance
Length dimension difference LHS pier alignment (Add Ch diff LHS)	+0.005	Width dimension difference LHS of bridge alignment (Add O/S diff between LHS and RHS)	-0.001
Length dimension difference RHS pier alignment (Add Ch diff RHS)	+0.004	Width dimension difference RHS of bridge alignment (Add O/S diff between LHS and RHS)	+0.002

12.7.2.3 Conformance linearity or planarity (shape) results

The same approach can be applied for conformance linearity or planarity results by measuring along the top / side/bottom edges of the constructed element at regular 1 – 2 metre intervals for chainage and offsets only.

Figure 12.7.2.3 - Example of linearity or planarity As Constructed Survey and conformance locations for headstock



12.7.2.4 Coreholes and fitment for prefabricated elements

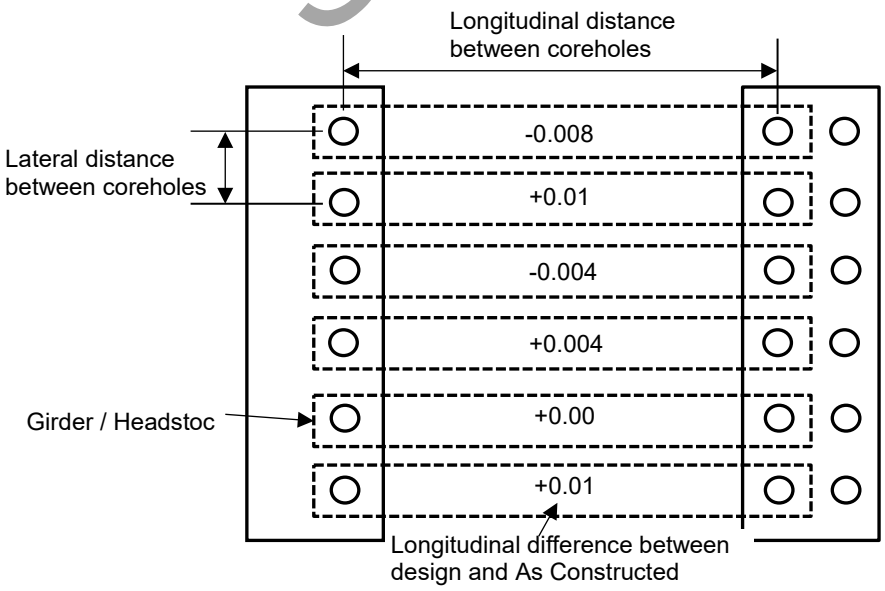
After abutments and headstock Works have been completed in accordance with MRTS70 *Concrete* or associated drawings and documentation, the conformance results for location for the coreholes are to be derived from the As Constructed Survey and associated drawings.

An example of typical location core hole and fitment for prefabricated girders / deck units conformance results can be shown in tabular form as shown in Table 12.7.2.4.

Table 12.7.2.4 - Example of typical location and fitment conformance corehole results

Location core hole conformance results (Pier chainage is 0.000 at intersection of pier and bridge alignments and in the direction as shown on the drawings)											
									In tolerance		
									Out of tolerance		
	Core hole No.	**Design Ch**	**As Con Ch**	**Ch Diff**	**Design O/S**	**As Con O/S**	**O/S Diff**	**Core hole No's.**	**Lateral Diff**	**Core hole No's.**	**Long Diff**
LHS Pier 1	1	-2.500	-2.507	+.0.007	-0.350	-0.345	-0.005				
	2	-1.500	-1.503	+0.003	-0.350	-0.352	+0.002	1-2	-0.002		
	3	-0.500	-0.495	-0.005	-0.350	-0.354	-0.006	2-3	-0.004		
	4	+0.500	+0.506	+0.006	-0.350	-0.357	+0.007	3-4	+0.001		
	5	+1.500	+1.501	+0.001	-0.350	-0.345	-0.005	4-5	+0.002		
	6	+2.500	+2.506	+0.006	-0.350	-0.356	+0.006	5-6	+0.001		
RHS Pier 2	7	-2.500	-2.493	-0.007	+0.350	+0.347	-0.003			1-7	-0.008
	8	-1.500	-1.505	+0.005	+0.350	+0.358	+0.008	7-8	+0.005	2-8	+0.010
	9	-0.500	-0.495	-0.005	+0.350	+0.352	+0.002	8-9	+0.010	3-9	-0.004
	10	+0.500	+0.498	-0.002	+0.350	+0.347	-0.003	9-10	-0.001	4-10	+0.004
	11	+1.500	+1.502	+0.002	+0.350	+0.356	+0.006	10-11	+0.003	5-11	+0.001
	12	+2.500	+2.498	+0.002	+0.350	+0.354	+0.004	11-12	+0.010	6-12	+0.010

Figure 12.7.2.4 - Example of fitment conformance results of coreholes between abutment / headstock to headstock



12.7.3 Bearing pedestals / plinths

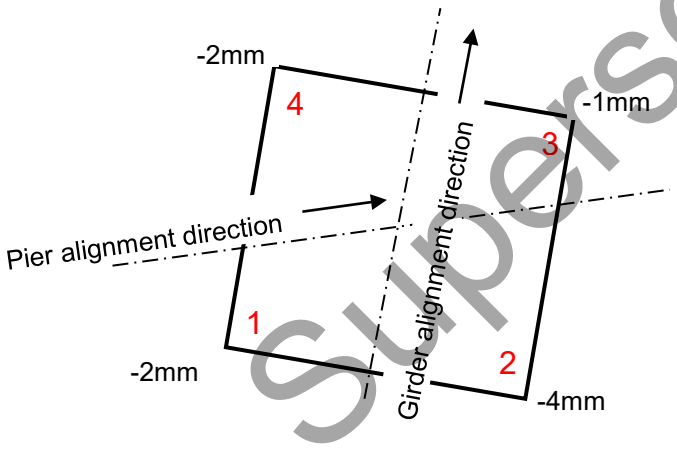
After bearing pedestal / plinth Works have been completed in accordance with MRTS70 *Concrete* and MRTS62 *Bridge Substructure* or associated drawings and documentation, the conformance results for location and dimensional requirements bearing pedestals / plinths are to be derived from the As Constructed Survey and associated drawings.

Heights measured by level and staff at the corners of the pedestal / plinth can be tabulated as shown in Table 12.7.3 and shown graphically in Figure 12.7.3.

Table 12.7.3 - Example of typical height conformance results of bearing pedestal

Height of Bearing Pedestal Surface			In tolerance	
			Out of tolerance	
	Point #	**Design Height**	**As Constructed Height**	**Height Differences**
Pedestal 1	1	146.372	146.370	-0.002
	2	146.372	146.368	-0.004
	3	146.400	146.399	-0.001
	4	146.400	146.398	-0.002

Figure 12.7.3 - Example of conformance results of bearing pedestal / plinth



Top surface Bearing pedestal / plinth

12.7.4 Girders / deck units

After placement girders / deck units have been completed in accordance with MRTS70 *Concrete* and MRTS73 *Manufacture of Prestressed Concrete Members and Stressing Units* or associated drawings and documentation, the conformance results for location and tolerances are to be derived from the As Constructed Survey and associated drawings.

12.7.4.1 Conformance positional and height location results

Apply the same methods as in Clause 12.7.2.1.

12.7.4.2 Hog conformance results

Apply the same methods as in Clause 12.7.2.1 only this time, along the top and bottom edges of the girders/deck units at regular 1 – 2 metre intervals.

12.7.4.3 Conformance dimensional results

Apply the same methods as in Clause 12.7.2.2.

12.7.5 Deck

After deck Works have been completed in accordance with MRTS70 *Concrete*, MRTS77 *Bridge Deck* and MRTS84 *Deck Wearing Surface* or associated drawings and documentation, the conformance results for location, finished surface level and deck thickness can be derived from the As Constructed Survey and associated drawings.

An example of Conformance results for a bridge deck with a concrete deck wearing surface (DWS) can be tabulated as shown in Table 12.7.5.

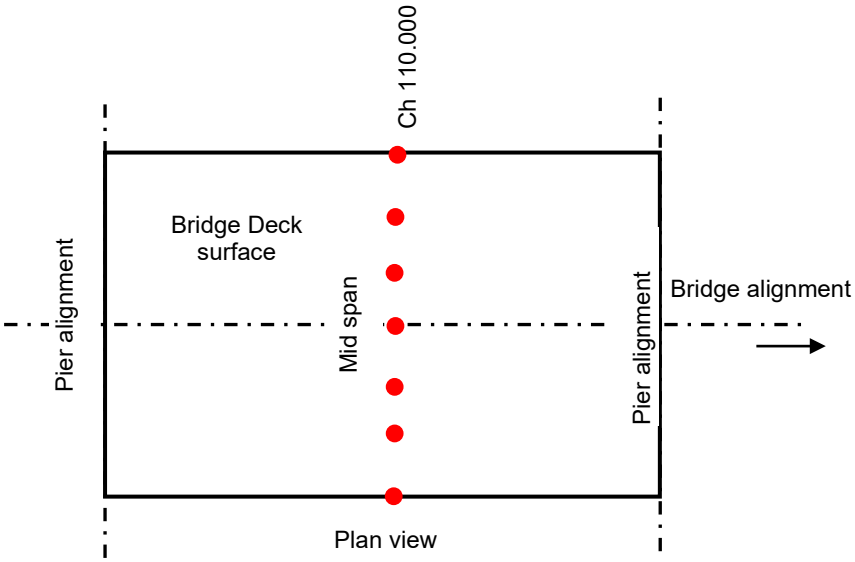
Note: If measured, use the As Constructed Survey values of the bottom of girders / deck units after concrete pour to measure actual pre-camber values, otherwise use the derived pre-camber values from the difference between the set out Final Surface Level (FSL) and the As Constructed Survey of the final deck surface. See Clause 11.2.7.

Table 12.7.5 - Example of typical As Constructed Survey conformance results of a bridge deck

As Constructed Survey of final surface of Bridge Deck							In tolerance Out of tolerance	
Ch	**O/S**	**Design FSL**	**As Con FSL**	**Diff. (Design FSL – As Con FSL**	**As Con top of girder (pre deck pour)**	**Derived pre-camber Values**	**As Con top of girder less pre-camber values**	**Deck thickness**
110.301	-3.515	146.701	146.702	0.001	146.498	0.006	146.489	0.210
110.306	-2.349	146.654	146.650	-0.004	146.462	0.006	146.445	0.194
110.304	-1.178	146.607	146.608	0.001	146.405	0.006	146.393	0.209
110.299	0.015	146.560	146.554	-0.006	146.356	0.006	146.350	0.204
110.307	1.185	146.513	146.512	-0.001	146.306	0.006	146.293	0.212
110.306	2.395	146.466	146.468	0.002	146.260	0.006	146.252	0.214
110.304	3.515	146.419	146.415	-0.004	146.213	0.006	146.207	0.208

Tolerance relaxed for bituminous deck wearing surface (DWS) to ± 20 mm provided that the deck thickness limitations and minimum concrete cover are maintained as specified in MRTS77 *Bridge Deck.*

Figure 12.7.5 - Example of typical plan view of As Constructed Survey and conformance locations across the mid-span of a bridge deck



13 Existing underground assets survey

In the event where any existing underground assets that may be fully or partly exposed during confined excavation Works that have been undertaken in accordance with MRTS04 *General Earthworks*, no backfilling of the excavated area shall be undertaken until the surveying requirements have been met and notice of such Works provided to the Administrator. **Hold Point 30**

Trenching Works for MRTS91 *Conduits and Pits*, MRTS03 *Drainage, Retaining Structures and Protective Treatments.*

Table 13 – Existing underground assets

Clause	Existing Assets Survey	Methodology (includes using appropriate codes as per the TMR Surveying Standards – Schedule 1)	Accuracy Hz & Vt (mm)
13	Survey any existing underground assets partly or fully exposed during construction	As prescribed in Underground Assets in the *TMR Surveying Standards, Part 2*	± 10

14 Volume surveys

14.1 Constructed feature volume

Where volumes (cut or fill) is required of a constructed feature (for example, embankment and pavement layers), use the 'TIN to TIN' method using the As Constructed models and/or other methods using the As Constructed models (for example, trimeshes).

14.2 Stockpile volume

Surveys to calculate a stockpile volume shall be undertaken by methods and equipment that enable the accuracy requirements stated in Section 1.3.1.4 Accuracies for 'Other' feature points to be met (see Volume Survey - *TMR Surveying Standards*).

15 Deliverables

Prior to the Date of Practical Completion, the Contractor must submit to the Administrator and emailed copies to TMR_Spatial_Enquiry@tmr.qld.gov.au:

- the Survey Control Register; as specified in Section 6.4.2 of the *TMR Surveying Standards, Part 2*
- a current Form 6 that includes a locality sketch and details for any new Permanent Mark that may have been placed. Form 6 may be found at: https://www.business.qld.gov.au/industries/building-property-development/titles-property-surveying/surveying/standards-forms
- Conformance and all As Constructed Survey information including an As Constructed Survey Model as specified in MRTS50 *Specific Quality System Requirements* **Witness Point 4**
- signed Surveyor Certification for work under the Contract.

Survey information in electronic format shall be provided in 12D TMRarchive file format using the current *TMR Surveying Standards*.

Large email attachments can be sent via a file hosting service such as OneDrive, Dropbox and so on.