GOVERNMENT OF WESTERN AUSTRALIA

Landgate

Landgate Requirements for Maintenance, Validation & Refurbishment of Geodetic Marks

GSU-04

Locate Value Secure

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Document control

Landgate Requirements for Maintenance, Validation & Refurbishment of Geodetic Survey Marks

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Sept 2025	Khandu	3	Changed of title from GSU 02 - Landgate requirements for refurbishment of geodetic marks to Landgate requirements for maintenance, validation & refurbishment of geodetic marks
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	Survey	1.0	Initial

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1. Purpose

The purpose of this document is to provide a standard for inspection & maintenance, validation and refurbishment of Geodetic Survey Marks in Western Australia (WA), serving as a reference guideline for all Landgate-contracted geodetic mark maintenance activities and those undertaken by third-party organisations or individuals.

As a Land Information Authority, Landgate manages the WA's geodetic infrastructure to provide an accurate and a reliable geodetic system for all users. Geodetic Survey Marks consists of the Standard Survey Marks (SSMs), Bench Marks (BMs), and the supporting Reference Marks (RMs). These marks are regularly inspected and maintained after its establishment to ensure accuracy, long-term stability, and usability.

2. Definitions and abbreviations

Abbreviation	Definition
ASCII	American Standard Code for Information Interchange
BM	Bench Mark
EDM	Electronic Distance Measurement
GNSS	Global Navigation Satellite Systems
Mark	Primary Mark or Reference Mark
Primary Mark	SSM or BM
RM	Reference Mark
RO	Reference Object
RTK	Real Time Kinematic
SIP	Star Iron Picket
SSM	Standard Survey Mark
VRS	Virtual Reference Station

3. Mark maintenance

3.1. General instructions

3.1.1 Physical maintenance of a SSM or BM involves the following tasks.

- checking the physical condition of the mark, including the hatch and lids,
- locating all the existing RMs that can be easily found **without** excavating or digging the ground surface,

- recording SSMs, BMs or RMs as destroyed if they are believed to be under valuable improvements (e.g., building, roads, driveways, footpaths),
- checking for the witness plate, if any,
- updating the access/location sketch, if the surroundings have significantly changed.

5.2.1 As a minimum, vegetation and soil should be removed from the lid and surround. Suitable gloves must be worn when lifting the hatch cover or lid and when removing soil or vegetation to avoid contact with sharp objects, insects, spiders or reptiles. See related examples in **Appendix D.**

3.1.2 The results of the field check must be annotated on a Station Summary or a **Redline Markup** (see example in **Appendix A**). Available photographic evidence should also be provided to support the findings.

3.1.3 The following table describes the aspects of field inspection and recommended maintenance actions:

Mark Type	Elements of inspection	Recommended Actions
Primary Marks (SSM or BM)	**1. Physical status**	
	a) **located** – found in good condition.	See **Clause 3.1.1** to **3.1.3**
	b) **damaged** – found visibly damaged (e.g., bent, broken concrete pillar)	Mark as **damaged**, if it can be refurbished. See **Section 5**.
	c) **destroyed** – found damaged beyond repair or completed removed and no longer exists.	Mark as **destroyed**, if it cannot be refurbished and *safely dispose of the remains*.
	d) **not located** – not found after extensive search	Marks that cannot be found after a reasonable effort can be marked as destroyed**.**
	2. Stamp	Is the **stamping correct**? If **not**, record it.
	3. BM horizontal accuracy	Update the horizontal accuracy and survey method, if existing horizontal accuracy is greater than 2.5 m.
	4. Hatch cover	Is the hatch or hatch cover or lid damaged? Is it missing? Replace it, if possible and dispose of safely.
		Is the hatch or hatch cover made from **asbestos**? If yes, contact Landgate.
	5. Witness plate (WP)	Is the WP damaged or missing? Replace it and dispose of safely.
	6. Access diagram	Has the **access** changed significantly? If yes, draw a new sketch.

Reference Marks (RM)	**Physical status** Same as above	**Note –** *There is no requirement to excavate the ground to locate a RM but every effort must be made to search for those on the surface (e.g., spikes in bitumen, nail on concrete pavements or walls).*
		Mark as **located**, only it its visually found.
		Mark as **damaged**, if it can be refurbished.
		Mark as **destroyed**, if it cannot be refurbished and *safely dispose of the remains*.
		Mark as **destroyed**, if it's believed to be *under buildings, footpaths, road pavements*.

Note - *There is no requirement to replace a mark that is destroyed.*

3.2. Damaged or missing WPs

3.2.1 Dispose of the damaged Witness Plates (WPs) and star iron picket (SIP) supporting the WP, if found damaged beyond repair. In most cases, the SIP or the supporting material (e.g., fence) does not need to be replaced. Landgate **does not recommend** placing WPs on power poles.

3.2.2 Missing or damaged WPs should be replaced, where applicable. WP's can be obtained from Landgate. In remote areas, the WP should be attached to a SIP and stamped with an azimuth and distance to the primary mark.

3.2.3 In built-up areas, a broad arrow pointing to the mark can be painted on a kerb or road in yellow colour (see **Appendix D**). Size of the lettering should not exceed 0.1 m.

4. Mark validation

4.1. General guidelines

4.1.1 Standard Survey Marks (SSMs) and Bench Marks (BMs) used must be validated from their existing Reference Marks (RMs) prior to commencing a **Geodetic Survey**. The same requirement applies to other forms of Surveying that rely on the established geodetic infrastructure in Western Australia, including cadastral connections, engineering and construction, among others.

4.1.2 The results of the validation should be annotated on the Station Summary or Redline Markup and recorded in a (digital) fieldbook.

4.1.3 Search and locate all the existing RMs associated with the Primary Mark. A metal detector may be used to locate the RMs. Note that some RMs may be nonferrous or situated near strong magnetic sources, and alternative techniques must be used to locate them.

4.1.4 Once the RMs are located, observe the ***horizontal distances*** and ***height differences*** from the Primary Mark to each of the RMs and in between the RMs.

4.1.5 For SSMs, observe the ***angles*** between the RMs or ***directions*** to each RM to verify the observed distances between the RMs. *As a check, the observed distance between RMs should agree within 5 mm of horizontal distance calculated from observed angles/directions and distances from the Primary Mark*.

4.1.6 For BMs, observe and verify the magnetic bearing to the RMs.

4.1.7 Observe the height differences from the Primary Mark to the top of the Hatch Cover and/or Ground Level as well as the height difference from the RMs to the Ground Level.

4.1.8 **Any updates or corrections must be annotated on the existing Station Summary or Redline Markup to ensure that the information reflects the current conditions.** See example in **Appendix B**.

4.1.9 If none of the RMs are located, the following alternative methods must be used:

a) For horizontal validation, nearby SSM(s) can be used or included in the Survey. Alternative SSMs used must also be validated from its RMs to confirm horizontal reliability.

b) Vertical validation can be achieved by differential levelling to a nearby BM or a SSM with a required vertical accuracy. The BM or SSM shall be validated from its RMs to confirm vertical reliability.

4.2. Horizontal

4.2.1 The horizontal distance can be measured by using an offset tape and a traditional plumb bob or an EDM instrument.

4.2.2 If an EDM instrument is used, ensure that the instrument has a current calibration certificate.

4.2.3 If a Total Station is used, only a high precision prism (2mm or better at steep vertical angles) installed on (preferably) a mini pole should be used.

4.2.4 GNSS methods are not recommended for validating a SSM or a BM from their RMs. See more information in ***GSU-03 – Landgate Requirements for Geodetic Surveys by Differential Levelling***.

4.2.5 Where the observed horizontal distance from a SSM to the RM(s) exceeds by 10 mm from the original value, the new measurement(s) must be verified again to eliminate any gross errors.

4.2.6 If any of the RMs have moved horizontally, a new azimuth must be calculated by using the azimuth of a stable RM and the angles/directions observed to the moved RM(s). An average azimuth should be obtained if there are two or more stable RMs.

4.2.7 If all the RMs are found to have moved horizontally, a new azimuth must be established by connecting to an adjacent SSM or a nearby GNSS-based reference object (RO).

4.2.8 It is also possible that the SSM may have moved horizontally relative to the RMs. Refer to **GSU-06 – Landgate Guidelines for Dealing with Disturbed Geodetic Survey Marks** for more information on how to identify and treat disturbed Geodetic Survey Marks.

4.3. Vertical

4.3.1 The height differences to the RMs shall be measured using a digital or optical level with measured height differences stated to the nearest 1 mm.

4.3.2 Total Station can also be used to determine height differences provided survey methodology meets the required accuracy (as a minimum, observations should be taken on both faces of the instrument).

4.3.3 Where the observed height difference from a Primary Mark to the RM(s) exceed by 10 mm from the original value, the new measurement(s) must be verified again to eliminate any gross errors.

4.3.4 If the observed height differences to all or majority of the RMs are more than 10 mm and shows inconsistent physical movement (i.e., random plus/minus sign), the Primary Mark must be checked levelled to the next available SSM/BM of same vertical accuracy.

4.3.5 It is also possible that the Primary Mark may have moved vertically relative to the RMs. Refer to ***GSU-06 – Landgate Guidelines for Dealing with Disturbed Geodetic Survey Marks***.

4.4. Missing RMs

4.4.1 As a minimum requirement, each SSM should have three (3) RMs separated approximately 120° from each other at a distance of 3-5 m from the SSM.

4.4.2 If the required minimum number of RMs are not located or found, additional RM(s) should be installed to meet the required standard. See requirements in **GSU-01 – *Landgate Requirements for Placement of Geodetic Survey Marks***.

4.4.3 Installing a new RM in the same location as the missing or destroyed one may cause stability issues. Thus, it is preferable to establish the new RM(s) in a new location to provide greater longevity.

4.4.4 The naming (numbering) of new RM(s) should continue sequentially and clockwise from the highest RM number provided in the station report.

4.4.5 In case, a complete set of new RMs are installed, the lowest name (number) should be assigned to the first RM clockwise from north when standing on the SSM.

4.4.6 A BM should have a minimum requirement of two (2) RMs.

4.4.7 If the required minimum number of RMs are not located or found, additional RM(s) should be installed to meet the required standard. See requirements in ***GSU-01 – Landgate Requirements for Placement of Geodetic Survey Marks***.

4.4.8 The height differences should be measured using digital or optical levels with measured height differences stated to the nearest 1 mm.

5. Mark refurbishment

5.1. General guidelines

5.2.1 A quick physical maintenance must be carried out as per **Section 3** of this document or at least reported to Landgate before using a Geodetic Survey Mark.

5.2.2 Further refurbishments may be required for the following:

- Damaged/bent top of the Primary Mark
- Damaged or missing hatch and/or hatch cover or lid
- Mark buried under ground surface
- Damaged or missing RMs

5.2.3 Refer to related examples in **Appendix D.**

Note – *To ensure public safety, Primary Marks and/or RMs found damaged beyond repair must be disposed of appropriately. Damaged hatch surrounds, hatch covers or lids, and WPs can also be disposed of, if found beyond repair.*

5.2. Damaged/bent top of the Primary Mark

5.2.4 Marks with damaged concrete or precast concrete should be repaired.

5.2.5 Damaged or bent tops should be repaired or straightened to ensure that centre of the mark can be clearly defined.

5.2.6 Once repaired, a new round of measurements (see, Section 4) should be carried out and recorded. **If no existing RMs are available, contact Landgate for further advice.**

5.3. Damaged or missing hatch

5.3.1 Dispose of the damaged hatch surround, hatch cover and lid, if found damaged beyond repair.

5.3.2 When installing a new surround care should be taken to ensure the Primary Mark is not disturbed. There must be a physical separation between the primary mark and the hatch surround (see ***GSU-01 – Landgate Requirements for Placement of Geodetic Survey Marks*** for details).

5.3.3 To ensure that the Primary Mark is not disturbed during installation or repair, the mark must be validated once again according to Section 4.

5.4. Marks buried under ground surface

5.4.1 Hatch covers found 0.1 m or more below the ground surface should be raised flush, if practical.

5.5. Damaged or missing RMs

5.5.1 Dispose of the damaged RM, if found damaged beyond repair.

5.5.2 If a damaged RM can be repaired (or straightened), a new round of measurements must be carried out after repairing it as per **Section 4**.

6. Entry onto Land

6.1.1 Maintaining good public relations is vital and essential to Landgate. Where entry onto private or leasehold land or vested reserves is required to access Geodetic Survey Marks, contact must be made with the relevant owner, occupier, or authority prior to entry.

6.1.2 Entry onto land is governed by the *Standard Survey Marks Act 1924*.

6.1.3 Geodetic marks located in **restricted areas** such as Rail Reserves, Airport Airside, Port restricted and Military installations will require access permission from the relevant authority before entry. These areas may be controlled by statutory legislation and the process of obtaining entry can make visiting a mark impractical or impossible.

7. Handling asbestos

7.1.1 Some hatch surrounds were historically constructed using asbestos materials. While Landgate has made efforts to identify and document them, there may still be marks with asbestos-containing surrounds that have not been recorded.

7.1.2 If a hatch surround is suspected to contain asbestos and is not listed on the Landgate information sheet, it must be reported to Landgate immediately. Refer to **OSH-01K Asbestos in Geodetic Survey Mark Hatch Cover Surrounds** for more information about handling asbestos.

7.1.3 Notify Landgate via email at geodesy@landgate.wa.gov.au or by phone on (08) 9273 7111 if an asbestos-containing hatch surround is found to be damaged, weathered, or otherwise degraded.

8. Documentation and reporting

8.1. Redline markups

8.1.1 The physical inspection and validation results and new installations and measurements should be recorded clearly for each mark on the **Redline Markup** (see **Appendix A** and **Appendix B**).

8.1.2 Scanned **colour** copies of redline markups shall be supplied in pdf format. If there are more than one mark, it is recommended to compile into a single pdf document in the in alphabetical order of Mark Name.

8.2. Digital records

8.2.1 If electronic instruments were used to record the observations, they should be converted into a readable ASCII file/s to support the Redline Markups. The ASCII file/s must be checked to ensure that correct station name (as per station summary), target name, instrument height, prism height, prism type, etc) are provided.

8.2.2 Where possible, reduce slope distances to horizontal and vertical distances.

8.3. Access sketch

8.3.1 Where new reference mark(s) have been installed, a sketch of the RM array showing all the observations and validations including numbering of RMs, depth and type of RM shall be provided. A readable PDF scan of a field book is acceptable. It can also be recorded on the Redline Markup.

8.3.2 The position and distances to the new RMs with respect to nearby features such as kerbs, power poles, footpaths etc. should be captured and provided to easily locate a RM in the future.

8.4. Drafting of station summaries

8.4.1 For Landgate-related works, a Station Summary template can be supplied along with all existing CAD drawing files of the marks, if they exist. For all other works, the template can be provided on request.

8.4.2 For marks that require a summary amendment and do not have an existing CAD drawing, a new drawing will need to be drafted using the supplied template.

8.4.3 AutoCAD® DWG™ is the preferred format. Any other format requires approval by Landgate prior to use. See requirements in ***GSU-07 – Landgate Specifications for Drafting Geodetic Survey Mark Station Summaries***.

8.4.4 Amend any existing station summary or create a new one where RMs have been placed or dimensions, access, location, or recovery features have significantly changed.

8.4.5 Refer to ***GSU-06 – Landgate Guidelines for Dealing with Disturbed Geodetic Survey Marks*** to determine if new measurements to existing marks are to be adopted or to retain the original value.

8.5. Mark status updates

8.5.1 Mark status for all marks must be updated online using Map Viewer Plus. To be able to submit an update the user must have an active SLIP account. If you do not have a SLIP account, the user guide can be found here on how to create one. You will also need access to ***Geodetic Online***, which you can request it once you have a SLIP account by logging in and using the ***Request Private Access***.

8.6. Height difference reductions

8.6.1 Height differences shall be reduced on the Landgate excel spreadsheet ***GSU-03A – Abstract for Class C Levelling*** (*Levelling abstractv3.xlsm*). Enable editing and macros when prompted so that it can populate the required information from the geodetic database via SLIP (account required). See the Landgate Standards and Guidelines page for information and samples of input data. **All levelling is to be reduced into one only excel abstract file**. Additional sheets can be added to the excel file for clarity or to separate areas.

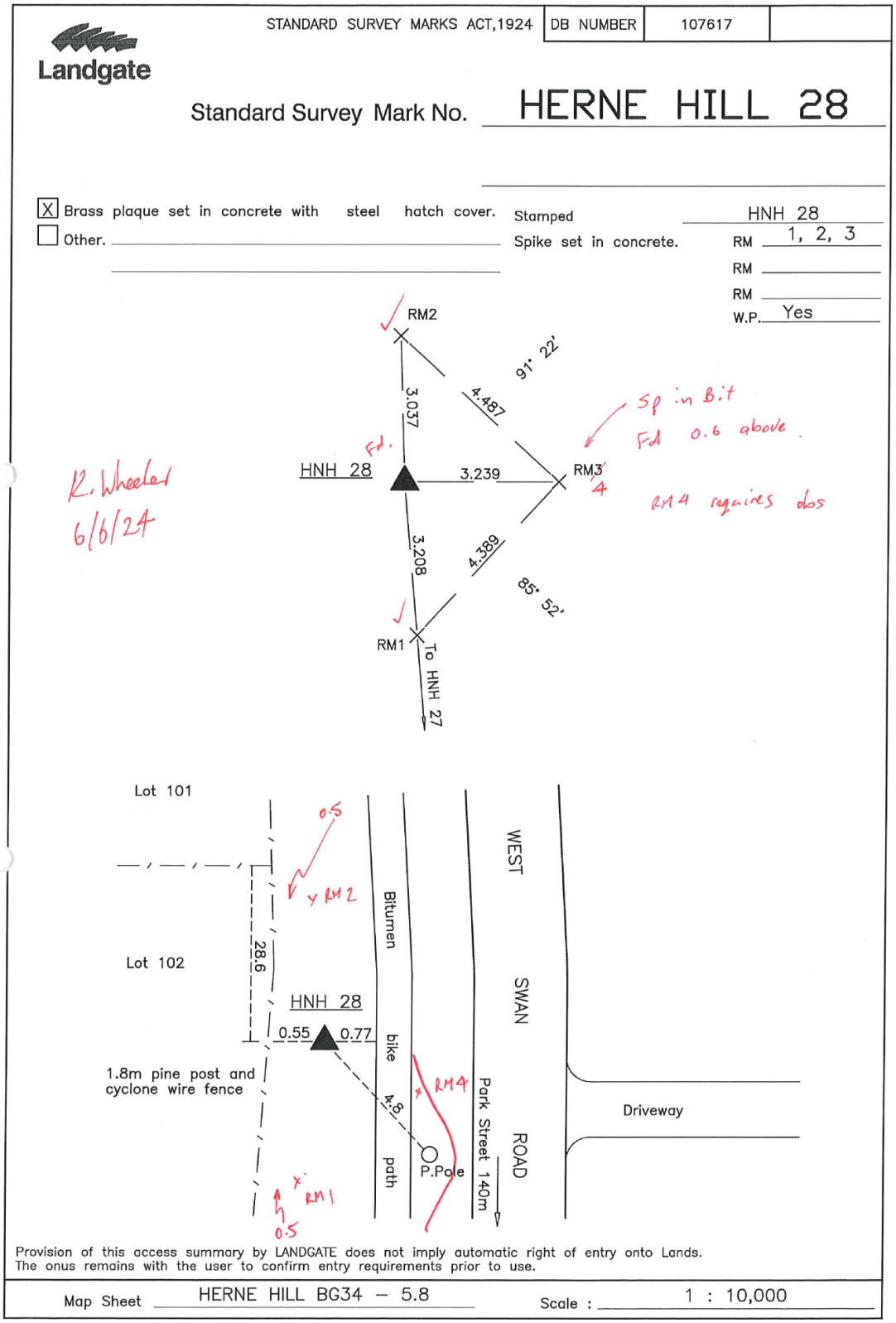
8.6.2 All RM check levels are to be shown in the abstract and reduced per the example in the abstract (see example in **Appendix C**).

8.7. Reporting

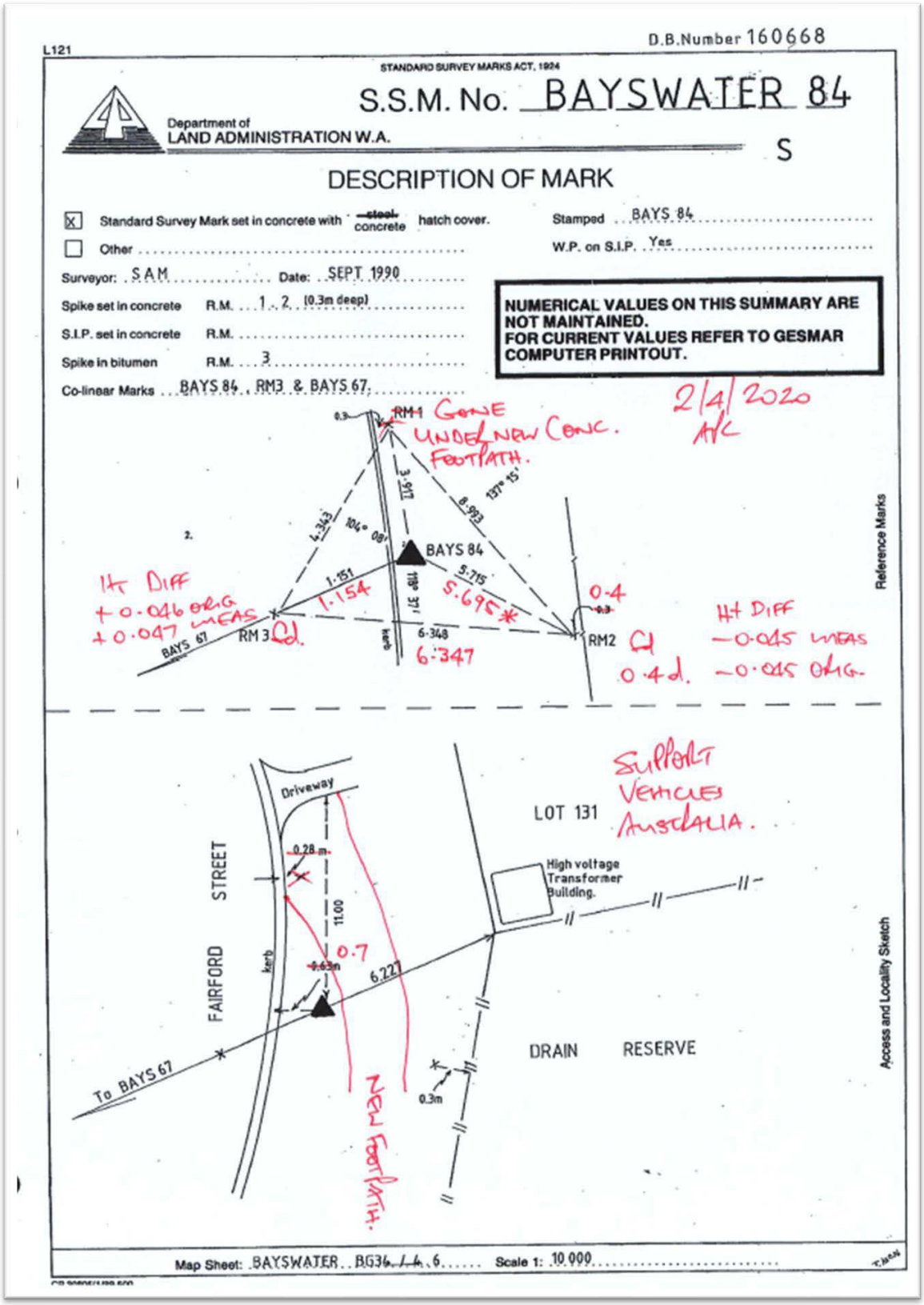
8.7.1 A short report of the findings or maintenance conducted at each mark shall be included in a common digital format such as Microsoft Word document or PDF, including any photographs of before and after the maintenance.

8.7.2 The images should be named and ideally taken with a device that provides geographical location embedded in the image. Images can be reduced to a size that still shows relevant detail. Images shall be supplied in JPG format.

9. Appendix A – Redline Markup (Inspection of SSM/BM)



10. Appendix B – Redline Markup (Mark validation)



11. Appendix C – Measurement variations

SURVEYOR T. Lloyd				ABSTRACT OF CLASS C LEVELLING					Calculation File E20232250		Import							
Level Book No. E20232250				Job No. JN20232250 - Busselton Mark Maintenance Contr					Computer B. Hellmund/Khandu		Update	GES						
Date of Survey 16 Dec 2024				Staff No. 1.000000 0.000010			Inst. No. STP(°C) = 25		Date 04 Feb 2025		Update							
	Distance	From BM	To RM	Total Distance	Difference in Elevation Forward	Calibrated Mean	Difference (Allow 0.010)	Elevation Above AHD Original Diff.	BM	Adjusted	Remarks	Meas Dist	Meas Az	Orig Dist	Orig Az	Meas Dir	Dist Diff(m)	Az Diff(m)
	km			From														
									BUS 94		New Summary	RO	13 22 50.14			0 00 00		
		BUS 94	RM 1		0.020		~~-0.012~~	0.032	RM 1			~~1.002~~	319 27 43.14	1.000	~~304 0 0~~	306 04 53	0.002	0.277
			RM 2		-0.050		-0.002	-0.048	RM 2			~~1.000~~	222 27 11.14	1.000	~~209 0 0~~	209 04 21	0.000	0.239
			RM 3		0.555				RM 3		New RM (Dsp)	6.044	85 48 46.14			72 25 56		
									BUS 160A		New Summary	RO	64 54 29.87			0 00 00		
		BUS 160A	RM 4		0.237		-0.004	0.241	RM 4			3.268	0 49 27.87	~~3.281~~	~~1 12 34~~	295 54 58	-0.013	-0.022
			RM 5		-0.171		0.000	-0.171	RM 5			~~2.220~~	~~139 31 08.87~~	2.219	139 33 34	74 36 39	0.001	-0.002
			RM 6		0.399		0.004	0.395	RM 6			~~2.596~~	~~277 25 33.87~~	2.598	277 23 34	212 31 04	-0.002	0.002
			RM 7		0.105				RM 7		New RM (Dsp)	4.171	8 12 53.87			303 18 24		
			RM 8		0.080				RM 8		New RM (Sp)	4.179	227 45 48.87			162 51 19		
									BUS 179		New Summary	RO	167 42 13.41			0 00 00		
		BUS 179	RM 2		-0.279		0.005	-0.284	RM 2			~~3.071~~	~~162 22 37.41~~	3.066	162 19 56	354 40 24	0.005	0.002
			RM 3		-0.321		0.002	-0.323	RM 3			~~2.946~~	~~356 41 11.41~~	2.945	356 43 6	188 58 58	0.001	-0.002
			RM 4		-0.062				RM 4		New RM (Sp)	4.165	~~79 40 43.41~~		79 38 02.	271 58 30		
									BUS 192		New Summary	RO	62 00 18.40			0 00 00		
		BUS 192	RM 2		0.000		~~0.030~~	-0.030	RM 2			~~3.113~~	~~183 06 38.40~~	3.122	183 8 44	121 06 20	-0.009	-0.002
			RM 3		-0.239		~~0.073~~	-0.312	RM 3			~~2.768~~	~~276 35 03.40~~	2.777	276 37 9	214 34 45	-0.009	-0.002
			RM 4		0.058				RM 4		New RM (Dsp)	3.864	~~7 42 23.40~~		7 44 29.	305 42 05		
									BUS 199		New Summary	RO	315 46 40.25			0 00 00		
		BUS 199	RM 1		-0.209		-0.009	-0.200	RM 1			~~4.952~~	35 31 53.25	4.950	~~35 25 10~~	79 45 13	0.002	0.010
			RM 4		-0.439				RM 4		New RM (Sp)	4.577	108 45 42.25			152 59 02		
			RM 5		-0.370				RM 5		New RM (Dsp)	4.598	169 52 11.25			214 05 31		
									BUS 209		New Summary (remove RM 4)	RO	175 28 32.83			0 00 00		

12. Appendix D – Mark maintenance

A missing lid creating a hazard.

The lid replaced, painted and SSM stencilled on Kerb.

A BM and witness plate in poor condition.

A refurbished BM and witness plate.

Broken asbestos hatch with lid missing, and witness plate creating a hazard.

Asbestos hatch surround removed and replaced, with BM stencilled on kerb.