BRUNSWICK WEST TRAMWAY SUBSTATION INCLUDING PLANT AND EQUIPMENT

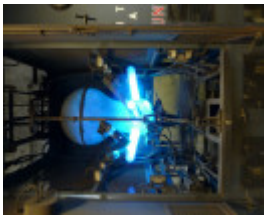
Brunswick West Tramway Substation

Brunswick West Tramway Substation

Brunswick West Tramway Substation from above

Brunswick West Tramway Substation from rear

Mercury arc rectifier



Mercury arc rectifier operating as a number 55 tram approached

Substation circuit diagram

Tapestry brick and window grill

Box for mercury arc rectifier

Switchboard meter

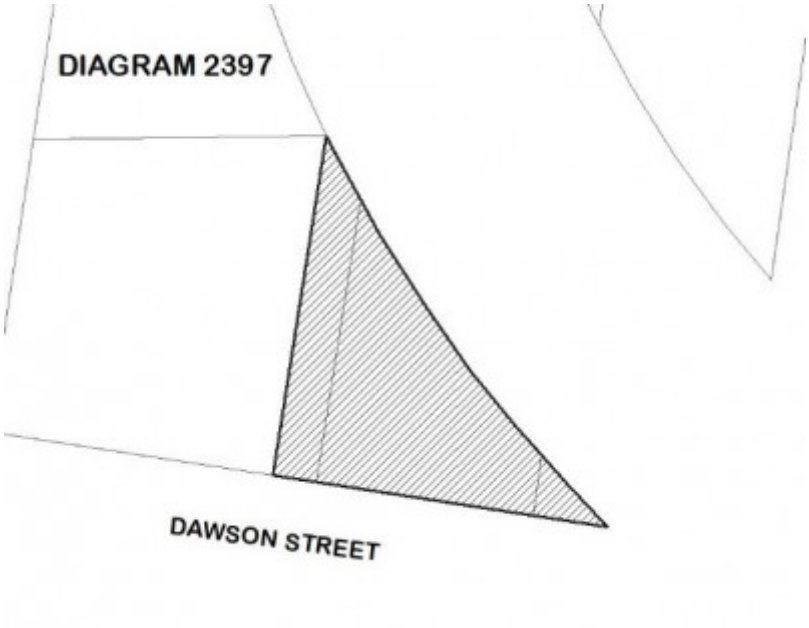


Diagram 2397.jpg

Location

196A DAWSON STREET BRUNSWICK WEST, MORELAND CITY

Municipality

MERRI-BEK CITY

Level of significance

Registered

Victorian Heritage Register (VHR) Number

H2397

Heritage Overlay Numbers

HO64

VHR Registration

February 13, 2020

Heritage Listing

Victorian Heritage Register

Statement of Significance

Last updated on - April 7, 2021

What is significant?
The Brunswick West Tramway Substation building, land and objects integral to the place including:
. The following fixed items of electrical equipment and their interconnecting cabling including: open three phase bus bars to bring high voltage (HV) AC power from Dawson Street; 6.6 kV AC switchgear; an air cooled transformer; a choke inductor; a bank of four mercury arc rectifier bulbs in steel cabinets; a 600 Volt DC switchboard including automatic control gear and current limiting resistors; a 600 Volt DC negative high speed circuit breaker; emergency resistor coils; three outgoing feeders to the overhead tram traction wires via isolators to carry DC power out of the building to the overhead tramway wires; underground cables bringing DC power from the tram rails back into the building and an AC switchboard.
. All fixtures attached to the building at the time of registration including the brick cells to hold the AC switchgear, light fittings, wire screens and gates, toilet and hand basin.
. The following movable items: a timber box for transporting one mercury arc rectifier bulb, electrical schematic diagrams, substation diaries and other documents, substation operating tools and furniture.
How is it significant?
The Brunswick West Tramway Substation is of historical significance to the State of Victoria. It satisfies the following criterion for inclusion in the Victorian Heritage Register:
Criterion A
Importance to the course, or pattern, of Victoria's cultural history.
Criterion B
Possession of uncommon, rare or endangered aspects of Victoria's cultural history.
Criterion D
Importance in demonstrating the principal characteristics of a class of cultural places and objects.
Why is it significant?
The Brunswick West Tramway Substation is significant at the State level for the following reasons:
The Brunswick West Tramway Substation is historically significant for its association with the electrification of the existing cable tramways in the 1920s and 30s, and the widespread construction of new electric tramways beyond the reach of the cable tram system. It serviced the West Coburg Tramway which facilitated the development of much of the western side of Brunswick and Coburg. Operation of electric tramways provided a number of advantages to the Melbourne and Metropolitan Tramway Board (M&MTB) over cable tram operation. These included lower capital costs, greater speed and flexibility, adaptability to extension and simplification of terminal shunting. While power was provided to the West Coburg line from Sydney Road from 1925, there would have problems with voltage drop leading to slow and inefficient operation of the tramcars. The 1936 creation of the Brunswick West Tramway Substation on Melville Road overcame this. The refined Moderne design of the building with the prominent display of the large electrical transformer demonstrates the pride felt by the M&MTB in its establishment of a progressive electric tram system. (Criterion A)
The Brunswick West Tramway Substation is historically significant as a rare example of a substation with all its original equipment still located in the building. It is one of only three substations in Victoria known to retain mercury arc rectification equipment, and the only one which is complete. All the equipment is present and still connected which means that the substation could be returned to operation. The mercury arc bulbs, their matching transformer and some other equipment were made overseas and the automatic control equipment on the DC switchboard was designed and manufactured by the M&MTB. (Criterion B) The Brunswick West Tramway Substation is significant because it is oneofthe few places which demonstrates the principal characteristicsandfunctioning of a tramway substation utilising mercury arcrectifyingequipment. The Brunswick West Tramway Substation is a notableexample ofa tram substation as it contains all the originalrectification equipment showing how banks of mercury arc glass bulbrectifierstogether with their matching specialised transformer, a chokeinductor,switchgear, switchboards, circuit breakers, control gearandinterconnecting cables converted AC power to DC power for the DCmotorson trams. The location of the substation next to a tram linedemonstrates how the DC motors in trams needed to be supplied by a600Volt DC source approximately every four kilometres in order toprovide astable power supply without excessive voltage drop limiting thetram'sspeed. (Criterion D)

Permit Exemptions

General Exemptions:

General exemptions apply to all places and objects included in the Victorian Heritage Register (VHR). General exemptions have been designed to allow everyday activities, maintenance and changes to your property, which don't harm its cultural heritage significance, to proceed without the need to obtain approvals under the Heritage Act 2017.

Places of worship: In some circumstances, you can alter a place of worship to accommodate religious practices without a permit, but you must notify the Executive Director of Heritage Victoria before you start the works or activities at least 20 business days before the works or activities are to commence.

Subdivision/consolidation: Permit exemptions exist for some subdivisions and consolidations. If the subdivision or consolidation is in accordance with a planning permit granted under Part 4 of the *Planning and Environment Act 1987* and the application for the planning permit was referred to the Executive Director of Heritage Victoria as a determining referral authority, a permit is not required.

Specific exemptions may also apply to your registered place or object. If applicable, these are listed below. Specific exemptions are tailored to the conservation and management needs of an individual registered place or object and set out works and activities that are exempt from the requirements of a permit. Specific exemptions prevail if they conflict with general exemptions.

Find out more about heritage permit exemptions here.

Specific Exemptions:

General Conditions: 1. All exempted alterations are to be planned and carried out in a manner which prevents damage to the fabric of the registered place or object. General Conditions: 2. Should it become apparent during further inspection or the carrying out of works that original or previously hidden or inaccessible details of the place or object are revealed which relate to the significance of the place or object, then the exemption covering such works shall cease and Heritage Victoria shall be notified as soon as possible. General Conditions: 3. All works should ideally be informed by Conservation Management Plans prepared for the place. The Executive Director is not bound by any Conservation Management Plan and permits still must be obtained for works suggested in any Conservation Management Plan. General Conditions: 4. Nothing in this determination prevents the Heritage Council from amending or rescinding all or any of the permit exemptions. General Conditions: 5. Nothing in this determination exempts owners or their agents from the responsibility to seek relevant planning or building permits from the relevant responsible authority, where applicable.
Specific Permit Exemptions: The following works do not require a permit provided that they are carried out in a manner which does not harm the cultural heritage significance of the place.

Maintenance:

Minor patching, repair and maintenance of the building which replaces like with like. Repairs must maximise protection and retention of significant fabric and include the conservation of existing details or elements. Any new materials used for repair must not exacerbate the decay of significant fabric due to chemical incompatibility, obscure significant fabric or limit access to significant fabric for future maintenance.

.Maintenance, replacement and installation of existing fire services where this does not impact on significant fabric.

Safety and Security:

The erection of temporary security fencing, scaffolding, hoardings or surveillance systems not attached to the building or equipment to prevent unauthorised access or secure public safety.

.Emergency stabilisation necessary to secure safety where a site feature has been irreparably damaged or destabilised and represents a safety risk to its users or the public. All works are to be reported to the Executive Director within 21 days of completion of the works.

Landscape: Mowing and weed control.

Theme

3. Connecting Victorians by transport and communications 6. Building towns cities and the garden state

Construction dates	1935,
Architect/Designer	Unknown,
Heritage Act Categories	Registered place, Registered object integral to a registered place,
Other Names	TRAM SUBSTATION,
Hermes Number	201776
Property Number	

History

Electrification of Melbourne's Tramways

Between 1885 and 1891 the Melbourne Tramway Trust (MTT), comprising eleven municipalities, constructed the world's largest united cable tramway system, which was leased to the Melbourne Tramway and Omnibus Company (MT&OCo) for operation until 1916. The MTT also constructed two horse tramways in conjunction with its cable lines, three other horse lines were constructed by private companies, and the MT&OCo built its own horse tramway through Royal Park. A privately constructed cable tramway was operated through Northcote. During the world-wide era of experimentation with electric traction for tramways in the 1880s, a pioneer electric line operated between Box Hill and Doncaster from 1889 until 1896.

During 1906 the Victorian Railways opened an *Electric Street Railway* from St Kilda to Brighton, and an English company built electric tramways through Essendon and Flemington in conjunction with its lighting and power operations. Local councils immediately saw the advantages of electric tramways and five municipal tramway trusts (Prahran & Malvern Tramway Trust, Hawthorn Tramway Trust, Melbourne Brunswick & Coburg Tramway Trust, Fitzroy, Northcote and Preston Tramway Trust and the Footscray Tramway Trust) constructed them over the following decade.

A Royal Commission in 1910-11 recommended that the cabletrams be converted for electric operation, and in 1916 an interim Tramway Board was established to operate the cable tramway system and the Royal Park horse tramway pending establishment of a body to integrate and operate the majority of Melbourne's tramways. The advantages of electric tramways were considered to be lower capital costs, greater speed and flexibility, adaptability to extension and simplification of terminal shunting. In 1919 the Melbourne and Metropolitan Tramway Board (M&MTB) was established to carry out this enormous task and took over all existing tramways except for two electric lines operated by the Victorian Railways.

In 1923 the M&MTB formulated a comprehensive plan (*The General Scheme*) for integration and development of the system as a whole, with considerable extension of the electric lines and gradual conversion of most of the cable lines. Twenty new electric lines were opened during the 1920s and between 1925 and 1940 the cable tramways were replaced with new electric lines or bus services. Many new tram depots and substations were required. Hundreds of new large electric trams were constructed to replace the fleets of smaller cars operated by the municipal tramway trusts.

Substations

Electricity to power Melbourne's tram lines was supplied from the public electricity supply. In Victoria both AC and DC electric power systems were used. [Electric current can be Direct Current (DC) or Alternating Current (AC). DC is the flow of electric charge in only one direction while AC reverses its direction at regular intervals.] In 1932 the State Electricity Commission of Victoria (SECV) decided to gradually phase out the DC system in favour of AC. This was because DC transmission lost a lot of power over long distances, and DC could not be easily stepped down to safe voltages for domestic and commercial use.

However, DC motors were well-suited to use on trams as they were compact and light and could easily be incorporated into the restricted space on the trams. Therefore, the M&MTB needed to convert (or rectify) the mains AC power to DC traction power to supply trams. Substations were constructed to hold rectifier plant. DC voltage drops quickly with distance and tram performance therefore suffers if the tram is much more than four kilometres from the power source. This meant that substations had to be constructed approximately every four kilometres along a tram route.

M&MTB substations were denoted by letters which related to their suburb, for example the West Brunswick Tramway Substation is known as 'W". Some substations were co-located within tram depots, and others were free standing buildings. By 1933 there were nineteen substations. In order to reduce labour costs, the M&MTB constructed remote supervisory equipment of its own design for its substations. Fifteen of its nineteen substations were fully automatic unattended stations. The main central control room was in Queensberry Street at Carlton. By 2013 there were fifty-five substations, with more planned. Since the 1960s new substations have been constructed behind or near some earlier substations. In other cases, new equipment has been installed in existing substations (for example Carlton Tram Substation VHR H2325). Superseded equipment was usually removed and destroyed as part of the decommissioning process.

Rectification equipment

Substations constructed before 1930 contained rotary converters (which used electro-mechanical means to convert AC to DC). These early substations were specifically designed to house the massive rotary converters. The last new rotary converter in Melbourne was installed at South Melbourne in 1931 and many were still in use in the 1970s.

Mercury-arc rectifiers were invented by Peter Cooper Hewitt in the USA in 1902. Hewitt's company in the UK was *Westinghouse Cooper-Hewitt* (later the *Hewittic Electric Company)*. By the mid-1920s reliable industrial mercury-arc rectifiers were available from several makers including the Hewittic Electric Company which made the glass bulbs in the Brunswick West Tramway substation. This equipment was smaller than the rotary converter plant of similar capacity. A 'matching' rectifier transformer was needed for each rectifier bank. Hewittic mercury bulbs were always matched with transformers made by the UK based Hackbridge Electric Construction Co.

In Victoria from 1930, mercury-arc rectifiers started to supplant rotary converters because they were smaller and offered higher conversion efficiency. The mercury arc technology wasn't suited to locations with high power demands, such as the Malvern Tram Depot (VHR H0910) but was adequate for locations (and cheaper to run) at the outer ends of a line, like West Brunswick. As essentially 'static plant', maintenance was also minimal. The first example of Mercury Arc technology was installed at the substation in Holden St, Fitzroy in 1930. By 1935 the capacity limit for a single glass-bulb mercury arc bulb was 150 kW DC (620 V), however higher capacities could be achieved by operating two or more bulbs in parallel, as in many M&MTB substations, where up to four bulbs were typically used to create a 600 kW rectifier system.

From the 1960s the tram system slowly started to progress to solid state silicon diode rectifiers. In 1975 out of a total of twenty-six operating tram substations in Melbourne there were ten rotary converter substations, thirteen mercury arc substations (one of which was mobile) and one combination rotary converter and mercury arc substation. In addition, there were two silicon rectifier substations in operation. At that time the M&MTB planned to replace the remaining rotary converter systems with silicon rectifier systems. Silicon rectifier systems are still used today, together with electronics to control switching.

West Coburg Tramway

The West Coburg Progress Association had lobbied strongly for the building of a tramline. The Melville Road route which now forms an important north-south transport link through the western side of Brunswick did not exist until the early 1920s. The eventual construction of the tramline contributed to the development of much of the western side of Brunswick and Coburg. Major estates in the area developed all through the 1920s with the new electric tramway promoted as a feature.

The West Coburg Tram Line was initially built as a branch line to a new electric line constructed to enable the existing Essendon electric system at Flemington Bridge to enter the city via Flemington Road, Peel and William Streets as far south as Collins Street. It was constructed in four stages. The initial section of the West Coburg line, which was known as the East Brunswick Tram Line opened on 19 July 1925, left Flemington Road at Abbotsford Street and traversed Royal Park, Grantham and Dawson Streets to Daly Street, Brunswick. An additional section via Melville Road to Albion Street opened on 10 October 1925. On 15 May 1927 the line was

extended along Melville Road to Moreland Road, and on 26 June 1927 it was further extended to Bell Street, Coburg (now Ascot Vale South). The West Coburg Tramway was numbered route 55 or route 56 (on weekends) from 1934 until 2017 when route 55 was amalgamated with route 8 Toorak to become route 58.

The Brunswick West Tramway Substation was constructed in 1935 to serve the West Coburg Tram Line. The sources of DC power for the trams on the West Coburg line in the period between the opening of the line in 1925-7 and the installation of rectification equipment in the West Brunswick substation in 1936 are most likely to have been two substations on Sydney Road (where cable trams were still operating). These substations were located at the Former Cable Tram Engine House and Tram Substation (VHR H2332) and the Brunswick Tram Depot (HO171). On the West Coburg tram route at Grantham and Reynard Streets, approximately aligned to these substations, are two old M&MTB steel poles with remnant DC feeder cables which may have delivered the power to the West Coburg trams.

Brunswick West Tramway Substation

The M&MTB's 1934 Annual Report records the decision to convert the Sydney Road cable tramway to electric traction. The Annual Report for 1935 records that a new Brunswick West substation was being built. It is possible that the new Brunswick West substation was needed both to provide power further along the West Brunswick route and to simultaneously free up the DC output of the substations at the former Cable Tram Engine House & Tram Substation (VHR H2332) and the Brunswick Tramway Depot (HO171) to supply the newly converted Sydney Road tram route. The other reason for the construction of the new Brunswick West Substation was probably in response to rising patronage which led to the need for larger and more frequent trams. Larger trams require more DC power. The location of the new substation at the intersection of Dawson St and Melville Rd, further out on the Brunswick West route would also have improved voltage distribution along the route.

The land for the substation was donated by Hoffman's Brickworks. The original sharp turn from Dawson St into Melville Road was changed to a smooth curve which enabled higher speeds and less wear on the tram wheels and rails. Some other streets in the area were also altered. The re-alignment of Melville Road also created a small triangular plot of land which was used for the construction of the Brunswick West substation. The name of the architect of the substation is not known but would have been one of the M&MTB architects.

The prominent location of the large, air-cooled transformer in the large central opening has been suggested as demonstrating the Futurist architecture style. However, the remainder of the building is more conventional, and the prominent position of the transformer may instead have been a reflection of the M&MTB's pride and confidence in technology. There were also practical reasons, the transformer is air cooled and needs to be exposed to the exterior air. Transformers in other substations were sometimes located outside or on breezeways for the same reason.

The new Brunswick West substation building was completed at the end of 1935 and the mercury arc equipment was commissioned in 1936. From 1938-39 M&MTB designed supervisory equipment also known as 'Remote Terminal Equipment' was built at the Preston Tramway Workshops (VHR H2031) and installed in West Brunswick. The mercury arc bulbs assemblies, transformer and most individual switchgear items were made overseas and installation of all the mercury arc equipment and on-site assembly and construction of the 600 V DC switchboard was carried out by the MMTB.

Operation of the substation

High voltage electricity to power the substation was supplied at 6.6 kilovolts (kV) AC from the power pole at the corner of Dawson and Moule Streets, about 100 metres from the substation. A cable travels down the pole then underground to the substation.

Three phase bus bars transport the AC power into the substation at three brick cells containing 6.6kV AC switchgear. The cells are numbered X, Y and Z. Cells X and Z contain circuit breakers which protected the main transformer from overcurrent situations and short circuits. Cell X contains a small transformer to step down the 6.6 kV (66000 V) mains power to standard 240 V for the non-rectification equipment in the substation.

The main transformer stepped down the AC voltage from the public electricity supply to positive AC voltage that was suitable for the mercury arc rectifiers. It also operated the ignition circuits that kept the mercury bulbs operating as well performing as other tasks. The choke inductor smoothed and passed negative AC power.

The AC currents passed to a mercury-arc rectifier bank consisting of four glass bulbs. Operation of each rectifier relied on an electrical arc discharge in a sealed glass bulb containing a pool of liquid mercury. During operation the mercury is vaporised emitting characteristic blue-violet light.

The positive DC current passes to a 600V DC switchboard which contains circuit breakers and control gear and then out of the building through insulated holes (bushes) to the tram overhead lines. The DC current passed down the tram pole to the DC tram engine then into the rails completing the electrical circuit. The power then returned to the substation via underground cables to a negative high-speed circuit breaker.

The resistance coils only operated in emergencies to stop dangerous currents.

KEY REFERENCES USED TO PREPARE ASSESSMENT

Allom Lovell and Associates, *City of Moreland Heritage Review*, April 1998 (Revised January 1999)

- Thematic History (Volume 1)

- Building Citations Datasheets A-K (Volume 2, Part 1) , online at https://www.moreland.vic.gov.au/globalassets/areas/heritagelib-7504/moreland-heritage-review-building-citations-volume-2--part-1--datasheets-a--k.pdf

Brown, Geoff, Melbourne Tram Museum, *The tram through the park: the origins of the West Coburg tramway*, 2016, online at http://www.hawthorntramdepot.org.au/papers/westcoburg.htm

City of Melbourne, Melbourne Planning Scheme Incorporated Document (Amendment C327) Hoddle Grid Heritage Review: Statements of Significance, September 2018 https://www.planning.vic.gov.au/resource-library/incorporated-documents/melbourne/melb-C327-Incorp-Doc-Hoddle-Grid-Heritage-Review-Statements-of-Significance,-September-2018-Approval-Gazetted.pdf

Dunstan, David, *Trams*, Encyclopedia of Melbourne, undated, online at http://www.emelbourne.net.au/about.html

Hewittic Electric Co., *Installation Instructions - Hewittic Electric Co., Hewittic Arc Rectifier Bulbs, Unpacking, Installation & Maintenance*, 1944. Source: Museums Victoria, online at https://collections.museumvictoria.com.au/items/1785566

Jones, Russell, Melbourne Tram Museum, *Fares please! An economic history of the Melbourne & Metropolitan Tramway Board*, 2008, online at http://www.hawthorntramdepot.org.au/papers/ecohist/ecohist0.htm

Jones, Russell, Melbourne Tram Museum , *From Rotary Converters to solid-state: tramway substation architecture in Melbourne*, 2013; online at http://www.hawthorntramdepot.org.au/papers/substations.htm

Kianidis, Dimitrios, *Photographic Journal - Electrical substations of inner Melbourne*, 2012, unpub.

Melbourne and Metropolitan Tramway Board, *Annual Report*, various dates.

Melbourne and Metropolitan Tramway Board, *Summary of Main Events 1868-1968*, 1968, unpub.

Melbourne and Metropolitan Tramway Board, *Project 3-74, Replacement of Substation Equipment*, 1975, unpublished

Movie Soothsayer, *Evil of Frankenstein* undated, online at https://moviesoothsayer.wordpress.com/2012/06/26/movie-madness-16-evil-of-frankenstein/

Personal communications from:

. Warren Doubleday, Russell Jones and Mike Ryan, Melbourne Tram Museum

. Miles Pierce and Owen Peake, Electrical Engineers, Engineering Heritage Victoria

. Robert Green, retired Heritage Victoria staff member

. Craig Tooke, Principal Electrical Networks Specialist, Metrotrains

. Benjamin Greig, Team Manager, Power and Substations, Frank Denino, Manager, Power & Overhead and Paul Tracey, Yarra Trams

Prentice, Bob, *A Brief History of the Melbourne , Brunswick and Coburg Tramway Trust*, 1999

Ringwood Manor, *Peter Cooper Hewitt, 1861-1921*, online at http://www.ringwoodmanor.org/peter-cooper-hewitt.html

Steele, C L, *A Supervisory Control; System for Traction Substations*, The Electrical Engineer and Merchandiser magazine, 15 November 1933.

Vines, Gary, *Melbourne Metropolitan Tramway Heritage Study, Report for Heritage Victoria*. 2011, online at https://www.heritage.vic.gov.au/__data/assets/pdf_file/0024/61449/Tram-History-final_reduced__Chapter6_Part2.pdf

Wongm's Rail Gallery, *Melbourne tramway traction substations* , online at https://railgallery.wongm.com/melbourne-tramway-traction-substations/page/13/

Yarra Trams, *Melbourne's tram history*, undated, online at https://yarratrams.com.au/melbournes-tram-history

Assessment Against Criteria

Criterion
The Brunswick West Tramway Substation is of historical significance to the State of Victoria. It satisfies the following criterion for inclusion in the Victorian Heritage Register:

Criterion A
Importance to the course, or pattern, of Victoria's cultural history.

Criterion B
Possession of uncommon, rare or endangered aspects of Victoria's cultural history.

Criterion D
Importance in demonstrating the principal characteristics of a class of cultural places and objects.

Extent of Registration

Heritage Act 2017

NOTICE OF REGISTRATION

As Executive Director for the purpose of the **Heritage Act 2017**, I give notice under section 53 that the Victorian Heritage Register is amended by including a place in the Heritage Register:

Number: H2397

Category: Registered Place, Registered Objects Integral to a Registered Place

Place: Brunswick West Tramway Substation

Location: 96A Dawson Street Brunswick West

Municipality: Moreland City

All of the place shown hatched on Diagram 2397 encompassing all Lot 1 on Title Plan 680981, and Lots 1 and 2 on Title Plan 519046; and all fixtures attached to the building at the time of registration including the brick cells to hold the AC switchgear, light fittings, wire screens and gates, toilet and hand basins and also includes all movable objects integral to the place listed in the inventory dated November 2019, held by the Executive Director,

Heritage Victoria.

13 February 2020

STEVEN AVERY

Executive Director

This place/object may be included in the Victorian Heritage Register pursuant to the Heritage Act 2017. Check the Victorian Heritage Database, selecting 'Heritage Victoria' as the place source.

For further details about Heritage Overlay places, contact the relevant local council or go to Planning Schemes Online http://planningschemes.dpcd.vic.gov.au/