Fast Tracked: V8 Supercars vs. Survey Infrastructure in Newcastle

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ABSTRACT

Last year, in November 2017, the Newcastle 500 motor race was held as part of the Supercars Championship for the first time. In order to enable this event to occur, major infrastructure works were conducted to construct a race circuit through the heart of Newcastle East. Much of the works involved expansion of infrastructure within the entire boundary limit of the existing road corridor. As most survey infrastructure is located in the road corridor, it was paramount to protect and/or relocate this infrastructure during the progress of the construction works along the race circuit. In February 2017, de Witt Consulting Pty Ltd was engaged by project management consultancy iEDM (on behalf of V8 Supercars Australia Pty Ltd) to create and facilitate a survey infrastructure preservation strategy in order to fulfil the responsibilities in accordance with the Surveying and Spatial Information Act 2002. At this time, the draft remake of Surveyor General's Direction No. 11 (Preservation of Survey Infrastructure) had just been released. Having a very short time frame to survey the site before most of the existing survey infrastructure was destroyed was challenging and required some innovative approaches to get across the finish line. This was the first 'major project' to be managed by DFSI Spatial Services in accordance with the new Surveyor General's Direction No. 11. This paper outlines the project, strategies and steps undertaken to ensure the preservation of survey infrastructure at a site with no room to move and a very tight time frame.

KEYWORDS: *Preservation of survey infrastructure, Surveyor General's Direction No. 11, supercar racing.*

1 INTRODUCTION

NSW is currently experiencing an unprecedented amount of large infrastructure projects (Underwood, 2017). Unfortunately the previous version of Surveyor General's Direction No.11 (Preservation of Infrastructure) was not written to address the impacts on the survey infrastructure for large scale projects.

The V8 Supercars Newcastle 500 motor racing circuit is an example of such a large scale project within a densely populated and developed area in Newcastle East (Figures 1 & 2). It can be seen that these large scale projects can consume the entire road corridor. The road corridor is where survey infrastructure is most commonly placed because of the ease of access (being public land) and generally allowing unobstructed sightings to other points of interest for the survey. This project threatened to destroy survey infrastructure along street frontages of several blocks, creating a 'black hole' in survey marks available for applications like mapping and engineering projects or cadastral boundary definition (using cadastral marks

which are fundamental to ensure the integrity of the cadastre). The situation was amplified by this area of Newcastle East containing high property values with large buildings that are located on or near the boundary. The survey marks to be destroyed were placed between the 1950s and the present day, providing important survey control for the area. The extensive survey infrastructure preservation and relocation efforts performed as part of this project will ensure that survey marks in this part of Newcastle East will be maintained for many surveys to come.

Figure 1: View of part of the V8 Supercars Newcastle 500 circuit.

Figure 2: V8 Supercars Newcastle 500 circuit through Newcastle East (de Witt Consulting, 2017).

2 OVERVIEW OF THE REQUIREMENTS UNDER SGD11

With the release of the draft version of the new Surveyor General's Direction No.11 Preservation of Survey Infrastructure (SGD11) in January 2017 (DFSI Spatial Services, 2017), the V8 Supercars Newcastle 500 infrastructure project was about to commence construction in 6 weeks. As de Witt Consulting were engaged at this time, this meant they needed to act quickly to preserve the existing survey infrastructure.

A meeting was held a week later between de Witt Consulting and DFSI Spatial Services to reach agreement on how survey infrastructure preservation was to be implemented using the draft SGD11. This was the first large scale project to test the new (draft) Direction, and (like all projects) some obstacles required special strategies and unique solutions to make it a success.

2.1 Aim

The focus of SGD11 is generally divided into two areas:

1) To preserve the integrity of the state control network by ensuring that sufficient permanent survey marks are available following completion of the project. On completion of works the survey should be of sufficient horizontal and vertical Class to allow existing and/or replacement mark(s) to be coordinated to a similar standard as the mark(s) affected by the works.
2) To preserve sufficient cadastral infrastructure, place additional marks, and provide sufficient measurements in order to re-establish the cadastre at the accuracies specified in the Surveying and Spatial Information Regulation following completion of the works.

2.2 General Requirements

Be it a cadastral mark or a permanent survey mark (such as TSs, PMs and SSMs in the State's Survey Control Information Management System, SCIMS – see Kinlyside, 2013), an application for authorisation to remove or replace a survey mark needs to be made in accordance with clause 90 of the Surveying and Spatial Information Regulation 2017 (NSW Legislation, 2017). The application is to be made at least 14 business days before the proposed removal or replacement of survey marks is carried out (30 business days for large scale projects). An online form can be used for this purpose (Figure 3).

Before the application is made, some preliminary work is required. A visual inspection needs to be conducted to look for all survey marks that are on public record (such as in SCIMS and on Deposited Plans). All the survey marks at risk (and not noted as destroyed on public record) need to be identified and presented in a schedule indicating their status (i.e. found, not found or destroyed).

For large-scale projects a Survey Project Plan also needs to be prepared. This will show the strategy and methodology as to how the preservation of survey infrastructure will be conducted. It will contain a diagram visually showing the proposed works with all survey marks identified in the schedule.

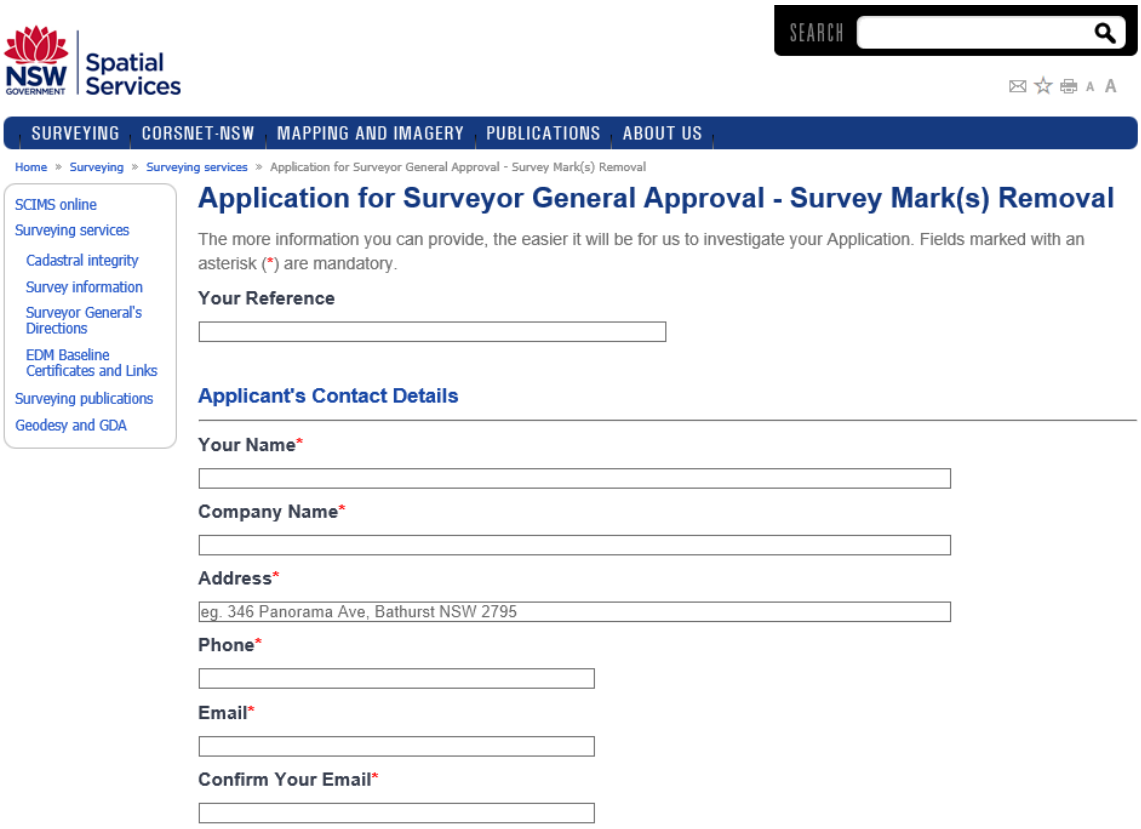

Figure 3: Online application form for survey mark(s) removal (DFSI Spatial Services, 2018).

Approval given for the destruction of survey infrastructure will be subject to specific conditions. In most circumstances a replacement mark has to be placed for the one(s) being destroyed.

In the case of permanent survey marks, at a minimum, a like-for-like approach is used. Where practical, this means if the mark was a type 4 PM, then a type 4 PM should be used to replace it. This like-for-like approach also reflects on the Class and Order of the replacement PM – for a discussion on the terms Class and Order, the reader is referred to ICSM (2007) and Dickson (2012). If the destroyed mark is of Class and Order B2, then the new mark will need to be at the same or a higher standard. This applies to both the horizontal and vertical classification of the permanent survey mark. However, there are some allowances that can be applied for in certain circumstances. One such example is that aiming for a vertical LBL2 or higher replacement mark is quite onerous and a LCL3 mark is generally the highest type of survey that is practically obtainable.

For cadastral marks (which can include cadastral reference marks, cadastral boundary marks, survey monuments, bench marks and PMs) a Plan of Survey Information Only needs to be prepared. This Deposited Plan (DP) needs to show connections from the cadastral marks at risk to marks that will remain undisturbed following the completion of the works. These recovery marks can be existing cadastral marks or permanent survey marks. However, if there are no suitable existing marks, than a survey mark (as described by the Surveying and Spatial Information Act 2002 – see NSW Legislation, 2018) can be placed to suit. The connections created need to be shown by closed survey (no open-ended traverses or unchecked radiations) and should not exceed 30 m in length. This procedure is specifically specified for small-scale projects. It also should be noted that a Plan of Survey Information Only cannot define or redefine cadastral boundaries. The intent is to show redundant measurements from survey

marks that will be destroyed to survey marks that will remain after the completion of works.

If it can be justified that these conditions are not required, they can be changed at the discretion of the authorised approver based on the merits of the argument.

3 ADAPTING SGD11 TO SUIT THE NEWCASTLE V8 SUPERCAR PROJECT

By the time the meeting had taken place with DFSI Spatial Services and de Witt Consulting, there were only 5 weeks (20 business days) left until ground works would commence. There had been no opportunity to conduct a site visit to investigate which survey marks existed for the creation of a Survey Project Plan.

It was agreed that a site mark audit of only the Permanent Marks (PMs) would be performed first and a plan for the control survey would be created to provide sufficient horizontal and vertical replacement marks. The targeted Class for the survey was B for horizontal (GDA94) and LC for vertical (AHD71). The equipment used was a 1" 1 mm Leica TS15 total station for traversing and a Leica DNA03 for levelling.

A desktop study showed that there were some 'holes' in the survey control network, created over the years as PMs had been destroyed but not replaced. This actually created an issue for the proposed survey, in that there was no appropriate survey control directly on the site. To assist de Witt, DFSI Spatial Services placed two new type 4 PMs (stainless steel pin in concrete) and surveyed these with static GNSS supported by traversing techniques. This allowed de Witt to focus their survey on their main area and without having to extend the survey drastically to 'chase' control. On the other hand, de Witt surveyed other unestablished PMs that were outside the proposed works to strengthen the state control network. The network design and survey practices used supported the desired outcome for the Class, and the control used additionally supported the desired outcome for the Order (Figures 4-6).

Once the survey data and other required information was supplied to DFSI Spatial Services, it was reduced and entered into least squares adjustment packages GeoLab and levadj. Running a successful minimally constrained adjustment proved that the survey was free of gross errors and showed that the desired Class was met. Running a fully constrained adjustment demonstrated that the desired Order had been achieved in a statistical and realistic fashion (Figure 7).

Figure 4: SCIMS marks already destroyed and to be destroyed.

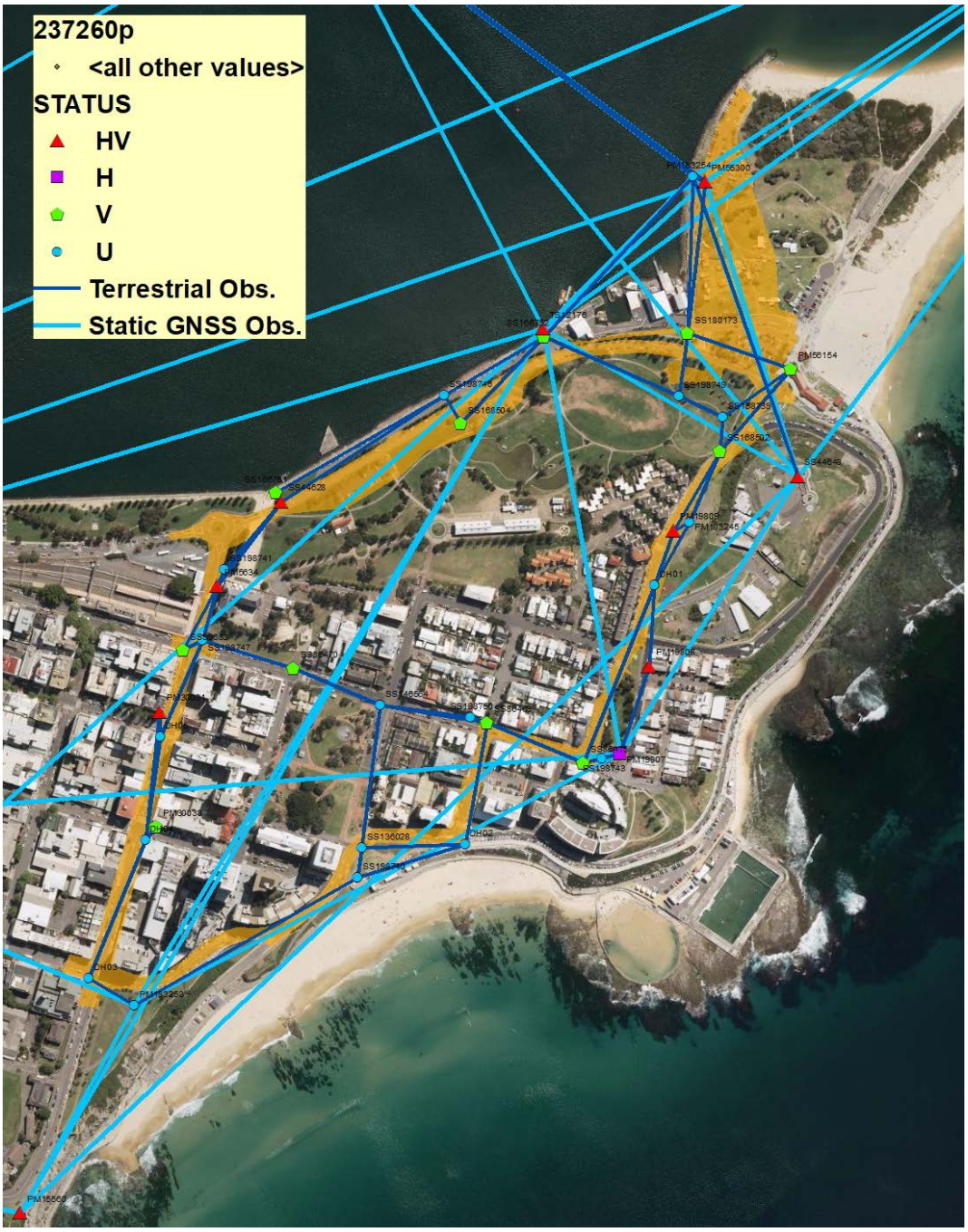

Figure 5: Horizontal GNSS and traversing network.

Figure 6: Vertical levelling network.

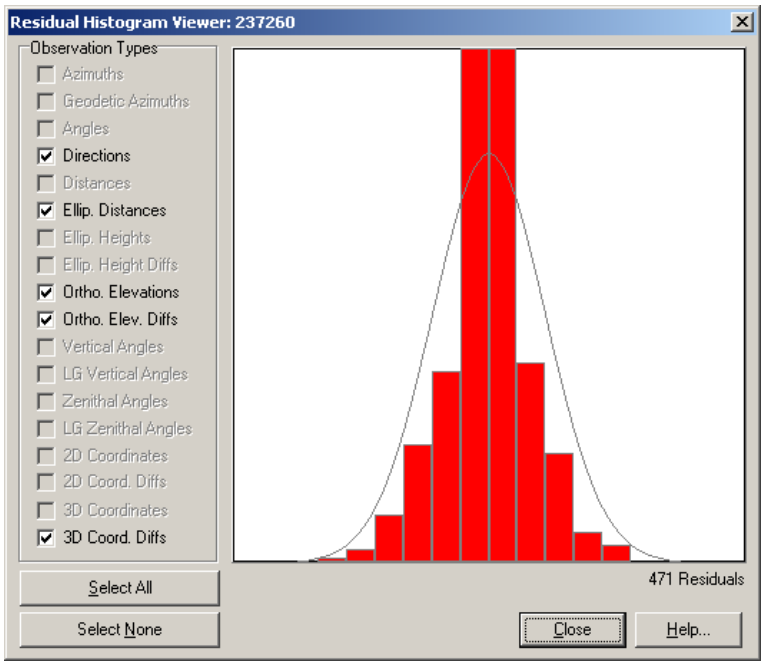

Figure 7: Histogram of traversing and static GNSS survey.

The results from the fully constrained adjustment where then used to produce the coordinates and heights to be entered into SCIMS. The requirements for the results of the survey control for SCIMS were predominantly met (a couple of marks were downgraded in Order due to mark density and extrapolation issues). The final result is that the state control network in Newcastle East is now in a better state than before the project was conducted (Table 1).

Table 1: Comparison of SCIMS marks pre-project to post-project.

SCIMS marks at risk or to be destroyed		**SCIMS marks placed and surveyed**		**Bonus SCIMS marks upgraded**	
Mark No.	**Class & Order**	**Mark No.**	**Class & Order**	**Mark No.**	**Class & Order (original)**
PM55300	A1 LDL4	SS198739	B2 LCL3	SS166752	B2 LCL3 (C3 LDL4)
SS180173	C3 LDL4	SS198740	B2 LCL3	PM56154	B3 LCL3 (C3 LCL3)
SS168504	C3 LDL4	SS198741	B2 LCL3	SS166751	B2 LCL3 (D4 LDL4)
SS168502	C3 LDL4	SS198743	B2 LCL3	SS86470	B2 LCL3 (CU LDL4)
SS44628	B2 LCL3	SS198746	B2 LCL3	SS146564	B3 LCL3 (UU D5)
PM19809	B2 LCL3	SS198747	B2 LCL4	PM19807	B2 LCL3 (B2 UU)
SS99633	CU LBL2	SS198749	B2 LCL3	**TOTAL: 6**	
SS86469	CU B2	SS198750	B2 LCL3		
SS136028	C4 UU	PM183245	B2 LCL3		
PM5634	B2 LBL2	PM183253	B2 LCL4		
SS86475	CU B2	PM183254	B2 LCL4		
TOTAL: 11		**TOTAL: 11**			

With the state control network survey being worked on, a desktop study was conducted by de Witt Consulting for the cadastral marks. By the time the state control survey field work and least squares adjustment were completed, the cadastral investigation was also finished. The cadastral mark survey was now ready to commence by using the minimally constrained adjustment from the state control network survey as control.

Due to time constraints, it was agreed that the Survey Project Plan (with its audit schedule of all cadastral marks) could be created post survey. An initial cadastral mark pickup was conducted with a stakeout of any missing cadastral marks performed soon after. Over the 2.6

km of track, there were 110 cadastral marks located (not including any cadastral SCIMS marks). In the Preservation of Survey Infrastructure (POSI) strategy (de Witt Consulting, 2017), 95 of these cadastral marks were identified as to be destroyed or listed as vulnerable (Figure 8).

This approach left little time to deal with any issues that the verifying authority (i.e. the Surveyor General's representative) may find in regards to survey marks identified or with the proposed strategy in how to mitigate the loss of survey infrastructure. Once the marks are destroyed, there is no going back to add a little more surveying. However, this was unfortunately the best way forward in this project, as risky as it was. Constant communication was paramount for the success of this course of action (Figures 9-10).

Figure 8: Part of the final POSI plan diagram (de Witt Consulting, 2017).

For this project, any mark that was vulnerable, or may potentially be impacted by ground works that extend beyond the original plan, was located and connected to the recovery marks (both for cadastral and permanent survey marks). This little extra work, though arguably not needed, provides greater flexibility and creates safety measures for any unforeseen events. It is well known that large projects may extend the area of works at a moment's notice, and unfortunately the surveyor is not always told this information at the appropriate time.

One of the issues that were identified early was the problem of placing recovery points to show connections to because parts of the infrastructure works encompassed the entire road corridor (building to building). SGD11 indicates that two connections of less than 30 m in length should be shown. This was not practical in this case, as the block lengths were at least 100 m. Consequently, a strategy had to be devised in order to address this issue. It should be

noted that a recovery mark or surviving survey mark can be used more than once to show the required connections. This allows for more efficiency in the surveying and clarity when drafting the DP.

Figure 9: Looking north down Watt Street to the foreshore of the completed works (at the intersection of Shortland Esplanade).

Figure 10: Looking north down Watt Street to the foreshore of the completed works (at the intersection of Hunter Street).

For this project, the 30 m rule was loosened to generally a 60 m maximum distance for connections, but closed connections still needed to be shown. This being the case, a recovery mark could be placed approximately mid-block to allow all the connections to conform to this 60 m allowance. The solution to the preservation of the recovery mark (such as a drill hole & wing, DH&W) was to place these in either the side of buildings, on top of low brick walls or just inside lots in concrete driveways (with the consent of the land owner when appropriate) (Figures 11-13).

While SGD11 explicitly states that connections must be less than 30 m in length for small-scale projects, it does not provide a specific limit for large-scale projects. This is to allow flexibility to the project to adapt an appropriate solution to the circumstances because a blanket rule for large-scale projects will not always be workable. The standards applied to small-scale projects should be used as a guide for large-scale projects whenever possible.

Figure 11: Recovery mark placed in wall (AO from DP).

Figure 12: Recovery mark placed on top of brick wall (O from DP).

In this context, the utilisation of major structures as useful objects to place recovery marks should be considered. For example, Figure 14 shows a navigation target for ships that use the Port of Newcastle. The concrete base of this target is quite significant and will not be disturbed easily. It is designed to last into the future and therefore a good option for hosting a recovery mark.

Selecting such unique locations for placing survey marks increases their chance of survival during construction works and provides easy access to surveyors in the future. Some other structures on which survey marks can be placed on are the edging of large telco and electricity pits (Figure 15).

Figure 13: Recovery mark placed in concrete (FW from DP).

Figure 14: Recovery mark placed in concrete base of ship navigation target (CQ from DP).

Figure 15: State Survey Mark in telco pit, reference mark in pit, and bench mark in pit (de Belin, 2015).

However, as de Belin (2015) states, there is still the risk of the top of the concrete edging to be destroyed during new paving works. As this infrastructure project was focused on creating a roadway that suited a race track, there was no guarantee that an 'untouchable large pit' would stop it from being modified. Consequently, no recovery marks were placed on this type of structure for this project.

In the future, a recovery mark may unfortunately be lost without any preservation works being carried out. However, the use of the redundant measurements (in this case two separate connections from a recovery mark to a destroyed cadastral mark) should allow the secondary mark to be used. There should be less risk of losing groups of these new recovery marks by a single infrastructure or development project, as they have been placed on a diverse range of structures.

The entire project was included in one Plan of Survey Information Only, i.e. DP1233256. This DP contains 6 pages and is presented so that it clearly shows which marks are the recovery marks. These recovery marks are shown by the use of traverse lines. By presenting it in this fashion on the DP, a surveyor will be able to quickly identify the recovery marks they are looking for (Figures 16-18).

The manner, in which the cadastral marks are shown in their true location and not shown at the cadastral corner they reference, also helps the next surveyor to identify which mark it refers to. The addition of stating which DP the mark originates from is very important in assisting future users.

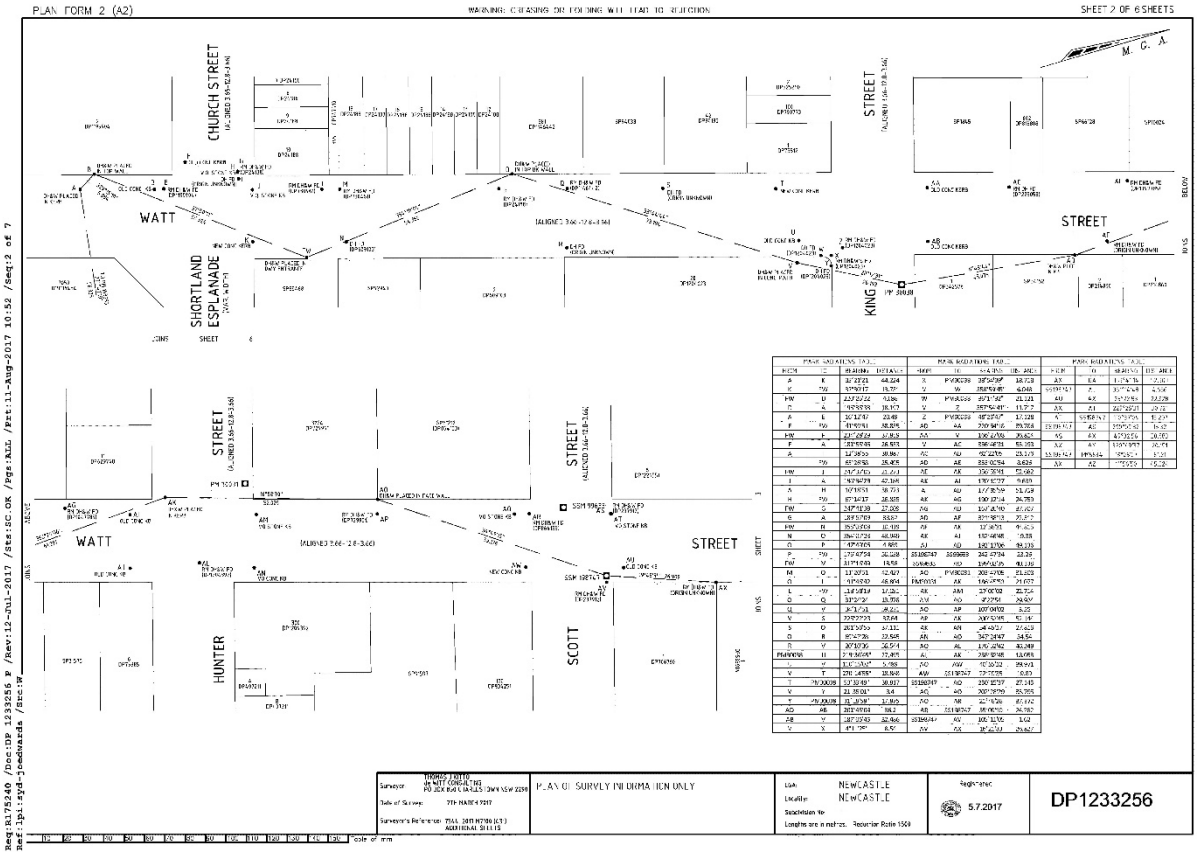

Figure 16: Page 2 of 6, DP1233256.

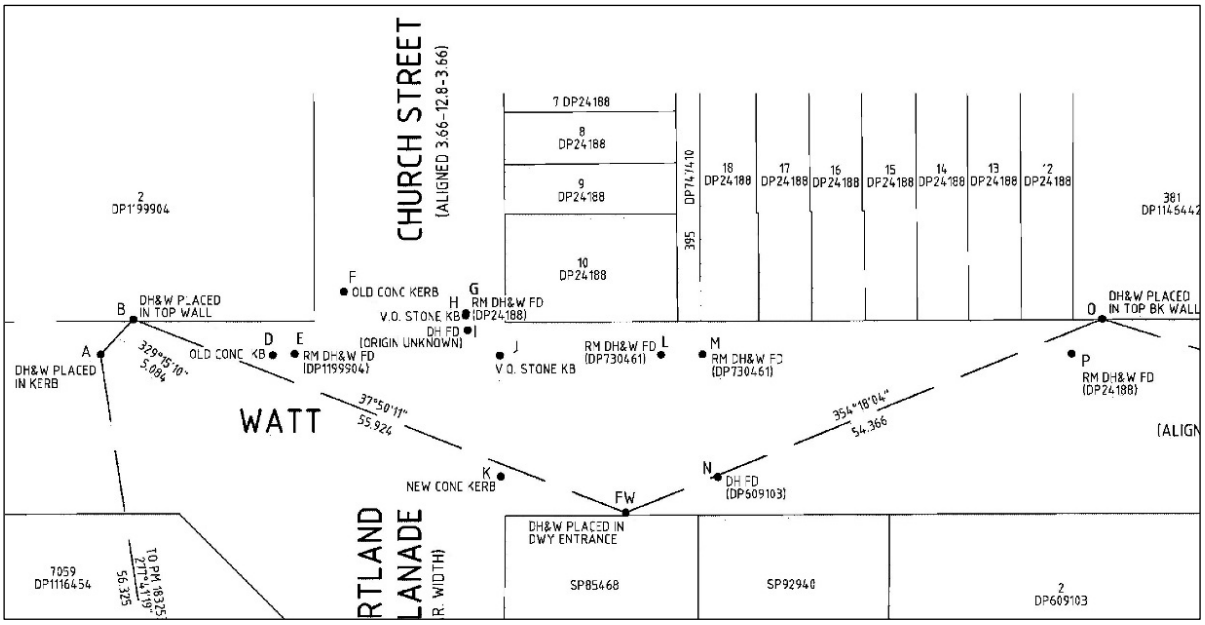

Figure 17: Section of page 2 of 6, DP1233256.

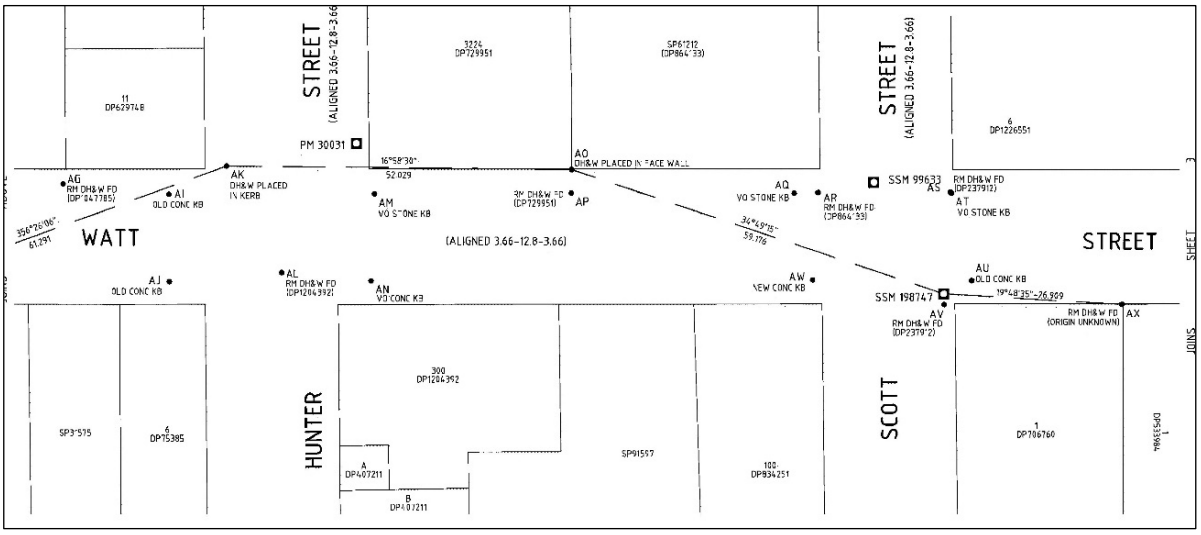

Figure 18: Section of page 2 of 6, DP1233256.

4 FINDING AND USING PLANS OF SURVEY INFORMATION ONLY

Locating more survey marks than needed helps to prevent issues from potential project creep. In this project, some marks have survived the works although they have been recovered. It must be remembered that a Plan of Survey Information Only does not tell future surveyors that the cadastral marks have been destroyed. The intent of this type of plan is to provide valuable survey information on public record that can be used by other surveyors and provides valuable evidence for the relocation of boundaries. Therefore, any future surveyor should still look for the cadastral marks that are shown on any Plan of Survey Information Only and not assume that they are destroyed.

When conducting a Cadastral Record Enquiry (CRE) search in the race track area, DP1233256 will show up, but knowing how to obtain the information from a CRE is sometimes tricky. It is helpful to know when doing a CRE search that the current cadastral

fabric (current titles only) is all that is shown on the map at face value. The dashed lines indicate if there is an underlying or overlying plan that may be of benefit, e.g. acquisition and resumption plans, small easement plans and survey information only plans (Figure 19). These plans can then be found on the notation section of the CRE.

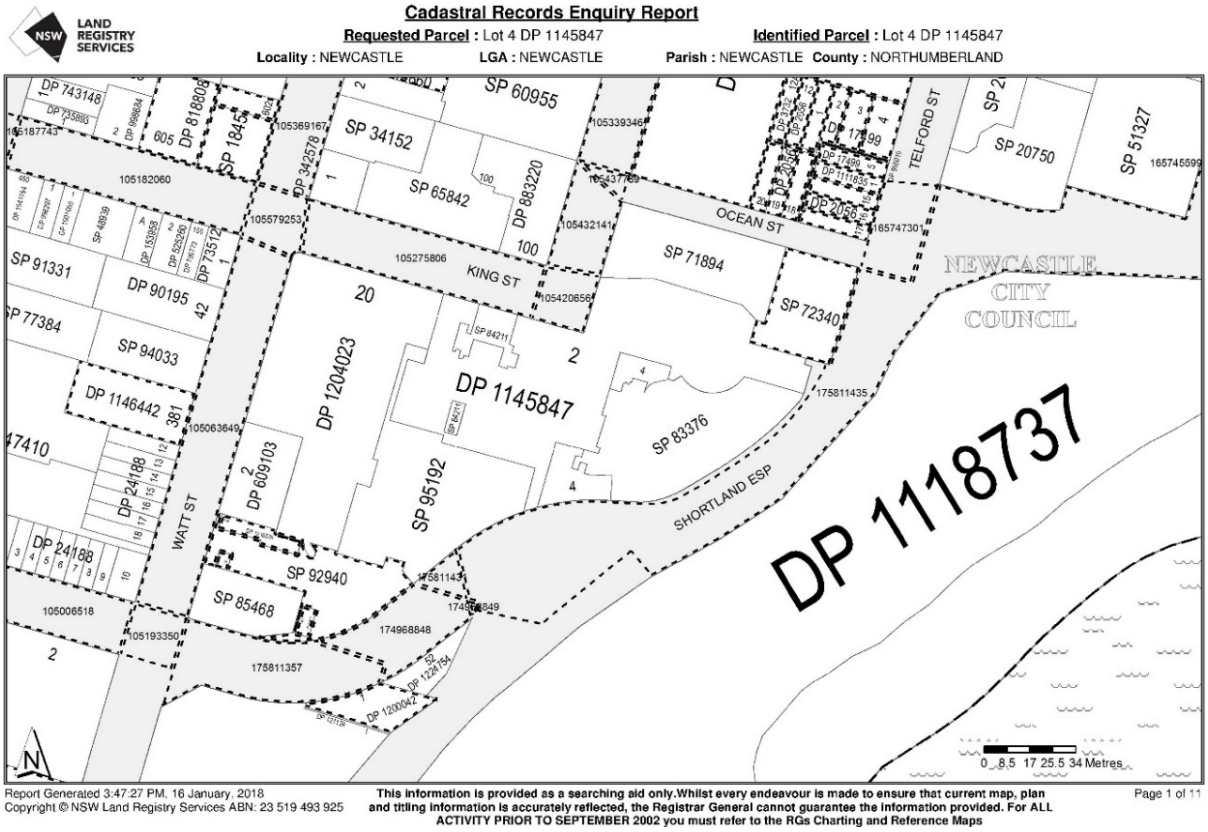

Figure 19: Map of CRE in the Newcastle East area.

If one of these plans from the notation section is on a road reserve, then a polygon ID number is used (as there is no title to refer to) and shown on the map to help refer the user to its location. Large plans, such as DP1233256, may contain multiple polygon IDs, due to the large area it is contained within (Figure 20).

Cadastral Records Enquiry Report

Requested Parcel : Lot 4 DP 1145847 **Identified Parcel :** Lot 4 DP 1145847

Locality : NEWCASTLE **LGA :** NEWCASTLE **Parish :** NEWCASTLE **County :** NORTHUMBERLAND

Status	Surv/Comp	Purpose
Polygon Id(s): 175811357, 175811431, 175811435		
DP1224752 REGISTERED	SURVEY	RESUMPTION OR ACQUISITION
NSW GAZ. 18-08-2017 ACQUIRED FOR PUBLIC ROAD - LOT 20 DP1224752		Folio : 4491
Polygon Id(s): 174968848, 175811357, 175811431, 175811435		
NSW GAZ. 18-02-2011 ACQUIRED AND DEDICATED PUBLIC ROAD FOR THE PURPOSES OF THE ROADS ACT 1993 - LOT 2 DP1029006. ERRATUM GAZ. 3-6-2011 FOL. 3479 AND GAZ. 17-6-2011 FOL. 4495		Folio : 1218
Polygon Id(s): 105006518, 105063649, 105182060, 105275806, 105339346, 105369167, 105432141, 165745599, 165747301, 174968848, 175811357, 175811431, 175811435		
DP1233256 REGISTERED	SURVEY	SURVEY INFORMATION ONLY

Figure 20: Notations of CRE in the Newcastle East area.

5 CONCLUDING REMARKS

This paper has outlined how the new SGD11 (Preservation of Survey Infrastructure) was practically applied to the Newcastle V8 Supercars – Newcastle 500 large-scale project. It was demonstrated that even on a site with little to no room to place survey marks and under severe time constraints, a good result could be obtained with close collaboration and communication. The new SGD11 has been generated to help guide surveyors and personnel authorised by the Surveyor General to preserve and protect survey infrastructure for future use by tomorrow's surveyors.

ACKNOWLEDGEMENTS

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REFERENCES

de Belin F. (2015) Re-markable roads: When is a street fix fixed? *Proceedings of Association of Public Authority Surveyors Conference (APAS2015), Coffs Harbour, Australia, 16-18 March, 232-246.*

de Witt Consulting (2017) V8 Supercars – Newcastle 500 Project: Preservation of Survey Infrastructure Strategy (POSI), provided to DFSI Spatial Services in June 2017.

DFSI Spatial Services (2017) Surveyor General's Direction No. 11: Preservation of Survey Infrastructure, http://spatialservices.finance.nsw.gov.au/surveying/publications/surveyor_generals_directions (accessed Mar 2018).

DFSI Spatial Services (2018) Application for Surveyor General Approval – Survey Mark(s) Removal, http://spatialservices.finance.nsw.gov.au/surveying/surveying_services/forms_and_applications/survey_marks_removal (accessed Mar 2018).

Dickson G. (2012) Control Surveys: Why things are the way they are and not the way you think they should be! *Proceedings of Association of Public Authority Surveyors Conference (APAS2012), Wollongong, Australia, 19-21 March, 12-28.*

ICSM (2007) Standards and practices for control surveys (SP1), version 1.7, http://www.icsm.gov.au/publications/sp1/sp1v1-7.pdf (accessed Mar 2018).

Kinlyside D. (2013) SCIMS3: The next generation Survey Control Information Management System, *Proceedings of Association of Public Authority Surveyors Conference (APAS2013)*, Canberra, Australia, 12-14 March, 174-186.

NSW Legislation (2017) Surveying and Spatial Information Regulation 2017, https://www.legislation.nsw.gov.au/#/view/regulation/2017/486 (accessed Mar 2018).

NSW Legislation (2018) Surveying and Spatial Information Act 2002, https://www.legislation.nsw.gov.au/#/view/act/2002/83 (accessed Mar 2018).

Underwood N. (2017) An Introduction to Surveyor-General's Direction No. 11 Preservation of Survey Infrastructure, *Azimuth*, 56(10), 10.