Cadastral Survey for the Sea Cliff Bridge on Lawrence Hargrave Drive by the Roads and Maritime Services

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ABSTRACT

This paper describes the cadastral survey carried out by the Roads and Maritime Services (RMS) to define the new road boundaries to accommodate the Sea Cliff Bridge on Lawrence Hargrave Drive near Clifton, NSW. The survey had to contend with inhospitable terrain and the instability of the geological structure of the Illawarra Escarpment. It is shown how the application of traditional survey techniques, coupled with modern technology, under these difficult conditions, has produced a very comprehensive and rigorous cadastral survey. The paper describes how marks that were over 100 years old were located along the ocean rock shelf, as well as locating rare stone cubes placed as monuments along the old road alignment. The political urgency of reopening the road as quickly as possible meant that design of the property boundaries was left until after completion of the bridge. This required the survey team to liaise with land owners and other stakeholders to determine the optimal final boundaries and extent of the survey. Complicating this was the need to accommodate a bridge suspended over the sea bed, reclamation of the sea bed off the NSW coast and survey requirements to protect sensitive heritage items. The survey reinstated some of the most challenging boundaries faced by cadastral surveyors including railways, irregular roads, mean high water, as well as creation of stratum lots and boundaries. The paper touches on the unique rugged beauty of the site and the privilege of being entrusted with the survey of what has become an iconic structure. Corporations worldwide are currently using images of the Sea Cliff Bridge to promote their products. The survey commenced in December 2005, immediately after completion of the bridge, with plan registration completed in April 2009.

KEYWORDS: *Cadastral survey, Sea Cliff Bridge, mean high water, stratum, heritage items.*

1 INTRODUCTION

1.1 The Problem

The section of the Lawrence Hargrave Drive between Coalcliff and Clifton hugs the most unstable section of the Illawarra Escarpment between Wollongong and Sydney, NSW. The Illawarra Escarpment north of Thirroul is noted for its instability and the risks this poses to structures and the public. In August 2003, a major rock fall onto the road surface led to the closure of this section of road by the Roads and Maritime Services (RMS) until it could be made safe for traffic. The closure follows a long history of road failures and reconstruction due to rock falls and subsidence since its opening in the 1880s. This closure virtually spilt the villages along the coastal strip into two sections, requiring those on the northern side to

endure considerable extra travel time to Wollongong and those on the southern side extra travel time to Sydney. The resulting public unrest forced the NSW government to ask the RMS to seek a permanent solution; that solution was the construction of the Sea Cliff Bridge.

1.2 The Site

The high battlements of the escarpment and the vast openness of the Tasman Sea offer a vista of some of the most spectacular coastline in NSW for motorists (Figure 1). However, the geotechnical structure of the escarpment, steep cliff faces, thick vegetation covering the escarpment and the pounding sea make this area one of the most difficult for road/bridge construction and associated survey work.

Figure 1: View of the coastline from the top of the escarpment.

This is the environment that confronted the RMS survey team to carry out the cadastral survey to define the boundaries for the new Sea Cliff Bridge. It created significant logistical and Occupational Health & Safety (OHS) problems for the team that would make the survey physically very demanding, as well as adding to the timeframe and cost.

Two examples of the logistical and OHS problems that confronted the survey team on this site were as follows. Example 1: Permanent Mark 51440 was used with PM 17237 as orientation for the survey. Permanent Mark 51440 is located in the South Coast Railway reserve on the eastern side of the track and railway fence. To gain access to the mark, the survey team had to drive to the western side of the railway, seek permission to enter private property, then proceed along the old Clifton School right-of-way access track, then walk via a creek bed and through a concrete pipe culvert under the railway line back to the eastern side of the railway line, and finally cut a track through thick lantana to reach the mark. Example 2: All survey marks placed by this survey along the base of the cliff were reference marks set back from the cliff to minimise the hazard of falling rocks to this survey team and surveyors using the marks in the future (see lot 23 on sheet 3 of DP 1137408 included in the appendix of this paper). No survey marks were placed along boundary lines near the cliff face for safety reasons.

The survey team's first visit to the site was just prior to the bridge's opening in December 2005. This enabled them to consult with construction personnel to understand OHS risks associated with the site and develop a Safe Work Method Statement (SWMS) specific to the cadastral survey. The Safety Management Plan for construction identified the risk of rocks falling from the escarpment onto the old road formation as high and recommended avoiding work in that area where possible but if necessary then a lookout was required. Figure 2 shows a typical rock fall that led to the closure of the road in August 2003 and was still possible during the time of the survey.

Figure 2: Typical rock fall during 2003.

The survey team agreed that at least three staff were required whenever survey work was carried out on or near the old road formation at the base of the cliff or close to the water's edge.

The geology of the escarpment has seen many rock falls and slips throughout the existence of Lawrence Hargrave Drive along this section of road. Since 1980, the RMS has carried out significant restoration work in this area after road failures. This has involved removal of the existing road formation, sometimes to depths of 18 metres and rebuilding the road. Finding survey monuments along this section of the road corridor was considered very unlikely because of these road failures and restoration works. However, it was still incumbent on the survey team to search for these monuments to establish their existence or otherwise.

1.3 Project Alliance

Due to disruption to local traffic created by the road closure, the RMS developed an Alliance to deliver the Sea Cliff Bridge as quickly and efficiently as possible. Alliances are expected to reduce the planning and tendering phase as well as reduce friction during construction. There are also incentives to contractors based on any efficiency gains they may develop to reduce construction costs. The partners for the Alliance were the RMS to oversee and manage the project, Barclay-Mowlem to carry out construction, Maunsell to carry out the design and Coffey Geosciences for geotechnical services.

However, while there were efficiency gains and tight time and budget constraints were achieved, there were implications for the cadastral survey. The RMS did not carry out its

normal practice of planning and charting property boundaries during the planning phase of the project. The urgency of reopening the road to the public and the dynamic nature of the Alliance, where the design was carried out during construction, restricted the ability of the RMS to pre-plan and design the final cadastral boundaries. The Authority was not in a position to chart cadastral boundaries as the final size and position of the structures were still being finalised. They therefore made the decision to postpone work on property boundaries until after or near completion of the work. An email from the Alliance's Public Liaison Officer to the RMS Property Manager in September 2005, just three months prior to the opening of the bridge, states that they were then ready to determine the land required for the works.

This made the scope of the Survey Instruction for the cadastral survey open-ended and deliberately vague, leaving the survey team to liaise with stakeholders to determine the optimum position of the final boundaries. This was possible on this project as the affected land was owned by three other government agencies, apart from land owned by the Illawarra Coke Works. That part of the Illawarra Coke Company land affected was unused due to its physical terrain and, in addition, the proposed acquisition had no effect on their coke making operations. The affected government-owned property was basically unused due to its physical terrain.

Nevertheless, it was still necessary that the cadastral survey provided the RMS with sufficient land to maintain the road and that the road did not encroach onto land they did not own. There were also a number of heritage items identified in the Review of Environmental Factors (REF) that had to be protected from construction and future maintenance work. These items also had to have public access.

2 FIELD SURVEY

2.1 Survey Traverse

The work-as-executed plans for the bridge could not be located, so the original intention was to traverse along the bridge's footway to check that the bridge was constructed to design. This method would also enable radiations from the bridge deck to look for marks on the old road formation and on the 30.48-metre reserve from mean high water. However, RMS bridge engineers advised that the bridge could not be considered a stable structure and movements of up to 100 mm were possible. Another solution was required.

Traversing over the escarpment with its height, steep slopes and thick vegetation was not considered as an option. The next option was to use the rock shelf, which is uncovered for some distance from the shoreline at low tide. Geotechnical advice was that the shelf was much more stable than the escarpment and therefore suitable for placing survey marks. A suitably placed mark would enable a surveyor to sight both ends of the survey and to look for marks along the old road corridor and shoreline. These requirements determined the position of SS 141552 (see sheet 4 of DP 1137408 in the appendix).

However, as shown on DP 1137408, this mark is on the seaward side of mean high water but is nevertheless frequently uncovered. Therefore survey work occupying the mark had to be planned in advance, including consultation with the RMS Survey Manager to provide extra staff for OHS compliance. It also needed optimum predictions for rain, tide, wind direction

and strength, wave direction and height and, on one occasion, satellite availability for GNSS observations to ensure successful completion of survey tasks (Figure 3).

Figure 3: GNSS position fixing of SS 141552.

GNSS was used to establish the control network due to the rugged nature of the terrain, accessibility of marks and length of sight lines (sheet 8 of DP 1137408 contains the control survey: RMS Control Plan number 0185.497.CS.8243). However, as the bridge was designed on the Integrated Survey Grid (ISG), the survey was carried out on ISG orientation, which made it easier to compare the bridge's design position with its constructed position.

2.2 Survey for Stratum Lots

The RMS Property Manager originally expressed the view that the survey should create a stratum two metres below the soffit of the bridge and in plan view, two metres either side of the constructed bridge, to enable access to the road surface and, if needed, to the soffit of the bridge from equipment placed on its deck. The RMS has adopted this policy for bridges, particularly in residential areas, where the bridge is over private land or land in public use. It negates the need to resume land underneath bridges.

The Property Manager also felt that there should be easements of support over the batters of the road for maintenance purposes.

In order to define stratum lots to accommodate the bridge structure, the survey team traversed along the old road formation, placing traverse stations on the extended centreline of the piers that were to be included in the stratum. The extended centreline was determined by eyeing out either side of the pier with a plumb line and the traverse station placed equidistant between these two points. This enabled an XYZ check of the bridge at known cross section by reflectorless radiation to bridge components.

During construction, the Alliance surveyors established the survey control network for the bridge by fixing (gluing) survey control marks (reflectors) to the face of the cliff. These were still in place during the cadastral survey. These marks were also radiated to compare the design position of the bridge components to their constructed position. Generally, good

agreement was found with the constructed position of the bridge fitting with its design position within the order of one to two centimetres.

The survey team also spent some time radiating and coordinating extremities of gabion walls, that formed batters and other road structures that supported the road formation, to establish the extent of proposed easements of support.

However, after spending considerable time in the field, it became apparent that the stratum envisaged for the bridge was not the most efficient approach for this project. This was based on the fact that the bridge was over land in the control of the Crown Lands Division of the Department of Primary Industries (CLD of DPI) and the main use of the land was access to the shoreline. Land between Lawrence Hargrave Drive and the Tasman Sea contains a steep slope which has a high risk of slips and falls and a rock shelf, which only the hardy access for rock fishing.

It was then decided on resuming all of the land between the old road alignment and mean high water for the new road without creating a stratum for the bridge. This solution provided a far less complex cadastre of the affected land than that originally envisaged.

There are a number of precedents of bridges carrying traffic over waterways without the need to create a stratum for the bridge, e.g. the Sydney Harbour Bridge. However, where the bridge is suspended over a waterway and is part of a toll road, then creating stratum lots for the bridge would be required as the road is leased to the tollway consortium for the life of the tollway lease. The lease must include the physical structures of the road and allow access for maintenance of the road/bridge. However, the option of a toll for this section of road was not considered.

In addition, defining and marking easements for batter support for the road would be of little value given the unstable nature of the terrain in the vicinity of the road formation. Defining land outside the toe of batter for maintenance access was problematic given the steep slope on which the batters are built. Also, the nature of maintenance work on this road would, more than likely, destroy any survey marks if reconstruction of the batter was required. However, a stratum lot was created for the heritage items as outlined in section 2.3.

2.3 Heritage Items

The land in lot 6 of DP 1137408 is part of the 30.48-metre reserve (plan 3045-3000) and will remain in public ownership with the CLD of DPI. On sheet 2 of DP 1137408, Diagram B shows lot 18, which is a stratum lot above a stratum plane of 31.0 m AHD and above lot 6.

Lot 18 includes the bridge which after resumption will be dedicated as road and will be vested in Wollongong City Council. If the stratum lot was not created, then lot 18 would include the heritage items, which in turn would become the responsibility of the council; something the council did not want. To overcome this problem, for the land bound by the plan dimensions of lot 18, only that which is above RL 31.0 metres AHD is dedicated as road and that which is below 31.0 metres AHD remains part of lot 6 and as part of the 30.48-metre reserve.

The heritage items in lot 6 include:
1. Steel boiler used during the life of the closed Coalcliff mine.
2. Entrance to closed Coalcliff mine, which was sealed in 1992.

3. Some brickworks placed to stabilise the cliff near the mine entrance.
4. Entrance to an air vent tunnel for the mine.

The REF describes the boiler and the brickwork as having high significance. Figure 4 shows the sealed entrance to the mine and the brickworks.

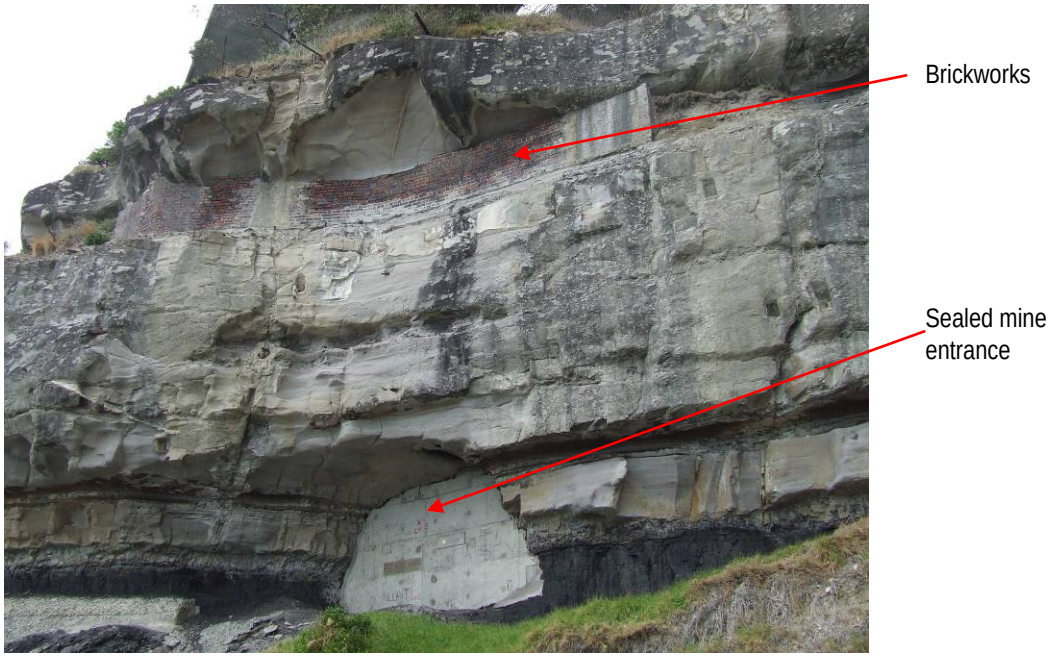


Figure 4: Sensitive heritage items.

All of the items listed above are under the bridge except for the air vent tunnel entrance and some of the brickworks. The shape of lot 6 north-west of lot 18, as shown on sheet 2 of DP 1173408, is to include the air vent tunnel entrance and the face of the cliff where some of the brickworks for stabilising the cliff face were placed. Figure 5 is a LISCAD screen dump showing the position of heritage items and other features which determined the shape of lot 18. It also shows other mine buildings and the jetty, the remains of which are no longer visible but were relocated by using measurements shown in Surveyor Hall's field book (FB 7612).

The significance of the old mine boiler was highlighted at the start of the project and caused a change in the bridge design when it became clear that a bridge pier was to be constructed over it. The bridge pier shown green in Figure 5 is in the final constructed position, not in the position originally intended.

The boundary of lot 6 north-west of lot 18 had to pass between the pier and the boiler to ensure that the pier is located in lot 19 (to be dedicated as road) and the boiler remained in lot 6. The two green rectangles shown in Figure 5 are the outlines of the pile cap and the pier itself.

The REF describes the boiler as 4 metres long and 0.6 metres in diameter (although Figure 6 suggests that it is a 0.6-metre radius, not diameter), consisting of seven cylindrical hoops riveted together.

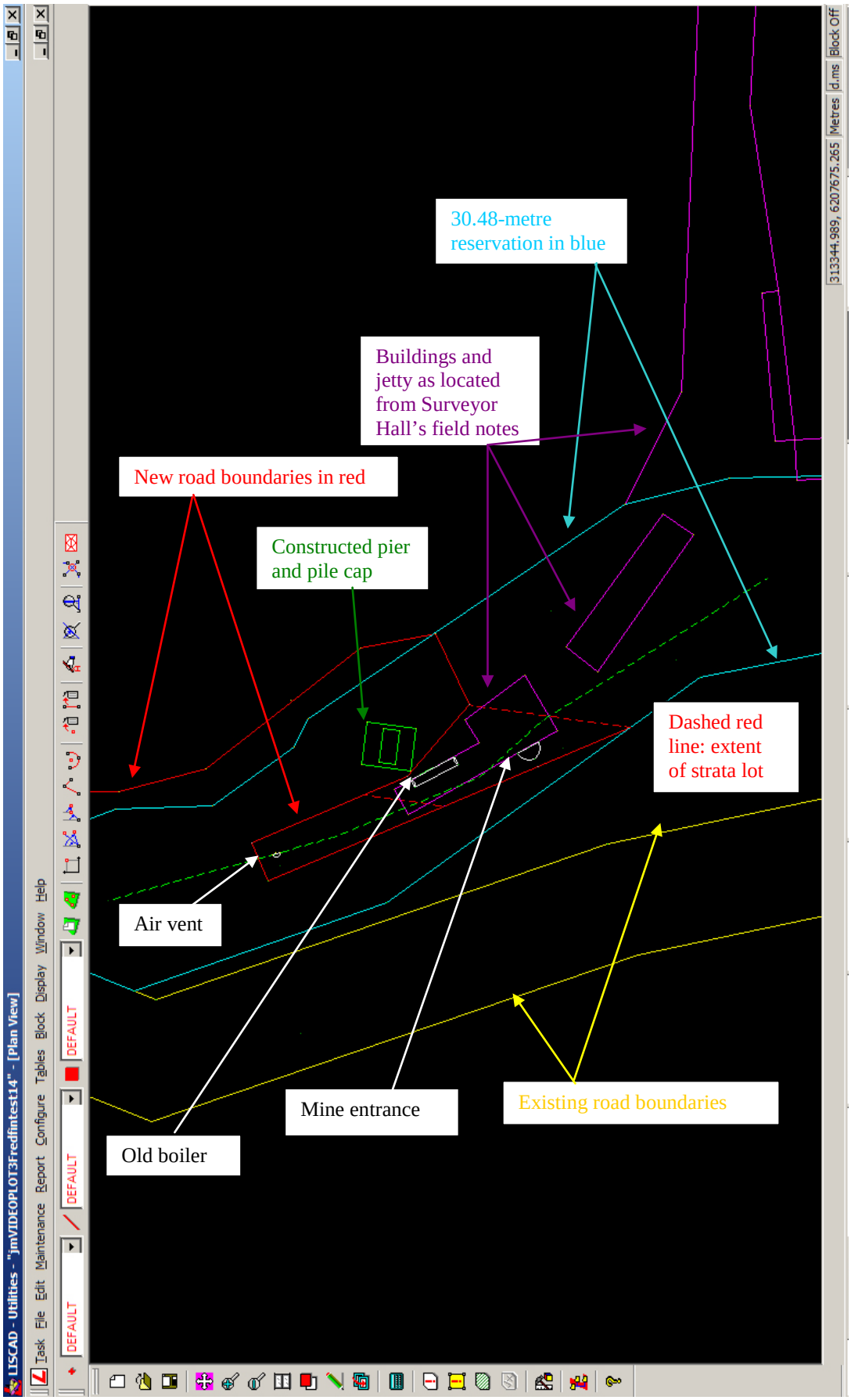


Figure 5: LISCAD screen dump of heritage items.

Figure 6: Land Surveyor Stephen Bennett with the exposed boiler.

2.4 Illawarra Coke Company Land

In order to protect Lawrence Hargrave Drive from future erosion and rock falls at the northern end of the site, the RMS required an easement over land owned by the Illawarra Coke Company, shown as lot 13 on sheet 6 of DP 1137408 (see appendix). They want to restrict access to land shown as [G] and establish an easement for stabilisation over the area for that purpose. Easement shown as [E] is for access to [G] should restoration work be required.

Clause 18 of the Surveying and Spatial Information Regulation 2006 (Lands, 2006) requires that the terminals of an easement must be connected to a monument. The survey team were able to locate survey marks for a connection to the northern end of the easement [E] from recent survey plans. However, finding a monument for connection to the southern end of [E] was much more problematic and difficult, particularly given the rugged terrain.

The decision was made to search for survey marks where the South Coast Railway land cuts the northern boundary of land survey by DP 397976 along the top of the escarpment. An initial trek through thick vegetation and bush to the top of the escarpment carried out a reconnaissance using a handheld Garmin GNSS receiver. However, this revealed that the likely positions of the marks were covered by thick ferns. The survey team made their first visit to the top of the escarpment without survey equipment as they were unsure of the terrain and undergrowth and of the likelihood of the existence of the survey marks. Before making the long trek back down, they placed a traverse station from which they could sight PM 17237 at the southern end of the survey and SS 141552 placed on the rock shelf outside the shoreline (see sheets 1 and 4 of DP 1137408 respectively).

The second trek to the top of the escarpment was much more difficult as it required hauling in the necessary survey equipment, which required extra staff. Before leaving on the trek, a new risk assessment of the proposed work on the escarpment was carried out with new safety controls implemented for the SWMS. The walk took about 45 minutes with the last 200 metres through waist high dense fern that covered a large number of fallen logs, creating the perfect situation for slips, trips and fall hazards.

However, the effort was rewarded when the reference mark, a galvanised iron pipe, on the eastern boundary of the South Coast Railway reserve was located with the aid of a metal detector. This was without the assistance of a calculated radiation from the traverse station placed by the first reconnaissance. It is believed that this exposure of the reference pipe is the first time in the 50 years since the original survey.

The determination of the position of the traverse station was by an eccentric station fix procedure by measuring distances to PM 17237 and SS 141552, as well as the included angle. Later, distances from those two marks back up to the traverse station, as well as the included angles, were also measured to give a more accurate fix of the traverse station. Finding the reference pipe allowed calculation of radiations to the other survey marks for the cuts on the railway boundaries, which were also located.

3 PROPERTY BOUNDARIES

3.1 Boundary Reinstatement

3.1.1 Lawrence Hargrave Drive

Surveyor Henry Fraser Hall carried out the survey to define Lawrence Hargrave Drive between Clifton and Coalcliff in 1908, and a survey to create the 30.48-metre reserve to the east of the road in 1909. The road plan is 9592-1603 and the 30.48-metre reserve is shown in plan 3045-3000. Surveyor Hall's original field notes are contained in Field Book number 7612.

A feature of the road survey was the placement of stone cubes with a drill hole and broad arrow to mark angles in the road (Figure 7). Surveyor Hall also carried out a survey in 1909 to create a right-of-way to the Clifton School and also placed stone cubes with a drill hole and broad arrow for that survey (see DP 935466). The survey team located some of the stone cubes to refix the road boundary, one of which was buried 600 millimetres.

Figure 7: One of the stone cube monuments placed by Surveyor Hall.

A stone cube was located at the southern end of the survey near Clifton School Parade as well as two stone cubes being located in Clifton School Parade (DP 935466) and two more stone

cubes at the northern end of the survey near Paterson Road. Good agreement was found between the three stone cubes at the southern end. One of the stone cubes at the northern end was shown as disturbed by DP 636375. The refix of Lawrence Hargrave Drive at the northern end showed that the most eastern stone cube has continued to move since the survey for DP 636375. The only survey mark found between the stone cubes at either end of the road survey was a reference mark drill hole and wing placed (DP 397977, 1956) in the face of the rock cliff at the most eastern corner of lot 17 of DP 1137408, which was adopted.

Surveyor Hall's use of the stone cubes found by the survey team as survey monuments is unusual if not unique. A literature search failed to provide extra background information about the stones.

Some surveyors of the time were critical of the use of 4-foot high alignment posts as it was not possible to set the instrument over them and suggested instead that placing a mark in the ground would be more user-friendly. Whether Surveyor Henry Hall's use of stone cube marks was prompted by this feeling is not known but the use of stone cubes appears not to have become widespread. However, Henry Fraser Hall still holds a significant place in the history of surveying by being appointed the Surveyor General of NSW in 1925.

Two rock marks shown as found by the road survey (plan 3045-3000) were found at the northern end of the survey (Figure 8). However, plan 3045-3000 did not show any reference to the origin of these marks. This required further investigation to establish their origin before they could be shown on the final Deposited Plan for this survey. A search located a road survey from Blue Gum Forest to Coalcliff carried out by Surveyor John Richmond in 1883 shown in plan 1778A-1603. This survey was a re-survey of that section of road that was originally surveyed in 1863. In almost 50 years of cadastral surveying, these are the oldest marks sighted by the co-author of this paper. Adoption of the two rock marks strengthened the boundary fix of Lawrence Hargrave Drive (see sheet 4 of DP 1137408 in the appendix).

Figure 8: One of the 1883 rock marks found at the northern end.

3.1.2 Mean High Water

At the southern end of the survey a 30.48-metre reserve from mean high water of the Tasman Sea abuts the land to the east of the old road reserve. Further north the 30.48-metre reserve abuts the old road reserve and, in places, cuts across it (see sheets 1 and 2 of DP 1137408). As

mean high water is a natural boundary it must be redefined to redefine the 30.48-metre reserve. Plan 3045-3000, lodged in 1909, shows high water as the eastern boundary of the 30.48-metre wide public reserve. The Survey Practice Regulation states that where a plan shows high water it can be accepted to be mean high water.

The terrain where mean high water was to be located is a rock shelf that is resistant to erosion of any significant amount in the past 100 years. Any accretion by rock falls would not be gradual or imperceptible and therefore cannot be taken to change the mean high water boundary. Therefore, the opinion was expressed, and accepted by NSW Land and Property Information (LPI), that high water as defined in 1909 would still define the mean high water boundary today. Therefore, redefining the 1909 boundary would redefine the mean high water. Survey marks along the rock shelf east of the road were more likely to be found than survey marks on the old road formation due to the instability of the cliff face.

Marks found in Clifton School Parade shown in DP 703699 and DP 397977 redefined Clifton School Parade and its intersection with Lawrence Hargrave Drive. DP 397977 also provides a connection to the southern boundary of the 30.48-metre reserve. This enabled calculations for radiations to search for survey marks shown on plan 3045-3000. Marks were also found at the northern end of the survey near Paterson Road, which provided a connection to the northern end of the 30.48-metre reserve. This would have provided a fix of the reserve but it is still incumbent on a surveyor to look for all survey marks when refixing a boundary. Many cadastral surveyors feel that one of the more rewarding experiences in surveying is where the survey team is searching for and finding survey marks that are not readily apparent, especially those marks that have not been found since they were placed.

The probability of finding the rock mark at the eastern end of the southern boundary of the 30.48-metre reserve at first appeared very small (Figure 9). The amount of slips on the side of the slope and the quantity of rocks on the rock shelf below suggested that the mark was, at least, inaccessible. However, as shown in Figure 10, the mark was located and found to be in good agreement with other traverse marks found from 3045-3000. Six traverse stations from 3045-3000 were found, as shown on sheets 1, 3 and 4 of DP 1137408, which enabled reinstatement of 3045-3000.

The refixes of Lawrence Hargrave Drive and the 30.48-metre reservation were carried out independently from marks found in both plans. However, the two plans intersect where the reservation abuts the road reserve. The abuttal common points were used to reinstate the western boundaries of the 30.48-metre reservation using dimensions shown by plan 3045-3000. The abuttal common points are shown on sheet 3 of DP 1137408 adjacent to lot 21.

The marks found placed by 3045-3000 were traverse stations with traverse lines shown as blue lines. The plan did not contain dimensions of the mean high water boundary of the reserve. However, Surveyor Hall's 1909 field book for the survey (Field Book number 7666) showed the offsets from the traverse lines to high water. Using these, it was possible to calculate joins between the ends of the offsets to produce a right line boundary approximating the mean high water boundary of the reserve as shown on sheets 1, 2 and 3 of DP 1137408 in the appendix.

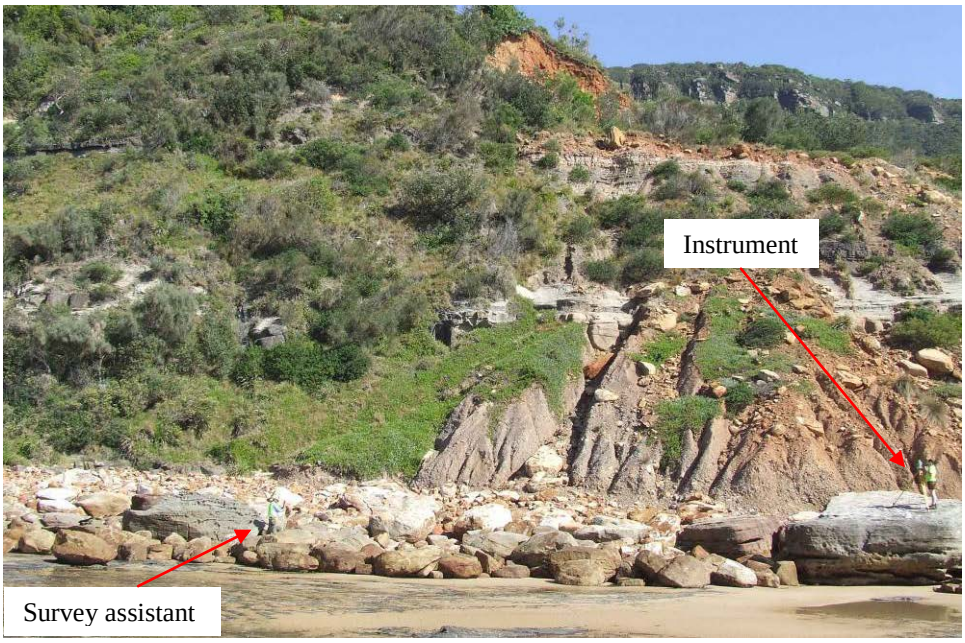


Figure 9: Searching for Surveyor Hall's rock mark.

Figure 10: Radiating rock mark placed by Surveyor Hall in 1909.

Surveyor Hall's Field Book 7666 with the offsets to high water was invaluable for refixing the eastern boundary of the reserve. The notes also include the raw field measurements. It was decided to go through and check all of the field reductions to ensure a precise refix of the boundary as originally measured by Surveyor Hall. This led to the discovery of a 1-minute error by Surveyor Hall in carrying the bearings through the traverse, which was corrected.

3.2 New Boundaries

3.2.1 Lawrence Hargrave Drive

There were some restrictions that had to be considered when creating the new boundaries for Lawrence Hargrave Drive, as outlined in Table 1. The lot numbers reference DP 1137408.

Table 1: Creation of New Boundaries for Lawrence Hargrave Drive.

Lot	Boundary	Constraint	Action
14	western	Wollongong City Council constructed a children's playground on lot 10 after a batch plant used for construction left the site.	The boundary to the first angle is set by the fence line.
14	western	The Alliance constructed gabion baskets for batter protection on lot 14 north of the playground.	Boundary placed to include gabion baskets in the road reserve.
16	western	The new road formation encroached over the western side of the old Lawrence Hargrave Drive alignment. The Roads and Maritime Services (RMS) also required a storage area in the event of restoration work in the future.	Boundary placed to remove encroachment and taken back to edge of clearing for a possible worksite.
15	eastern	Provide sufficient resumption to accommodate road and leave access to the 30.48-metre reserve and not encroach on to the public park at southern end.	Boundary placed to suit these criteria.
6	northern	Heritage items, see section 2.3.	
23	western	The construction of safety fences, gabion baskets and stormwater calming devices to control rock falls and erosion of the cliff on western side of road.	Boundary placed to include all items and maintenance access.

3.2.2 Easements

(a) Easement for stabilisation

The geological instability of the land behind the cliff to the west of the road makes it unsuitable for development and poses a threat to the long-term viability of the road. Lot 17 in DP 1137408 was under the control of the Minister for Environment and Planning. The Roads and Maritime Services (RMS) acquired this land and dedicated it as road for that reason.

The Illawarra Coke Company owns the land north of lot 17 for coke production. However, for obvious reasons, they are not using the unstable land behind the cliff adjacent to the road. Therefore, they were agreeable to the RMS creating an easement for stabilisation over that land to protect the road.

A large section of the coke works land abuts the road north of the bridge where the road formation is close to the cliff face. The Alliance removed loose material from the cliff face at the northern end and inserted rock anchors to stabilise the cliff.

The survey brief was to create easements to accommodate the rock anchors and the unstable material. However, the Alliance was unable to provide any work-as-executed plans showing the location of the rock anchors. Consultation with the Alliance engineers revealed that the geological structure of the cliff face governed the depth of the anchors but none were driven to a depth greater than 20 metres. Therefore, an easement set back at least 20 metres from the cliff face would include the rock anchors. The most northern line of the easement boundary that meets Lawrence Hargrave Drive (17°04'50" – 118.56 as shown on sheet 6 of DP 1137408 in the appendix) includes the rock anchors.

However, the easement boundary south of the rock anchors was not as easy to define. The easement should include all of the loose talus material above the cliff face. To find the top of the slope, the survey team started at the bottom and climbed up through thick bush and lantana along an eroded and overgrown track. After an hour of the climb it became obvious that the slope extended all the way to the top of the escarpment. It was then decided to create

the easement such that it would include the top of the escarpment at the south western corner of lot 13.

(b) Easements for power lines and access

With the closure of Lawrence Hargrave Drive in August 2003 the power lines along the old road were also removed. At the Coalcliff end the power was joined to the existing grid within Illawarra Coke Company land. The Alliance agreed to create an easement over the coke company's land for the overhead power lines, which is shown as easement [F] on sheet 7 of DP 1137408 in the appendix.

Easement [E] was created for access to the easement for stabilisation for maintenance purposes.

4 LAND TITLES

4.1 Reclamation of the Sea Bed

The Sea Cliff Bridge is believed to be unique in NSW because it carries traffic over the sea bed, i.e. the bridge is on the seaward side of mean high water and outside the boundary of NSW. The section of road where this occurs is shown on sheet 2 of DP 1137408 to the east of where lot 20 abuts lot 19. The eastern boundary of lot 20 (3,403 m^2) is noted as the *Approximate Extent of Reclamation* on the plan. Lot 22 (383.7 m^2) is also land reclaimed from the sea bed but its main use is for an access track.

A permanent solution for this section of road called for construction of the bridge far enough east of the existing road such that rocks falling from the cliff face would not reach the travelling public, this included rocks that may bounce off the existing pavement into the sea. This necessitated construction of some of the piers on the sea bed. Construction of piers in water is not uncommon as noted by the number of bridges across large expanses of water in NSW. Construction is usually achieved by constructing temporary coffer dams around the piers. However, construction of coffer dams on this site was not possible as the rock shelf would prevent sheet piles being driven into the sea bed.

In addition, designers were concerned about the corrosive effect of salt from the sea on the steel reinforcement within the bridge piers. This was partially addressed by designing a cathodic prevention system within the piers to minimise corrosion. There was also concern about the wave motion of the sea that could cause salt water to splash over the piers, adding to the amount of salt that could affect the steel. Raising the pile caps above sea level would minimise the possibility of sea water splashing over the pile caps and piers.

Reclamation of some of the sea bed was carried out to allow construction of the piers on compacted land raised above sea level and for access tracks for construction of the piers. Figure 11 shows one of the piers constructed on compacted fill placed on the reclaimed sea bed.

The boundary of the reclamation was defined where the toe of the batter of the imported material forming the platform for the piers met the sea bed.

Figure 11: Pier constructed on land reclaimed from the sea bed.

4.1.1 Title of the Sea Bed

The RMS had not confronted the problem of acquiring land from the sea bed prior to this project. Initial search carried out regarding title of the sea bed located an article on boundaries in the 1932 edition of the Australian Surveyor. This article reported on a lecture by A.W. Miller, MIS NSW, given to the Institution of Surveyors, NSW in September and October of 1931 (Miller, 1932). In it, Mr. J. Le Gay Brereton, Barrister-at-Law, gives precedents to the Crown owning the sea bed. He also gives precedents indicating that the title of the Crown extends seaward for three miles from mean high water.

The RMS Surveying Manager sought advice from the Chief Surveyor for the ACT, ACT Planning and Land Authority, regarding the status of land below mean high water and if there is a title for it. The advice included reference to mean high water and mean low water.

Original legal definition from England by letters patent sent to the Crown colonies decreed that the limit of State's land is mean low water. It is understood that this still applies in NSW. As the land abutting the foreshore is Crown Land under the control of the CLD of DPI, the land out to the mean low water is also under the control of CLD of DPI. During the 1970s there was a dispute between the Commonwealth and the states over ownership of the sea bed outside the area defined by the letters patent. This resulted in the High Court bring down a decision that the sea was owned by the Commonwealth. However, the Federal Government's Offshore Constitutional Settlement Act in 1982 gave the states ownership of the sea bed, known as the territorial sea.

Determination of the mean low water mark for this project was seen as of little value as land between mean low and mean high water still resides with the Crown and is controlled by the CLD of DPI. Therefore, it was decided that the reclaimed land would be placed in one lot without a partition for the land between the two mean water levels. This is shown by lots 20 and 22 of DP 1137408, which are the two areas of reclamation required for construction of

the piers. The Administration Sheet of DP1137408 shows the approval of the plan by the Nowra Crown Lands Office.

4.2 Crown Land

Plan 3045-3000 is a plan of the 100-foot (30.48-metre) reservation within portion 18, which was approved on 30 June 1909. However, this was unreserved Crown Land until the issuing of Government Gazette of 29 June 2007 folios 4182-4213, which created Reservation numbers for all unreserved Crown Land in each parish in NSW. The Government Gazette lists each parish within NSW and gives each one a different number for all unreserved Crown Land within that parish starting from R750000. All previously unreserved Crown Land in the Parish of Southend, which covers this survey, is now listed as reserved Crown Land in R752054. This includes the 30.48-metre reservation created by 3045-3000.

However, Mining Lease 3 was issued over part of the reservation shown in pencil on 3045-300 on 10 October 1910 and plan ML3. The Government Gazette issued on 5 February 1913, over that part of the 30.48-metre reservation outside of the mining lease, created Reservation R48541 for Public Recreation. The RMS Senior Property Road Corridor Officer's contact with the Department of Mineral and Resources revealed that the Mining Lease ML3 had expired and the land covered by that lease is now included in Reservation R752054. The southern boundary of lot 6 of DP 1137408 is along the southern boundary of expired mining lease ML3. Similarly, the boundary between lots 19 and 21 of DP 1137408 is along the northern boundary of the expired mining lease.

The title of DP 1052428 is a "Plan of Crown Land Showing Former Artificial ID". This is a plan of the northern portion of the 30.48-metre reservation north of the expired mining lease and is shown as lot 7037. This plan was prepared by LPI as departmental plan and created a limited title over the land. DP 1117499 is a plan for Crown Land conversion of the 30.48-metre reservation abutting the southern boundary of DP 1052428 and the northern boundary of the expired mining lease and is shown as lot 7036. The boundary between lots 21 and 24 of DP 1137408 is along the boundary between lots 7036 and 7037 as described above.

4.3 Land Owned by the Minister Administrating the Environment Planning & Assessment Act 1979

The National Parks and Wild Life Services (NPWLS) resumed land shown as lot 9 in DP 1137408 in 2005 and dedicated it as the "Illawarra State Conservation Area" (see Government Gazette 11-3-2005 folio 754). However, no instrument or advice was passed on to LPI in order to inform LPI of the resumption, so that the title to the land owned by the Minister Administrating the Environment Planning & Assessment Act 1979 (EPA) was not amended. A title search of the land showed that the EPA land comprised all of lot 32 in DP 881726, which is the original parcel of land prior to the resumption. The RMS Senior Property Road Corridor Officer alerted LPI to the resumption while preparing the search for the final plan for the Sea Cliff Bridge survey. A recent folio identifier of the land includes reference to the NPWLS resumption but still shows the land as 32/88176. Sheet 5 of DP 1137408 is a subdivision of land owned by the EPA, with NPWLS requiring lot 9 for the conservation area and the RMS requires lot 17 for road. This subdivision assisted the EPA's administration of their property.

4.4 Ownership of 30.48-metre Reservation

The 30.48-metre reservation around the shoreline is Crown Land and is normally the responsibility of the CLD of DPI. However, the RMS Senior Property Road Corridor Officer could not gain concurrence over the ownership of the land between the CLD of DPI and Wollongong City Council, with both parties advising that the land is the responsibility of the other agency. The matter was finally resolved by phone conversation between the three agencies with the CLD of DPI assuming responsibility. This allowed the RMS Property Section to enter into negotiations to acquire the land for road from the CLD of DPI.

5 PLAN PREPARATION AND PRESENTATION

The field survey for the Sea Cliff Bridge cadastral boundaries was carried out using a Leica TCRA 1103 PLUS total station that stored the data on a Compact Flash Card. The data was then transferred to LISCAD software for processing. A LISCAD *.see file was then used to create a plot of the survey. A hard copy plot of the survey was then printed and all the relevant survey information added by hand before passing onto the Cadastral Information Officer in Goulburn and the Senior Property Road Corridor Officer in Wollongong for plan preparation. The LISCAD *.see file was changed to a *.lcd file to prepare the final plan. The plan was lodged electronically by “ePlan” following normal RMS practice.

The plan title is “Plan of land to be acquired for the purposes of the Roads Act, 1993 and proposed easements” and is a plan of acquisition. A plan of acquisition is sometimes called a “non-current plan” as the lots shown on the plan are only activated after the land has been acquired by the RMS, which may be some years in the future. On each sheet of DP 1137408 the current folio identifier, plan reference and, where appropriate, reference to any government gazettes affecting the land, are provided for each lot created by the plan to assist the acquisitions process. This arrangement is an agreement between the RMS and LPI and is not available for subdivisions carried out by the private sector.

LPI granted the RMS Property Section approval to present the plan for the survey in more than four sheets as normally specified; the final number of sheets being eight, plus two administration sheets.

The plan was drawn on MGA94 grid orientation in compliance with RMS policy. Sheet 8 shows the survey control for the cadastral survey and is the only sheet to plot the Sea Cliff Bridge, but without any dimensions. This plot was considered appropriate as the bridge itself is not shown anywhere on the plan in relation to any boundaries. This will assist surveyors in the future to establish their general position in relation to the bridge structure.

6 CONCLUDING REMARKS

The creation of the property boundaries for a 21st century icon, the Sea Cliff Bridge, is an example of latest survey technology working with the traditional practices of boundary definition to refix boundaries that were created over 100 years ago. RMS surveyors carrying out the survey used the latest electronic total stations and data recorders to collect field data for the survey and current computer software to carry out survey calculations for processing the survey. The data were electronically transferred to Cadastral Information Officers for plan

preparation and verification of property information before lodging the plan electronically with the Land Titles Office. The use of the latest GNSS equipment and technology also assisted the field survey in both expedience and precision.

However, all this technology is of little value if survey knowledge and experience is not applied with it. The final DP was signed by Registered Land Surveyor Stephen Bennett, who has almost 50 years survey experience, principally as a cadastral surveyor, and that knowledge was required for this survey. The instability of the land where the survey was carried out makes it difficult to find survey marks and if found, to gain agreement between them. This survey was able to demonstrate that the application of traditional cadastral survey techniques and practices still provides the best outcome. But the logistical challenges described in this paper made it much more difficult than normal to apply those techniques and practices. The team's field search for survey monuments along the shoreline and the escarpment, and the history search to locate the origin of survey monuments placed in 1883, are evidence of the application of experience and dedication to this survey.

Refixing irregular road boundaries, natural boundaries and railway boundaries is always a challenge but not uncommon. Refixing these three boundaries when in close proximity and running nearly parallel to each other is far less common. Refixing these boundaries, as well as reclamation of the sea bed, with the logistic problems encountered during this survey, makes it unique.

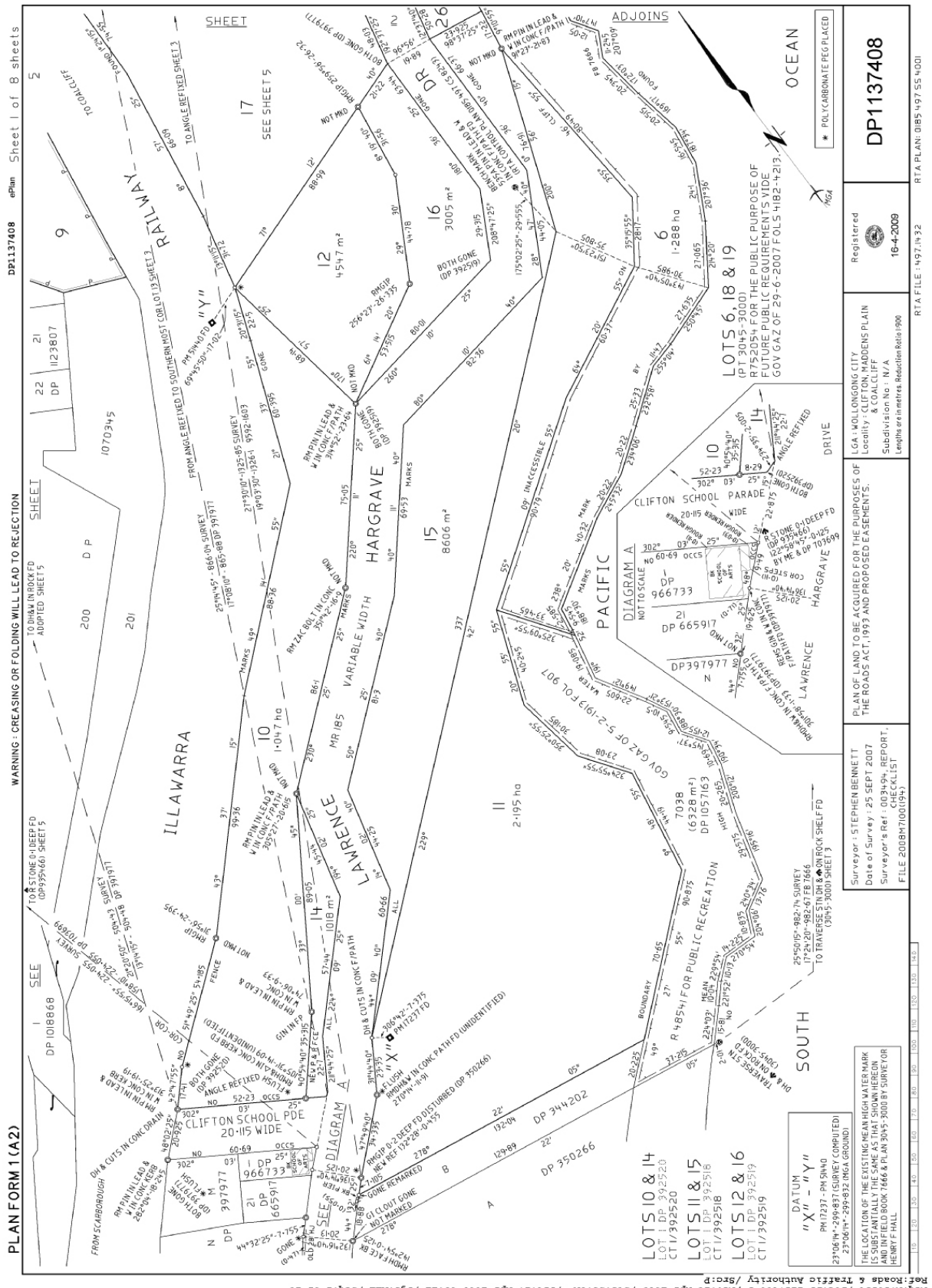
REFERENCES

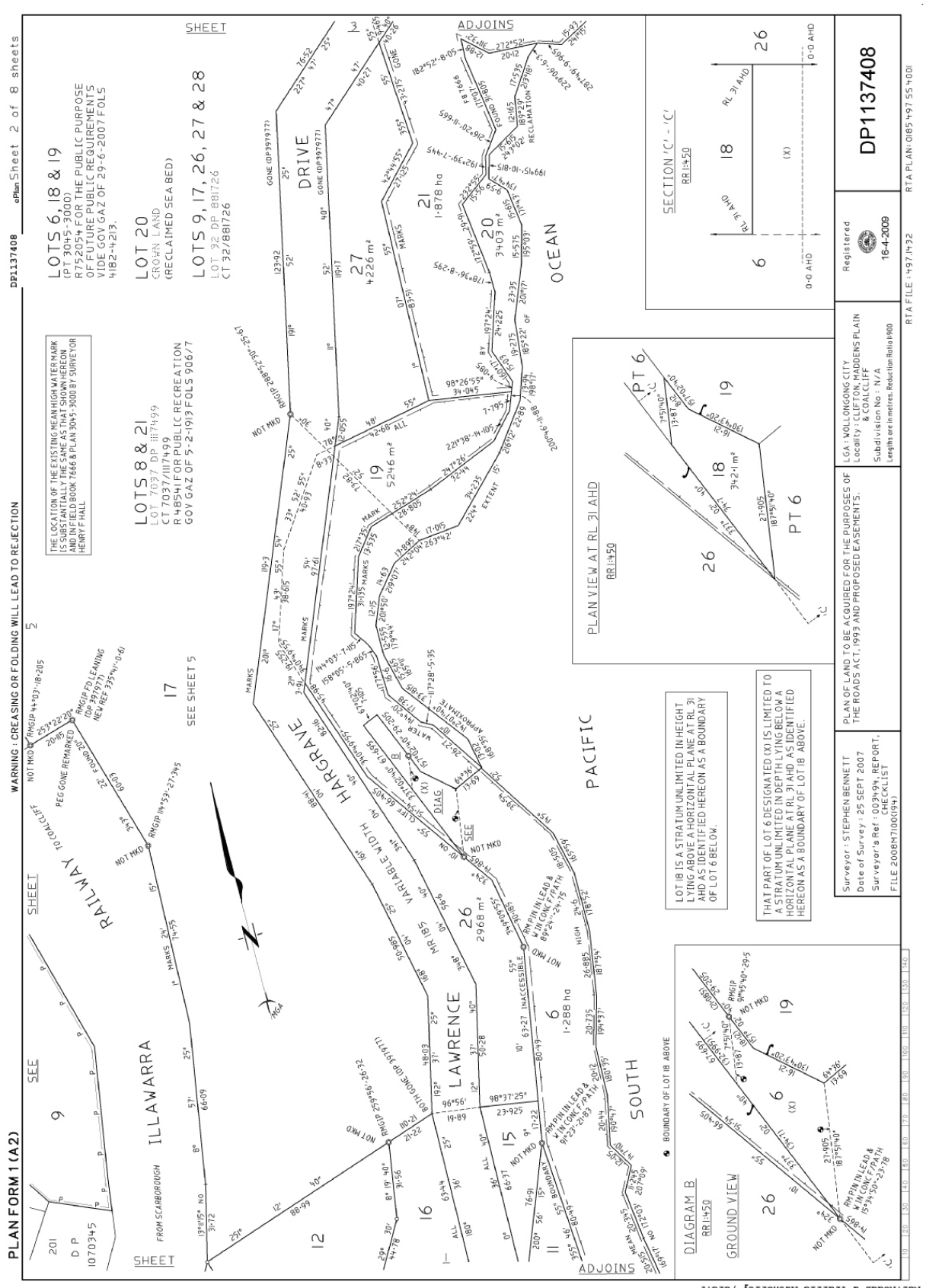
Lands (2006) Surveying and Spatial Information Regulation 2006, http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+530+2006+cd+0+N (accessed Feb 2012).

Miller A.W. (1932) Boundaries, *The Australian Surveyor*, 4(1), 28-57.

APPENDIX

Deposited Plan 1137408 – Cadastral boundaries for the Sea Cliff Bridge.


PLAN FORM 1 (A2)
WARNING : CREASING OR FOLDING WILL LEAD TO REJECTION
DP1137408
ePlan
Sheet 1 of 8 sheets
ILLAWARRA
RAILWAY
OCEAN
SOUTH
PACIFIC
DRIVE
HARGRAVE
LAWRENCE
VARIABLE WIDTH
MR 185
CLIFTON SCHOOL PDE
20·115 WIDE
DIAGRAM A
NOT TO SCALE
SEE DIAGRAM A
R 48541 FOR PUBLIC RECREATION
GOV GAZ OF 5-2-1913 FOL 907
LOTS 6, 18 & 19
(PT 3045-3000)
R75205 FOR THE PUBLIC PURPOSE OF FUTURE PUBLIC REQUIREMENTS VIDE GOV GAZ OF 29-6-2007 FOLS 4182-4213
10
1·047 ha
11
2·195 ha
12
4547 m²
14
1018 m²
15
8606 m²
16
3005 m²
17
SEE SHEET 5
6
1·288 ha
7038
(6328 m²)
DP 1057163
DP 344202
DP 350266
DP 397977
DP 966733
DP 665917
DP 1018868
DP 1123807
DP 1070345
* POLYCARBONATE PEG PLACED
MGA
THE LOCATION OF THE EXISTING MEAN HIGH WATER MARK IS SUBSTANTIALLY THE SAME AS THAT SHOWN HEREON AND IN FIELD BOOK 7666 & PLAN 3045-3000 BY SURVEYOR HENRY F HALL
DATUM
"X" - "Y"
PM 17237 - PM 5440
23°06'14"-299·837 (SURVEY COMPUTED)
23°06'14"-299·832 (MGA GROUND)
LOTS 10 & 14
LOT 1 DP 392520
CT 1/392520
LOTS 11 & 15
LOT 1 DP 392518
CT 1/392518
LOTS 12 & 16
LOT 1 DP 392519
CT 1/392519
Surveyor : STEPHEN BENNETT
Date of Survey : 25 SEPT 2007
Surveyor's Ref : 003494, REPORT, CHECKLIST
FILE 2008M7100(194)
PLAN OF LAND TO BE ACQUIRED FOR THE PURPOSES OF THE ROADS ACT, 1993 AND PROPOSED EASEMENTS.
LGA : WOLLONGONG CITY
Locality : CLIFTON, MADDENS PLAIN & COALCLIFF
Subdivision No : N/A
Lengths are in metres. Reduction Ratio 1:900
Registered
16-4-2009
DP1137408
RTA FILE : 497.1432
RTA PLAN: 0185 497 SS 4001
Req:R730354 /Doc:DP 1137408 P /Rev:16-Apr-2009 /Sts:SC.OK /Prt:17-Apr-2009 09:22 /Pgs:ALL /Seq:1 of 10
Ref:Roads & Traffic Authority /Src:P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WARNING : CREASING OR FOLDING WILL LEAD TO REJECTION
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ePlan Sheet 2 of 8 sheets
LOTS 6, 18 & 19
(PT 3045-3000)
R752054 FOR THE PUBLIC PURPOSE
OF FUTURE PUBLIC REQUIREMENTS
VIDE GOV GAZ OF 29-6-2007 FOLS
4182-4213.
LOT 20
CROWN LAND
(RECLAIMED SEA BED)
LOTS 9, 17, 26, 27 & 28
LOT 32 DP 881726
CT 32/881726
LOTS 8 & 21
LOT 7037 DP 1117499
CT 7037/1117499
R485411 FOR PUBLIC RECREATION
GOV GAZ OF 5-2-1913 FOLS 906/7
THE LOCATION OF THE EXISTING MEAN HIGH WATER MARK
IS SUBSTANTIALLY THE SAME AS THAT SHOWN HEREON
AND IN FIELD BOOK 7666 & PLAN 3045-3000 BY SURVEYOR
HENRY F HALL
SEE SHEET 5
SHEET 3
ADJOINS
DRIVE
OCEAN
PACIFIC
SOUTH
HARGRAVE
LAWRENCE
ILLAWARRA
RAILWAY TO COALCLIFF
FROM SCARBOROUGH
SECTION 'C' - 'C'
RR 1:450
PLAN VIEW AT RL 31 AHD
RR 1:450
DIAGRAM B
RR 1:450
GROUND VIEW
LOT 18 IS A STRATUM UNLIMITED IN HEIGHT
LYING ABOVE A HORIZONTAL PLANE AT RL 31
AHD AS IDENTIFIED HEREON AS A BOUNDARY
OF LOT 6 BELOW.
THAT PART OF LOT 6 DESIGNATED (X) IS LIMITED TO
A STRATUM UNLIMITED IN DEPTH LYING BELOW A
HORIZONTAL PLANE AT RL 31 AHD AS IDENTIFIED
HEREON AS A BOUNDARY OF LOT 18 ABOVE.
PLAN OF LAND TO BE ACQUIRED FOR THE PURPOSES OF
THE ROADS ACT, 1993 AND PROPOSED EASEMENTS.
Surveyor : STEPHEN BENNETT
Date of Survey : 25 SEPT 2007
Surveyor's Ref : 009494, REPORT,
CHECKLIST
FILE 2008M7100(194)
LGA : WOLLONGONG CITY
Locality : CLIFTON, MADDENS PLAIN
& COALCLIFF
Subdivision No : N/A
Lengths are in metres. Reduction Ratio 1:500
Registered
16-4-2009
DP1137408
RTA FILE : 497.1432
RTA PLAN: 0185 497 SS 4001
Req:R730354 /Doc:DP 1137408 P /Rev:16-Apr-2009 /Sts:SC.OK /Prt:17-Apr-2009 09:22 /Pgs:ALL /Seq:2 of 10
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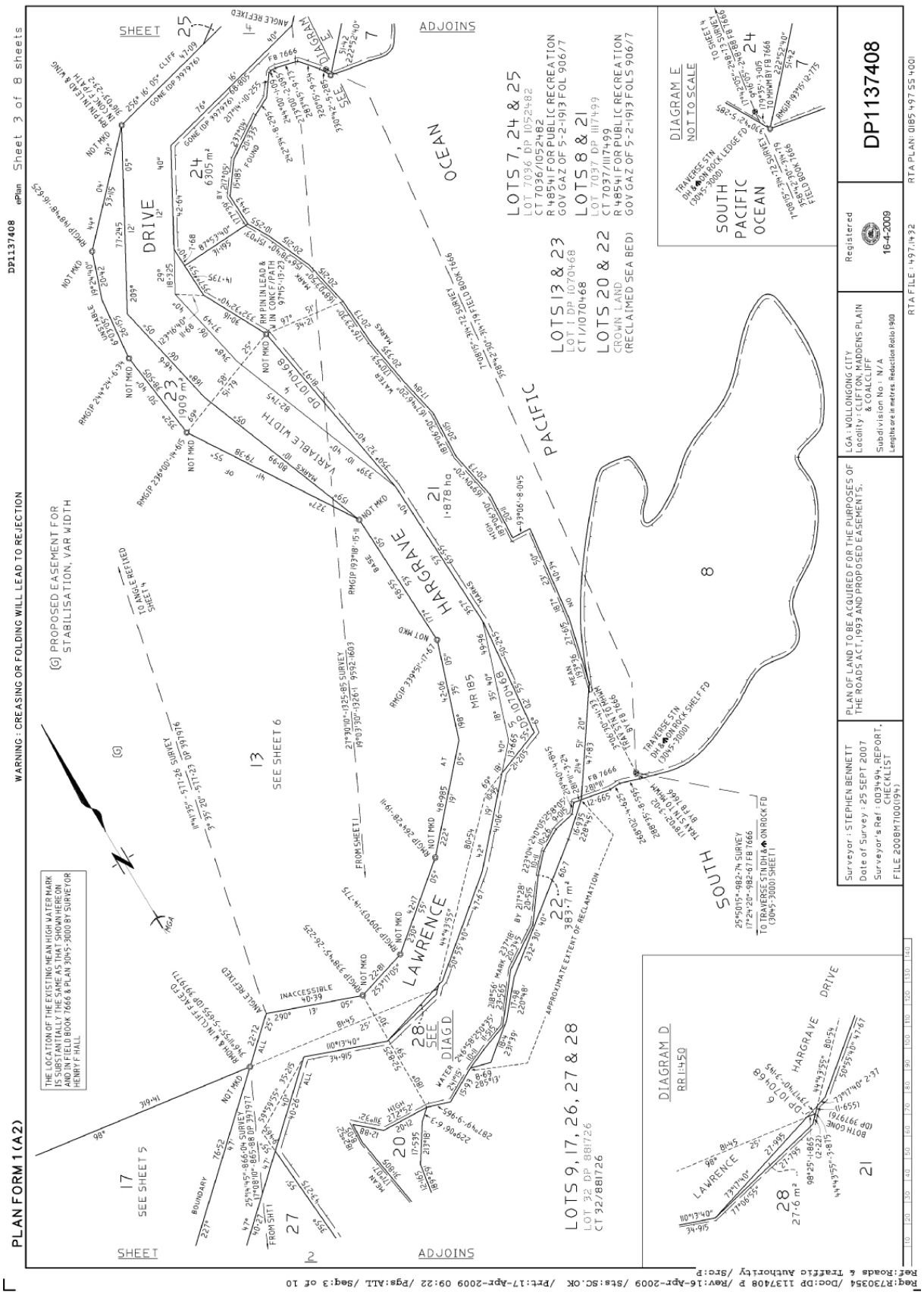
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DP1137408
Registered
16-4-2009
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RTA FILE : 497.1432
LGA : WOLLONGONG CITY
Locality : CLIFTON, MADDENS PLAIN & COALCLIFF
Subdivision No : N/A
Lengths are in metres. Reduction Ratio 1:900
PLAN OF LAND TO BE ACQUIRED FOR THE PURPOSES OF THE ROADS ACT, 1993 AND PROPOSED EASEMENTS.
Surveyor : STEPHEN BENNETT
Date of Survey : 25 SEPT 2007
Surveyor's Ref : 003449, REPORT, CHECKLIST
FILE 2008M7100(194)
OCEAN
PACIFIC
SOUTH
PACIFIC
OCEAN
LOTS 7, 24 & 25
LOT 7036 DP 1052482
CT 7036/1052482
R 485411 FOR PUBLIC RECREATION
GOV GAZ OF 5-2-1913 FOL 906/7
LOTS 8 & 21
LOT 7037 DP 1117499
CT 7037/1117499
R 485411 FOR PUBLIC RECREATION
GOV GAZ OF 5-2-1913 FOLS 906/7
LOTS 13 & 23
LOT 1 DP 1070468
CT 1/1070468
LOTS 20 & 22
CROWN LAND
(RECLAIMED SEA BED)
LOTS 9, 17, 26, 27 & 28
LOT 32 DP 881726
CT 32/881726
DIAGRAM E
NOT TO SCALE
DIAGRAM D
RR 1450
HARGRAVE DRIVE
LAWRENCE DRIVE
VARIABLE WIDTH
(G) PROPOSED EASEMENT FOR STABILISATION, VAR WIDTH
THE LOCATION OF THE EXISTING MEAN HIGH WATER MARK AS SURVEYED IS TYPICALLY THE SAME AS THAT SHOWN HEREON AND IN FIELD BOOK 7666 & PLAN 3045-3000 BY SURVEYOR HENRY F HALL
SEE SHEET 6
SEE SHEET 5
SEE DIAG D
APPROXIMATE EXTENT OF RECLAMATION
TO SHEET 4
FROM SHEET 1
ADJOINS
SHEET 2
SHEET 4
SHEET 25
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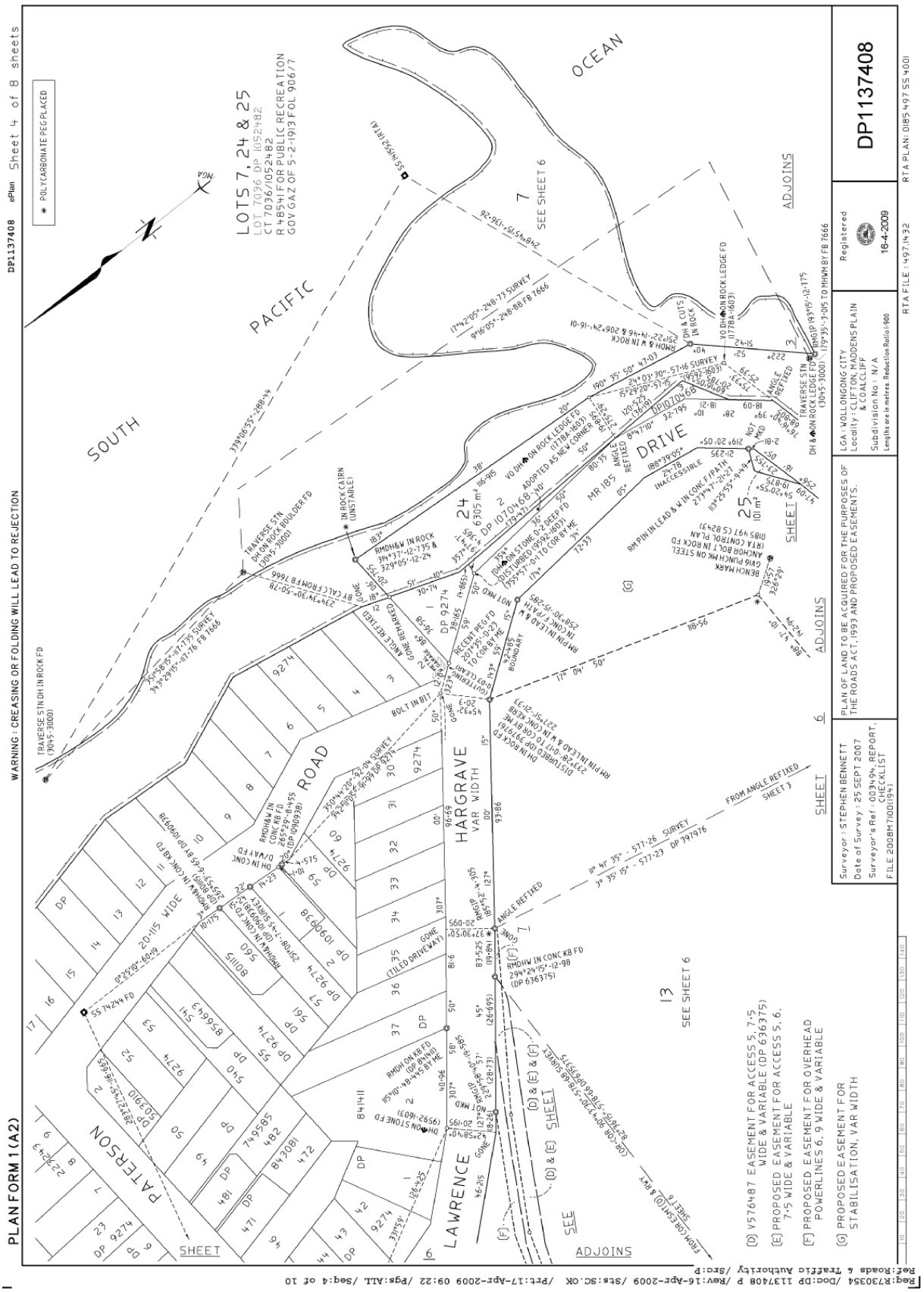
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WARNING: CREASING OR FOLDING WILL LEAD TO REJECTION
PLAN FORM 1 (A2)
* POLYCARBONATE PEG PLACED
LOTS 7, 24 & 25
LOT 7036 DP 1052482
CT 7036/105248
R48541 FOR PUBLIC RECREATION
GOV GAZ OF 5-2-1913 FOL 906 & 7
SOUTH PACIFIC OCEAN
SEE SHEET 6
ADJOINS
DRIVE
HARGRAVE ROAD
VAR WIDTH
LAWRENCE
PATERSON
SHEET
SEE SHEET 6
Surveyor : STEPHEN BENNETT
Date of Survey : 25 SEPT 2007
Surveyor's Ref : 003494, REPORT, CHECKLIST
FILE 2008M7100(194)
PLAN OF LAND TO BE ACQUIRED FOR THE PURPOSES OF THE ROADS ACT, 1993 AND PROPOSED EASEMENTS.
LGA : WOLLONGONG CITY
Locality : LAKE CON, MADDENS PLAIN
Parish : COALCLIFF
County : CORANGAMITE
Subdivision No : N/A
Lengths are in metres. Reduction Ratio 1:900
Registered
16-4-2009
DP1137408
RTA PLAN: 0185 497 SS 4001
RTA FILE : 497.1432
(D) V576487 EASEMENT FOR ACCESS 5, 7-5 WIDE & VARIABLE (DP 636375)
(E) PROPOSED EASEMENT FOR ACCESS 5, 6, 7-5 WIDE & VARIABLE
(F) PROPOSED EASEMENT FOR OVERHEAD POWERLINES 6, 9 WIDE & VARIABLE
(G) PROPOSED EASEMENT FOR STABILISATION, VAR WIDTH
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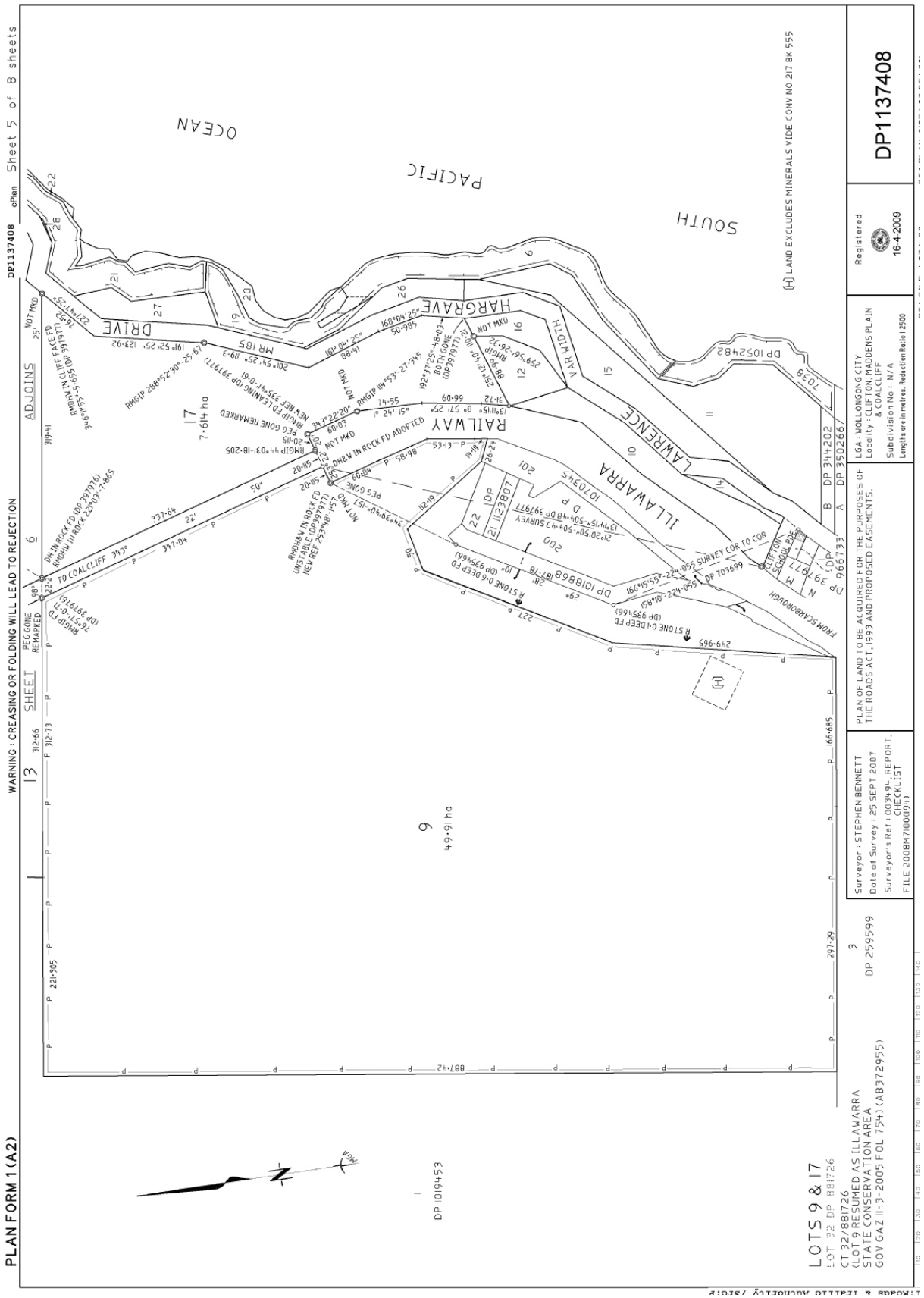
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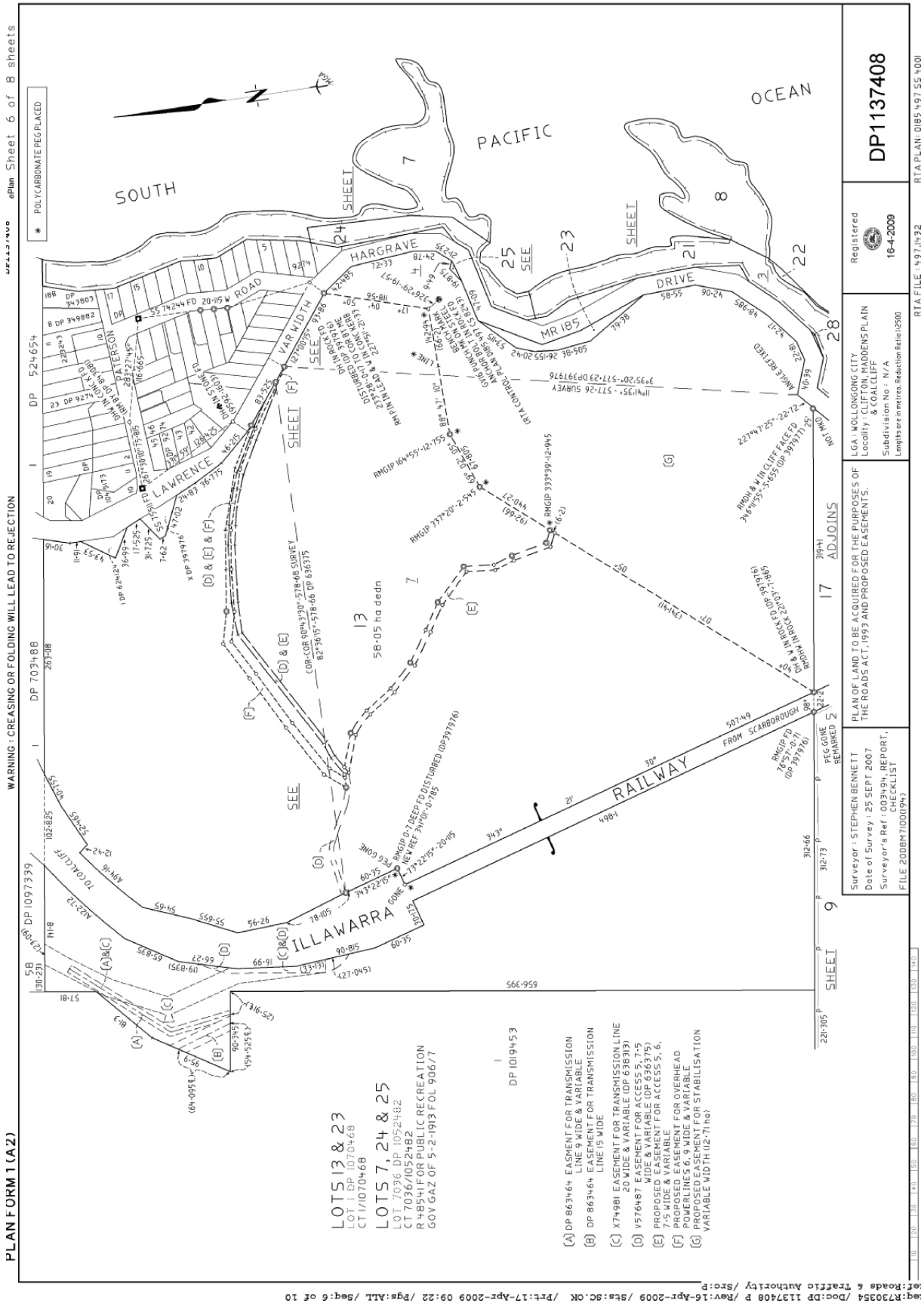
WARNING : CREASING OR FOLDING WILL LEAD TO REJECTION
DP1137408 ePlan Sheet 5 of 8 sheets
PACIFIC OCEAN
SOUTH
HARGRAVE DRIVE
RAILWAY
LAWRENCE
ILLAWARRA
VAR WIDTH
MR 185
ADJOINS SHEET 13
17
7·614 ha
9
49·91 ha
TO COALCLIFF
FROM SCARBOROUGH
CLIFTON SCHOOL PDE
DP 1019453
DP 1018868
IDP 1123807
DP 1052482
DP 703699
DP 344202
DP 350266
DP 966733
DP 397977
(H) LAND EXCLUDES MINERALS VIDE CONV NO 217 BK 555
LOTS 9 & 17
LOT 32 DP 881726
CT 32/881726
(LOT 9 RESUMED AS ILLAWARRA STATE CONSERVATION AREA GOV GAZ 11-3-2005 FOL 754) (AB372955)
3
DP 259599
Surveyor : STEPHEN BENNETT
Date of Survey : 25 SEPT 2007
Surveyor's Ref : 003494, REPORT, CHECKLIST
FILE 2008M7100(194)
PLAN OF LAND TO BE ACQUIRED FOR THE PURPOSES OF THE ROADS ACT, 1993 AND PROPOSED EASEMENTS.
LGA : WOLLONGONG CITY
Locality : CLIFTON, MADDENS PLAIN & COALCLIFF
Subdivision No : N/A
Lengths are in metres. Reduction Ratio 1:2500
Registered
16-4-2009
DP1137408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WARNING : CREASING OR FOLDING WILL LEAD TO REJECTION
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SOUTH
PACIFIC
OCEAN
HARGRAVE ROAD
VARWIDTH
LAWRENCE
PATERSON
DRIVE
MR 185
ILLAWARRA
RAILWAY
FROM SCARBOROUGH
58·05 ha dedn
LOTS 13 & 23
LOT 1 DP 1070468
CT 1/1070468
LOTS 7, 24 & 25
LOT 7036 DP 1052482
CT 7036/1052482
R48541 FOR PUBLIC RECREATION
GOV GAZ OF 5-2-1913 FOL 906677
(A) DP 863464 EASEMENT FOR TRANSMISSION LINE 9 WIDE & VARIABLE
(B) DP 863464 EASEMENT FOR TRANSMISSION LINE 15 WIDE
(C) X74981 EASEMENT FOR TRANSMISSION LINE 20 WIDE & VARIABLE (DP 638319)
(D) Y576487 EASEMENT FOR ACCESS 5, 7·5 WIDE & VARIABLE (DP 636375)
(E) PROPOSED EASEMENT FOR ACCESS 5, 6, 7·5 WIDE & VARIABLE
(F) PROPOSED EASEMENT FOR OVERHEAD POWERLINES 6, 9 WIDE & VARIABLE
(G) PROPOSED EASEMENT FOR STABILISATION VARIABLE WIDTH (12·71 ha)
DP 1019453
DP 1097339
DP 709488
DP 524654
ADJOINS
SHEET 7
SHEET 8
SHEET 9
SEE
DP1137408
Registered
16-4-2009
LGA : WOLLONGONG CITY
Locality : CLIFTON, MADDENS PLAIN
Parish : KEMBLA
County : CAMPBELL
Subdivision No : N/A
Lengths are in metres. Reduction Ratio 1:2500
PLAN OF LAND TO BE ACQUIRED FOR THE PURPOSES OF THE ROADS ACT, 1993 AND PROPOSED EASEMENTS.
Surveyor : STEPHEN BENNETT
Date of Survey : 25 SEPT 2007
Surveyor's Ref : 003494, REPORT, CHECKLIST
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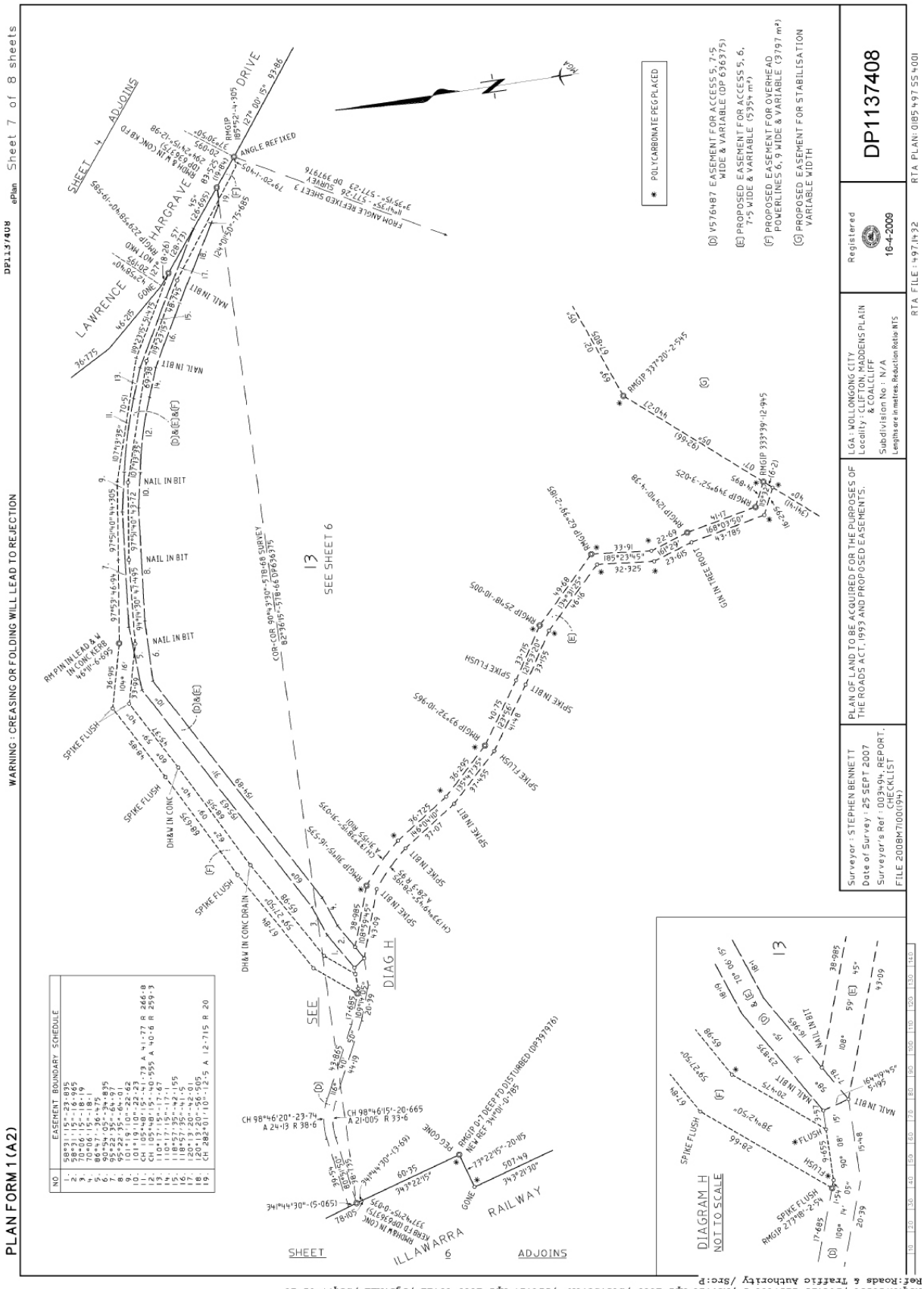
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DP1137408
ePlan
Sheet 7 of 8 sheets
DP1137408
Registered
16-4-2009
LGA : WOLLONGONG CITY
Locality : CLIFTON, MADDENS PLAIN & COALCLIFF
Subdivision No : N/A
Lengths are in metres. Reduction Ratio NTS
PLAN OF LAND TO BE ACQUIRED FOR THE PURPOSES OF THE ROADS ACT, 1993 AND PROPOSED EASEMENTS.
Surveyor : STEPHEN BENNETT
Date of Survey : 25 SEPT 2007
Surveyor's Ref : 003+94, REPORT, CHECKLIST
FILE 2008M7100(194)
RTA FILE : 497.1432
RTA PLAN: 0185 497 SS 4001
EASEMENT BOUNDARY SCHEDULE
SEE SHEET 6
DIAG H
DIAGRAM H
NOT TO SCALE
LAWRENCE HARGRAVE DRIVE
ILLAWARRA RAILWAY
SHEET 6 ADJOINS
POLYCARBONATE PEG PLACED
(D) V576487 EASEMENT FOR ACCESS 5, 7·5 WIDE & VARIABLE (DP 636375)
(E) PROPOSED EASEMENT FOR ACCESS 5, 6, 7·5 WIDE & VARIABLE (5354 m²)
(F) PROPOSED EASEMENT FOR OVERHEAD POWERLINES 6, 9 WIDE & VARIABLE (3797 m²)
(G) PROPOSED EASEMENT FOR STABILISATION VARIABLE WIDTH
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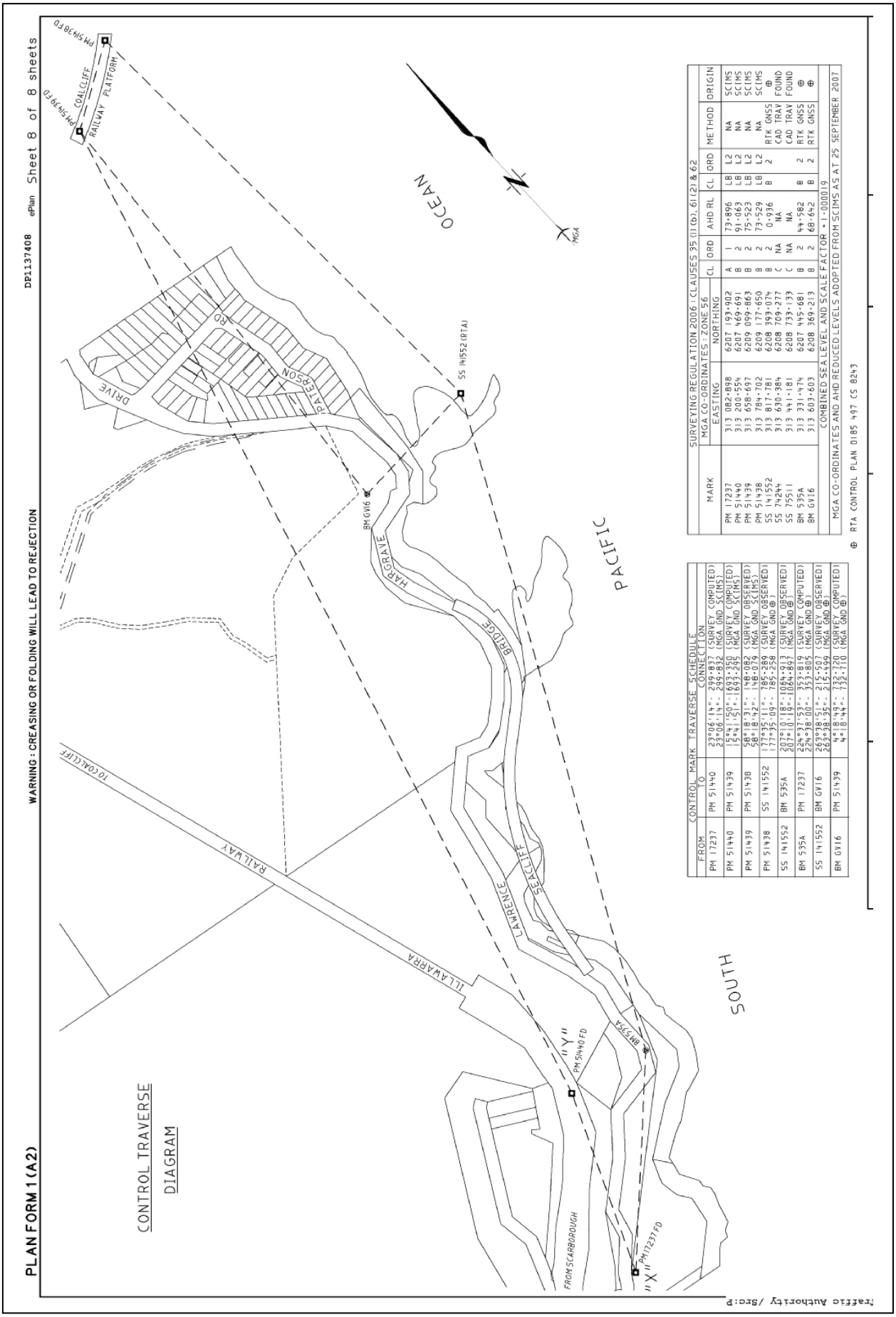
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WARNING : CREASING OR FOLDING WILL LEAD TO REJECTION
DP1137408
ePlan
Sheet 8 of 8 sheets
CONTROL TRAVERSE
DIAGRAM
PM 51438 FD
PM 51439 FD
COALCLIFF
RAILWAY PLATFORM
OCEAN
MGA
SS 141552 (RTA)
BM GV16
HARGRAVE
BRIDGE
PACIFIC
LAWRENCE
SEACLIFF
ILLAWARRA
RAILWAY
TO COALCLIFF
"Y" PM 51440 FD
BM 535A
"X" PM 17237 FD
FROM SCARBOROUGH
SOUTH
CONTROL MARK TRAVERSE SCHEDULE
FROM TO CONNECTION
PM 17237 PM 51440 23°06'14"- 249·832 (SURVEY COMPUTED)
23°06'14"- 238·832 (MGA GND SCIMS)
PM 51440 PM 51439 154°11'50"- 1693·356 (SURVEY COMPUTED)
154°11'50"- 1693·295 (MGA GND SCIMS)
PM 51439 PM 51438 58°18'31"- 148·082 (SURVEY OBSERVED)
58°18'42"- 148·079 (MGA GND SCIMS)
PM 51438 SS 141552 177°35'11"- 785·289 (SURVEY OBSERVED)
177°35'09"- 785·258 (MGA GND ⊕)
SS 141552 BM 535A 207°10'18"-1064·913 (SURVEY OBSERVED)
207°10'19"-1064·877 (MGA GND ⊕)
BM 535A PM 17237 254°38'03"- 353·815 (SURVEY COMPUTED)
254°38'03"- 353·805 (MGA GND ⊕)
SS 141552 BM GV16 263°38'51"- 215·507 (SURVEY OBSERVED)
263°38'35"- 215·499 (MGA GND ⊕)
BM GV16 PM 51439 4°18'49"- 732·720 (SURVEY COMPUTED)
4°18'44"- 732·710 (MGA GND ⊕)
SURVEYING REGULATION 2006 : CLAUSES 35 (1) (b), 61 (2) & 62
MARK MGA CO-ORDINATES : ZONE 56 CL ORD AHD RL CL ORD METHOD ORIGIN
EASTING NORTHING
PM 17237 313 082·898 6207 193·902 A 1 73·896 LB L2 NA SCIMS
PM 51440 313 200·554 6207 469·691 B 2 91·063 LB L2 NA SCIMS
PM 51439 313 658·697 6209 099·863 B 2 75·523 LB L2 NA SCIMS
PM 51438 313 789·702 6209 177·650 B 2 73·529 LB L2 NA SCIMS
SS 141552 313 817·781 6208 393·074 B 2 0·936 B 2 RTK GNSS ⊕
SS 74294 313 630·384 6208 709·277 C NA NA CAD TRAY FOUND
SS 75511 313 441·181 6208 733·133 C NA NA CAD TRAY FOUND
BM 535A 313 331·474 6207 445·681 B 2 44·582 B 2 RTK GNSS ⊕
BM GV16 313 603·603 6208 369·213 B 2 68·642 B 2 RTK GNSS ⊕
COMBINED SEA LEVEL AND SCALE FACTOR = 1·000019
MGA CO-ORDINATES AND AHD REDUCED LEVELS ADOPTED FROM SCIMS AS AT 25 SEPTEMBER 2007
⊕ RTA CONTROL PLAN 0185 497 CS 8243
Traffic Authority /Src:P