DEWATERING AND GROUNDWATER MANAGEMENT PLAN

Former Kirrawee Brick Works
564-594 Princess Highway
Kirrawee NSW

Prepared for

South Village Pty Ltd
c/o Ionic Management Pty Ltd
Shop 1, 22 Gadigal Avenue
Zetland NSW 2017

Prepared by

DLA Environmental

DL3060_S001251

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1.0 INTRODUCTION

DLA Environmental (DLA) have been commissioned by South Village Pty Ltd to prepare a Dewatering and Groundwater Management Plan for the dewatering of the former Kirrawee Brick Pit located on the property identified as Lot 2 DP589977 at 566-594 Princes Highway, Kirrawee (the Site). The Site covers an area of approximately 4.2 hectares and is located thirty (30) kilometres south of the Sydney CBD.

The proposed development plans include the draining of the existing water-filled excavation followed by partial backfilling with select fill material and construction of various buildings and parkland across the footprint of the former quarry.

The brick pit is approximately 215m in length, 90m wide, up to 6m deep and the survey conducted by AWT in 2006 estimated the water body to have a volume of 42,717m^3. Water contained in the Brick Pit is believed to be the combined result of surface runoff and groundwater inflow.

Refer to **Figure 1** -*Site Location* and **Figure 2** – *Site Survey.*

Previous environmental investigations conducted on the Site indicated elevated concentrations of Manganese and Iron at depth within the brick pit. As such, a responsible strategy for safeguarding environmental concerns and ensuring there will be no short or long-term detrimental impacts to the receiving waters during the dewatering process needs to be implemented.

This dewatering and groundwater management plan provides initiatives for the management of dewatering and groundwater issues that may occur during the dewatering exercise from an environmental perspective.

2.0 WATER QUALITY ASSESSMENTS

Previous water quality assessments on the water contained within the Brick Pit include:

- *Stage 2 Environmental Site Investigation – Kirrawee Brick Pit, 566-594 Princes Highway prepared by Australian Water Technologies dated December 2001;*
- *Water Quality Assessment: Former Kirrawee Brick Pit prepared by URS dated 2006;*
- *Hydrogeological Data Report – Redevelopment of Former Brick Pit, Kirrawee prepared by C.M. Jewell & Associates dated October 2010; and*
- *Preliminary Site Environmental Assessment prepared by DLA Environmental dated July 2013.*

Based on the water quality information presented in previous reports, including DLA's most recent water quality assessment conducted in July and December 2013 (see **Tables 1-3** below), the physical and chemical parameters of the water contained within the brick pit shows no evidence of unacceptable impact by natural or anthropogenic influences, and is compliant with Australian and New Zealand Guidelines for Fresh Water Quality *(for 95% level of protection) (ANZECC 2000)*.

Table 1 – Brick Pit Water Quality Results July 2013

Parameters	Surface water		Depth 2.0m	
	east	west	east	west
pH	7.8	7.7	8.0	8.0
Electrical Conductivity (µS/cm)	950	980	930	930
Total Suspended Solids (TSS) (mg/L)	20	20	81	51
Total Dissolved Solids (TDS) (mg/L)	480	530	490	460
Oil & Grease (LLE)	<5	<5	<5	<5
Arsenic	1	2	2	1
Cadmium	<0.1	<0.1	<0.1	<0.1
Chromium	<1	<1	<1	<1
Copper	<1	<1	<1	<1
Lead	<1	<1	1	<1
Mercury	<0.05	<0.05	<0.05	<0.05
Nickel	<1	<1	<1	<1
Zinc	6	9	5	4

DLA undertook additional water sampling in December 2013. Water was sampled at depths of below 2m and 4m from two (2) locations (east and west) within the brick pit and from the two (2) remaining groundwater wells onsite. Samples were also collected from the proposed receiving waters of Dents Creek and Oyster Gully.

All samples were analysed for Manganese and Iron, identified as contaminants of concern in previous reports. Analysis indicated manganese concentrations were not detected above the laboratory limit of reporting (LOR) at depths within the brickpit of 2m, with concentrations of 930µg/L and 1200µg/L at a depth of below 4m. Recorded concentrations fall below the trigger level for manganese of 1900µg/L in the ANZECC Water Quality Guidelines for Fresh and Marine Waters 2000 (95% freshwater).

Iron concentrations of 22µg/L at 2m depths at both locations and 11µg/L at 4m were found to be significantly lower than in both proposed receiving waters (110µg/L in Dents Creek and 160µg/L in Oyster Gully). No action trigger levels currently exist for iron in the ANZECC Water Quality Guidelines for Fresh and Marine Waters 2000 (95% freshwater). As such there is no indication that the addition of water contained within the brickpit will adversely impact on the water quality of the receiving waters and is suitable for discharge to the stormwater system.

Table 2 – Brick Pit Water Quality Results December 2013

Parameters	Pit East		Pit West	
	2m	4m	2m	4m
pH	-	7.4	-	7.4
Electrical Conductivity (µS/cm)	-	970	-	970
Total Suspended Solids (TSS) (mg/L)	-	20	-	28
Total Dissolved Solids (TDS) (mg/L)	-	510	-	490
Arsenic	-	<1	-	1
Cadmium	-	<0.1	-	<0.1
Chromium	-	<1	-	<1
Copper	-	<1	-	<1
Lead	-	<1	-	<1
Mercury	-	<0.05	-	<0.05
Nickel	-	<1	-	<1
Zinc	-	<1	-	4
Iron	22	<10	22	11
Manganese	<5	930	<5	1200
Boron	520	540	530	540

Table 4 – Receiving Waters Water Quality Results December 2013

Parameters	Dents Creek	Oyster Gully (east)	Oyster Gully (west)
pH	7.4	8.0	7.4
Electrical Conductivity (µS/cm)	610	650	530
Total Suspended Solids (TSS) (mg/L)	<5	33	<5
Total Dissolved Solids (TDS) (mg/L)	320	340	290
Arsenic	<1	<1	<1
Cadmium	<0.1	0.1	<0.1
Chromium	<1	<1	<1
Copper	3	3	2
Lead	<1	<1	<1
Mercury	<0.05	<0.05	<0.05
Nickel	1	8	<1
Zinc	28	14	18
Iron	110	25	160
Manganese	<5	<5	9
Boron	55	94	43

3.0 GROUNDWATER ASSESSMENT

Groundwater in the vicinity of the Site flows predominantly within discontinuities such as joints, bedding plane partings and other fractures, which form a fractured rock aquifer within the shale and underlying weathered sandstone. Groundwater flow direction beneath the site coincides with both the local topographic expression and the regional inclination of the Hawkesbury Sandstone, with groundwater flowing from the north-western corner of the site to the east and south-east. It was also noted in the AWT Report that the brick pit excavation is likely to drain localised groundwater from the north of the excavation, and that the surface water level contained within the brick pit excavation is connected to the local groundwater.

Previous groundwater assessments had been conducted by Australian Water Technologies (AWT) in 1999 and 2001. Concentrations of copper, lead, mercury, zinc and nickel (lower level range only) detected in groundwater samples collected exceeded the NEPC (1999) Groundwater Investigation Levels (GIL) for the protection of aquatic ecosystems (Freshwater). Further groundwater assessments were conducted by Douglas Partners and CM Jewell & Associates, both in 2008. Douglas Partners have been conducting quarterly water level monitoring at the Site, with the most recent monitoring event occurring in March 2013.

The presence of contaminant concentrations in exceedance of the adopted Groundwater Investigations Levels (GILs) in the National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No.1) triggers further investigation of aquifer conditions to assess the source(s) of contamination and the lateral and vertical extent of the contamination. The adopted GILs are based on the *Australian Water Quality Guidelines 2000* (AWQG) and *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)* 95% Freshwater Criteria, and are presented in **Table 4** below:

Table 4 – Groundwater Investigation Levels

Analytes	Fresh Waters (µg/L)	Marine Waters (µg/L)
Benzene	950	500
Toluene	-	-
Ethylbenzene	-	-
O-Xylene	350	-
P-Xylene	200	
Arsenic (III)	24	-
Cadmium	0.2	0.7
Chromium (VI)	1	4.4
Copper	1.4	1.3
Lead	3.4	4.4
Mercury (inorganic)	0.06	0.1
Nickel	11	7
Zinc	8	15
PAH's		
Naphthalene	16	50
B(a)P	-	-

DLA conducted groundwater sampling in July and December 2013 from wells previously installed by AWT in 1999. Overall results indicate that groundwater presents no major concerns from a quality perspective.

The findings of DLA's most recent investigations into on-site groundwater conditions were consistent with those identified in earlier assessments, which identified concentrations of copper, lead and zinc in excess of the trigger values set for the protection of 95% of species in freshwater in the ANZECC Guidelines. It is the opinion of DLA that these concentrations are typical of urban groundwater in low-permeability formation in the Sydney metropolitan area, and reflecting the impact of diffuse urban pollution that has been concentrated during recharge.

It is anticipated that groundwater recharge of the brick pit will occur during dewatering and as such will require regular weekly monitoring for changes in water table depth and groundwater quality.

4.0 DEWATERING

The brick pit water quality presents no concerns in its present state, and as such it is considered reasonable to allow discharge to the stormwater system provided controls are put in place and contingency plans are initiated in the event the present water quality changes. The challenge will be to keep the quality consistent, particularly as to sediment loading (Total Suspended Solids) during discharge.

The most appropriate dewatering method has been determined to be discharging the standing water via the existing stormwater drainage network. As the Site lies on the crest of a ridge that divides the lower Woronora River and Hacking River drainage systems, there is the potential to discharge the water into two (2) separate receiving waterways:

- Southwards into Dents Creek, which discharges into the North-West Arm of Gymea Bay; and,
- Northwards into Oyster Gully, which discharges into Oyster Bay on the Georges River.

The Brick Pit can be dewatered by way of piping directly via two (2) discharge points into the local stormwater system. Water discharged to the south towards the freshwater Dents Creek would enter the Creek approximately 750m south-east of the Site, approximately 650m of which through a concrete encased culvert. Water discharged to the north towards Oyster Gully would enter the existing stormwater line on the corner of Oak Road North and the Princes Highway and flow via concrete culvert approximately 150m before entering the Gully.

All discharged water will pass through a suitably designed containment device located on-site, before being released into the stormwater system. The anticipated discharge rate would be limited to 15L/sec per pump to ensure no damage is caused to Council infrastructure and to minimise any disturbance to local residents and businesses. The proposed pumping rate is low in comparison to the capacity of all but the smallest stormwater drains, and is highly unlikely to cause overload at any point in the drainage system.

5.0 SCHEDULE

The schedule for the dewatering procedure will be dependent upon authorisation to utilise two (2) pumps. In the event that the use of only one (1) pump is approved, then the estimated timeframes for the dewatering process outlined below would be doubled.

At the discharge rates of 15L/sec per pump and assuming operational hours are 7am – 5pm (540,000L per pump / day), the extraction and discharge of 42ML would take approximately:

One pump ~ 78 days
Two pumps ~39 days

If discharge were to be permitted 24hrs/day (1,296,000L per pump / day):

One pump ~ 32 days
Two pumps ~16 days

Discharge of water from the brick pit will be halted during wet weather events to ensure sufficient capacity is maintained within Council's stormwater system.

6.0 ASSESSMENT CRITERIA

For protection of Groundwater and Receiving Waters threshold concentrations based on the ANZECC Water Quality Guidelines for Fresh and Marine Waters 2000 (95% freshwater) are used.

In order to ensure adequate response times in the event of detection of undesirable concentrations of contaminants, a **Trigger and Action** level for target contaminants has been formulated. The trigger level being 50% of the recommended threshold with the action level set at 75% of the relevant threshold.

Trigger – implement more rigid monitoring and investigation.

Action – cease off-site discharge until water quality improves and implement Contingency Plans

Table 3 - Contaminant Trigger and Action Levels

Parameters	Trigger	Action
pH		<6.5 - >8.5
Suspended Solids (TSS)	Visually turbid	50mg/L
EC	750µs/cm	1000µs/cm
Total Dissolved Solids (TDS)	500mg/L	750mg/L
Oil & Grease	5.0mg/L	7.5mg/L
Metals		
Arsenic	12µg/L	37µg/L
Cadmium	0.1µg/L	0.2µg/L
Chromium	0.5µg/L	0.74µg/L
Copper	0.7µg/L	1.1µg/L
Iron	-	-
Lead	1.7µg/L	2.5µg/L
Manganese	950µg/L	1425µg/L
Mercury	0.03µg/L	0.05µg/L
Nickel	5.5µg/L	0.9µg/L
Zinc	4µg/L	6µg/L

Source: Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000.

7.0 MONITORING

Regular monitoring and analysis of water quality would be undertaken continuously from set locations during the early and final stages of the dewatering process. Analysis will include Manganese and Iron, identified as pollutants of concern in previous studies. It is anticipated the monitoring regime could be reduced to twice weekly once the operation is underway and provided initial monitoring results are satisfactory.

Discharged water will be required to meet the following ANZECC Water Quality Guidelines for Fresh and Marine Waters 2000 (95% freshwater) criteria:

- Total Suspended Sediment (TSS) must be less than 50mg/L
- Turbidity must be less than 150 NTU
- Oil & Grease must be less than 10mg/L
- pH must be between 6.5 – 8.5
- BOD 5 must be less than 30mg/L

Visual inspection and monitoring of stormwater discharge points into natural receiving waters is to occur at the discharged water entry points into Dents Creek and Oyster Gully.

7.1 Groundwater

Dewatering the Site has the potential to effect changes on groundwater levels within the local aquifer. These changes, if significant enough may impact on the Site and surrounding properties. It is therefore necessary to monitor the water table around the Site to ensure that potential impacts related to dewatering are identified and addressed.

DLA will conduct ongoing monitoring of changes in groundwater levels and quality during the dewatering process. DLA acknowledge and will adopt the management recommendations for monitoring requirements for environmental impacts during dewatering as outlined in the Pells Sullivan Meynink Geotechnical Groundwater and Assessment Report (October 2013) and Geotechnical Monitoring Plan During Dewatering (November 2013).

As it has been noted that a hydraulic connection between the water level within the brick pit and the groundwater of the local area is likely (URS, 2006), twice weekly monitoring of groundwater levels in monitoring wells located on-site will be undertaken to identify changes occurring in surrounding groundwater levels as a result of the dewatering process. The rate of change in the surrounding groundwater level will play a role in

determining the dewatering rate, which may be decreased if found to be adversely impacting on groundwater levels.

As the site has been identified to fall within a fractured rock aquifer and meets the criteria of a less productive groundwater source, a decline in water table of less than 2m is identified in the Minimal Impact Considerations for Aquifer Interference Activities from Less Productive Groundwater Sources as an acceptable impact on the water table.

A change in groundwater levels of 1m from pre-dewatering levels will be utilised as a trigger for increased frequency of groundwater level monitoring and the Site's geotechnical consultants will be notified. In the event of a change in groundwater levels of 1.5m or greater from pre-dewatering levels, DLA will work with the site's Geotechnical consultants, with the option of reducing or ceasing discharge until further geotechnical investigations have been undertaken.

8.0 DEWATERING MANAGEMENT PROTOCOL

The management of the brick pit dewatering will be in accordance with the following:

Procedure

1. Establish dewatering system following an initial review of the likelihood of contaminants being present.

2. Test Brick Pit water in the area to be de-watered.

3. If results comply with site Trigger levels commence discharge. During discharge to the stormwater system, implement routine monitoring daily initially and twice per week when satisfied as to the long term water quality.

4. Continue to discharge while acceptable results are being recorded.

5. If initial results or subsequent monitoring exceed the trigger concentrations appropriate action is to be taken. If exceedances of the action level are recorded then discharge must cease. The contingency actions are to remain in place until an assurance can be given as to acceptable water quality.

6. Remedial action has been highlighted as a contingency in the event of contamination being above action levels long-term.

Remedial Actions

The Contingency Plan is outlined in more detail below:

Water Quality in Exceedance of Trigger Levels

Initial receipt of notification of contaminant(s) above trigger levels for discharge to storage pond or stormwater system.

Stage 1

Action:

1. Immediately collect water sample for confirmation of discharge water quality.
2. Warn Contractor of trigger exceedance event.
3. Return sample analysis details within 24hrs

   Negative result (less than trigger value) - Return to water quality monitoring test regime
   Intermediate Result (between trigger and action) - Implement monitoring every second day
   Positive result (in excess of action level) - Proceed to Stage 2

Water Quality in Exceedance of Action Levels

Contaminant concentrations in excess of action levels for discharge to stormwater system.

Stage 2

Action:

Immediately cease discharge to the stormwater system.

1. Collect water sample for confirmation of contamination levels.
2. Return sample analysis details within 24hrs.

   Negative result (less than trigger value) - Return to water quality monitoring test regime
   Intermediate Result (between trigger and action) - Return to Stage 1
   Positive result (in excess of action level) - Proceed to Stage 3

Water Quality Continued Exceedance of Action Levels

Continued analysis of contaminant(s) in excess of action levels for discharge to stormwater system.

Stage 3

Action:

1. Procure equipment and materials for establishment of treatment strategy.
2. Establish and commission treatment facility.
3. Sample and analyse initial discharge following treatment.
4. Return sample analysis details within 24hrs.

   Negative result (less than action value) - Return to water quality monitoring test regime Stages 2 and 1.
   Positive result (in excess of action level) - Cease discharge and re-assess treatment

9.0 CONTINGENCIES

In the event that inspections or monitoring note that key indicators are not compliant, some action will be required. Examples may include:

Unacceptable TSS levels from discharge pipe(s):

1. Check excessive sediments are not being extracted at intake. If so, take appropriate measures to rectify; and

2. Consider additional strategies, such as reducing the discharge rate or flocculation.

Erosion noted at Creek input areas:

1. Install dissipation devices ;

2. Reduce flow rate; and

3. Different discharge location.

Extended discharge time, due to reduced flow rates or weather:

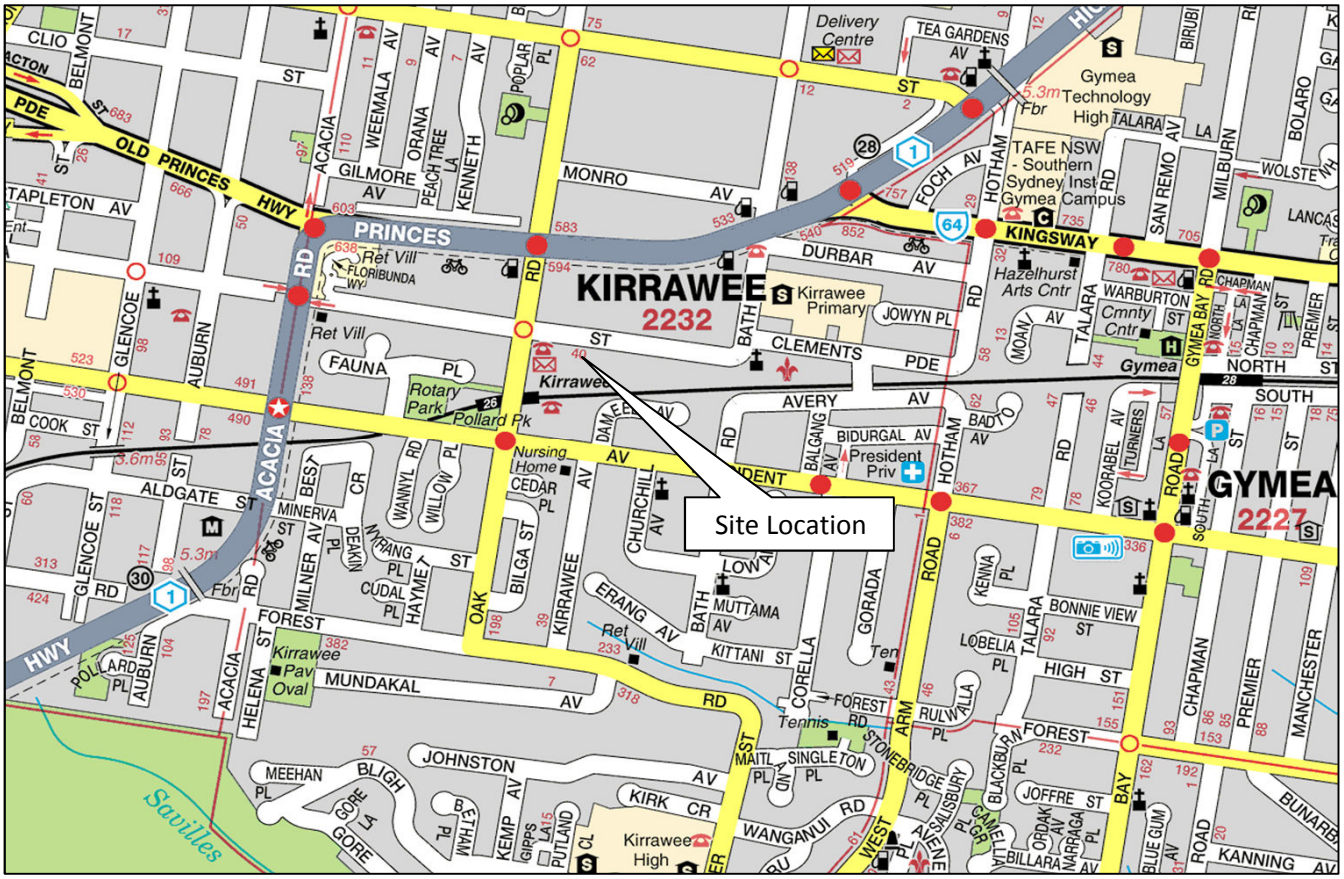
1. Consider additional pipes

10.0 CONCLUSION

This management plan has provided a means to manage the dewatering of the Brick Pit and groundwater on-site at 564-594 Princes Highway Kirrawee in a manner that does not threaten the local environment or cause health concerns for workers or local residences, including the loss of amenity. Adequate monitoring has been outlined to ensure that a low risk to the surrounding environment is maintained.

Figure 1

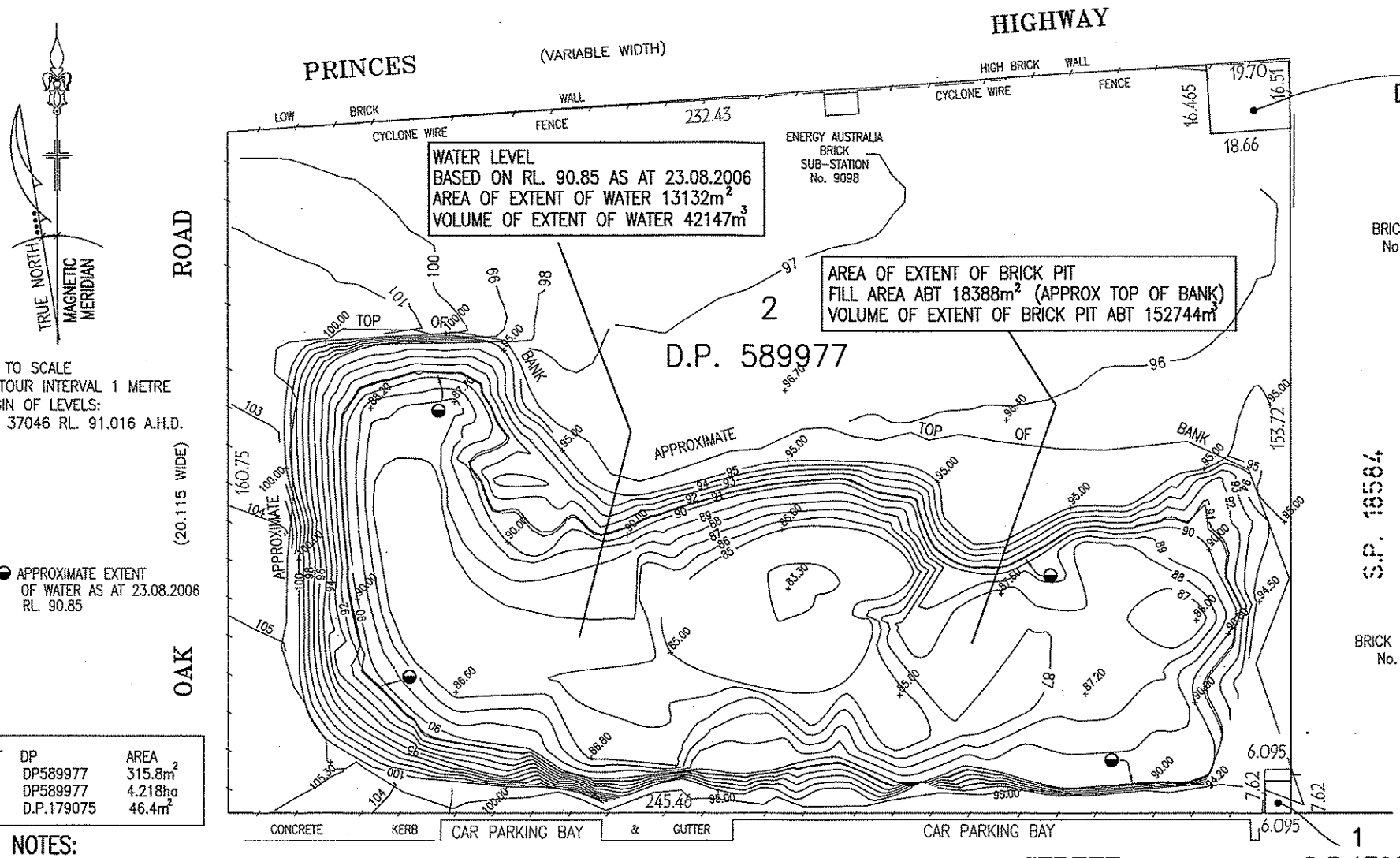
Site Location



DLA environmental Unit 2b/30 Leighton Place Hornsby, NSW 2077	**DESIGNED:** DLA	SITE LOCATION	
	COMPILED: JC	**CLIENT:** Ionic Management	**DRAWING:** 9/07/2013
	PROJ. No. DL3060	**LOCATION:** Lot 2 DP 589977 566-594 Princes Highway Kirrawee	**FIGURE:** 1

Figure 2

Site Survey



LOT	DP	AREA
1	DP589977	315.8m²
2	DP589977	4.218ha
1	D.P.179075	46.4m²

NOTES:

1) THIS DRAWING HAS BEEN PREPARED BY AWT SURVEY FOR SWC IN ACCORDANCE WITH A SPECIFIC BRIEF FOR THE PURPOSES OF OBTAINING VOLUME OF WATER AND SHOULD NOT BE RELIED UPON FOR ANY OTHER PURPOSE

2) EXTENT OF WATER AND TOP OF BANK OBTAINED FROM URS AUSTRALIA PLAN 43167325-001 (REV A) DATED: 30-03-2006

3) HISTORICAL CONTOURS FOR BOTTOM OF BRICK PIT HAVE BEEN OBTAINED FROM PLAN W.P.6524 DATED 27.04.1972 (LEVELS BASED ON BENCH MARK - BOLT IN KERB WITH RL 105.48) AND PLAN URS AUSTRALIA PLAN 43167325-001 (REV A) DATED: 30-03-2006

LETTER	DETAILS OF AMENDMENT	APP'D	DATE
B	HISTORICAL CONTOURS ADDED (SEE NOTE 3)	J.S.	22.09.2006

AWT_A3_R APRIL 2005

SURVEYED: D.BURKE
DRAWN: J.SZPYTMA
VERIFIED: D.BURKE
PROJECT No. 060811
REGISTERED SURVEYOR: D.BURKE
P.CARR DATE: 25.09.'06
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LOCALITY: KIRRAWEE

PLAN SHOWING BOUNDARIES, AREAS AND VOLUMES OF KIRRAWEE BRICK PIT (STAGE 3) AT FLORA ST, KIRRAWEE

DRAWING No. 060811
SHEET 1 OF 1
FINAL DRAWING STATUS: B FINAL FOR ISSUE