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Job No: 7508/23
Our Ref: 7508/23-AA Final Revised
8 March 2010

Delfin Lend Lease Pty Ltd
P O Box 1124
ST MARYS NSW 1790

Attention: Mr A Ali

Dear Sir

re: **Western Precinct - Jordan Springs**
The Northern Road, Cranebrook
Salinity Review

Further to your request, and in accordance with Geotech Testing Pty Ltd quote Q717AH dated 23 February 2010, we have reviewed salinity reports prepared by others for the Western Precinct to satisfy salinity requirements and for inclusion in the tender documents.

Documents Received
We are in receipt of the following salinity reports:

- SKM Report on water, soil and infrastructure for the St Marys Project, Western Precinct Plan dated May 2009, which included the following reports by EIS (a division of Jeffery & Katauskas Pty Ltd):
  - Report E13431F Volume 1 dated 31 May 2000.
  - Report E13431FRPT Volume 2 dated 31 May 2000.
  - Report E13431FRPT Volume 3 dated 31 May 2000.
- EIS Report E13431FRPT-ASI dated 7 March 2001 (Additional investigation in Western Precinct).

Scope of Work
In preparation for this report, the following work was completed:

- Review of all documents received.
- Review of other information provided for development and building in a saline environment.
- Research and contemplate experiences gained from previous projects with similar ground conditions.

Soil Investigation
The soil investigations for the preparation of the foregoing reports were carried out over a period between 1999 and 2001 and generally included electromagnetic survey, excavation of test pits, installation of groundwater monitoring wells, recovery of soil and groundwater samples, laboratory testing and submission of detailed engineering reports. These investigations were carried out by EIS, and the results were used by SKM in preparation of their report on water, soil and infrastructure in 2009.

The following sections summarise the results of the investigation that is relevant to the scope of works.

Electromagnetic Induction (EMI) Survey
An EMI was carried out across the entire development site in December 1999 (Refer EIS report, Volume 2) and generally indicated a low saline profile in the Western Precinct with the exception of a highly saline anomaly, which, after further investigation and laboratory testing, indicated a moderate rather than a high saline profile.

Soil Salinity
Based on the available soil maps, the soils at the site are likely to belong to the Luddenham Group, which is characterised by undulating to rolling low hills on Bringelly Shale of the Wianamatta Group of Shales, and comprise narrow ridges, hillcrests and valleys. Soils in this group are likely to be up to 1.5m deep, highly plastic, moderately reactive, locally impermeable and susceptible to high erosion hazards. The salinity publication indicates that the soils on the site are potentially moderately saline.

Electrical Conductivity (EC) testing was carried out to assess soil salinity. The determined EC is multiplied by a factor (varying from 6 to 17) based on the texture of the soil sample, to obtain the Corrected Electrical Conductivity designated as EC_e, as outlined in the Department of Infrastructure, Planning and Natural Resources (DIPNR) publication "*Dryland Salinity – Introductory Extension Notes - 1991*". The DIPNR publication defines various classes of saline soils, as follows:

TABLE 1

Classification	EC_e (dS/m)
Non-saline	<2
Slightly saline	2 – 4
Moderately saline	4 – 8
Very saline	8 – 16
Highly saline	>16

The results carried out on recovered soil samples indicated:

- About 52% of the results were less than 4dS/m or non-saline to slightly saline
- About 50% of the results were in the range of 4 – 8 dS/m or moderately saline
- One result indicated very saline soil (EC_e = 9.90dS/m)

In addition, the test results indicated that the topsoil was generally non-saline and increasing in salinity with depth. Based on the test results, it is assessed that the soils on site are generally slightly saline to moderately saline (Refer Figures 5.5, 5.6 & 5.7, which are extracts from the SKM report). It should be noted that the laboratory test results are based on a very limited number of recovered soil samples.

Soil pH
Soil pH or acidity is an important soil fertility parameter. Soils with strong acidity are aggressive to both concrete and steel structures buried within the soil. The original EIS report indicated possible strongly acidic soil. It should be noted that the majority of the soils are residual in nature and are not expected to be acidic. Acidic soils may be encountered at low-lying grounds that are subject to frequent flooding, such as those close to waterways and creeks. The acid sulphate soil mapping indicates 'no known occurrence" of acid sulphate soils west of Parramatta River and Prospect. Based on our experience in the area, it is our opinion that soil acidity would not affect site works or the development of the site.

Dispersive Soil
Dispersive soil is commonly associated with erosion, sediment loss to waterways, susceptibility to tunnelling or piping through earth dams and soil softening when saturated. Based on the soil mapping and previous investigations, the surface soils on site are likely to be slightly to moderately dispersive, while the deeper soils are likely to be highly dispersive. This will affect site works during construction.

Regional Hydrogeology & Groundwater Salinity

There are two groundwater bearing systems (aquifers) within the Western Precinct. The shallow aquifer is generally fresh, with low salinity and typically unconfined. The materials making up the shallow aquifer are predominately impervious clay, with a low to medium rate of permeability. This aquifer is affected by surface run-off and rainwater. The deep aquifer is generally saline, high salinity approaching seawater levels and confined within the underlying Bringelly Shale. This aquifer is less permeable and is less affected by surface run-off and rain.

The results of the investigation generally indicate that the groundwater on site is moderately saline (Refer Figures 5.9 & 5.10, which are extracts from the SKM report).

Conclusions

Based on the investigation, it is concluded that the moderately saline conditions encountered on site are typical of the area in general. Implementation of a Soil and Water Management Plan is essential to maintain current conditions of the site.

The report prepared by SKM included a salinity, erosion and sediment management strategy overview (Table 5.5, attached), which should be implemented for quality control during construction.

In addition to these measures, there are some additional measures that Geotech Testing Pty Ltd might recommend or disagree with, as shown below:

1.0 Treatment of the majority of the site with lime and gypsum (EIS Report Volume 1)

There is no need for such treatment, as the implementation of a soil erosion control plan would suffice. However, it might be required to stabilise local area(s) that would encounter very highly dispersive (erodible) soils.

In addition to the soil erosion control plan, it is recommended that all exposed embankments are battered to about 1V:2.5H in natural clays (1V:3H in compacted fill) and seeded to produce a vegetation cover that will minimise the effect of surface run-off on the embankment. Dish drains may be used on top of selected embankments to divert surface run-off, if affected by dispersive soils.

2.0 Use of Groundwater for irrigation purposes (Table 5.5 in SKM Report)

Groundwater extracted from the underlying deep aquifer is likely to be saline and thus should not be introduced to the surface or allowed to mix with surface waters, which are likely to feed the shallower fresh aquifer.

3.0 Excavation exposing moderately saline soils

It is likely that excavation to depths of about 2m, (as part of the proposed site works or for installation of utilities) would expose soils that could be assessed as moderately saline. It is recommended that exposed moderately saline soils are covered with about 500mm of non-saline material ,which may include topsoil.

To confirm the presence of moderately saline soils, additional salinity testing at bulk excavation level (at the rate of two tests for a typical residential lot) may be carried out.

Excavated materials may be re-used on site provided they are replaced in the same order they are removed from the ground. Recommendations in Section 4.4 of the SKM report (attached) should be implemented.

The Building Code of Australia (BCA) has provisions in the 2008 edition, including “high impact resistant” membrane of 0.2mm nominal thickness to be used below all ground supported house slabs. This membrane is now used for construction of all residential slabs, with the main purpose being to stop rising vapour or dampness to the underside of the slab, thus eliminating the effect of any salinity on the slab.

In addition, the DIPNR prepared a bulletin in 2003, titled "Building in Saline Environment", which commented on the different standards commonly used in the building industry in terms of salinity issues. These are:

- AS3600: Concrete Structures
- AS3700: Masonry Structures
- AS2870: Residential slabs and footings
- AS4419: Soils for Landscaping and Garden Use

The bulletin also included specifications for concrete strength depending on the aggressivity of the environment. These are reproduced below in Table 2.

TABLE 2

	Non Aggressive Environment	B2 (Moderately Aggressive Environment)	C (Aggressive Environment)
Concrete strength	20 MPa	40 MPa	50 MPa
Curing time	3 days	7 days	7 days
Cover to reinforcement	40mm	45mm	50mm

Adaptation of the recommendations by BCA and DIPNR (or DNR as it is now known) would reduce the effect of any potential moderately saline soils within the ground that might come into contact with the foundations of future residences.

4.0 Importation of fill during site works

It is also understood that additional fill might be imported during site works. All imported fill should be tested by a qualified Geotechnical Engineer for salinity prior to importation, along with submission of a quality process system addressing the following:

- Segregation of material at excavation
- Monitoring process
- Transportation routes

The imported fill should be non-saline to slightly saline for use on all fill layers, so as not to adversely affect existing salinity conditions on site.

In general imported fill (VENM or ENM) should be:

- Low to medium plasticity clays such as sandy, silty and gravelly clays
- Non-saline to slightly saline soils
- Non-dispersive to slightly dispersive
- Non-aggressive to slightly aggressive to concrete and concrete
- Free of acid sulphate soils

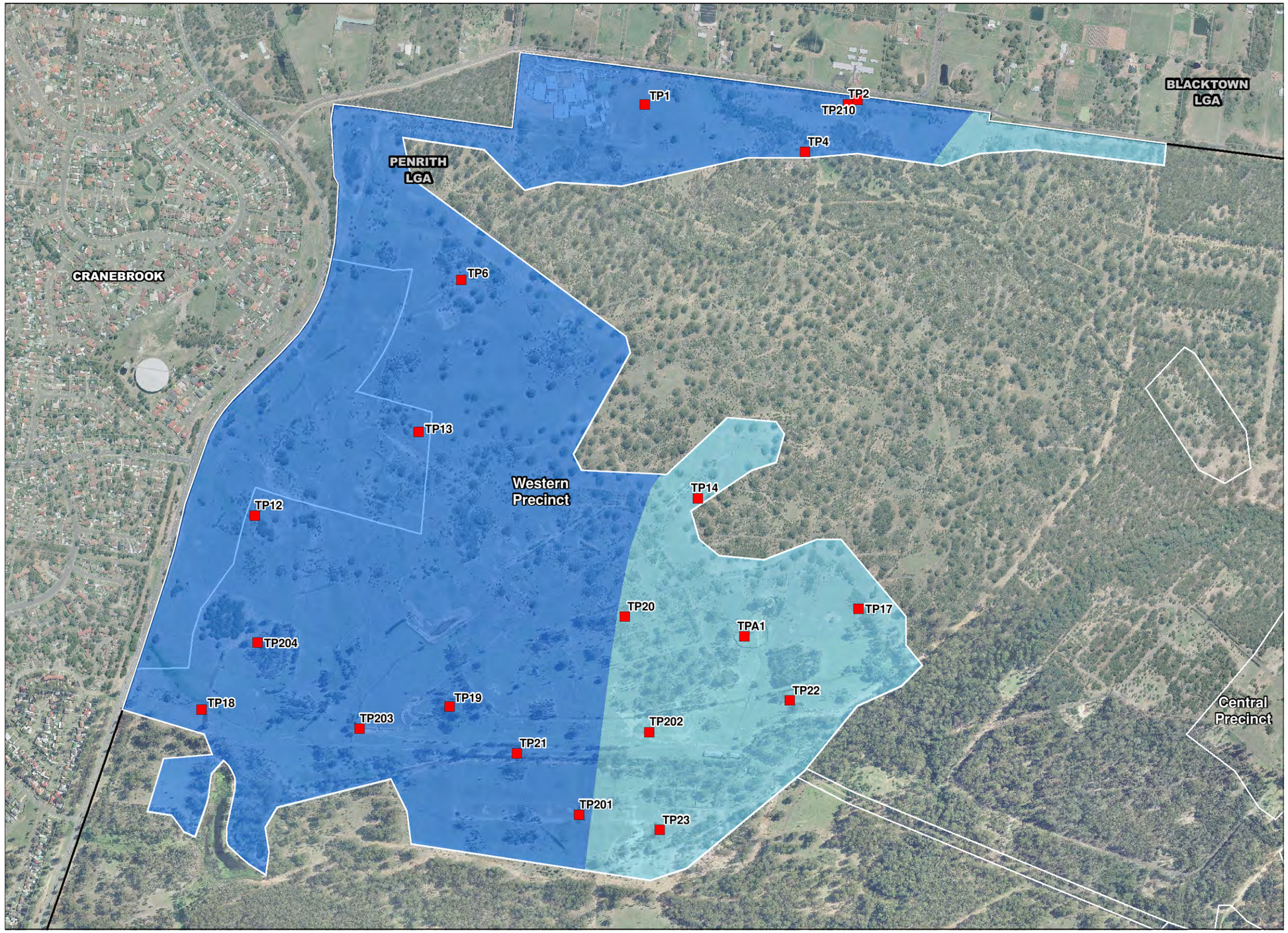
The salinity report accompanied by a validation certificate shall be submitted to the certifying authority for approval prior to commencement of fill importation (Refer DA Consent of Conditions set by Penrith City Council).

If you have any questions, please do not hesitate to contact the undersigned.

Yours faithfully
GEOTECH TESTING PTY LTD

EMGED RIZKALLA
Director

Attachments Extracts from SKM report
-Fig 5.5: Soil Salinity at a Depth of 0.3m (A-Horizon)
-Fig 5.6: Soil Salinity at a Depth of 0.75m (B-Horizon)
-Fig 5.7: Soil Salinity at a Depth of 2m (Lower B-Horizon in Weathered Shale)
-Fig 5.9: Groundwater Salinity (J & K Nov 1999)
-Fig 5.10: Groundwater Salinity (J & K Jan 2000)
Table 5.5: Salinity, Erosion and Sediment Management Strategy Systems
Section 4.4: Soil and Water Management Strategy



Legend

SREP 30 boundaries

Site boundary

(Sydney Regional Environmental Plan No 30 – St Marys Structure Plan Amendment No 1. Environmental Planning and Assessment Act, 1979. 11/04/2006. NSW Department of Planning.)

Property boundaries (LPI 2007)

LGA boundaries (LPI 2007)

Soil Bore Locations

Soil Salinity

Class	EC_e (dS/m)
Non-Saline	<2
Slightly Saline	2-4
Moderately Saline	4-8
Very Saline	8-16
Highly Saline	>16

2007 Aerial Photography by AUSIMAGE

0 250
Metres

Fig 5.5 : Soil Salinity at a Depth of 0.3m (A-Horizon)

St Marys Development Project - Western Precinct

GDA 94 MGA Zone 56

June 26, 2008
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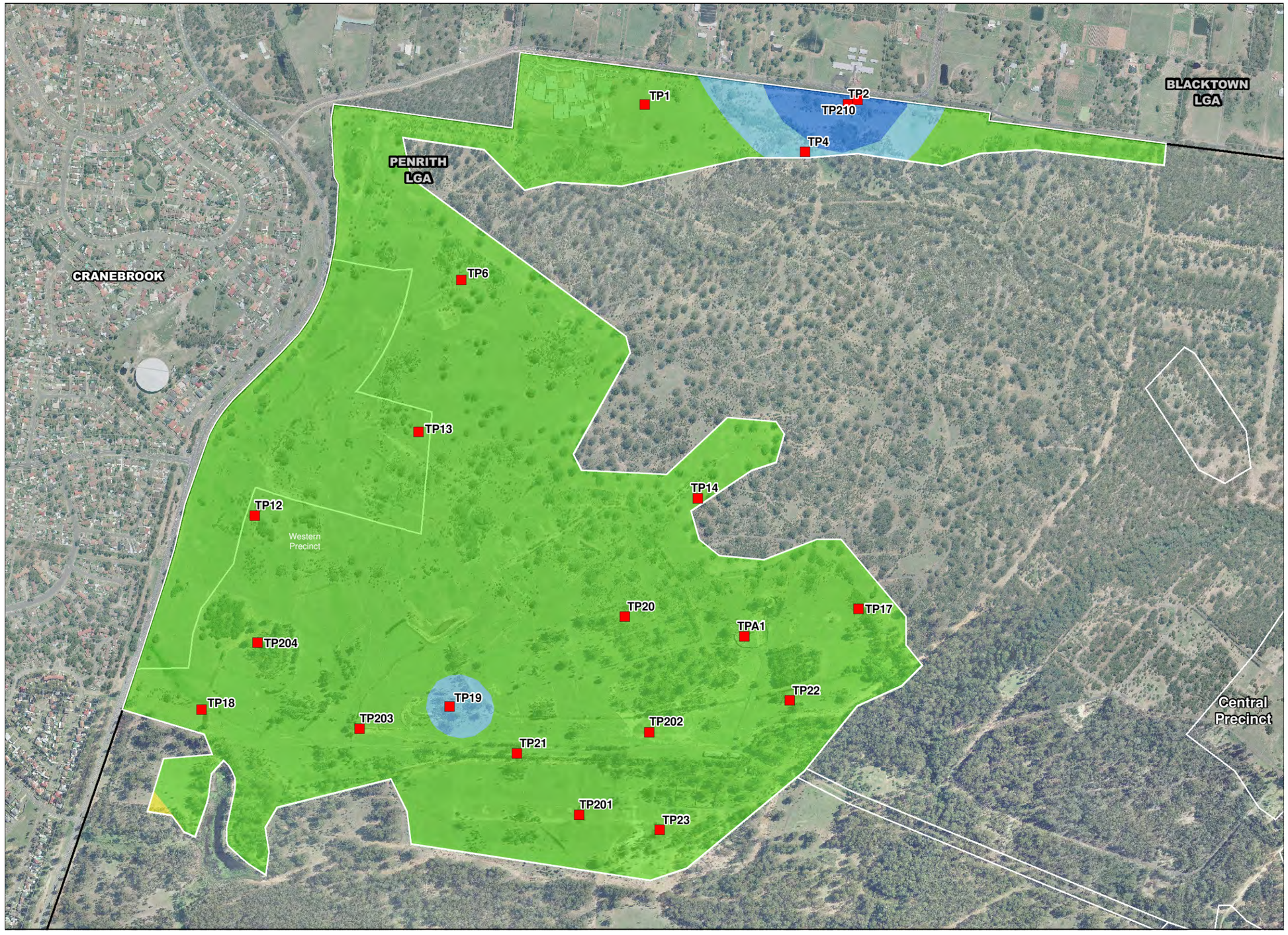

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SREP 30 boundaries

Site boundary

(Sydney Regional Environmental Plan No 30 – St Marys Structure Plan Amendment No 1. Environmental Planning and Assessment Act, 1979. 11/04/2006. NSW Department of Planning.)

Property boundaries (LPI 2007)

LGA boundaries (LPI 2007)

Soil Bore Locations

Soil Salinity

Class	EC_e (dS/m)
Non-Saline	<2
Slightly Saline	2-4
Moderately Saline	4-8
Very Saline	8-16
Highly Saline	>16

2007 Aerial Photography by AUSIMAGE

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Metres

Fig 5.6 : Soil Salinity at a Depth of 0.75m (B-Horizon)

GDA 94 MGA Zone 56

St Marys Development Project - Western Precinct

June 26, 2008
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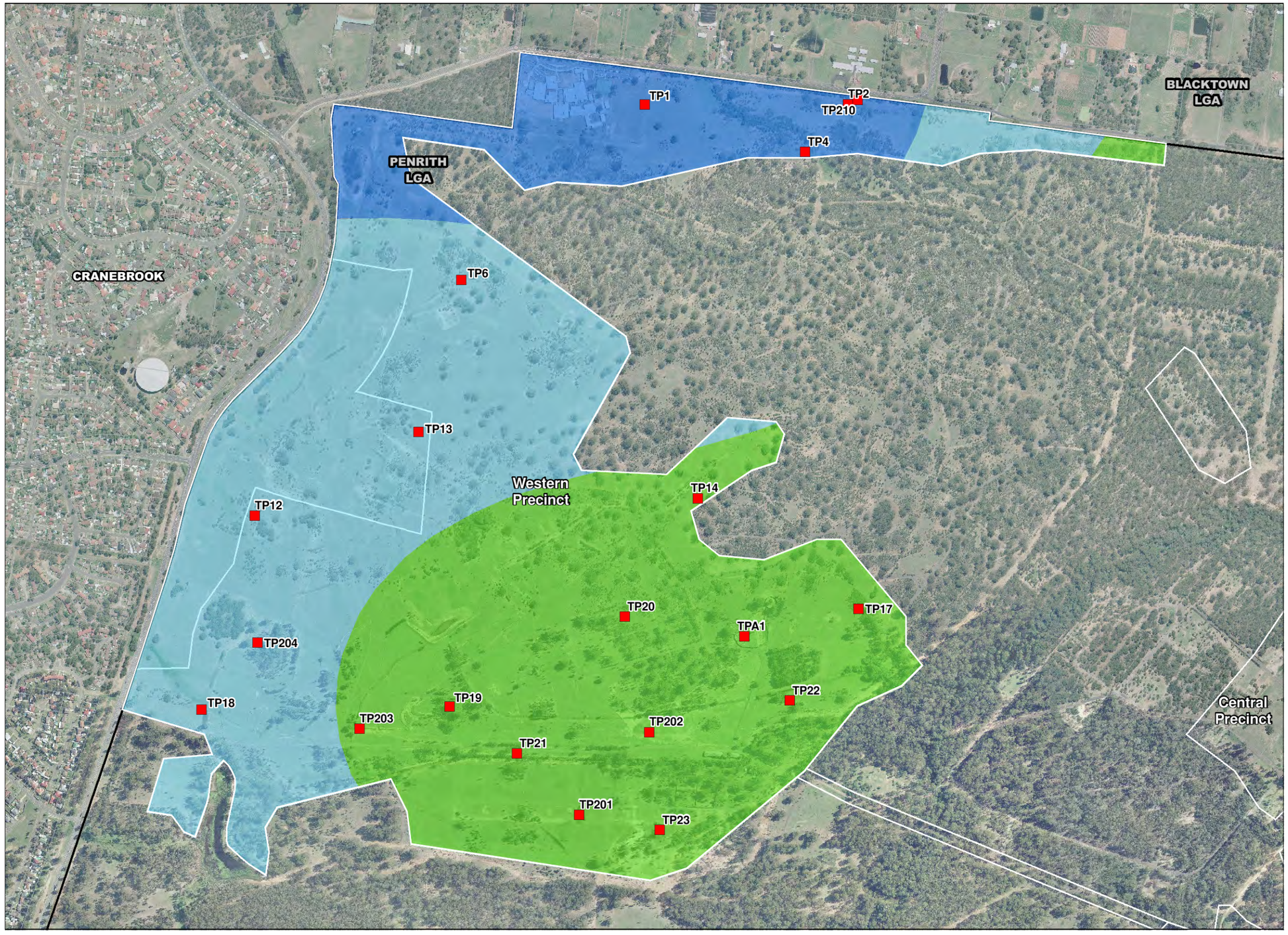

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SREP 30 boundaries

Site boundary

(Sydney Regional Environmental Plan No 30 – St Marys Structure Plan Amendment No 1. Environmental Planning and Assessment Act, 1979. 11/04/2006. NSW Department of Planning.)

Property boundaries (LPI 2007)

LGA boundaries (LPI 2007)

Soil Bore Locations

Soil Salinity

Class	EC_e (dS/m)
Non-Saline	<2
Slightly Saline	2-4
Moderately Saline	4-8
Very Saline	8-16
Highly Saline	>16

2007 Aerial Photography by AUSIMAGE

0 250

Metres

Fig 5.7 : Soil Salinity at a Depth of 2m (Lower B-Horizon in Weathered Shale)

St Marys Development Project - Western Precinct

GDA 94 MGA Zone 56

June 26, 2008
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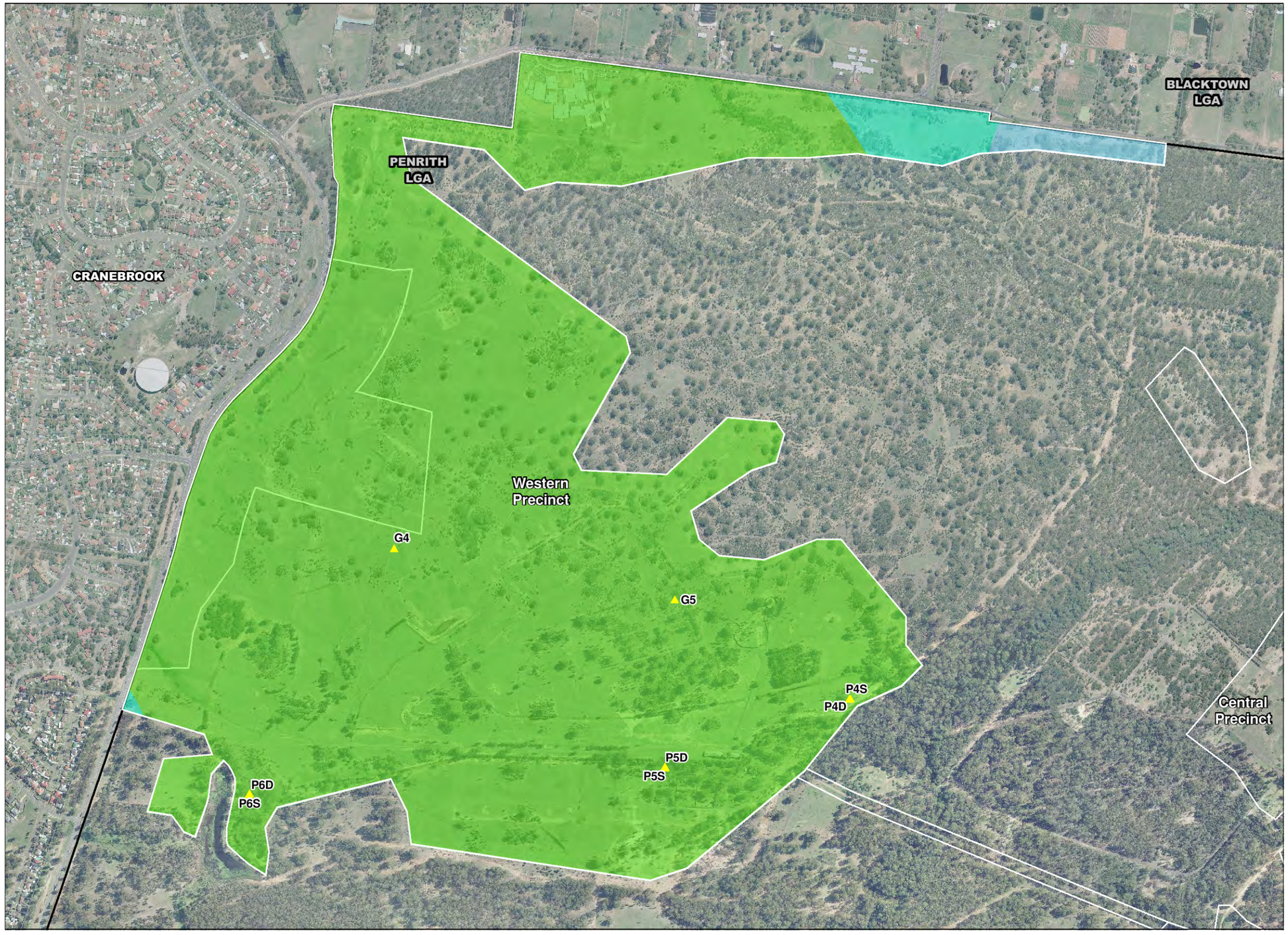

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SREP 30 boundaries

Site boundary

(Sydney Regional Environmental Plan No 30 – St Marys Structure Plan Amendment No 1. Environmental Planning and Assessment Act, 1979. 11/04/2006. NSW Department of Planning.)

Property boundaries (LPI 2007)

LGA boundaries (LPI 2007)

Piezometers (J & K, Nov 1999)

Groundwater Salinity

Groundwater Salinity (µS/cm)
0 - 2,000
2,000 - 10,000
10,000 - 20,000
20,000 - 40,000
40,000 - 60,000
60,000 - 70,000
>70,000

2007 Aerial Photography by AUSIMAGE

0 250
Metres

Fig 5.9: Groundwater Salinity (J & K Nov 1999)

St Marys Development Project - Western Precinct

GDA 94 MGA Zone 56

June 27, 2008
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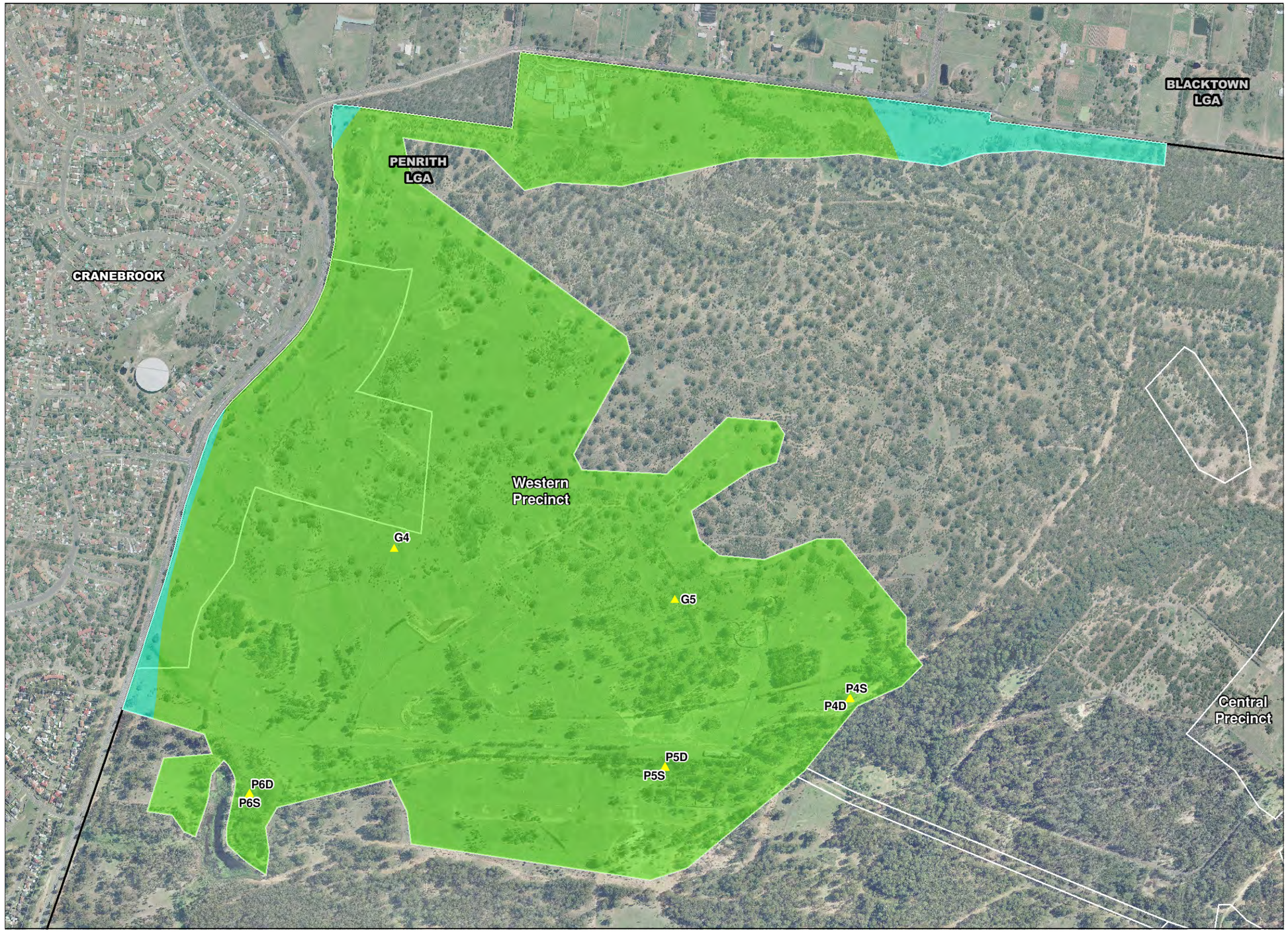

Legend

SREP 30 boundaries

Site boundary

(Sydney Regional Environmental Plan No 30 – St Marys Structure Plan Amendment No 1. Environmental Planning and Assessment Act, 1979. 11/04/2006. NSW Department of Planning.)

Property boundaries (LPI 2007)

LGA boundaries (LPI 2007)

Piezometers (J & K, Jan 2000)

Groundwater Salinity

Groundwater Salinity (µS/cm)
0 - 2,000
2,000 - 10,000
10,000 - 20,000
20,000 - 40,000
40,000 - 60,000
60,000 - 70,000
>70,000

2007 Aerial Photography by AUSIMAGE

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Metres

Fig 5.10: Groundwater Salinity (J & K Jan 2000)

St Marys Development Project - Western Precinct

GDA 94 MGA Zone 56

June 27, 2008
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Table 5-5 Salinity, Erosion and Sediment Management Strategy Overview

OBJECTIVE	BENEFIT	CONTROL	DETAILS	MONITORING METHOD	MANAGEMENT METHOD
SALINITY CONTROL MINIMISE GROUNDWATER RECHARGE	PREVENT RISING GROUNDWATER TABLE LEVEL AND DEVELOPMENT OF SALINE SOIL PROBLEMS	MINIMISE IMPORTATION AND USE OF POTABLE WATER ONTO THE SITE	• REUSE STORMWATER FOR IRRIGATION OF OPEN AREAS • MINIMISE POTABLE WATER DEMAND	INSTALL MONITORING BORE NETWORK	• MONITOR GROUNDWATER TABLE LEVELS • PERFORM REGULAR, RANDOM INSPECTIONS OF HOUSE SITES, AND VEGETATION AND GENERAL INFRASTRUCTURE AREAS
		REDUCE IRRIGATION REQUIREMENTS	• ADOPT SMALL GARDEN/LAWN AREAS • ESTABLISH LOW WATER REQUIREMENT PLANTS • USE MULCH COVER • USE LOW FLOW WATERING FACILITIES		
		AVOID USE OF INFILTRATION PITS TO DISPERSE SURFACE WATER	• DESIGN STORMWATER SYSTEM TO NEGATE NEED FOR HOME SITE STORMWATER STORAGE DISPOSAL • CONNECT ALL DOWNPIPES DIRECTLY TO STORMWATER		
		PREVENT LEAKAGE FROM WETLAND AND DRAINAGE FACILITIES	• LINE ALL PERMANENT STORMWATER RETENTION STRUCTURES AND WETLANDS		
SALINITY CONTROL ENCOURAGE USE OF GROUNDWATER AS A RESOURCE	MAINTAIN OR LOWER GROUNDWATER TABLE LEVEL	ENCOURAGE TREE PLANTING AND RETENTION, ESPECIALLY IN AREAS OF HIGHER RECHARGE	• USE/RETAIN NATIVE, DEEP-ROOTED, LARGE GROWING SPECIES		
EROSION CONTROL	PREVENTS SILTATION PROBLEMS IN DRAINAGE FACILITIES AND DAMAGE THAT COULD RESULT FROM EROSION	DESIGN ALL WORKS TO LIMIT GENERATION OF POTENTIAL EROSION SURFACES AND STABILISE DISTURBED AREAS AS SOON AS POSSIBLE	• STABILISE DISTURBED SURFACES • CONSERVE TOPSOIL BY STOCKPILING FOR LATER REUSE • USE FAST GROWING GRASS SPECIES • USE TEMPORARY GROUND COVER OR MULCH FOR AREAS TO BE REDISTURBED • MINIMISE AREA OF DISTURBANCE • COVER STOCKPILES WITHIN 10 DAYS • USE LIME STABILISATION DURING EARTHWORKS TO IMPROVE SUBGRADE AND REDUCE DISPERSIBILITY	• UNDERTAKE REGULAR INSPECTIONS OF ALL CONSTRUCTION ACTIVITIES • PERFORM REGULAR INSPECTION OF VEGETATION CONDITION IN DEVELOPMENT AREA	REGULAR INSPECTION REPORTS TO BE SUBMITTED TO CONTROLLING AUTHORITY
SEDIMENT CONTROL	CONTROL SEDIMENT GENERATED BY CONSTRUCTION AND OTHER ACTIVITIES	INCLUDE SEDIMENT CONTROL CONSIDERATIONS IN ALL DESIGNS	• PROTECT STOCKPILES FROM EROSION • USE TEMPORARY SEDIMENT BASINS • USE SPECIFIC SOIL STABILISATION MEASURES IN AREAS OF HIGH POTENTIAL SOIL EROSION		

4.4 Soil and Water Management Strategy

This section describes the Soil and Water Management Strategy (SWMS) for the construction phase of the project and with respect to groundwater and salinity management measures should be read in conjunction with section 5.9 and Appendix C.

Overall Approach

A soil and water management plan would need to be prepared as part of the development application. Its purpose is to safeguard the environment during the construction stages of the development.

The objectives of the SWMS are to:

Provide an overall erosion and sediment control concept for the proposed development;

Control the erosion of soil from disturbed areas on the site;

Limit the area of disturbance that is necessary;

Protect downstream water quality; and

Prevent any sediment-laden water from entering South Creek.

In addition to the controls that have been identified in the SWMS, Erosion and Sediment Controls Plans (ESCP) for the site would need to be prepared at the development application stage in accordance with the requirements of : *Penrith City Council, Erosion and Sediment Control DCP, December 2006- section 2.4,* and the Landcom "*Soils and Construction " Manual, 2004,* known as the "Blue Book". The ESCP would describe the requirements for erosion and sediment controls, such as handling of excavation and filling, sediment fences, diversion drains, top soil stockpiles and reuse of soils, barrier fences, energy dissipaters, check dams, temporary culvert crossings and sedimentation basins.

Management Measures

The following soil and water management measures would be used during the construction phase of the development.

Land Disturbance Protection

Land disturbance during construction will be minimised to reduce the soil erosion hazard on site and may include the following;

- Clearly visible barrier fencing will be installed at the discretion of the site superintendent to minimise unnecessary site disturbance and to ensure construction traffic is controlled. Vehicular access to the site will be limited to only those essential for construction work and they will enter and exit the site only through the stabilised access points;

- Soil materials should be replaced in the same order that they are removed from the ground. It is particularly important that all subsoils are buried and topsoils are replaced on the surface at the completion of the works;
- The duration of all works, and thus the potential for soil erosion and pollution, should be minimised;
- Where practical, foot and vehicular traffic will be kept away from all recently stabilised areas; and
- Stockpiles should be seeded.

Erosion and Sediment Control Measures

The relevant measures listed below to address erosion and sedimentation should be used on site:

- Stabilised entry/exit point;
- Sediment filter fences;
- Weed-free straw bales;
- Barrier fences;
- Diversion drain banks/channels;
- Check dams;
- Temporary sedimentation basins; and
- Top soil stockpiles.

These control structures are described in the following sections.

Stabilised Entry/Exit Point

A stabilised entry/exit structure should be installed at the access point to the site to reduce the likelihood of vehicles tracking soil materials onto public roads. A shaker ramp (cattle grid) will also be used in addition to the stabilised gravel access.

Sediment Filter Fences

Sediment filter fences should be installed where needed to confine the coarser sediment fraction (including aggregated fines) as near to their source as possible.

Barrier Fences

Barrier mesh fences should be installed to define those areas on site that should not be entered to avoid unnecessary soil/land disturbance.

Diversion Drain Banks/Channels

Diversion banks intended to remain effective for more than 2 weeks will be rehabilitated when possible. Hessian cloth can be used if tacked with an anionic bitumen emulsion (0.5L/m^2). Foot

and vehicular traffic will be kept away from these areas. Pipe culvert crossings that can withstand the maximum expected trucks loads will be installed where required. Concrete encasement for the pipe may be used if needed.

Check Dams

Check dams should be installed on diversion drains that are laid on longitudinal slopes greater than 2.5% to reduce runoff velocities. Check dams are to be located at intervals of approximately 100m.

Temporary Sedimentation Basins

Sediment basins will need to be constructed. These basins would be located at the furthest downstream point in their sub-catchment to maximise the capture and treatment of surface runoff during the construction phase. The sedimentation basins will need to be designed to suit type D (Dispersible) soils. Stored contents of the basins should be treated with gypsum or other approved flocculating agents where they contain more than 50mg/L of suspended solids. An energy dissipater rip rap may be installed at the weir outlet located at the downstream end of each sediment basin outlet to reduce runoff velocities where required.

Top Soil Stockpiles

Stockpiles will be constructed away from hazardous areas, particularly areas that are likely to have concentrated water flows. Stockpiles may be seeded.

Main Principles of Erosion and Sediment Control during Construction

The main principles for erosion and sediment control are summarised below:

- Stockpile and reuse all topsoil;
- Divert clean runoff water from the upstream drainage system around the disturbed open trench area;
- Restrict vehicular access to stabilised entry and exit points with controls to reduce soil export attached to excavators and truck tyres exiting the site;
- Restrict access to areas that do not require land disturbance;
- Provide adequately designed sediment fences, barrier fences, catch drains, check dams, sediment fences and other required structures;
- Ensure that the temporary top soil stockpiles are protected from erosion when works are unlikely to continue for long periods. Ensure that stockpiles are not placed in the flow path of upslope runoff;
- Make provisions for emergency quick clean-up and removal of any accidental spills of soil on to public property and provide tanker with pump to cope with accidental runoff;

- Provide wire mesh and gravel inlet filters at stormwater kerbs (if any) located downstream of the entrance to the site to trap any accidental spill of soil material;
- Monitor and maintain all sediment and erosion control measures;
- Minimise additional solid disturbance activities during wet weather;
- Undertake water quality monitoring at the outlet of the sediment basins to ensure compliance with the DECC (formerly EPA) guidelines;
- Stabilise rehabilitated surfaces as soon as possible; and
- Obtain additional information needed from the *"Soils and Construction", Landcom 2004* manual.

4.5 Flooding

The Western Precinct lies to the west of South Creek and the site is not at risk of flooding from South Creek in the 1 in 100 year ARI event.

4.6 Flood Evacuation Strategy

The Probable Maximum Flood (PMF), the regional flooding in the Hawkesbury-Nepean River system, does not impact on the Western Precinct which is demonstrated on the SREP30 Structure Plans.

4.7 Conclusion

The MUSIC model results, as provided indicate that the proposed stormwater management wetlands would meet the SREP30 water quality objectives of ensuring that there is no net increase in the annual pollutant load in the developed case compared to the existing case.

This assessment identifies fewer stormwater management ponds across the St Marys Project site compared with the 1998 Study. This result is an expected one, as the proposed area to be developed by MDC has been reduced since the 1998 SKM report was produced. In summary, the modelling results indicate that the proposed stormwater management wetlands would meet the water quality and quantity objectives.

4.8 References

1) ANZECC Guidelines for Fresh and Marine Water Quality, 2000.
2) Environmental Investigation Services, *Soil and Groundwater Investigation*, December 2006
3) eWater, *MUSIC User Guide,* Version 3.1
4) Healthy Rivers Commission of New South Wales, *Independent Inquiry into the Hawkesbury Nepean River System, Final Report*, August 1998.
5) Landcom, *Soils and Construction*, 2004