menanglepark

Menangle Park LES

Local Flooding And Stormwater Quantity Management (Detention)

26th May 2010

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CONTENTS

1 INTRODUCTION

1.1 PLANNING AT MENANGLE PARK

Campbelltown City Council undertook a Local Environmental Study (LES) for the Menangle Park in 1990 but ceased work, as the area was subject to an air and water quality moratorium under the South-Western Sydney Strategy.

In light of concerns regarding pressures on the Sydney housing market and housing affordability, the State Government announced in December 2001 that land in Western Sydney would be investigated for future residential release. Menangle Park was one of the key sites identified as part of this program. It was subsequently included in the Metropolitan Development Program.

Council recommenced preparation of an LES in 2003. The aim was to investigate the environmental, social and economic opportunities and constraints of the Menangle Park Study Area. It was intended to identify the capability of the area to accommodate urban development and recommend appropriate land use zones for incorporation into a subsequent draft LEP for the area. The owners of the two largest land holdings (Campbelltown City Council and Landcom) commissioned various studies to assist the preparation of the LES and concept Master Plan.

The LES was substantially completed when the project was put on hold in July 2004 to allow implications of land subsidence due to coal mining to be assessed. A Cabinet-requested Working Group reached an agreed position on this issue in 2005 and completion of the LES is now possible.

To this end, Campbelltown City Council and Landcom have asked APP to review and update the 2003/04 LES work before the LEP and DCP is completed.

1.2 OBJECTIVES OF THIS STUDY

GHD were appointed, by Campbelltown City Council and Landcom, to assist with the surface water management for the Menangle Park Release Area and in the formulation of a Water Sensitive Urban Design strategy. The Water Sensitive Urban Design strategy was to be compiled by two separate consultancies, who liaised to ensure maximised outcomes in managing surface water and flooding. The consultancies were:

- GHD – Nepean flooding, local flooding and stormwater quantity management (detention); and
- Aecom – Stormwater quality management

The objectives of this study are to report on local flooding and stormwater quantity management (detention) strategies. The Nepean flooding has been reported on in a separate report (GHD, 2008). The objectives of this study are to:

- Define and report on local flooding at the site;
- Define the impact of the development footprint as provided in the Masterplan, and propose a stormwater quantity management (detention) strategy that interfaces with the stormwater quality management strategy;
- Provide input and contribute to the integrated planning team on matters related to flooding and water cycle management; and
- Ensure efficient use of land for water cycle management facilities through co-location with other land-use elements, to maximise developable land and in consideration of other site constraints/opportunities (eg riparian corridors, climate, existing infrastructure).

1.3 WATER SENSITIVE URBAN DESIGN (WSUD)

WSUD encompasses all aspects of urban water cycle management including water supply, wastewater and stormwater management. WSUD is a multi-disciplinary approach that promotes opportunities for linking water infrastructure, landscape design and the urban built form to minimize the impacts of development upon the water cycle and achieve more sustainable forms of urban development.

The principles of WSUD are incorporated in the Campbelltown City Council Sustainable City DCP and the Growth Centres Commission Development Code. The intent of Councils' requirements in relation to stormwater management is to ensure systems are carefully planned, designed and located to prevent the disturbance, redirection, reshaping or modification of watercourses and associated vegetation and to protect the quality of receiving waters. If adequate WSUD measures are not adopted, the proposed development may have the following impacts:

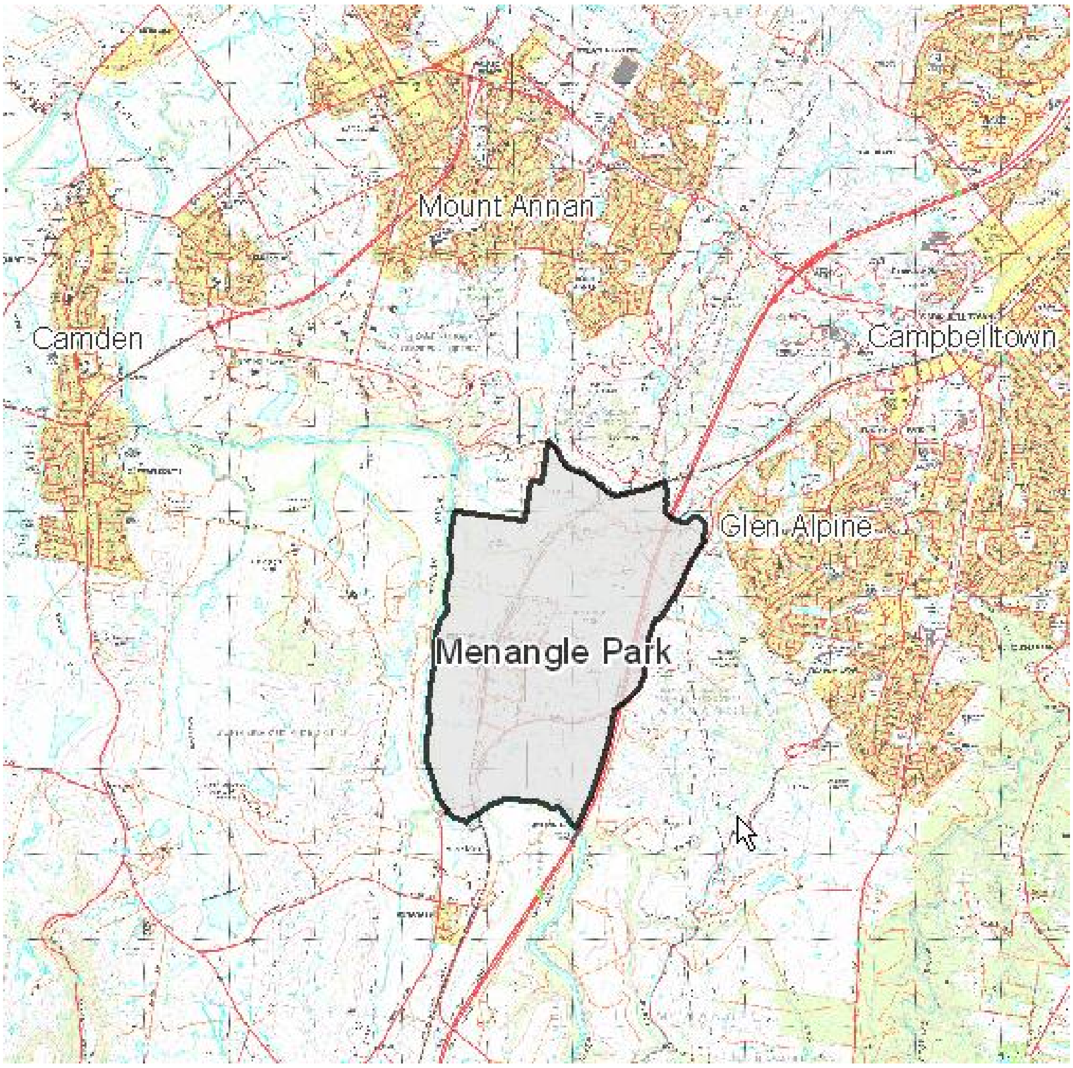
- Increased stormwater runoff, which could impact sensitive downstream habitats in terms of flushing regimes (frequency, volume and rate), water quality and wetting cycles;
- Reduction in rainfall infiltration and decreased groundwater recharge; and
- Disturbance of groundwater flow due to site compaction, fill, landform reshaping and underground structures.

The suitability of WSUD solutions to any proposed development depends upon a number of factors, including climate and rainfall, site topography, geology and available land.

1.4 MASTER PLAN

This report responds to the Master Plan dated 2/12/2009 ISSUE 4 (DRAFT Revised Structure Plan), which is included in Appendix A.

Figure 1 Menangle Park Site



2 SITE DESCRIPTION AND DERIVED CONSTRAINTS

2.1 CLIMATE AND RAINFALL

Referring to Figure 1, the site is located some approximately 25 km inland and is buffered from the typical Sydney coastal climatic conditions by intermediate terrain, such as the Royal National Park. The area experiences greater variations in temperature and is generally dryer than Sydney.

The nearest pluviograph stations in proximity of the site are located at Waterfall, Lucas Heights and Liverpool, all of which are considered too distant to provide representative data for the study area. A number of daily rainfall stations are located in close proximity to the study area. Table 1 summarises the stations located closest to the study site, providing station number, name and recording start and end years.

Table 1 Daily Rainfall Data

Station Number	Station Name	Start Date	End Date
068041	Menangle	1895	1952
068216	Menangle Bridge (Nepean River)	2000	ongoing
068013	Menangle (Elizabeth Macarthur Agricultural Institute)	1861	1992
068227	Ambarvale Clennam Ave	1961	1988
068014	Campbelltown 1	1845	ongoing
068081	Campbelltown Swimming Centre	1959	1984

Daily rainfall data was obtained from the Bureau of Meteorology (BOM) for the Menangle Elizabeth Macarthur Agricultural Institute station (Station No. 068013). An analysis undertaken on this data indicated that there is significant annual variability in the rainfall with the maximum annual rainfall of 1560 mm while the minimum annual rainfall recorded was 280 mm. The average annual rainfall at the gauge is 722 mm with the median being 710 mm. Figure 2 provides a plot of the annual rainfall to indicate the variability.

A frequency analysis (
Figure 3) was undertaken to determine the likely range of annual rainfalls. It was found that the 1 percentile annual rainfall was approximately 1300 mm a year while the 99 percentile of rainfall was likely to be in the order of 295 mm a year.

An analysis was undertaken of the monthly rainfall records between 1878 and 1992 to determine seasonal trends in the rainfall. As indicated in Figure 4 there is the possibility of a relatively high month of rainfall, at any period during the year. A mild seasonal pattern was evident in the average and median rainfalls for the month, with generally the average being higher in late summer and early autumn, dropping to a low towards the end of winter and early spring, rising again towards summertime. Based on

that historical period of record there is the possibility of no rainfall, or minimal rainfall, in any month of the year.
Mean daily evaporation data for the site, listed in Table 2, was sourced from BOM from the 068013 pluviograph site (Elizabeth Macarthur), which also measured evaporation.

The high likelihood of rainfall occurring in any month throughout the year would support utilisation of vegetated systems such as swales and wetlands to manage stormwater. Furthermore, the mild seasonal variability would indicate that rainwater collection via rainwater tanks might be viable for domestic uses.

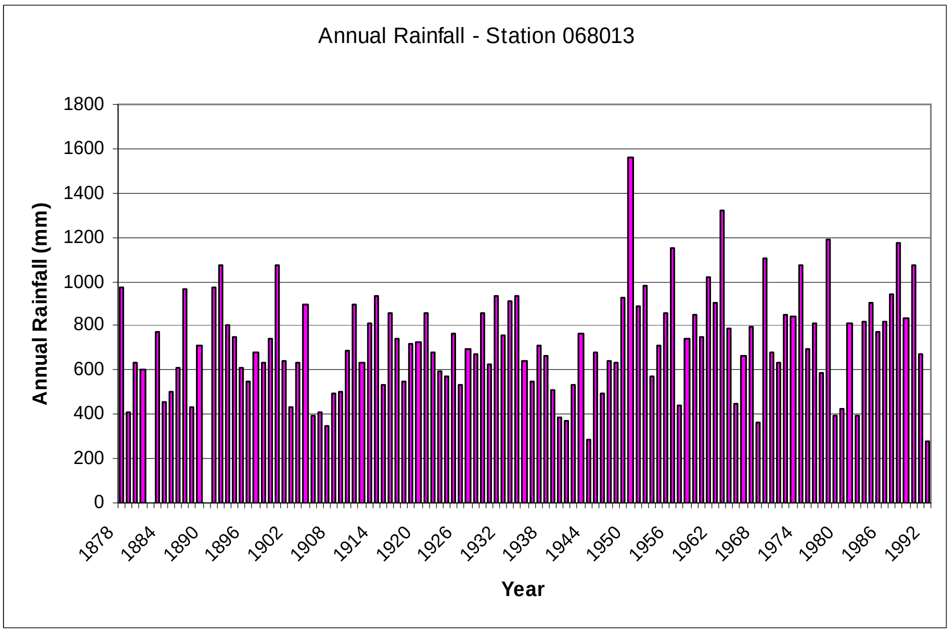


Figure 2 Annual Rainfall

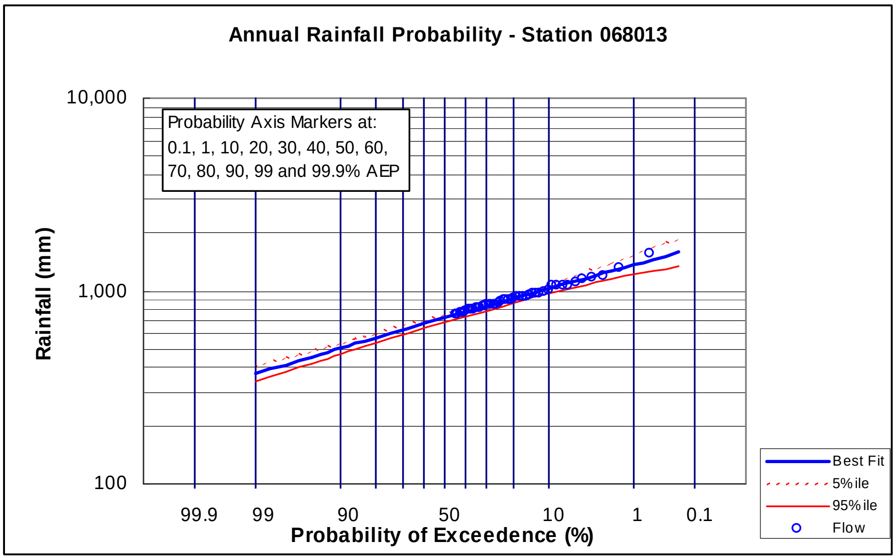


Figure 3 Annual Rainfall Frequency Analysis

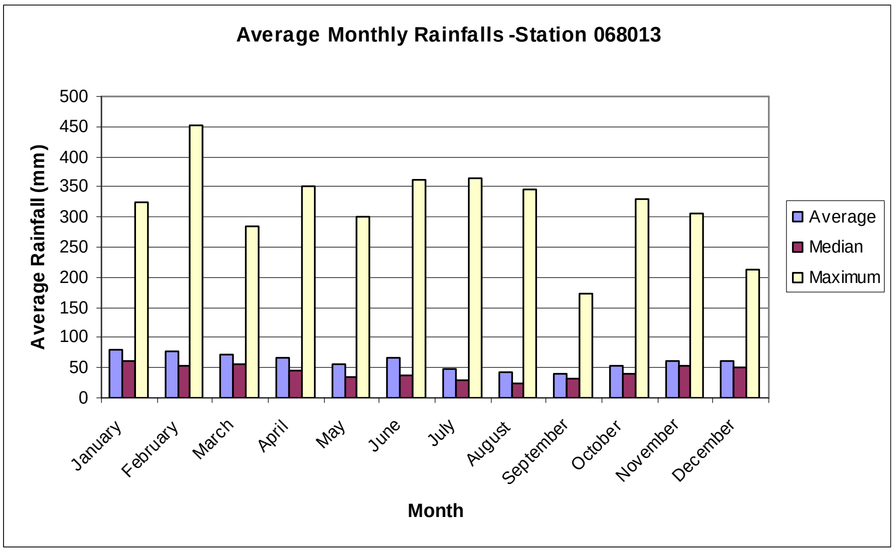


Figure 4 Monthly Rainfall Distribution

Table 2 Mean Daily Evaporation

Month	Mean Daily Evaporation (mm)
January	5.6
February	5.2
March	4.5
April	3.9
May	2.4
June	2.1
July	2.1
August	2.9
September	4.2
October	4.9
November	5.8
December	6.3

2.2 TOPOGRAPHY

The broader catchment area in which the site is located is characterised by higher relief rolling hills to the east and north, most noteworthy are Menangle, Sugarloaf and Mount Annan, sloping toward a flatter alluvial terrace in the centre, namely the Nepean River floodplain. There are three distinct drainage creek valleys draining roughly east to west and discharging into the Nepean River.

Referring to Table 3 approximately 60 to 70% of the site is located in reasonably steep terrain with slopes in excess of 2 to 3%.

The hydrological catchment is 43% larger than the study area and the highest relief areas (slopes in excess of 5%) are generally located to the east and north of the study area boundary. The Main Southern Railway line generally traverses the edge of the Nepean flood plain demarcating the eastern edge of the low relief areas.

Table 3 Site Slope Analysis

Slope Range	Percentage of the Study Site
0.0% to 2.0%	18%
2.0% to 5.0%	37%
5.0% to 10.0%	32%
Above 10.0%	13%

Steeper slopes (generally greater than 4%) generally make construction of large regional wetlands and detention basins more difficult, particularly when located off-channel. Steeper slopes (greater than 5 to 10%) generally make construction of flow attenuation via vegetated swales and bio-retention systems less desirable due to excessive flow velocities, reduced detention times and potential scouring.

2.3 WATERWAYS AND CREEKS

The Nepean River bounds the study site in the west and south, and receives discharge from all drainage systems on the Menangle Park site. A large portion of the site area includes the Nepean River and it's floodplain. The Nepean has its headwaters in the Illawarra Range to the west of Wollongong some 60 km to the south of Camden. Upstream of Camden the catchment area of the Nepean River is some 1380 km^2. The 13.5 km^2 Menangle Park catchment only contributes a small percentage of the total runoff arriving at Bergins Weir (located in the Nepean River, adjacent to the Glenlee Washery).

The Nepean River and its floodplain has been subject to a separate study (GHD, 2008), which provides 20-, 50-, 100-year and PMF flooding information.

The site is drained by a number of smaller onsite creeks. All creeks generally drain in a westward direction towards the Nepean River. It is customary to identify significant creeks and drainage channels as those identified as 'blue lines' on the 1 in 25 000 topographic series, subject to site investigation with DECCW representatives and confirmation of extent. Referring to Figure 1, there are five such creeks that are located within the study area. With exception of one creek, the creeks are not named, and for the sake of this report, Table 4 lists a naming convention adopted in previous studies. Also listed are general flooding implications of each creek.

The main catchment draining the site (Creek M – Howes Creek) discharges from the east of the South Western Freeway, through the site to the Nepean River north of Menangle Park Village. This catchment drains approximately 43% of the total site catchment. There are a number of smaller drainage systems, one to the north (Creek N) draining approximately 27% of the northern part of the main study area and two to the south (Creek S1 and S2). Smaller drainage channels discharge local runoff from Menangle Park Village north of the Menangle Park Raceway, and south of the Menangle Park Paceway.

Table 4 Significant Creeks in the Study Area

Name	Approximate Catchment (ha)	Catchment Area within Study Area (ha)	Description
Creek N	370	110	Flooding in upper reaches could affect urban footprint, lower reaches affected by Nepean flooding backwaters
Creek M – Howes Creek	590	380	Flooding in upper reaches could affect urban footprint, lower reaches affected by Nepean flooding backwater
Creek S1	130	95	Flooding in upper reaches could affect urban footprint, lower reaches affected by Nepean flooding backwater
Creek S2	55	30	Entire creek likely to be affected by Nepean flooding backwater
Village Creeks	220	220	Entire creek likely to be affected by Nepean flooding backwater
TOTAL	1365	835	

Along the drainage paths, some creeks discharge under the South Western Freeway, Main Southern Railway and/or Menangle Road. These crossings are achieved via culverts, which could potentially attenuate floods and affect local flood levels on the upstream side of the structure.

Some of the creeks have existing farm dams located along their reaches. These dams generally have small basins. In one instance, a tributary of Creek M, appears to have been diverted to allow discharge to enter an off-channel dam.

Creek slopes are flat (less than 1%) in the Nepean River floodplain, generally to the west of the Main Southern Railway, and Nepean River flood levels and backwater effects dominate flooding in this area.

2.5 RIPARIAN CORRIDORS

The GHD Riparian Areas Assessment for Menangle Park (September 2008) categorised streams (please see Appendix B) in accordance with the Water Management Act. In broad terms, the management objectives of each category were:

- 3rd Order (Category 1) - Environmental Corridor – minimum Core Riparian Zone (CRZ) of 20-40 m from the top of each bank, with a further 10m vegetated buffer to counter edge effects. The entire riparian zone is to consist of local provenance native vegetation with the CRZ including full structural floristics of the endemic vegetation community. Utility services, bushfire asset protection, recreational activities and stormwater treatment facilities etc to be located outside the CRZ;
- 2nd Order (Category 2)- Terrestrial and Aquatic Habitat – minimum CRZ of 20 m from the top of each bank, with a further 10m vegetated buffer to counter edge effects. The entire riparian zone is to consist of local provenance native vegetation, with the CRZ including full structural floristics of the endemic vegetation community. Utility services, recreational activities and stormwater treatment facilities etc to be located outside the CRZ; and
- 1st Order (Category 3) - Bank Stability and Water Quality – CRZ minimum width of 10m from top of each bank on each side of the drainage line and generally no vegetated buffer. Vegetation used in restoration will be of local provenance. Previous planning decisions have, on occasions, enabled 1st order streams to be 'managed' like a vegetated buffer and/or incorporated into WSUD initiatives.

2.6 COUNCIL CONSIDERATIONS

Council, over the course of the study, has expressed a range of preferences in terms of formulating the Water Sensitive Urban Design strategy for the precincts. In particular, Council has:

- Reviewed and requested revisions to the sub-catchment break-up;
- Provided preferred parameters for use in hydrological and other models;
- Provided preferred design parameters for water management facilities, such as depths, side slopes and configuration of filter media in bio-retention systems; and
- Provided preferences for co-located precinct scale basins over on-lot treatment.

3 DESIGN CRITERIA

3.1 SUPPORTING DOCUMENTS

Campbelltown (Sustainable City) Development Control Plan 2009 (CCC, 2009), and the NSW Floodplain Development Manual, 2005 define the requirements for management of stormwater quantity, quality and flooding at the precincts.

3.2 LOCAL FLOODING AND STORMWATER QUANTITY MANAGEMENT (DETENTION)

The Campbelltown (Sustainable City) Development Control Plan (CCC, 2009) requires developed flood peaks to match the undeveloped natural peak flow rates for all storm events up to and including the critical duration 100-year ARI event.

Development and land-use in flood prone areas should be in accordance with the Campbelltown (Sustainable City) Development Control Plan and the NSW Floodplain Development Manual. In assessing the flood risk, consideration needs to be given to the full range of risks to people and property, for a full range of flood events up to and including the PMF. Development guidelines specify, amongst others:

- Habitable floor levels of new residences, commercial and industrial developments, together with normally occupied floors of special use developments should either be at or above the Flood Planning Level or be flood proofed to this level. For habitable floor levels, the Flood Planning Level is defined as 300mm above the 100-year ARI level where the flood depth is less than 300mm, and 500mm above the 100-year ARI level where the flood depth is greater than 300mm. The 100-year ARI level is associated with the creeks across the site and any precinct basins or local flood routes, as well as levels defined by flooding in the Nepean River;
- For development in flood storage areas and flood ways, development must not lead to a significant increase in flood levels, flood damages, flood behaviour or flood hazard at the site or elsewhere. Provision of adequate and acceptable compensating works to offset must be provided; and
- Effective evacuation procedures must be provided for all flood prone lands (i.e up to the PMF)

For flooding associated with discharges on internal roads and other areas of concentrated flow, overland flows should be limited to lower flow velocities and depths, thereby reducing the flood hazard. This could be achieved through a detailed design of the subsurface stormwater infrastructure. In addition, areas of elevated velocity (for example in riparian corridors) may require energy dissipation using environmentally acceptable strategies (for example rock protection).

Most of the precinct site area is generally located above PMF levels. Areas that are inundated by the PMF require a flood evacuation strategy. Elevated areas would provide suitable evacuation muster areas.

4 SUPPORTING SIMULATIONS

Numerical modelling was used to assess the local flooding and stormwater quantity management (detention) strategy, which:

- Defined existing condition flood peaks and flood levels for the creeks within the precinct, for a range of design storm events (using RAFTS and TUFLOW); and
- Determined appropriate volumes of detention throughout the precinct, that responded as best possible to the Masterplan, and which throttled post development flood peaks to existing condition flood peaks in accordance with the design criteria (using RAFTS).

4.1 SIMULATING STORMWATER FLOOD HYDROGRAPHS

The Menangle Park area is partially developed and is considered as a rural catchment. Flood peaks and detention requirements were simulated using the RAFTS hydrological model. The RAFTS model was simulated for the 2-year and 100-year ARI events and durations ranging from 25 minutes to 12 hours. For each event the critical duration was reported.

Three RAFTS models were prepared, namely:

- For flood modelling, an existing conditions RAFTS model for the catchments draining to the creeks in Table 4 and associated tributaries discharging through the site (2-year and 100-yr ARI events);
- For sizing of detention basins, an existing conditions RAFTS model for the on site catchments (2-yr, 100-yr and the PMF); and
- For sizing of detention basins, a developed conditions RAFTS model in response to the Masterplan. For the developed condition a number of assumptions in regard to impervious percentages were made. This model was also used to size detention storage requirements to manage the increase in impervious area on account of the development (2-yr and 100-yr ARI events).

Compilation of the RAFTS model included:

- Catchment delineation;
- Hydrological parameter determination; and
- Intensity-Duration-Frequency determination for generating storm rainfall events

Lag times were based on average slopes and flow velocities, ranging between 1 m/s and 2 m/s depending on slope.

Percentages of impervious areas, used in the hydrology model, were as follows:

- Commercial 100%
- Town Centre 95%
- Employment 90%
- 350 to 390 sqm lots 90%
- 540 to 700 sqm lots 80%
- 1000 to 1500 sqm lots 60%
- 2000+ sqm lots 30%
- Heritage 25%
- Open spaces 10%
- Playing Fields 10%

For existing conditions areas, percent of impervious areas were determined from the topographic maps and aerial photography. The modelling parameters are consistent with Appendix B of Council's DCP, Volume 2 (2009). Key parameters for the RAFTS modelling are provided in Table 5, in accordance with Council's DCP. Detailed listings of the RAFTS models are provided in Appendix C.

Table 5 Key Rafts Parameters

Catchment Conditions	Pern n	Initial loss	Continuous loss
Pervious area	0.025	15 mm	2.5 mm/hr
Impervious area	0.015	1.5 mm	0 mm/hr

4.2 SIMULATING FLOOD RISK

Flood levels were simulated for existing conditions using the TUFLOW software. For the hydrological analysis, it was assumed that any future development upstream of the precinct would be required to provide management strategies, which ensure that flood peaks discharging the precincts are maintained at existing conditions, by provision of detention storage within these areas.

The model extent is shown in Appendix D, which includes catchments draining to the creeks in Table 4 and associated tributaries discharging through the site. The TUFLOW model compilation, with key parameters shown in Table 6, was undertaken as follows:

- Available survey data for the local area was imported into a digital terrain-modelling program and triangulated to represent the ground surface;
- A TUFLOW grid was generated with a cell size of 2 m^2. Each point in the grid was given an elevation based on its location in the DTM. The grid size was chosen because this is a compromise between the accuracy of the DTM data, simulation run time, model stability, and the accuracy of the results;
- Supplied cadastral information was imported into GIS and the aerial photography geo-referenced;
- Using aerial photography and surveyed data, the locations of hydraulic structures in the catchment were digitised into strings to form the one-dimensional part of the network;
- The sub-catchments used in the RAFTS hydrologic modelling were applied as "rainfall inflows" over the 2-D model, with inflows distributed and divided over the model grid points; and
- Based on aerial photography and site inspections, hydraulic roughness coefficients for the floodplain were input to the model. These coefficients were digitised into MapInfo as polygons to represent the various surfaces. Table 6 lists the roughness categories used in this model.
- RAFTS storm event hydrographs were used as upstream boundary conditions. Downstream boundary conditions were adopted as per Table 7.
- Coincidental flooding of the Nepean and the local drainage lines are expected and through discussions with Council, it was decided to adopt the 20-yr ARI backwater level of the Nepean for the 100-yr ARI discharge of the on-site creeks. For the 2-yr ARI case, the 5-yr backwater level of the Nepean was adopted. These levels were extracted from the 2008 GHD flood study for the Nepean, and shown in Table 7.

In the absence of corresponding rainfall (hyetograph) and runoff data, calibration of the TUFLOW model was not possible. Furthermore no historic flood markers were available for calibrating of overland flood depths. Calibration of the model was thus limited to checking the sensibility of the overland flow routes and depths, and qualitative comparisons.

Table 6 Key TUFLOW Parameters

Feature	Value
Time step	0.5 seconds
Grid size	2m x 2m
Manning's "n" – sealed roads	0.017
Manning's "n" – unsealed roads or exposed soil/ sand	0.022
Manning's "n" – floodplain short grass	0.03
Manning's "n" – floodplain high grass	0.035
Manning's "n" – light vegetation	0.05
Manning's "n" – private open space	0.06
Manning's "n" – medium vegetation	0.08
Manning's "n" – dense vegetation	0.1
Manning's "n" – houses or fenced areas (zero conveyance)	4

Table 7 Downstream Boundary Conditions for the 2-yr and 100-yr ARI Scenarios

ARI	Village Creeks *	Creek M – Howes Creek *	Creek S1 *
5-yr Nepean Flood Level	73.02 – 73.43 m AHD	72.80 m AHD	73.97 m AHD
20-yr Nepean Flood Level	74.837 – 75.45 m AHD	74.30 m AHD	76.60 m AHD

* These levels were extracted from the 2008 GHD Menangle Flood Study for the Nepean

The flood extents are provided in Appendix D for the 2- and 100-year ARI events and the PMF. It is important to note that the accuracy of the flood maps depends highly on the quality of digital terrain data. The results show that:

- A significant portion of the site is affected by backwater from the Nepean. This Nepean flooding would discharge through the railway culverts and the railway underpass and inundate portions of the site;
- In Creek M – Howes Creek, the 100-yr ARI event is mostly contained within its floodplain, with the flood extending into the precinct boundary during the larger events. The railway culverts attenuate the flood discharge. Should the Nepean River be in flood, backwater could back up through the culverts and define the local flooding;
- The South Western Freeway embankment height is approximately 5 m, resulting in considerable attenuation of the flood peaks from eastern tributaries of Creek M – Howes Creek. During large to extreme events, it is likely that a number of these creeks will combine upstream of the freeway embankment, with potential overflow of the freeway;
- In the 100-yr ARI event, overflow occurs at the South Western Freeway at the location of the 2 x 450 mm and the 2 x 1800 mm diameter culverts. Flows attenuated upstream of the freeway embankment are redistributed to the location of the 2 x 1800 diameter culverts and the freeway overtops by a depth of 1.9 m at its lowest point;

- The northern and southern tributaries of Creek M – Howes Creek convey significant flood flows from the adjacent catchments and these will need to be managed within the stormwater network of the development area with in-ground stormwater pipes and overland flow routes;
- A number of catchments drain through the existing Menangle Park village toward the railway embankment. Most of this flow is expected to be contained on the roads by the kerb and gutter however where there are no kerbs or depths are excessive the flood may discharge through the properties. At the railway embankment, the flood flows combine resulting in some local flooding. While it would appear that the Menangle Park village area is flood affected, flood depths are often shallow (< 50 mm) across a large portion of the village. Flood depths less than 50 mm have been eliminated from the flood extents shown in Appendix D;
- Creek N is mostly contained within its floodplain for the 100-yr ARI event until it discharges onto the Nepean floodplain where its channel capacity will likely be surpassed, resulting in a wide floodplain. Should the Nepean River be in flood, backwater would inundate this part of the floodplain and dominate the flooding;
- Flooding of Creek S1 is contained in the wide channel profile. Should the Nepean River be in flood, backwater would inundate the lower part of the Creek S1 floodplain and dominate the flooding. In addition the possibility of Menangle Road overflow exists with a portion of the Nepean flooding diverting over the road via a low saddle and through the railway underpass at Racecourse Avenue; and
- Some of the lower laying areas of the development would be subject to inundation in a PMF, however the undulating topography and proposed orientation of roads would be expected to provide evacuation routes.

5 WSUD MANAGEMENT STRATEGY

5.1 PRINCIPLES

In general, the principles for stormwater management at the site should aim to retain as much stormwater as possible, treat pollutant entrained in the stormwater, transport as little stormwater as possible to receiving waters, 'lose' as much stormwater as possible along the treatment train and slow the transmission of stormwater to receiving waters. In addition, water usage and water conservation along with maintaining the health of the surrounding environment are important considerations of any proposed development.

5.2 OBJECTIVES

In applying the above principles, the key Water Sensitive Urban design planning and design objectives are:

- To protect and enhance natural water systems in urban developments;
- To integrate stormwater treatment into the landscape by incorporating multiple-use corridors that maximise the visual and recreational amenity of the development;
- To manage water quality from the development;
- To reduce runoff and peak flows from developments by employing local detention measures, minimising impervious areas and maximising re-use; and
- To add value while minimising drainage infrastructure development and ongoing maintenance costs.

The development of a management plan to achieve the above must consider flood management, flow management, water quality management and flow attenuation.

For this project, as stated before, the Water Sensitive Urban Design strategy was to be compiled as two separate consultancies, who liaised to ensure maximised outcomes in managing surface water and flooding. The consultancies were:

- GHD – Nepean flooding, local flooding and stormwater quantity management (detention); and
- Aecom – Stormwater quality management

5.3 SITE OPPORTUNITIES

General opportunities for WSUD at the Menangle Park Site include:

- Maximise source control measures in preference to end of line treatment measures. Manage the quality of stormwater at or near the source, which will involve a significant component of education;
- Orientate roads to traverse contours, providing slopes with grades of 4% or less to promote the provision of above ground conveyance mechanisms such as vegetated swales into the streetscape;
- Maintain and re-establish vegetation along waterways and provide public open space along drainage lines to develop multi-use corridors linking public and private areas;
- Preserve and restore existing valuable elements of the stormwater drainage system such as wetlands, natural channels and riparian vegetation;
- Treatment practices such as precinct scale detention basins co-located with bio-retention in the basin invert, to manage water quality and quantity. These could be provided downstream or close to the point of discharge from development areas, before discharge to key riparian and waterway areas. Furthermore detention basins should be located off-line to riparian corridors; and

- Provide 'structural' stormwater quantity and quality management practices that provide flood management, flow attenuation and volume reduction, along with water quality management. Typical structures include detention basins, bioretention facilities, rehabilitated waterways, trunk drainage channels and water re-use schemes.

5.4 MENANGLE PARK WSUD STRATEGY (FLOODING AND STORMWATER QUANTITY MANAGEMENT (DETENTION))

The local flooding and stormwater quantity management (detention) components, of the proposed WSUD strategy for the Menangle Park site are provided in Appendix E. A number of specific "drivers" were identified, which have guided the flooding and stormwater quantity management (detention) strategy development:

- The undulating site topography:
- Requires management of stormwater at a number of discharge points corresponding to existing drainage lines;
- The flatter site topography in the lower reaches:
- Favours larger (precinct scale) co-located bio-retention and detention basins located offline before discharge to riparian corridors;
- Favours opportunistic provision of swales in the street;
- Favours co-located open space and stormwater treatment measures;
- The residential nature of the proposed development:
- Favours opportunistic landscape and bio-retention systems for treating road runoff at a local scale.
- The high likelihood of rainfall occurring in any month throughout the year and the mild seasonal variability:
- Supports utilisation of WSUD vegetated systems such as swales, bio-retention and wetlands to manage stormwater;
- Favours rainwater collection via rainwater tanks depending on roof areas and demands for the captured water;
- The presence of riparian corridors; and
- The potential for lined infiltration based treatment facilities, to manage the groundwater recharge.

5.5 STORMWATER QUANTITY MANAGEMENT (DETENTION)

Referring to Appendix E:

- Environmentally sympathetic drainage channels will be provided along the identified main flow routes. These channels will convey flows up to 100-year ARI storm event and will be vegetated swales;
- Precinct scale co-located detention/ bio-retention systems will be provided at discharge locations to riparian corridors. These systems would comprise a dry basin (to provide detention function) combined with bio-retention (to provide water quality treatment function) situated in the invert of the basin; and
- Rainwater tanks are recommended throughout. The size of the tanks will be decided as part of the lot development. Even though, the purpose of rainwater tanks is for roof water harvesting, they also detain the stormwater flows to a certain extent. However this function was not included in the assessment of detention requirements for the precinct. Installation of rainwater tanks in residential areas in conjunction with recycled water should be further explored. Rainwater would be utilised first with recycled water used to supplement the supply when necessary.

To test the effectiveness of the strategy, detention storage basins were configured in the RAFTS model at key locations and simulated. The results for the entire precinct showed the approximate detention storage requirements presented in Table 8.

Table 9 shows the effectiveness of the detention strategy at a number of locations during the 2- and 100-year ARI event, which are typical events that govern the land take in regards to precinct scale stormwater management facilities. The table shows that the developed flood peaks are suitably throttled.

Table 8 Stormwater Quantity Management (Detention)

Drainage System	Basin (see Appendix E)	Active Detention storage (m^3) * [A]	Upstream + offset treatment area** (ha) [B]	[A] / [B] (m^3/ha)
Creek M – Howes Creek	2	7400	31.9	232
	4	5100	33.7	151
	4a	2100	16.4	128
	5	2900	15.9	182
	6	2800	29.3	95
	12	12700	76.1	167
Creek S1	9	5300	57.3	92
Creek S2	11	1600	20.1	80
Creek N	13	4800	31.4	153
Tributaries west of Menangle Park	7	6200	25.5	243
	8	6900	44.7	154

*Active detention storage is equal to the storage in the basin between the top of the water quality zone and the maximum 100-year ARI event flood level

** offset treatment areas do not drain directly to the basin, however, the basin has been designed to over attenuate so that flows downstream are no greater than pre development levels.

Table 9 Effectiveness of Detention Strategy

Drainage System	100-year Flood Peak (m^3/s) for critical duration			
	Location	Existing	Developed (no mitigation)	Developed with mitigation
Creek M – Howes Creek	Basin 2 outflow	10.5	14.3	8.5
	Basin 4 outflow	11.2	14.9	10.4
	Basin 4a	6.2	8.3	6.0
	Basin 5 outflow	6.6	8.5	6.0
	Basin 6 outflow	10.2	11.9	9.9
	Basin 12 outflow	19.0	25.7	18.2
	D/S of Basins 2, 4, 4a, 5, 6, 12 at the railway	142	136	139
Creek S1	Basin 9 outflow	15.0	16.3	15.0
Creek S2	Basin 11 outflow	7.9	9.6	7.9
Creek N	Basin 13 outflow	10.5	14.2	10.5
Tributaries west of Menangle Park	Basin 7 outflow	8.9	12.4	4.5
	Basin 8 outflow	20.6	26.5	20.4
Drainage System	2-year Flood Peak (m^3/s) for critical duration			
	Location	Existing	Developed (no mitigation)	Developed with mitigation
Creek M – Howes Creek	Basin 2 outflow	2.7	6.7	2.1
	Basin 4 outflow	3.7	6.7	3.1
	Basin 4a	1.9	3.7	1.8
	Basin 5 outflow	2.0	3.3	1.9
	Basin 6 outflow	3.3	5.0	3.2
	Basin 12 outflow	6.0	11.7	5.7
	D/S of Basins 2, 4, 4a, 5, 6, 12 at the railway	46	44	46
Creek S1	Basin 9 outflow	5.1	5.6	4.9
Creek S2	Basin 11 outflow	2.6	3.6	2.4
Creek N	Basin 13 outflow	3.3	6.3	3.2
Tributaries west of Menangle Park	Basin 7 outflow	3.8	5.9	2.6
	Basin 8 outflow	6.1	12.5	6.1

5.6 FLOODING AND FLOOD RISK

Development and land-use in flood prone areas must be in accordance with Campbelltown (Sustainable City) Development Control Plan 2009 (CCC, 2009), and the NSW Floodplain Development Manual.

- All buildings would be located above the Flood Planning Level associated with the creeks across the site and any precinct basins or local flood routes. It is proposed that Flood Planning Levels be adopted that locate floor levels of buildings as defined by the design criteria (Section 3);
- For flooding associated with discharges on internal roads and other areas of concentrated flow, it is proposed to limit the overland flows and lowering flow velocities and depths to reduce the flood hazard. Campbelltown City Council DCP Volume 2 requires a velocity depth product of v x d <0.4. This could be achieved through a detailed design of the subsurface stormwater infrastructure including provision of a larger pipe system. In addition, areas of high velocity (for example in riparian corridors) may require energy dissipation using environmentally acceptable strategies (for example rock protection); and
- Areas that are inundated by the PMF would be provided with a flood evacuation strategy. Elevated areas would provide suitable evacuation muster areas. As shown in Appendix D, some of the lower laying areas of the development would be subject to inundation in a PMF, however the undulating topography and proposed orientation of roads would be expected to provide adequate evacuation routes.

The management of floods and floodplains are the responsibility of Campbelltown City Council. SES is mainly responsible for dealing with floods. Flood planning and land management rest with Council. The main considerations for the evacuation strategy are:

- The areas to be evacuated, which include areas within 500 year ARI flood extents;
- Numbers of people to be evacuated and the time available;
- Muster areas and evacuation routes; and
- Resources and transport means necessary to meet these needs.

Given the timing of flood peaks, the evacuation will be required at short notice. The strategy and operations must be pre-planned during design stages. It is considered, the site has sufficient space and locations to assemble and evacuate during flood events.

5.7 DETAILED DESCRIPTION OF STORMWATER MANAGEMENT STRATEGY

Referring to Appendix E the table below discusses the stormwater strategy on a basin by basin and catchment by catchment basis.

Table 10 Stormwater Quantity Management (detention) (see Appendix E for basin locations)

Basin	Contributing Catchments	Offset Catchments	Inflow source	Outflow
2	M63, M64, M67, M68, M69, M70		Runoff from contributing catchments for flows up to the 100-year ARI Event will be conveyed to the basin from the south and south-east via the pipe drainage network and overland flows in the road network. Fill will be required directly to the east of the basin to direct overland flows to the basin. The road network adjacent to Basin 12 will be graded such that runoff from catchments M63 and M64 is directed past Basin 12 towards Basin 2.	Flow released to Creek M – Howes Creek
4	M42, M43, M44, M45, M46, M50,		Runoff from contributing catchments for flows up to the 100-year ARI Event will be conveyed from the north via the pipe drainage network and	Flow released to Creek M – Howes Creek

Basin	Contributing Catchments	Offset Catchments	Inflow source	Outflow
	M51		overland flows in the road network before passing under the proposed Spring Farm Parkway via a culvert/culverts and discharging into the basin.	
4a	M47, M48, M49		Runoff from contributing catchments for flows up to the 100-year ARI Event will be conveyed to the basin from the east and north-east via the pipe drainage network and overland flows in the road network.	Outflow released to Creek M – Howes Creek via a culvert/culverts under the proposed Spring Farm Parkway
5	M26, M27, M28, M29, M30		Runoff from contributing catchments for flows up to the 100-year ARI Event will be conveyed to the basin from the North.Runoff from the east of the freeway passing under the culvert adjacent to the basin will bypass the basin via a 10 m wide 0.6 m deep open channel.	Flow released to Creek M – Howes Creek
6	M33, M34, M35, M36, M37, M38		Runoff from contributing catchments for flows up to the 100-year ARI Event will be conveyed to the basin from the south via the pipe drainage network and overland flows in the road network. The basin will be placed off-line from upstream flows from east of the freeway such that these flows bypass the basin via a riparian corridor.	Flow released to the riparian corridor that bypasses the basin
7	V17, V18, V19, V20, V21		Runoff from contributing catchments for flows up to the 100-year ARI Event will be conveyed to the basin from the north and east via the pipe drainage network and overland flows in the road network. Racecourse Avenue will be regraded to ensure that the 100-year ARI event can be conveyed from the north via overland flow in the road network.	Flow released to the Nepean floodplain via the 3x600 and 3x900 culverts underneath the railway corridor. The basin is designed to meet the capacities of these culverts. The discharge from the 3x900 culverts could be conveyed using a channel (with dimensions 12.5 m top width, 4 m base width, 0.55 flow depth with a 0.5 m freeboard) to the Nepean River. the location of this swale would need to be incorporated in any future Harness Racing Park masterplan
8	V1, V7, V8, V9, V10, V11, V12, V13, V14	V2. V3	Runoff from contributing catchments for flows up to the 100-year ARI Event will be conveyed to the basin from the east and north-east via the pipe drainage network and overland flows in the road network. Racecourse Avenue will be regraded to ensure that the 100-year ARI event can be conveyed from the north via overland flow in the road network. The Culverts underneath the railway corridor to the north of the basin will be closed such that runoff is directed southwards towards the basin rather than passing under the railway.	Flow released to the Nepean floodplain via a trunk drainage channel to the existing channel under the railway In discussion with Council (21/04/2010) it has been agreed that the access road to Harness Racing Park need not conform to Councils DCP in terms of drainage serviceability.

Basin	Contributing Catchments	Offset Catchments	Inflow source	Outflow
			In discussion with Council (21/04/2010) it was noted that a portion of Racecourse Avenue and adjacent lots could potentially be offset, should it not be desirable to grade these areas to Basin 8 using fill. This would be achieved by overcompensating in Basin 8 and allowing the small Racecourse Avenue catchment to bypass the basin. While this has not been simulated, it is expected to have a minor effect on the basin footprint.	
9	S6, S7, S8, S9, S10, S12, S13, S15, S17, S18	S5, S11, S14, S16	The basin will be located offline from Creek S1 on the north side of the creek. The basin will collect runoff from the north of the creek and offset runoff flows from the south of the creek rather than directing these flows to the basin. Runoff from contributing catchments for flows up to the 100-year ARI Event will be conveyed to the basin from the east via the pipe drainage network and overland flows in the road network. Fill will be required to the east of the basin to remove the natural low point in the topography and direct flows to the basin.	Basin outflow released directly to Creek S1. Offset flows to drain to the creek without any water quantity treatment.
11	Sa3, Sa4, Sa5, Sa6		Runoff from contributing catchments for flows up to the 100-year ARI Event will be conveyed to the basin from the north-west and north-east via the pipe drainage network and overland flows in the road network. Fill will be required to the west of the basin to direct overland flows to the basin.	Flow released to Creek S2
12	M53, M54, M55, M56, M57, M58, M59, M60, M61, M62, M65	M40	Runoff from contributing catchments for flows up to the 100-year ARI Event will be conveyed to the basin via a trunk drainage channel. The pipe drainage network and overland flows in the road network will be directed to discharge to the channel or directly to the basin. Runoff from Catchment M40 will not be directed to the basin but will be offset for water quantity through over-treating of flows entering the basin.	Flow released to Creek M – Howes Creek. Offset flows to drain to the creek without any water quantity treatment
13	N15, N16,N17, N18, N19		Runoff from contributing catchments for flows up to the 100-year ARI Event will be conveyed to the basin from the east and north-east via the pipe drainage network and overland flows in the road network.	Flow released to Creek N via a culvert/culverts underneath the railway alignment.

5.7.1 Railway Culverts

There are a number of existing railway culverts that are proposed to convey the outflow from the basins located immediately east of the railway (Basin 13, 7, and 8). The capacity to convey the outflows from these basins are predominantly governed by the tailwater level from the 20-yr ARI Nepean River flooding. Table 11 shows the capacities of the culverts and the tailwater levels used. The locations of these culverts are shown in Appendix E.

Culvert capacities are summarised below:

- The 3650 x 3930 culvert is able to adequately convey the outflow from Basin 13.
- The outflow from Basin 7 is over throttled to meet the capacities of the 3 x 600 and 3 x 900 culverts. Low flows are piped to the 3 x 600 culverts, whilst higher flows are conveyed by the 3 x 900 culverts.
- The 1500 diameter culvert has a depth of approximately 7 m at the tailwater, as a result of the Nepean flooding; consequently, this culvert has no capacity for conveying outflows from the basins.

Table 11 Culvert Information

Culvert Dimensions (mm)	Conveying outflow from	Tailwater level (mAHD) – 20-yr ARI flood level from Nepean River	Capacity (m^3/s)
3650 x 3930	Basin 13	80.9	13.26
3 x 900	Basin 7	77.6	3.86
3 x 600	Basin 7	76.3	0.47
1500 diameter	Basin 8	76.07	n/a

5.8 CONSIDERATION OF TOTAL LIFE CYCLE COSTS

GHD has proposed precinct scale co-located bio-retention/detention basins to manage stormwater water quantity and quality. These systems achieve the following common goals:

- The treatment area is optimised. Total land acquisition cost is minimised;
- The area could be landscaped without hindering its function; and
- Annual maintenance cost would be less compared to open water bodies such as wetland.

GHD has proposed trunk drainage channels at a number of locations. These are open channels system, which could be designed to treat water quality with low capital and maintenance costs. At this stage, any water quality treatments along arterial and local roads and at individual lots are not considered.

6 WSUD CONCEPT DESIGN AND COSTING

6.1 BACKGROUND

To assist in better determining the Section 94 contributions for the trunk stormwater infrastructure and water sensitive design facilities, concept design was undertaken. These concept designs were prepared for:

- Sizing of detention basins; and
- Consideration of diversions and/or other engineered trunk drainage creeks.

The level of detail for the concept designs was discussed and approved by Council.

6.2 CONCEPT DESIGN METHODOLOGY

The methodology for the basin concept designs was the following:

- First-cut estimate of basin designs was undertaken to check volumes, using 3D ground modelling software (12D);
- Revised estimate of basin designs was undertaken to check volumes, using 3D ground modelling software (12D);
- Workshop were held with the planners, to finalise basin positions in the context of the master planning;
- Final estimate of basin design was undertaken to confirm position and balance cut versus fill, plus confirmation of volume. In some instances this required adjustment of existing ground terrain to remove existing dams;
- Hydraulic concept design of outlet structures and spillways, using spreadsheets and RAFTS modelling. Multi-staged outlet dimensions were confirmed where required; and
- The concept design civil elements were transferred to CAD.

The methodology for the engineered trunk drainage creeks was the following:

- Creek vertical alignment to correspond with upstream and downstream inverts determined;
- The engineered trunk drainage channel was configured within 3D ground modelling software (12D); and
- The concept design civil elements were transferred to CAD.

6.3 CONCEPT DESIGN PARAMETERS

Key design parameters for the basins and drainage channels were determined in consultation with Council. These included:

- Embankment side slopes of 1:6;
- Active storage depths in basins of 1.2m;
- Extended storage depths over bio-retention media in basin inverts of 0.3m;
- Freeboard above 100-year ARI basin level of 0.5m;
- Basin low flow outlets to consist of pit and pipe configuration, and in some instances dual pit and pipe. When high flow required larger capacity, a box culvert configuration (or multiples of) were used;
- Minimum channel slope of 0.5%;
- Minimum channel side slopes of 1:4 as agreed with Council (21/04/2010); and
- Channels designed for 1 in 100yr ARI flow containment, with 0.5m freeboard allowance.

6.4 CONCEPT COSTING

A note on costs

The preliminary cost estimates presented in this section have been developed for the purposes of comparing options and may be used for preliminary budgeting. They are not to be used for any other purpose. The scope and quality of the works has not been fully defined and therefore the estimates are not warranted by GHD. These estimates are typically developed based on cost curves, budget quotes for some equipment items, extrapolation of recent similar project pricing and GHD experience. A functional design is recommended for budget setting purposes.

The concept designs were used to undertake the costing for Section 94 contribution purposes. The typical line items used for the costing were confirmed and approved by Council. GHD were not required to assess any existing utilities in terms of design and costing. Unit rates used in this costing was taken from Rawlinsons Australian Construction Handbook, Edition 26, 2008 and engineer's estimates.

Table 12 Concept Costing

DESCRIPTION		AMOUNT	
Detention Basins			
Basin 2		$	1,188,000
Basin 4		$	1,227,000
Basin 4a		$	738,000
Basin 5		$	736,000
Basin 6		$	866,000
Basin 7		$	1,115,000
Basin 8		$	1,582,000
Basin 9		$	1,027,000
Basin 11		$	861,000
Basin 12		$	1,720,000
Basin 13		$	1,261,000
	Subtotal for Detention Basins	$	12,221,000
Trunk Drainage			
Trunk Drainage leading into Basin 12		$	1,398,000
	Subtotal for Trunk Drainage	$	1,398,000
	TOTAL (Excl-GST)	$	13,619,000

7 SUMMARY AND CONCLUSIONS

- A number of opportunities for management of stormwater quality, quantity and flooding exist at the Menangle Park site. This management would benefit from the implementation of Water Sensitive Urban Design (WSUD) practices. WSUD encompasses all aspects of urban water cycle management including water supply, wastewater and stormwater management, that promotes opportunities for linking water infrastructure, landscape design and the urban built form to minimize the impacts of development upon the water cycle and achieve sustainable outcomes;
- The Water Sensitive Urban Design strategy was to be compiled as two separate consultancies, who liaised to ensure maximised outcomes in managing surface water and flooding. The consultancies were GHD for the Nepean flooding, local flooding and stormwater quantity management (detention); and Aecom for stormwater quality management;
- The objectives of this study are to report on local flooding and stormwater quantity management (detention) strategies. The Nepean flooding has been reported on in a separate report (GHD, 2008).
- A WSUD strategy for management of flooding and stormwater quantity (detention) has been developed for the site that nominates:
    - Environmentally sympathetic drainage channels along the identified main flow routes. The required width of the vegetated swales varies, according to the conveyed flows. These channels will convey flows up to 100-year ARI storm event and will be vegetated swales;
    - Precinct scale co-located detention/ bio-retention basins at key locations to treat the quantity and quality of stormwater flows. These systems would essentially comprise a dry basin (to provide detention function) combined with bio-retention (to provide water quality treatment function) situated in the invert of the basin.
    - Rainwater tanks throughout, as required and as appropriate.
- Development and land-use in flood prone areas management in accordance with the Campbelltown (Sustainable City) Development Control Plan and the NSW Floodplain Development Manual. Generally this would require:
    - All buildings would be located above the Flood Planning Level associated with the creeks across the site and any precinct basins or local flood routes. It is proposed that Flood Planning Levels be adopted that locate floor levels of buildings with a freeboard of 300 mm to 500 mm (depending on flow depth) above 100-year ARI flood levels; and
    - Flood evacuation planning for all areas designated flood prone land.
- To test the effectiveness of the WSUD strategy, numerical modelling was used as follows:
    - Flood peaks and flood levels for the creeks within the precinct were determined using RAFTS and TUFLOW;
    - Volumes of detention that responded as best possible to the Masterplan and which throttled flood peaks were determined using RAFTS; and
- The results of the numerical modelling have shown that the proposed flooding and stormwater quantity management (detention) strategy together with the flood plain management adequately satisfies the requirements of the Campbelltown (Sustainable City) Development Control Plan and the NSW Floodplain Development Manual for management of stormwater quantity and flooding at the site.

8 REFERENCES

- Campbelltown City Council 2009, Campbelltown (Sustainable City) Development Control Plan 2009 Volume 2 Engineering Design For Development, June 2009
- Department of Environment and Climate Change (DECC) 2006, Western Sydney Growth Centres – Stormwater Guidance for Precinct Planning, November 2006
- GHD 2008 Menangle Park Flood Study September 2008 Rev 4
- Institution of Engineers Australia 2001, Australian Rainfall and Runoff
- Landcom 2004, Soils and Construction, Managing Urban Stormwater, March 2004
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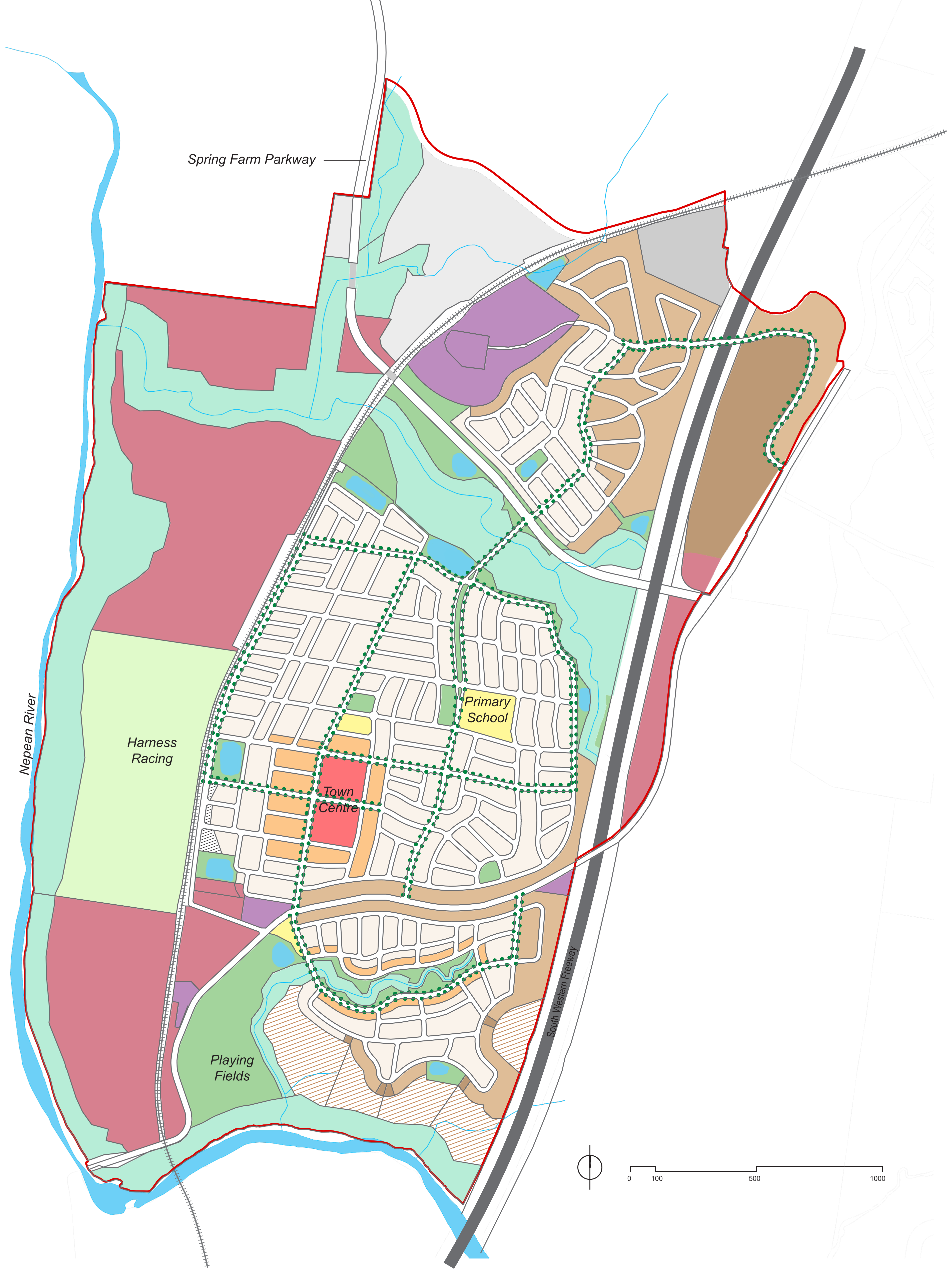
- Rawlinsons 2008, Australian Construction Handbook Edition 26, Rawlinsons Publishing
- BMT WBM, 2008, TUFLOW User Manual 2008 (Build 2008-08-AA)
- XP Software 1994, XP-RAFTS User Manual

Appendix A – Master Plan



350 - 390 sqm lots	Town Centre	Rural
540 - 700 sqm lots	Community Use	Heritage
1000 - 1500 sqm lots	Open Space	Employment
2000+ sqm lots	Riparian	Transgrid
Private Open Space	Private Recreation	Collector Roads

menanglepark

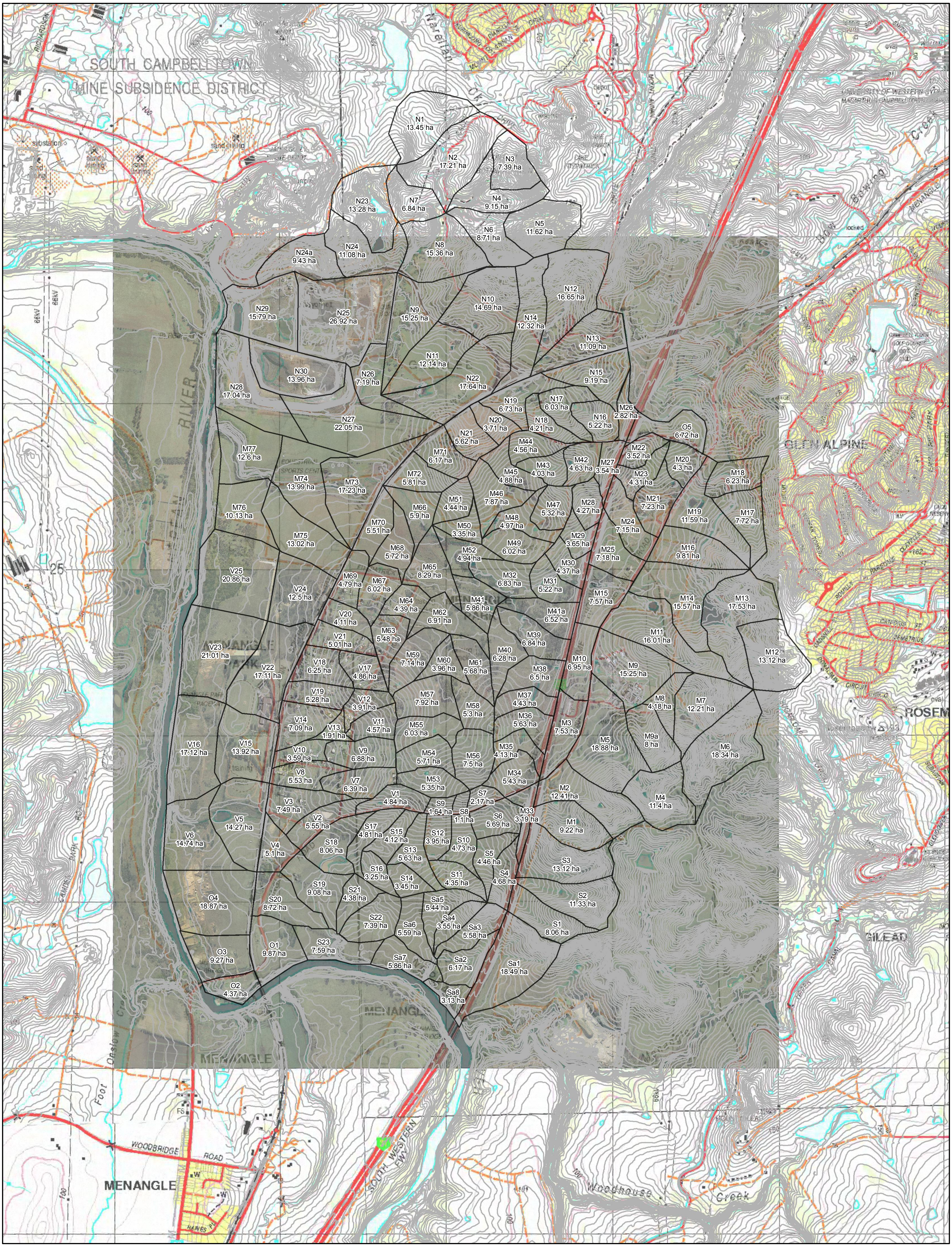
See Visual Scale	Urbis	Menangle Park
10 03 04 Structure Plan.indd	24/05/2010 ISSUE 11	DRAFT Revised Structure Plan

PROJECT PARTNERS
DRAFT
campbelltown city council
LANDCOM

Appendix B – Riparian Corridors


Mt. Annan Botanic
Gardens
NORTH 3
NORTH 2
NORTH 1
CATEGORY 2
CATEGORY 2
CATEGORY 2
CATEGORY 2
CATEGORY 3
South Western Freeway
MIDDLE 3
MIDDLE 1
MIDDLE 2
CATEGORY 2
CATEGORY 3
CATEGORY 1
CATEGORY 2
MIDDLE 3
Nepean River
CATEGORY 3
MIDDLE 4
CATEGORY 2
SOUTHERN 3
CATEGORY 2
SOUTHERN 1
CATEGORY 3
SOUTHERN 2
CATEGORY 3

Appendix C – RAFTS Modelling



1:20,000 at A3

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N
W E
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GHD

Campbelltown City Council/Landcom
Menangle Park Local Flooding and Detention

Job Number	21-15581
Revision	A
Date	20th Jan 2010

RAFTS Catchments

G:\21\15581\CADD\GIS\ArcGIS\Maps

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Existing Case - Subcatchments for Flood Study

South Creek

Subcatchment	Area (ha)	Impervious Catchment (ha)	Pervious Catchment (ha)	Slope (%)	Impervious Mannings n	Pervious Mannings n
S1	8.06	0.40	7.66	7.4	0.015	0.025
S2	11.33	0.57	10.76	11.4	0.015	0.025
S3	13.12	0.66	12.46	7.6	0.015	0.025
S4	4.68	0.47	4.21	12.1	0.015	0.025
S5	4.47	0.00	4.47	7.2	0.015	0.025
S6	5.69	0.00	5.69	7.5	0.015	0.025
S7	2.17	0.00	2.17	13.1	0.015	0.025
S8	1.10	0.00	1.10	12.9	0.015	0.025
S9	1.64	0.00	1.64	6.8	0.015	0.025
S10	4.73	0.00	4.73	8.8	0.015	0.025
S11	4.34	0.00	4.34	10.5	0.015	0.025
S12	3.95	0.00	3.95	7.6	0.015	0.025
S13	5.65	0.00	5.65	8.0	0.015	0.025
S14	3.45	0.00	3.45	4.9	0.015	0.025
S15	4.12	0.00	4.12	6.5	0.015	0.025
S16	3.25	0.00	3.25	7.7	0.015	0.025
S17	4.73	0.00	4.73	5.9	0.015	0.025
S18	8.14	0.00	8.14	4.9	0.015	0.025
S19	9.08	0.09	8.99	2.3	0.015	0.025
S20	8.72	0.87	7.85	1.8	0.015	0.025
S21	4.38	0.04	4.34	6.0	0.015	0.025
S22	7.39	0.00	7.39	6.5	0.015	0.025
S23	7.59	0.00	7.59	3.0	0.015	0.025
Sa1	18.49	1.85	16.64	9.4	0.015	0.025
Sa2	6.17	0.31	5.86	6.2	0.015	0.025
Sa3	5.58	0.28	5.30	8.9	0.015	0.025
Sa4	3.55	0.00	3.55	14.0	0.015	0.025
Sa5	5.44	0.00	5.44	7.5	0.015	0.025
Sa6	5.59	0.00	5.59	4.9	0.015	0.025
Sa7	5.86	0.00	5.86	3.0	0.015	0.025
Sa8	3.13	0.00	3.13	6.8	0.015	0.025

Howes Creek

Subcatchment	Area (ha)	Impervious Catchment (ha)	Pervious Catchment (ha)	Slope (%)	Impervious Mannings n	Pervious Mannings n
M1	9.22	0.46	8.76	14.8	0.015	0.025
M2	12.41	0.62	11.79	9.7	0.015	0.025
M3	7.50	0.75	6.75	2.5	0.015	0.025
M4	11.40	0.00	11.40	13.2	0.015	0.025
M5	18.88	0.94	17.94	4.0	0.015	0.025
M6	18.34	0.00	18.34	11.6	0.015	0.025
M7	12.21	0.00	12.21	23.1	0.015	0.025
M8	4.18	0.00	4.18	12.8	0.015	0.025
M9	15.25	6.10	9.15	4.4	0.015	0.025
M9a	8.00	0.00	8.00	14.0	0.015	0.025
M10	6.95	0.35	6.60	2.1	0.015	0.025
M11	16.01	0.00	16.01	7.0	0.015	0.025
M12	13.12	0.00	13.12	8.0	0.015	0.025

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Subcatchment	Area (ha)	Impervious Catchment (ha)	Pervious Catchment (ha)	Slope (%)	Impervious Mannings n	Pervious Mannings n
M13	17.53	0.88	16.65	11.9	0.015	0.025
M14	15.57	0.00	15.57	2.9	0.015	0.025
M15	7.57	0.38	7.19	1.7	0.015	0.025
M16	9.81	1.47	8.34	12.7	0.015	0.025
M17	7.72	1.54	6.18	11.8	0.015	0.025
M18	6.23	2.49	3.74	7.5	0.015	0.025
M19	11.59	1.16	10.43	11.8	0.015	0.025
M20	4.30	0.00	4.30	6.6	0.015	0.025
M21	7.23	0.72	6.51	3.4	0.015	0.025
M22	3.52	0.18	3.34	8.6	0.015	0.025
M23	4.31	0.65	3.66	8.0	0.015	0.025
M24	7.15	0.36	6.79	4.8	0.015	0.025
M25	7.18	0.36	6.82	2.5	0.015	0.025
M26	2.82	0.14	2.68	3.1	0.015	0.025
M27	3.54	0.53	3.01	5.0	0.015	0.025
M28	4.27	0.21	4.06	11.0	0.015	0.025
M29	3.65	0.18	3.47	3.6	0.015	0.025
M30	4.37	0.22	4.15	6.4	0.015	0.025
M31	5.22	0.26	4.96	5.6	0.015	0.025
M32	6.83	0.00	6.83	4.2	0.015	0.025
M33	3.19	0.96	2.23	10.2	0.015	0.025
M34	5.43	0.27	5.16	6.9	0.015	0.025
M35	4.13	0.21	3.92	8.1	0.015	0.025
M36	5.63	0.28	5.35	6.9	0.015	0.025
M37	4.43	0.22	4.21	5.2	0.015	0.025
M38	6.50	0.33	6.18	4.5	0.015	0.025
M39	6.84	0.34	6.50	2.3	0.015	0.025
M40	6.28	0.00	6.28	3.6	0.015	0.025
M41	5.86	0.00	5.86	2.5	0.015	0.025
M41a	6.52	0.33	6.19	3.0	0.015	0.025
M42	4.63	0.46	4.17	11.7	0.015	0.025
M43	4.03	0.00	4.03	5.0	0.015	0.025
M44	4.56	0.00	4.56	6.4	0.015	0.025
M45	4.88	0.00	4.88	7.7	0.015	0.025
M46	7.87	0.00	7.87	5.9	0.015	0.025
M47	5.32	0.27	5.05	10.2	0.015	0.025
M48	4.97	0.25	4.72	5.6	0.015	0.025
M49	6.02	0.00	6.02	4.4	0.015	0.025
M50	3.35	0.00	3.35	7.0	0.015	0.025
M51	4.44	0.00	4.44	11.4	0.015	0.025
M52	4.94	0.00	4.94	3.1	0.015	0.025
M53	5.35	0.00	5.35	7.2	0.015	0.025
M54	5.71	0.00	5.71	5.4	0.015	0.025
M55	6.03	0.00	6.03	4.9	0.015	0.025
M56	7.50	0.00	7.50	7.9	0.015	0.025
M57	7.92	0.00	7.92	8.2	0.015	0.025
M58	5.30	0.00	5.30	5.8	0.015	0.025
M59	7.14	0.00	7.14	4.8	0.015	0.025
M60	3.96	0.00	3.96	3.8	0.015	0.025
M61	5.68	0.00	5.68	3.0	0.015	0.025
M62	6.91	0.00	6.91	3.0	0.015	0.025

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Subcatchment	Area (ha)	Impervious Catchment (ha)	Pervious Catchment (ha)	Slope (%)	Impervious Mannings n	Pervious Mannings n
M63	5.48	1.10	4.38	5.0	0.015	0.025
M64	4.39	0.66	3.73	3.0	0.015	0.025
M65	8.29	0.00	8.29	2.3	0.015	0.025
M66	5.90	0.00	5.90	1.0	0.015	0.025
M67	6.02	0.90	5.12	3.8	0.015	0.025
M68	5.72	0.00	5.72	2.6	0.015	0.025
M69	4.79	0.72	4.07	2.6	0.015	0.025
M70	5.51	0.55	4.96	2.5	0.015	0.025
M71	6.17	0.62	5.55	7.9	0.015	0.025
M72	5.81	0.58	5.23	8.4	0.015	0.025
M73	17.23	1.72	15.51	1.5	0.015	0.025
M74	13.99	0.00	13.99	2.7	0.015	0.025
M75	13.02	0.65	12.37	2.4	0.015	0.025
M76	10.13	0.00	10.13	1.5	0.015	0.025
M77	12.60	0.00	12.60	1.0	0.015	0.025

North Creek

Subcatchment	Area (ha)	Impervious Catchment (ha)	Pervious Catchment (ha)	Slope (%)	Impervious Mannings n	Pervious Mannings n
N1	13.45	0.00	13.45	4.6	0.015	0.025
N2	17.21	0.00	17.21	7.7	0.015	0.025
N3	7.39	0.00	7.39	10.3	0.015	0.025
N4	9.15	0.00	9.15	4.2	0.015	0.025
N5	11.62	0.00	11.62	8.5	0.015	0.025
N6	8.71	0.00	8.71	21.3	0.015	0.025
N7	6.84	0.00	6.84	13.0	0.015	0.025
N8	15.36	1.54	13.82	23.1	0.015	0.025
N9	15.25	0.76	14.49	9.4	0.015	0.025
N10	14.69	0.00	14.69	19.1	0.015	0.025
N11	12.14	0.61	11.53	4.2	0.015	0.025
N12	16.65	0.83	15.82	11.2	0.015	0.025
N13	11.09	0.56	10.54	8.8	0.015	0.025
N14	12.32	0.62	11.70	14.0	0.015	0.025
N15	9.19	0.00	9.19	5.1	0.015	0.025
N16	5.22	0.00	5.22	7.4	0.015	0.025
N17	6.03	0.00	6.03	10.4	0.015	0.025
N18	4.21	0.00	4.21	9.2	0.015	0.025
N19	6.73	0.00	6.73	10.3	0.015	0.025
N20	3.71	0.00	3.71	9.7	0.015	0.025
N21	5.62	0.00	5.62	9.4	0.015	0.025
N22	17.64	0.88	16.76	5.0	0.015	0.025
N23	13.28	0.00	13.28	10.5	0.015	0.025
N24	11.08	1.11	9.97	14.5	0.015	0.025
N24a	9.79	0.94	8.85	14.5	0.015	0.025
N25	26.93	17.51	9.43	2.7	0.015	0.025
N26	7.19	0.36	6.83	2.0	0.015	0.025
N27	22.05	1.10	20.95	3.7	0.015	0.025
N28	17.04	5.11	11.93	3.5	0.015	0.025
N29	15.79	10.26	5.53	3.5	0.015	0.025
N30	13.96	9.07	4.89	0.1	0.015	0.025

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Subcatchment	Area (ha)	Impervious Catchment (ha)	Pervious Catchment (ha)	Slope (%)	Impervious Mannings n	Pervious Mannings n
Village Creeks						
Subcatchment	**Area (ha)**	**Impervious Catchment (ha)**	**Pervious Catchment (ha)**	**Slope (%)**	**Impervious Mannings n**	**Pervious Mannings n**
v1	4.84	0.73	4.11	4.7	0.015	0.025
v2	5.55	1.67	3.89	5.6	0.015	0.025
v3	7.49	0.75	6.74	5.3	0.015	0.025
v4	5.10	1.02	4.08	4.3	0.015	0.025
v5	14.27	1.43	12.84	4.8	0.015	0.025
v6	14.74	1.47	13.27	5.0	0.015	0.025
v7	6.39	1.28	5.11	7.5	0.015	0.025
v8	5.53	1.94	3.60	3.5	0.015	0.025
v9	6.88	0.69	6.19	6.6	0.015	0.025
v10	3.59	1.08	2.51	2.2	0.015	0.025
v11	4.57	0.69	3.89	8.3	0.015	0.025
v12	3.91	0.78	3.13	5.8	0.015	0.025
v13	1.91	0.38	1.53	4.5	0.015	0.025
v14	7.09	1.77	5.32	6.0	0.015	0.025
v15	13.92	1.39	12.53	1.0	0.015	0.025
v16	17.12	1.71	15.41	2.7	0.015	0.025
v17	4.86	1.46	3.40	5.1	0.015	0.025
v18	6.25	1.88	4.38	7.6	0.015	0.025
v19	5.28	1.58	3.70	7.7	0.015	0.025
v20	4.11	0.62	3.49	2.6	0.015	0.025
v21	5.01	1.50	3.51	3.8	0.015	0.025
v22	17.11	3.42	13.69	2.8	0.015	0.025
v23	21.01	4.20	16.81	1.4	0.015	0.025
v24	12.50	0.63	11.88	3.3	0.015	0.025
v25	20.86	2.09	18.77	1.3	0.015	0.025
O1	9.87	0.99	8.88	2.0	0.015	0.025
O2	4.37	0.44	3.93	3.0	0.015	0.025
O3	9.27	1.85	7.42	2.4	0.015	0.025
O4	18.87	5.66	13.21	2.7	0.015	0.025
O5	6.72	0.34	6.38	8.0	0.015	0.025

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Developed Case - Subcatchments for Flood Study

South Creek

Subcatchment	Area (ha)	Impervious Catchment (ha)	Pervious Catchment (ha)	Slope (%)	Impervious Mannings n	Pervious Mannings n
S1	8.06	0.40	7.66	7.4	0.015	0.025
S2	11.33	0.57	10.76	11.4	0.015	0.025
S3	13.12	0.66	12.46	7.6	0.015	0.025
S4	4.68	3.30	1.38	12.1	0.015	0.025
S5	4.47	2.41	2.06	7.2	0.015	0.025
S6	5.69	3.66	2.03	7.5	0.015	0.025
S7	2.17	1.37	0.80	13.1	0.015	0.025
S8	1.10	0.74	0.36	12.9	0.015	0.025
S9	1.64	0.98	0.66	6.8	0.015	0.025
S10	4.73	3.29	1.44	8.8	0.015	0.025
S11	4.36	2.92	1.44	10.5	0.015	0.025
S12	3.95	2.86	1.09	7.6	0.015	0.025
S13	5.63	3.83	1.80	8.0	0.015	0.025
S14	3.45	2.17	1.28	4.9	0.015	0.025
S15	4.12	3.32	0.80	6.5	0.015	0.025
S16	3.25	1.37	1.89	7.7	0.015	0.025
S17	4.73	3.03	1.70	5.9	0.015	0.025
S18	8.14	3.99	4.15	4.9	0.015	0.025
S19	9.08	0.91	8.17	2.3	0.015	0.025
S20	8.72	0.87	7.85	1.8	0.015	0.025
S21	4.38	1.14	3.24	6.0	0.015	0.025
S22	7.39	1.89	5.50	6.5	0.015	0.025
S23	7.59	0.76	6.83	3.0	0.015	0.025
Sa1	18.49	1.85	16.64	9.4	0.015	0.025
Sa2	6.17	1.42	4.75	6.2	0.015	0.025
Sa3	5.58	1.73	3.85	8.9	0.015	0.025
Sa4	3.55	1.46	2.09	14.0	0.015	0.025
Sa5	5.44	3.37	2.07	7.5	0.015	0.025
Sa6	5.59	2.68	2.91	4.9	0.015	0.025
Sa7	5.86	0.59	5.27	3.0	0.015	0.025
Sa8	3.13	0.44	2.69	6.8	0.015	0.025

Village Creeks

Subcatchment	Area (ha)	Impervious Catchment (ha)	Pervious Catchment (ha)	Slope (%)	Impervious Mannings n	Pervious Mannings n
M1	9.22	0.46	8.76	14.8	0.015	0.025
M2	12.41	0.62	11.79	9.7	0.015	0.025
M3	7.50	2.48	5.03	2.5	0.015	0.025
M4	11.40	0.00	11.40	13.2	0.015	0.025
M5	18.88	0.94	17.94	4.0	0.015	0.025
M6	18.34	0.00	18.34	11.6	0.015	0.025
M7	12.21	0.00	12.21	23.1	0.015	0.025
M8	4.18	0.00	4.18	12.8	0.015	0.025
M9	15.25	6.10	9.15	4.4	0.015	0.025
M9a	8.00	0.00	8.00	14.0	0.015	0.025
M10	6.95	2.29	4.66	2.1	0.015	0.025
M11	16.01	0.00	16.01	7.0	0.015	0.025
M12	13.12	0.00	13.12	8.0	0.015	0.025

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Subcatchment	Area (ha)	Impervious Catchment (ha)	Pervious Catchment (ha)	Slope (%)	Impervious Mannings n	Pervious Mannings n
M13	17.53	0.88	16.65	11.9	0.015	0.025
M14	15.57	0.00	15.57	2.9	0.015	0.025
M15	7.57	2.50	5.07	1.7	0.015	0.025
M16	9.81	1.47	8.34	12.7	0.015	0.025
M17	7.72	1.54	6.18	11.8	0.015	0.025
M18	6.23	2.49	3.74	7.5	0.015	0.025
M19	11.59	1.16	10.43	11.8	0.015	0.025
M20	4.30	1.42	2.88	6.6	0.015	0.025
M21	7.23	2.39	4.84	3.4	0.015	0.025
M22	3.52	1.16	2.36	8.6	0.015	0.025
M23	4.31	0.65	3.66	8.0	0.015	0.025
M24	7.15	2.36	4.79	4.8	0.015	0.025
M25	7.18	2.37	4.81	2.5	0.015	0.025
M26	2.82	2.41	0.41	3.1	0.015	0.025
M27	3.54	2.23	1.31	5.0	0.015	0.025
M28	4.27	2.69	1.58	11.0	0.015	0.025
M29	3.65	2.30	1.35	3.6	0.015	0.025
M30	4.37	2.08	2.29	6.4	0.015	0.025
M31	5.22	2.30	2.92	5.6	0.015	0.025
M32	6.83	3.11	3.72	4.2	0.015	0.025
M33	3.19	1.91	1.28	10.2	0.015	0.025
M34	5.43	3.42	2.01	6.9	0.015	0.025
M35	4.13	2.73	1.40	8.1	0.015	0.025
M36	5.63	3.83	1.80	6.9	0.015	0.025
M37	4.43	3.46	0.97	5.2	0.015	0.025
M38	6.50	3.61	2.89	4.5	0.015	0.025
M39	6.84	1.20	5.64	2.3	0.015	0.025
M40	6.28	5.12	1.16	3.6	0.015	0.025
M41	5.86	2.31	3.55	2.5	0.015	0.025
M41a	6.52	1.17	5.35	3.0	0.015	0.025
M42	4.63	2.92	1.71	11.7	0.015	0.025
M43	4.03	2.80	1.23	5.0	0.015	0.025
M44	4.56	3.15	1.41	6.4	0.015	0.025
M45	4.88	3.68	1.20	7.7	0.015	0.025
M46	7.87	6.12	1.76	5.9	0.015	0.025
M47	5.32	3.83	1.49	10.2	0.015	0.025
M48	4.97	3.68	1.29	5.6	0.015	0.025
M49	6.02	5.09	0.93	4.4	0.015	0.025
M50	3.35	2.18	1.17	7.0	0.015	0.025
M51	4.44	3.55	0.89	11.4	0.015	0.025
M52	4.94	1.38	3.56	3.1	0.015	0.025
M53	5.35	4.20	1.15	7.2	0.015	0.025
M54	5.71	4.68	1.03	5.4	0.015	0.025
M55	6.03	5.07	0.96	4.9	0.015	0.025
M56	7.50	5.66	1.84	7.9	0.015	0.025
M57	7.92	6.61	1.31	8.2	0.015	0.025
M58	5.30	4.32	0.98	5.8	0.015	0.025
M59	7.14	5.82	1.32	4.8	0.015	0.025
M60	3.96	2.53	1.43	3.8	0.015	0.025
M61	5.68	4.46	1.22	3.0	0.015	0.025
M62	6.91	4.46	2.45	3.0	0.015	0.025

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Subcatchment	Area (ha)	Impervious Catchment (ha)	Pervious Catchment (ha)	Slope (%)	Impervious Mannings n	Pervious Mannings n
M63	5.48	4.47	1.01	5.0	0.015	0.025
M64	4.39	3.58	0.81	3.0	0.015	0.025
M65	8.29	3.56	4.73	2.3	0.015	0.025
M66	5.90	1.18	4.72	1.0	0.015	0.025
M67	6.02	4.91	1.11	3.8	0.015	0.025
M68	5.72	3.66	2.06	2.6	0.015	0.025
M69	4.79	3.90	0.89	2.6	0.015	0.025
M70	5.51	3.91	1.60	2.5	0.015	0.025
M71	6.17	1.94	4.23	7.9	0.015	0.025
M72	5.81	3.43	2.38	8.4	0.015	0.025
M73	17.23	1.72	15.51	1.5	0.015	0.025
M74	13.99	0.00	13.99	2.7	0.015	0.025
M75	13.02	0.65	12.37	2.4	0.015	0.025
M76	10.13	0.00	10.13	1.5	0.015	0.025
M77	12.60	0.00	12.60	1.0	0.015	0.025
Village Creeks						
Subcatchment	**Area (ha)**	**Impervious Catchment (ha)**	**Pervious Catchment (ha)**	**Slope (%)**	**Impervious Mannings n**	**Pervious Mannings n**
N1	13.45	0.00	13.45	4.6	0.015	0.025
N2	17.21	0.00	17.21	7.7	0.015	0.025
N3	7.39	0.00	7.39	10.3	0.015	0.025
N4	9.15	0.00	9.15	4.2	0.015	0.025
N5	11.62	0.00	11.62	8.5	0.015	0.025
N6	8.71	0.00	8.71	21.3	0.015	0.025
N7	6.84	0.00	6.84	13.0	0.015	0.025
N8	15.36	1.54	13.82	23.1	0.015	0.025
N9	15.25	0.76	14.49	9.4	0.015	0.025
N10	14.69	0.00	14.69	19.1	0.015	0.025
N11	12.14	11.05	1.09	4.2	0.015	0.025
N12	16.65	0.83	15.82	11.2	0.015	0.025
N13	11.09	0.55	10.54	8.8	0.015	0.025
N14	12.32	0.62	11.70	14.0	0.015	0.025
N15	9.19	8.00	1.20	5.1	0.015	0.025
N16	5.22	3.45	1.78	7.4	0.015	0.025
N17	6.03	3.98	2.05	10.4	0.015	0.025
N18	4.21	2.65	1.56	9.2	0.015	0.025
N19	6.73	3.33	3.40	10.3	0.015	0.025
N20	3.71	1.17	2.54	9.7	0.015	0.025
N21	5.62	1.77	3.85	9.4	0.015	0.025
N22	17.64	16.85	0.79	5.0	0.015	0.025
N23	13.28	0.00	13.28	10.5	0.015	0.025
N24	11.08	1.11	9.97	14.5	0.015	0.025
N24a	9.43	0.94	8.49	14.5	0.015	0.025
N25	26.93	17.51	9.43	2.7	0.015	0.025
N26	7.19	0.36	6.83	2.0	0.015	0.025
N27	22.05	1.10	20.95	3.7	0.015	0.025
N28	17.04	5.11	11.93	3.5	0.015	0.025
N29	15.79	10.26	5.53	3.5	0.015	0.025
N30	13.96	9.07	4.89	0.1	0.015	0.025

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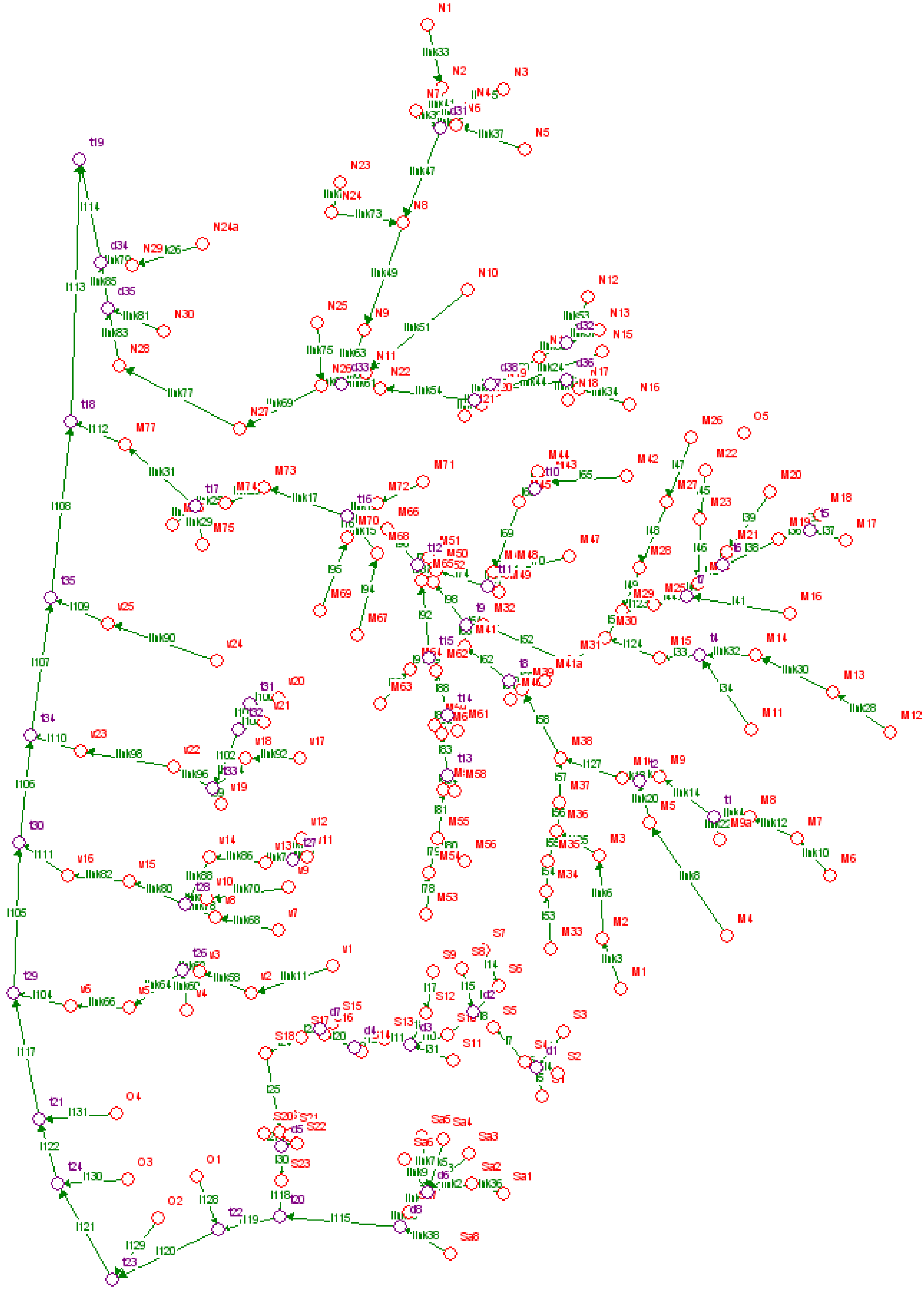
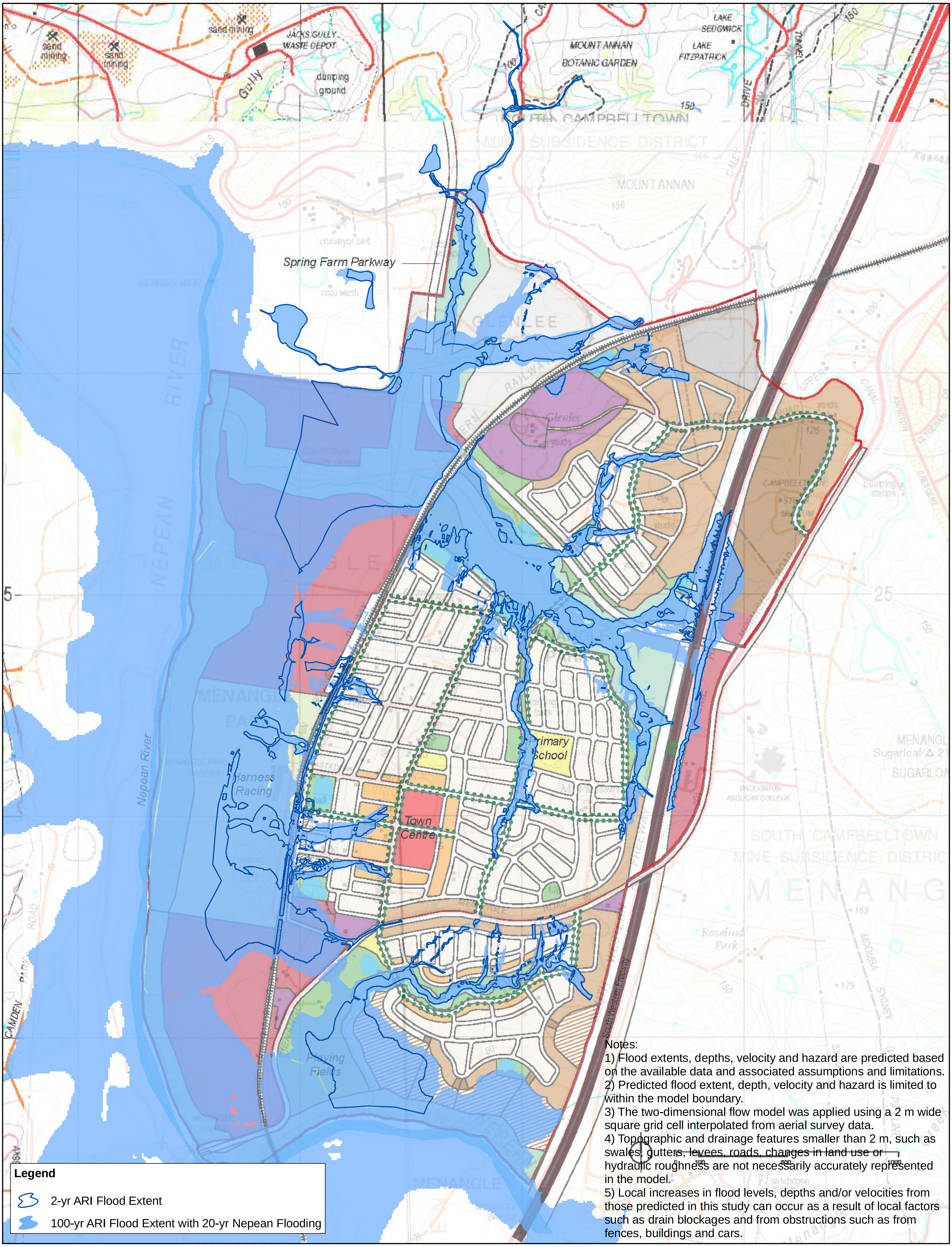
Subcatchment	Area (ha)	Impervious Catchment (ha)	Pervious Catchment (ha)	Slope (%)	Impervious Mannings n	Pervious Mannings n
Village Creeks						
Subcatchment	**Area (ha)**	**Impervious Catchment (ha)**	**Pervious Catchment (ha)**	**Slope (%)**	**Impervious Mannings n**	**Pervious Mannings n**
v1	4.84	3.19	1.65	4.7	0.015	0.025
v2	5.55	3.41	2.14	5.6	0.015	0.025
v3	7.49	5.95	1.54	5.3	0.015	0.025
v4	5.10	1.02	4.08	4.3	0.015	0.025
v5	14.27	1.43	12.84	4.8	0.015	0.025
v6	14.74	1.47	13.27	5.0	0.015	0.025
v7	6.39	5.38	1.01	7.5	0.015	0.025
v8	5.53	4.20	1.33	3.5	0.015	0.025
v9	6.88	6.36	0.52	6.6	0.015	0.025
v10	3.59	2.98	0.61	2.2	0.015	0.025
v11	4.57	4.26	0.31	8.3	0.015	0.025
v12	3.91	2.56	1.35	5.8	0.015	0.025
v13	1.91	1.72	0.19	4.5	0.015	0.025
v14	7.09	5.74	1.35	6.0	0.015	0.025
v15	13.92	1.39	12.53	1.0	0.015	0.025
v16	17.12	1.71	15.41	2.7	0.015	0.025
v17	4.86	3.79	1.07	5.1	0.015	0.025
v18	6.25	5.13	1.13	7.6	0.015	0.025
v19	5.28	4.30	0.98	7.7	0.015	0.025
v20	4.11	3.35	0.76	2.6	0.015	0.025
v21	5.01	4.08	0.93	3.8	0.015	0.025
v22	17.11	3.42	13.69	2.8	0.015	0.025
v23	21.01	4.20	16.81	1.4	0.015	0.025
v24	12.50	0.63	11.88	3.3	0.015	0.025
v25	20.86	2.09	18.77	1.3	0.015	0.025
O1	9.87	0.99	8.88	2.0	0.015	0.025
O2	4.37	0.44	3.93	3.0	0.015	0.025
O3	9.27	1.85	7.42	2.4	0.015	0.025
O4	18.87	5.66	13.21	2.7	0.015	0.025
O5	6.72	2.02	4.70	8.0	0.015	0.025

RAFTS Model Graphical Setup



Appendix D – Flood Maps



Legend

- 2-yr ARI Flood Extent
- 100-yr ARI Flood Extent with 20-yr Nepean Flooding

Notes:
1) Flood extents, depths, velocity and hazard are predicted based on the available data and associated assumptions and limitations.
2) Predicted flood extent, depth, velocity and hazard is limited to within the model boundary.
3) The two-dimensional flow model was applied using a 2 m wide square grid cell interpolated from aerial survey data.
4) Topographic and drainage features smaller than 2 m, such as swales, gutters, levees, roads, changes in land use or hydraulic roughness are not necessarily accurately represented in the model.
5) Local increases in flood levels, depths and/or velocities from those predicted in this study can occur as a result of local factors such as drain blockages and from obstructions such as from fences, buildings and cars.

1:15,000 at A3

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N W E S

GHD

THIS MAP SHOWS ONLY FLOOD EXTENTS GREATER THAN 50mm

Campbelltown City Council/Landcom
Menangle Park Local Flooding and Detention

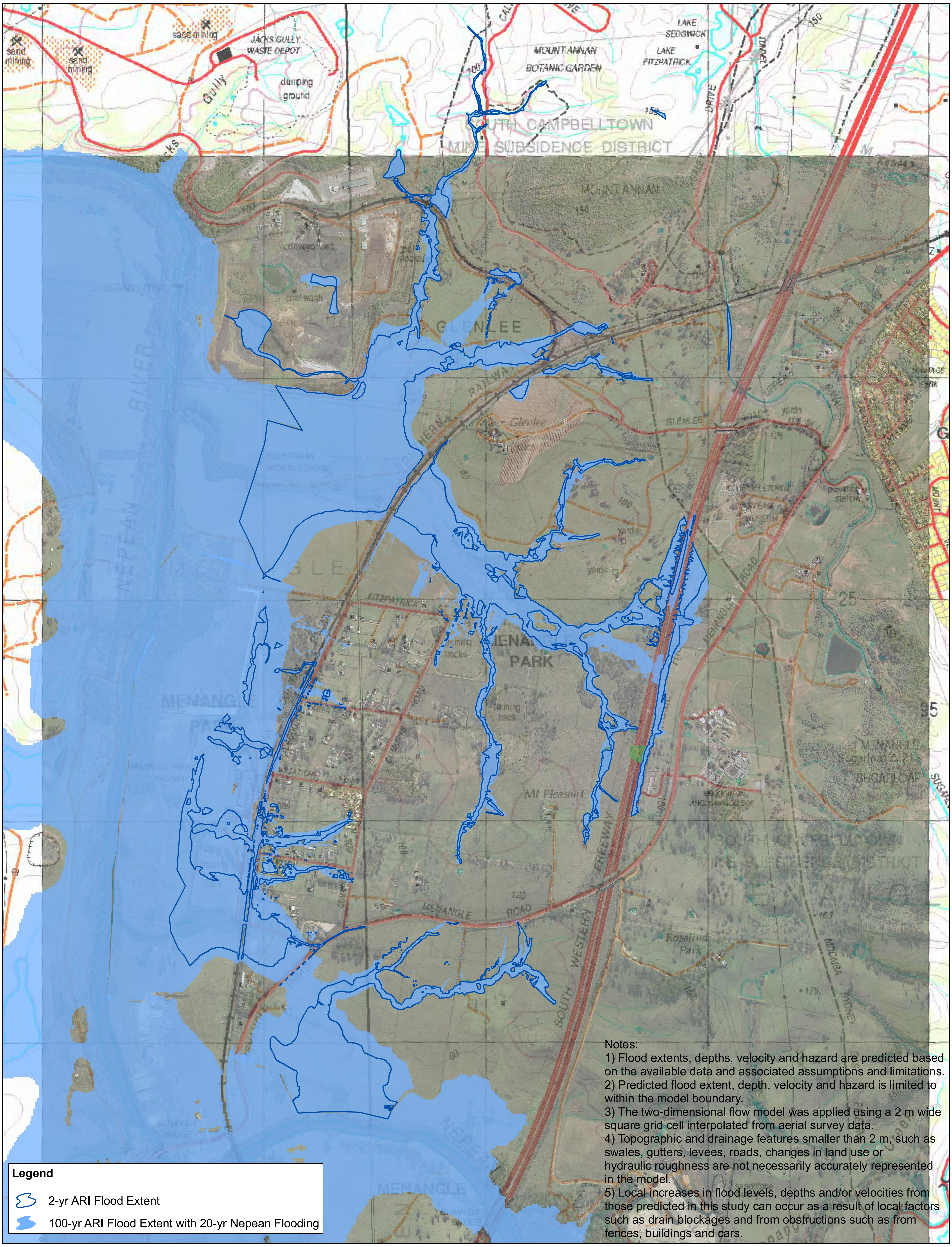
Job Number	21-15581
Revision	A
Date	May 2010

Flood Modelling (TUFLOW) Results
Developed Conditions

G:\21\15581\CADD\GIS\ArcGIS\Maps

Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia T 61 2 9239 7000 F 61 2 9239 7199 E sydmail@ghd.com Wwww.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: C Pappin



Notes:
1) Flood extents, depths, velocity and hazard are predicted based on the available data and associated assumptions and limitations.
2) Predicted flood extent, depth, velocity and hazard is limited to within the model boundary.
3) The two-dimensional flow model was applied using a 2 m wide square grid cell interpolated from aerial survey data.
4) Topographic and drainage features smaller than 2 m, such as swales, gutters, levees, roads, changes in land use or hydraulic roughness are not necessarily accurately represented in the model.
5) Local increases in flood levels, depths and/or velocities from those predicted in this study can occur as a result of local factors such as drain blockages and from obstructions such as from fences, buildings and cars.

1:15,000 at A3

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N W E S

THIS MAP SHOWS ONLY FLOOD EXTENTS GREATER THAN 50mm

Campbelltown City Council/Landcom
Menangle Park Local Flooding and Detention

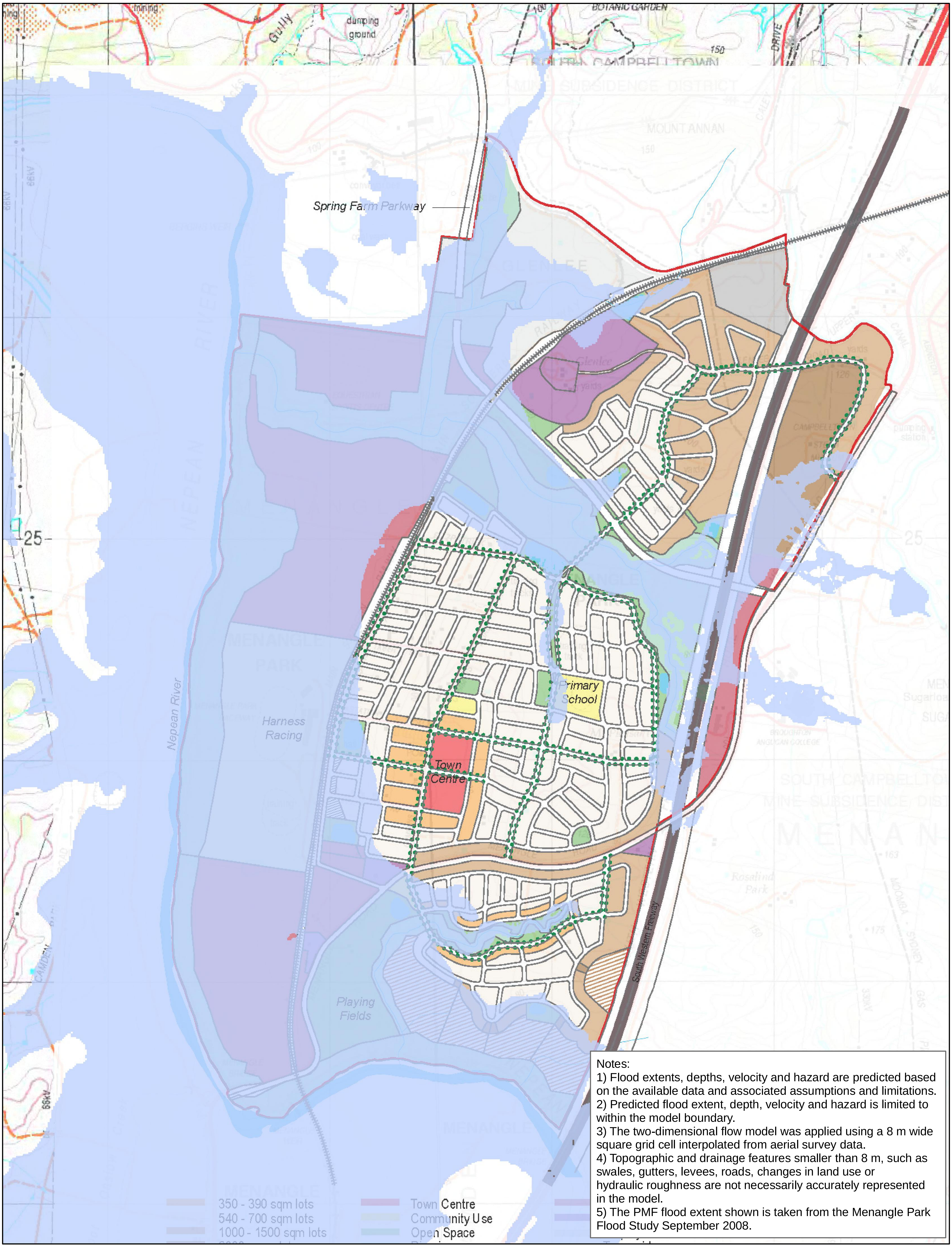
Job Number	21-15581
Revision	A
Date	17th Mar 2010

Flood Modelling (TUFLOW) Results Existing Conditions

G:\21\15581\CADD\GIS\ArcGIS\Maps

Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia **T** 61 2 9239 7000 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W**ww.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: C Pappin



Notes:
1) Flood extents, depths, velocity and hazard are predicted based on the available data and associated assumptions and limitations.
2) Predicted flood extent, depth, velocity and hazard is limited to within the model boundary.
3) The two-dimensional flow model was applied using a 8 m wide square grid cell interpolated from aerial survey data.
4) Topographic and drainage features smaller than 8 m, such as swales, gutters, levees, roads, changes in land use or hydraulic roughness are not necessarily accurately represented in the model.
5) The PMF flood extent shown is taken from the Menangle Park Flood Study September 2008.

1:15,000 at A3

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N W E S

THIS MAP SHOWS ONLY FLOOD EXTENTS GREATER THAN 50mm FLOOD DEPTH.

Campbelltown City Council/Landcom
Menangle Park Local Flooding and Detention

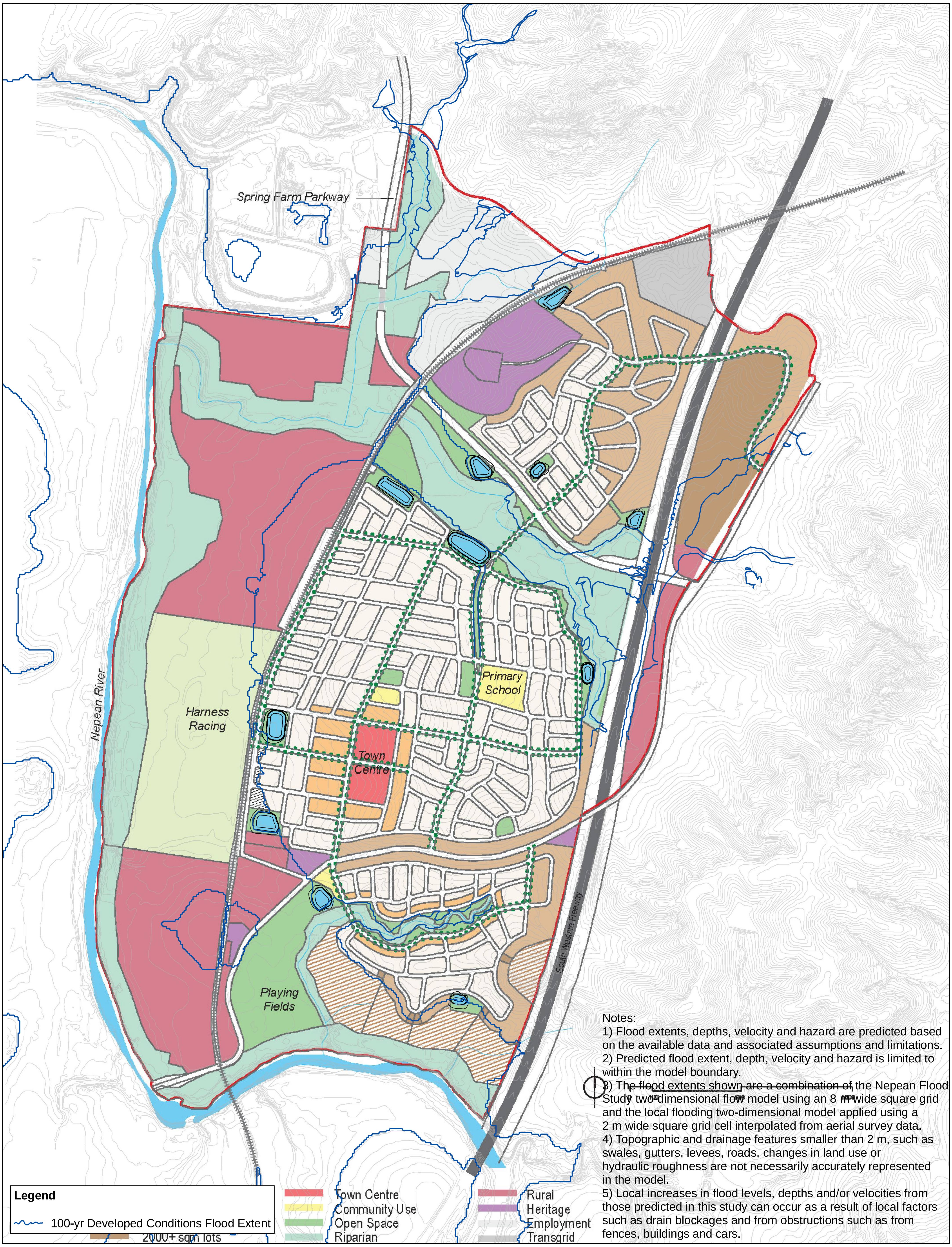
Job Number 21-15581
Revision A
Date May 2010

PMF Flood Extent

G:\21\15581\CADD\GIS\ArcGIS\Maps

Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia **T** 61 2 9239 7000 **F** 61 2 9239 7199 **E** sydmail@ghd.com Www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: C Pappin



Notes:

1) Flood extents, depths, velocity and hazard are predicted based on the available data and associated assumptions and limitations.

2) Predicted flood extent, depth, velocity and hazard is limited to within the model boundary.

3) The flood extents shown are a combination of the Nepean Flood Study two-dimensional flow model using an 8 m wide square grid and the local flooding two-dimensional model applied using a 2 m wide square grid cell interpolated from aerial survey data.

4) Topographic and drainage features smaller than 2 m, such as swales, gutters, levees, roads, changes in land use or hydraulic roughness are not necessarily accurately represented in the model.

5) Local increases in flood levels, depths and/or velocities from those predicted in this study can occur as a result of local factors such as drain blockages and from obstructions such as from fences, buildings and cars.

1:15,000 at A3

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N W E S

Campbelltown City Council/Landcom
Menangle Park Local Flooding and Detention

100-yr Flood Extent Developed Conditions

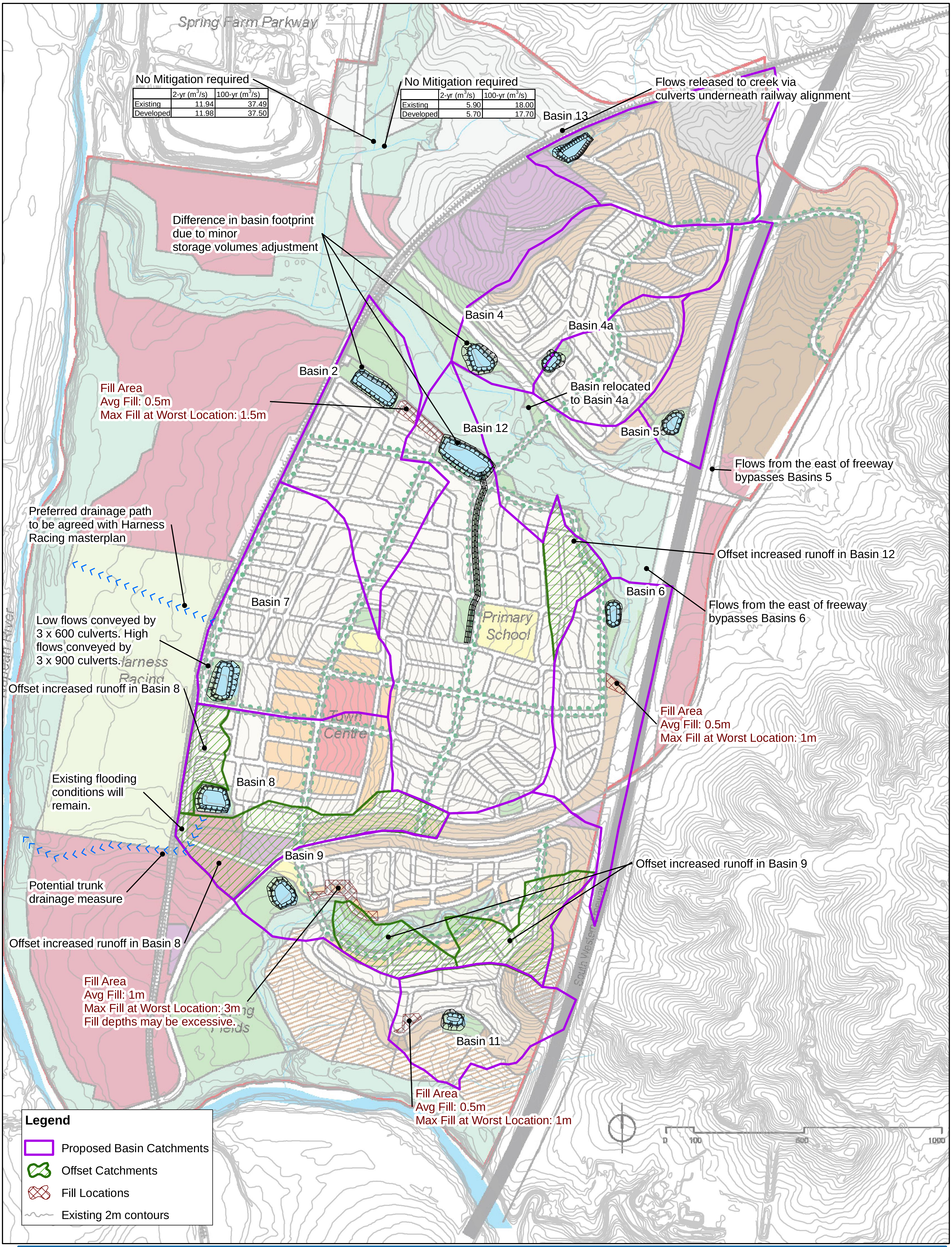
Job Number	21-15581
Revision	A
Date	May 2010

G:\21\15581\CADD\GIS\ArcGIS\Maps

Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia T 61 2 9239 7000 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: C Pappin

Appendix E – Stormwater Quantity Management Strategy



1:12,000 at A3

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N W E S

Campbelltown City Council/Landcom
Menangle Park Local Flooding and Detention

Job Number	21-15581
Revision	A
Date	May 2010

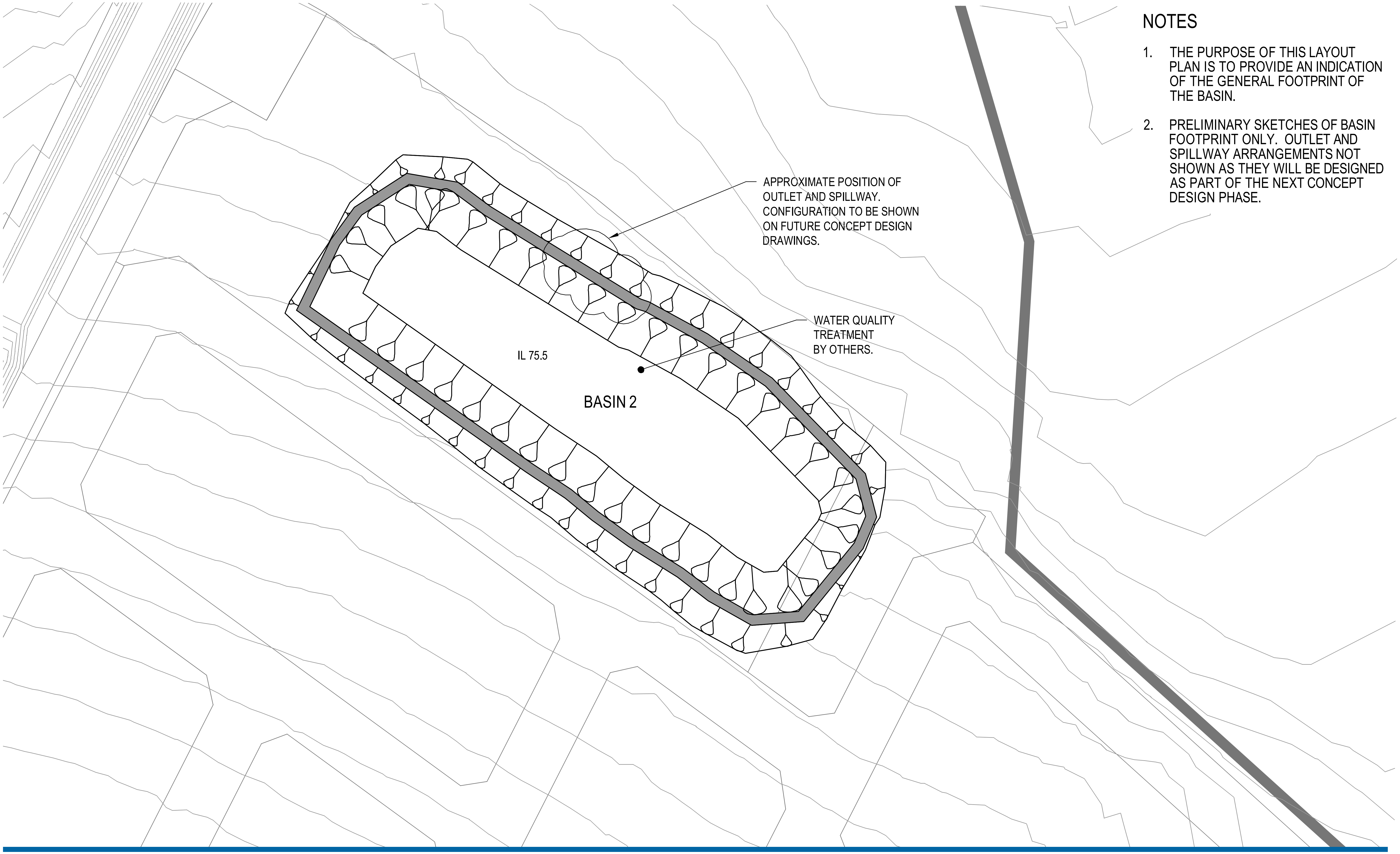
Stormwater Quantity Management Strategy

G:\21\15581\CADD\GIS\ArcGIS\Maps

Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia **T** 61 2 9239 7000 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: C Pappin

Appendix F – CAD Drawings



NOTES

1. THE PURPOSE OF THIS LAYOUT PLAN IS TO PROVIDE AN INDICATION OF THE GENERAL FOOTPRINT OF THE BASIN.
2. PRELIMINARY SKETCHES OF BASIN FOOTPRINT ONLY. OUTLET AND SPILLWAY ARRANGEMENTS NOT SHOWN AS THEY WILL BE DESIGNED AS PART OF THE NEXT CONCEPT DESIGN PHASE.

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Campbelltown City Council/Landcom
Menangle Park

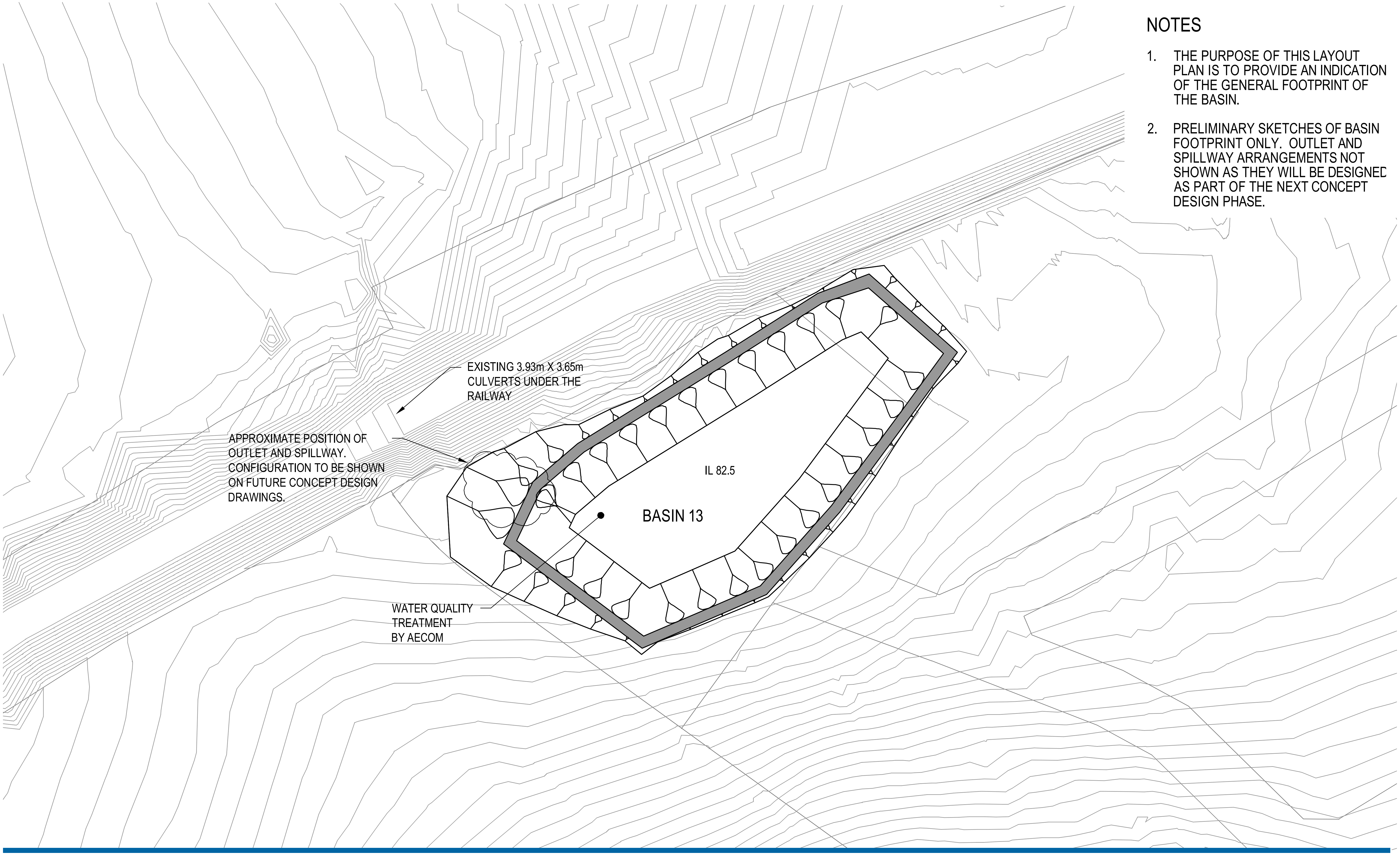
Basin 2
Indicative Layout Plan

Job Number	21-15581
Revision	A
Date	Feb 2010

Figure 001

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 8 February 2010 - 11:58 AM Plotted by: Wilson C. Lee Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG001.dwg



NOTES

1. THE PURPOSE OF THIS LAYOUT PLAN IS TO PROVIDE AN INDICATION OF THE GENERAL FOOTPRINT OF THE BASIN.
2. PRELIMINARY SKETCHES OF BASIN FOOTPRINT ONLY. OUTLET AND SPILLWAY ARRANGEMENTS NOT SHOWN AS THEY WILL BE DESIGNED AS PART OF THE NEXT CONCEPT DESIGN PHASE.

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Campbelltown City Council/Landcom
Menangle Park

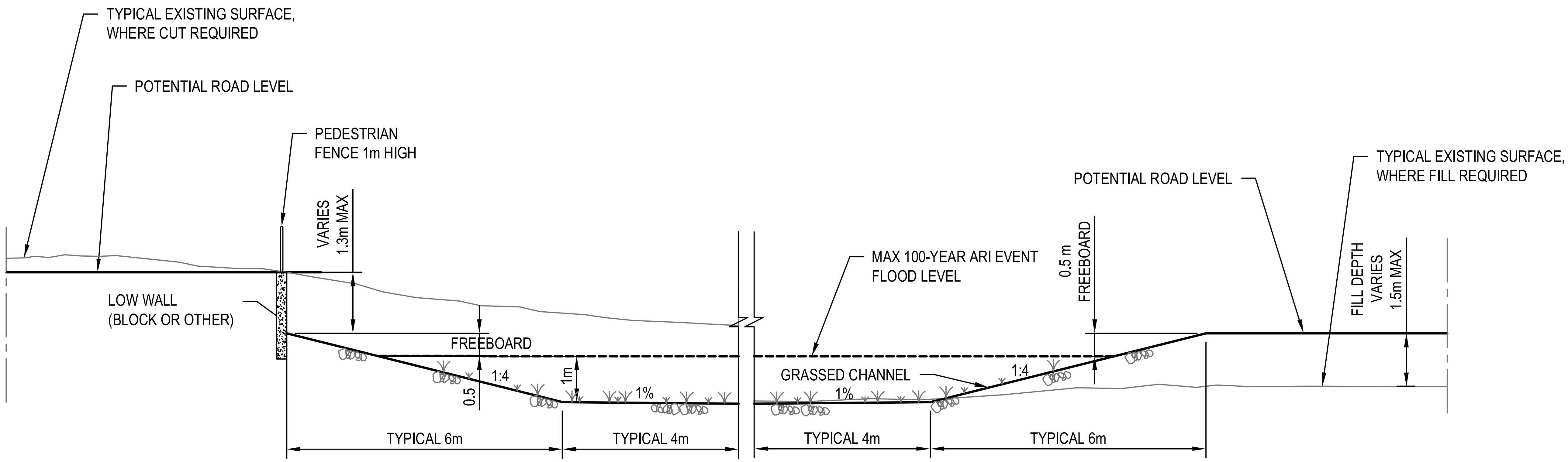
Basin 13
Indicative Layout Plan

Job Number	21-15581
Revision	A
Date	Feb 2010

Figure 011

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 8 February 2010 - 12:08 PM Plotted by: Wilson C. Lee Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG001.dwg



TYPICAL CUT SECTION

SCALE 1:100

TYPICAL FILL SECTION

SCALE 1:100

NOTE: ALL DIMENSIONS IN METRES

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Campbelltown City Council/Landcom
Menangle Park

Typical Channel Section
Draining to Basin 12

Job Number	21-15581
Revision	A
Date	Mar 2010

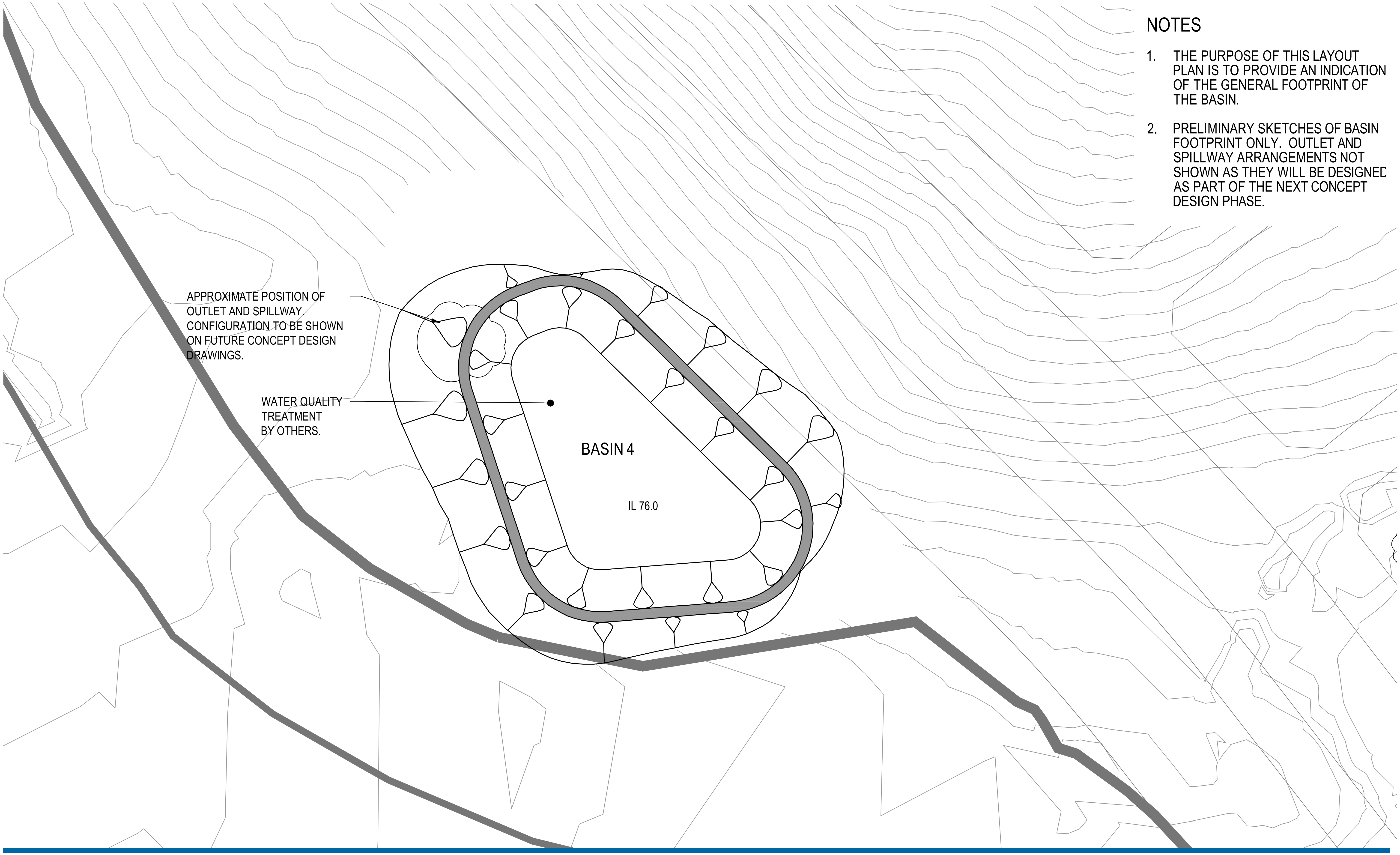
Figure 012

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 3 May 2010 - 11:31 AM Plotted by: Wilson C. Lee Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG012.dwg

NOTES

1. THE PURPOSE OF THIS LAYOUT PLAN IS TO PROVIDE AN INDICATION OF THE GENERAL FOOTPRINT OF THE BASIN.
2. PRELIMINARY SKETCHES OF BASIN FOOTPRINT ONLY. OUTLET AND SPILLWAY ARRANGEMENTS NOT SHOWN AS THEY WILL BE DESIGNED AS PART OF THE NEXT CONCEPT DESIGN PHASE.



0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

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Campbelltown City Council/Landcom
Menangle Park

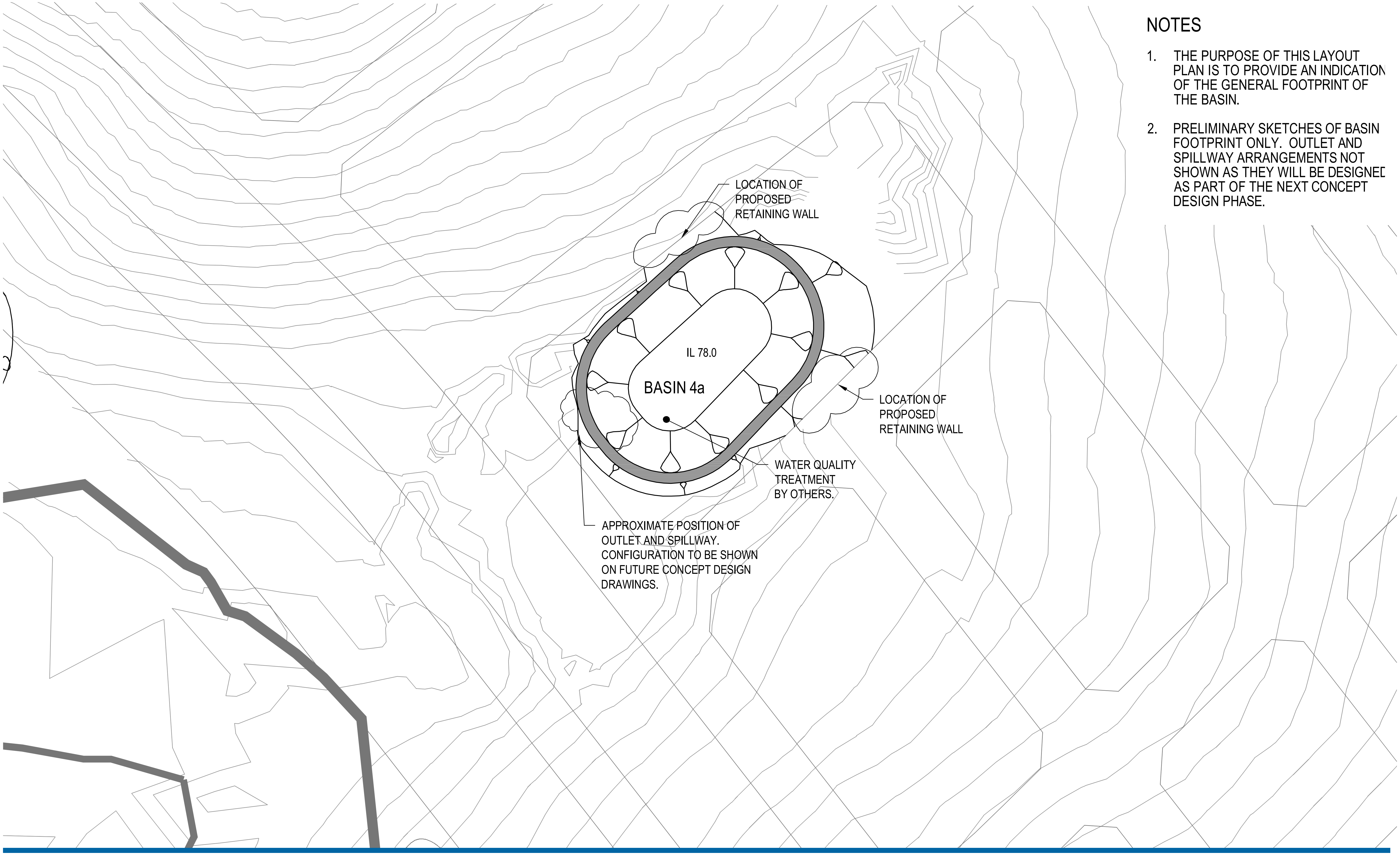
Basin 4
Indicative Layout Plan

Job Number	21-15581
Revision	A
Date	Feb 2010

Figure 002

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 8 February 2010 - 4:46 PM Plotted by: Wilson C. Lee Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG001.dwg



NOTES

1. THE PURPOSE OF THIS LAYOUT PLAN IS TO PROVIDE AN INDICATION OF THE GENERAL FOOTPRINT OF THE BASIN.
2. PRELIMINARY SKETCHES OF BASIN FOOTPRINT ONLY. OUTLET AND SPILLWAY ARRANGEMENTS NOT SHOWN AS THEY WILL BE DESIGNED AS PART OF THE NEXT CONCEPT DESIGN PHASE.

0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

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Campbelltown City Council/Landcom
Menangle Park

Basin 4a
Indicative Layout Plan

Job Number	21-15581
Revision	A
Date	Feb 2010

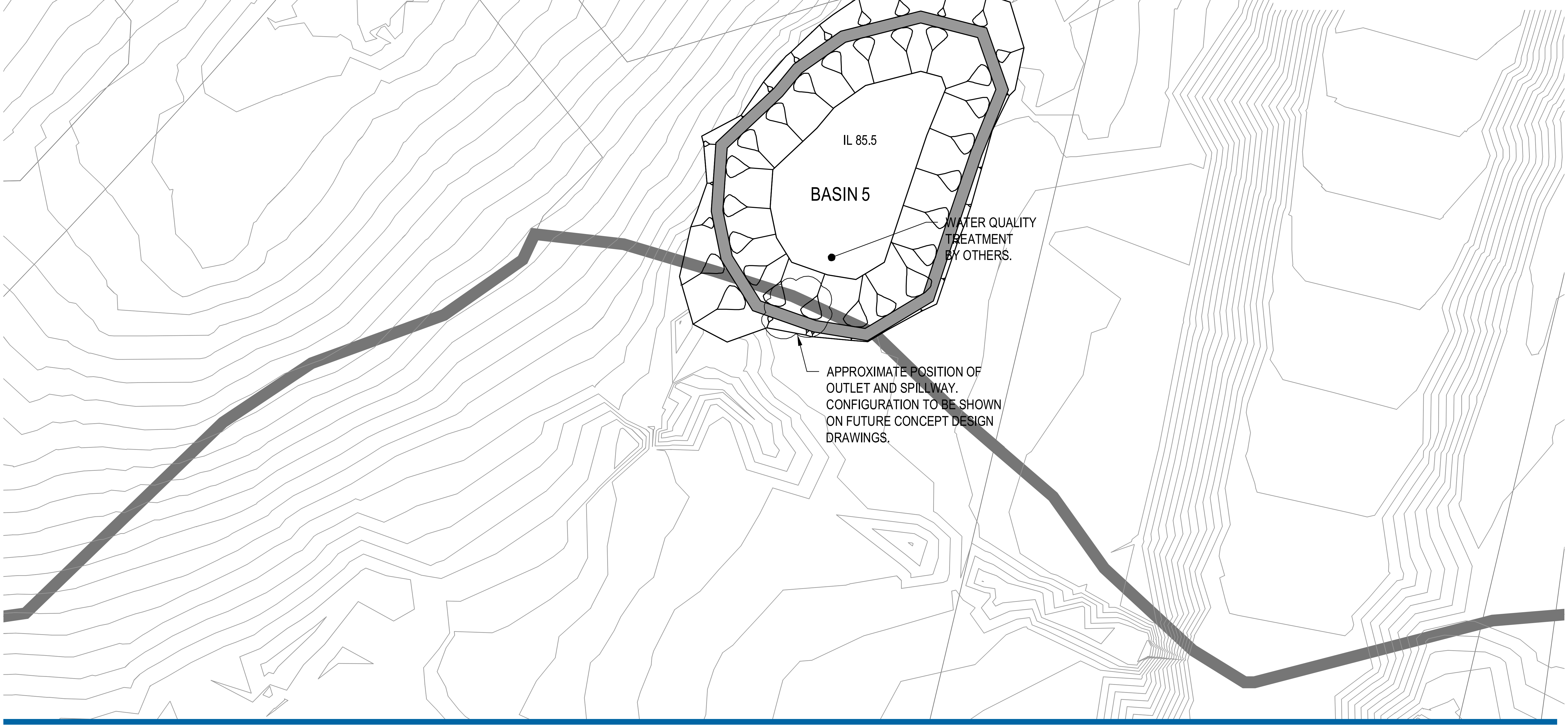
Figure 003

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 8 February 2010 - 5:59 PM Plotted by: Wilson C. Lee Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG001.dwg

NOTES

1. THE PURPOSE OF THIS LAYOUT PLAN IS TO PROVIDE AN INDICATION OF THE GENERAL FOOTPRINT OF THE BASIN.
2. PRELIMINARY SKETCHES OF BASIN FOOTPRINT ONLY. OUTLET AND SPILLWAY ARRANGEMENTS NOT SHOWN AS THEY WILL BE DESIGNED AS PART OF THE NEXT CONCEPT DESIGN PHASE



0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

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Campbelltown City Council/Landcom
Menangle Park

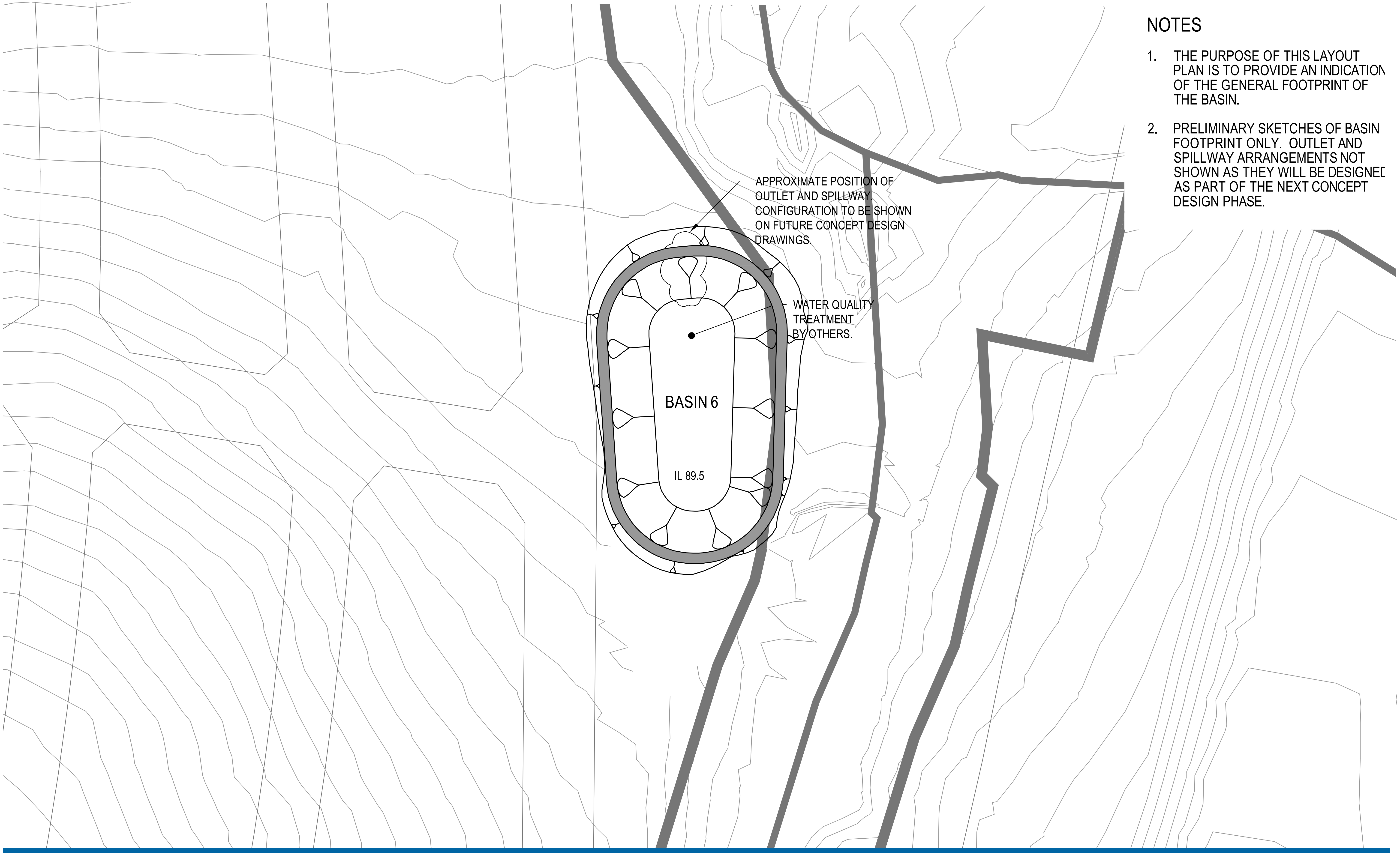
Basin 5
Indicative Layout Plan

Job Number	21-15581
Revision	A
Date	Feb 2010

Figure 004

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 8 February 2010 - 12:06 PM Plotted by: Wilson C. Lee Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG001.dwg



NOTES

1. THE PURPOSE OF THIS LAYOUT PLAN IS TO PROVIDE AN INDICATION OF THE GENERAL FOOTPRINT OF THE BASIN.
2. PRELIMINARY SKETCHES OF BASIN FOOTPRINT ONLY. OUTLET AND SPILLWAY ARRANGEMENTS NOT SHOWN AS THEY WILL BE DESIGNED AS PART OF THE NEXT CONCEPT DESIGN PHASE.

0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

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Campbelltown City Council/Landcom
Menangle Park

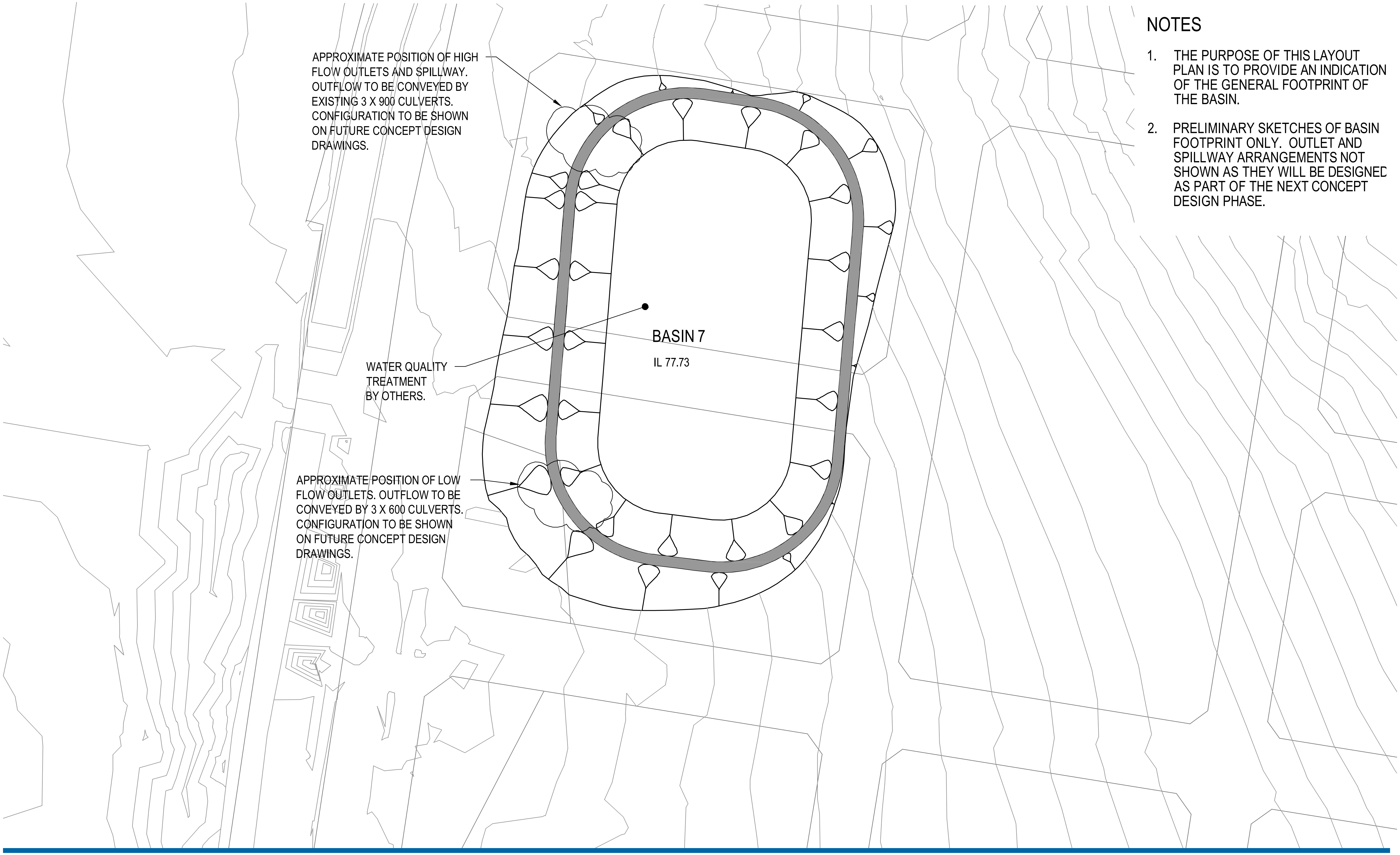
Basin 6
Indicative Layout Plan

Job Number	21-15581
Revision	A
Date	Feb 2010

Figure 005

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 8 February 2010 - 4:48 PM Plotted by: Wilson C. Lee Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG001.dwg



NOTES

1. THE PURPOSE OF THIS LAYOUT PLAN IS TO PROVIDE AN INDICATION OF THE GENERAL FOOTPRINT OF THE BASIN.
2. PRELIMINARY SKETCHES OF BASIN FOOTPRINT ONLY. OUTLET AND SPILLWAY ARRANGEMENTS NOT SHOWN AS THEY WILL BE DESIGNED AS PART OF THE NEXT CONCEPT DESIGN PHASE.

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Campbelltown City Council/Landcom
Menangle Park

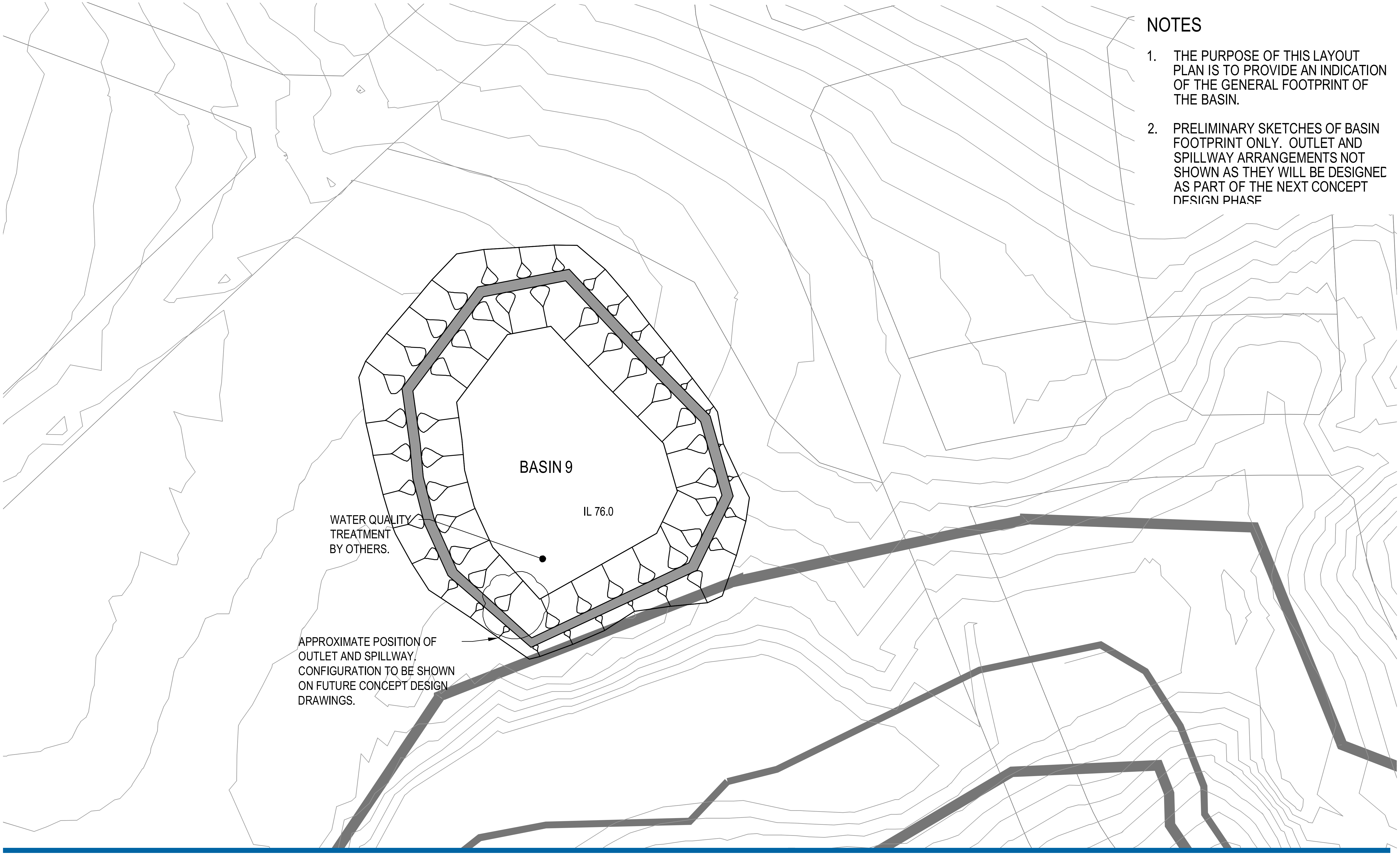
Basin 7
Indicative Layout Plan

Job Number	21-15581
Revision	A
Date	Mar 2010

Figure 006

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 6 April 2010 - 11:22 AM Plotted by: Wilson C. Lee Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG001.dwg



NOTES

1. THE PURPOSE OF THIS LAYOUT PLAN IS TO PROVIDE AN INDICATION OF THE GENERAL FOOTPRINT OF THE BASIN.
2. PRELIMINARY SKETCHES OF BASIN FOOTPRINT ONLY. OUTLET AND SPILLWAY ARRANGEMENTS NOT SHOWN AS THEY WILL BE DESIGNED AS PART OF THE NEXT CONCEPT DESIGN PHASE.

0 10 20 30m

SCALE 1:1000 AT ORIGINAL SIZE

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Campbelltown City Council/Landcom
Menangle Park

Basin 9
Indicative Layout Plan

Job Number	21-15581
Revision	A
Date	Feb 2010

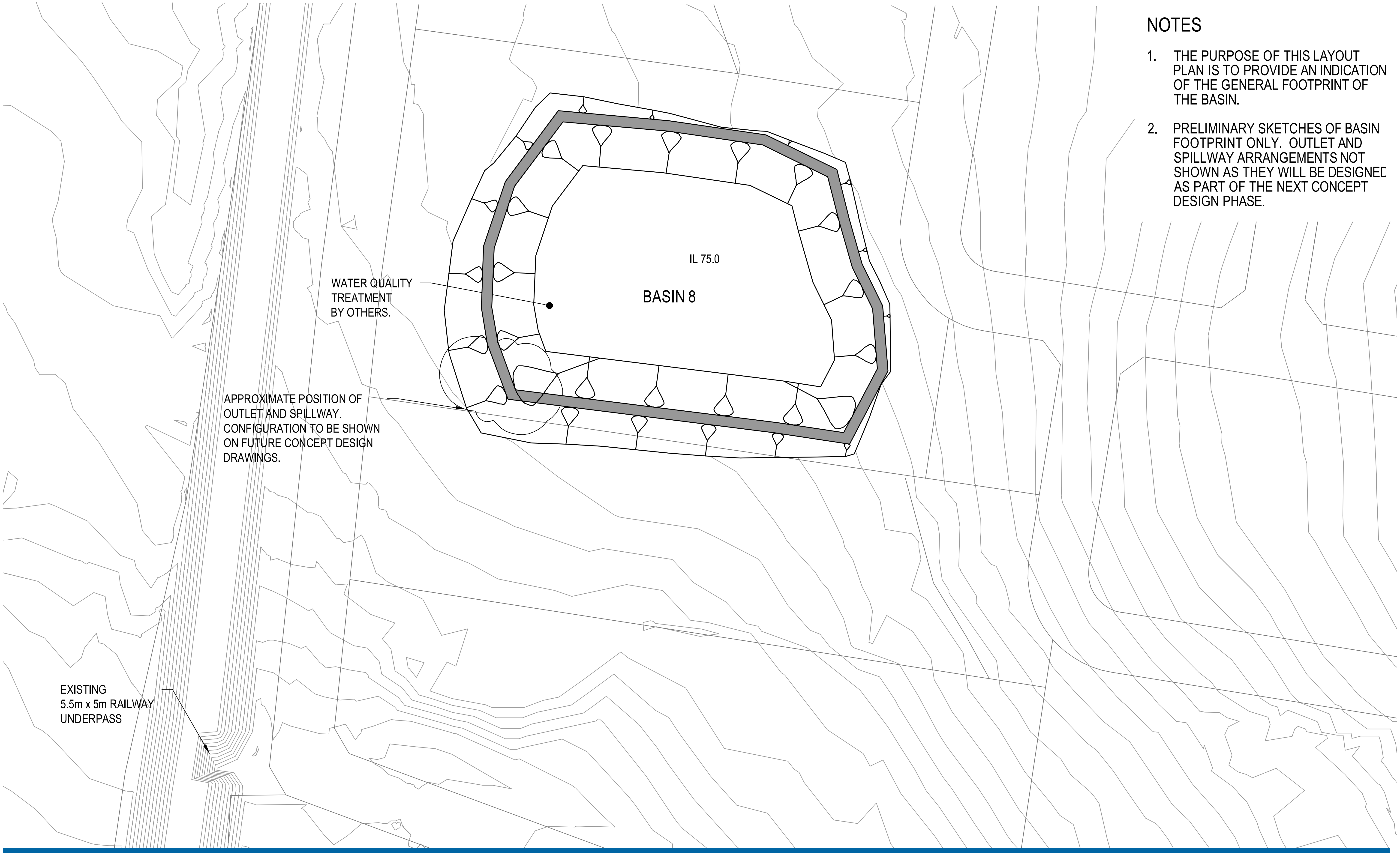
Figure 008

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 8 February 2010 - 12:07 PM Plotted by: Wilson C. Lee Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG001.dwg

NOTES

1. THE PURPOSE OF THIS LAYOUT PLAN IS TO PROVIDE AN INDICATION OF THE GENERAL FOOTPRINT OF THE BASIN.
2. PRELIMINARY SKETCHES OF BASIN FOOTPRINT ONLY. OUTLET AND SPILLWAY ARRANGEMENTS NOT SHOWN AS THEY WILL BE DESIGNED AS PART OF THE NEXT CONCEPT DESIGN PHASE.



0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

CLIENTS | PEOPLE | PERFORMANCE

Campbelltown City Council/Landcom
Menangle Park

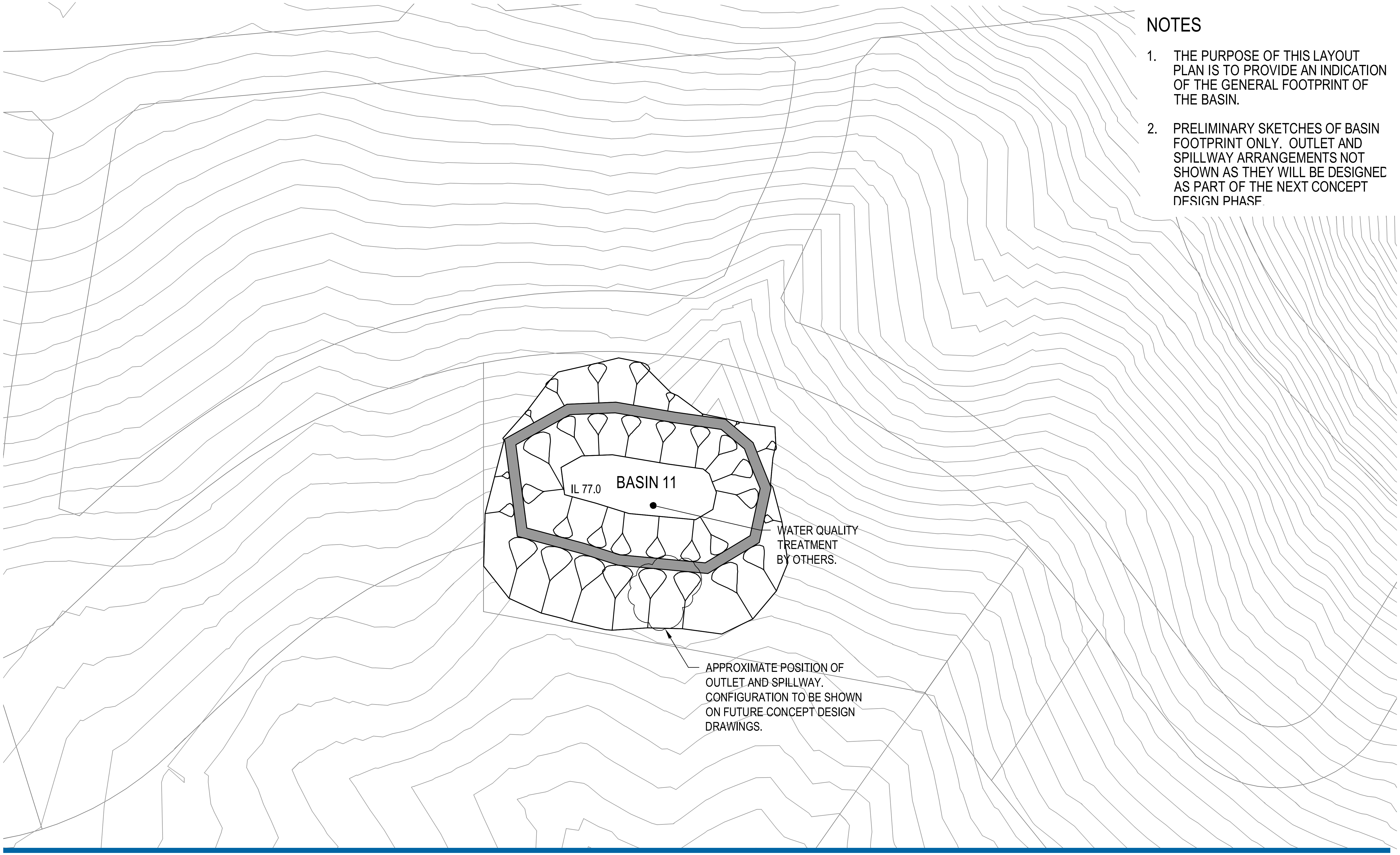
Basin 8
Indicative Layout Plan

Job Number	21-15581
Revision	A
Date	Feb 2010

Figure 007

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 10 February 2010 - 1:45 PM Plotted by: Wilson C. Lee Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG001.dwg



NOTES

1. THE PURPOSE OF THIS LAYOUT PLAN IS TO PROVIDE AN INDICATION OF THE GENERAL FOOTPRINT OF THE BASIN.
2. PRELIMINARY SKETCHES OF BASIN FOOTPRINT ONLY. OUTLET AND SPILLWAY ARRANGEMENTS NOT SHOWN AS THEY WILL BE DESIGNED AS PART OF THE NEXT CONCEPT DESIGN PHASE.

0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

GHD

CLIENTS | PEOPLE | PERFORMANCE

Campbelltown City Council/Landcom
Menangle Park

Basin 11
Indicative Layout Plan

Job Number	21-15581
Revision	A
Date	Feb 2010

Figure 009

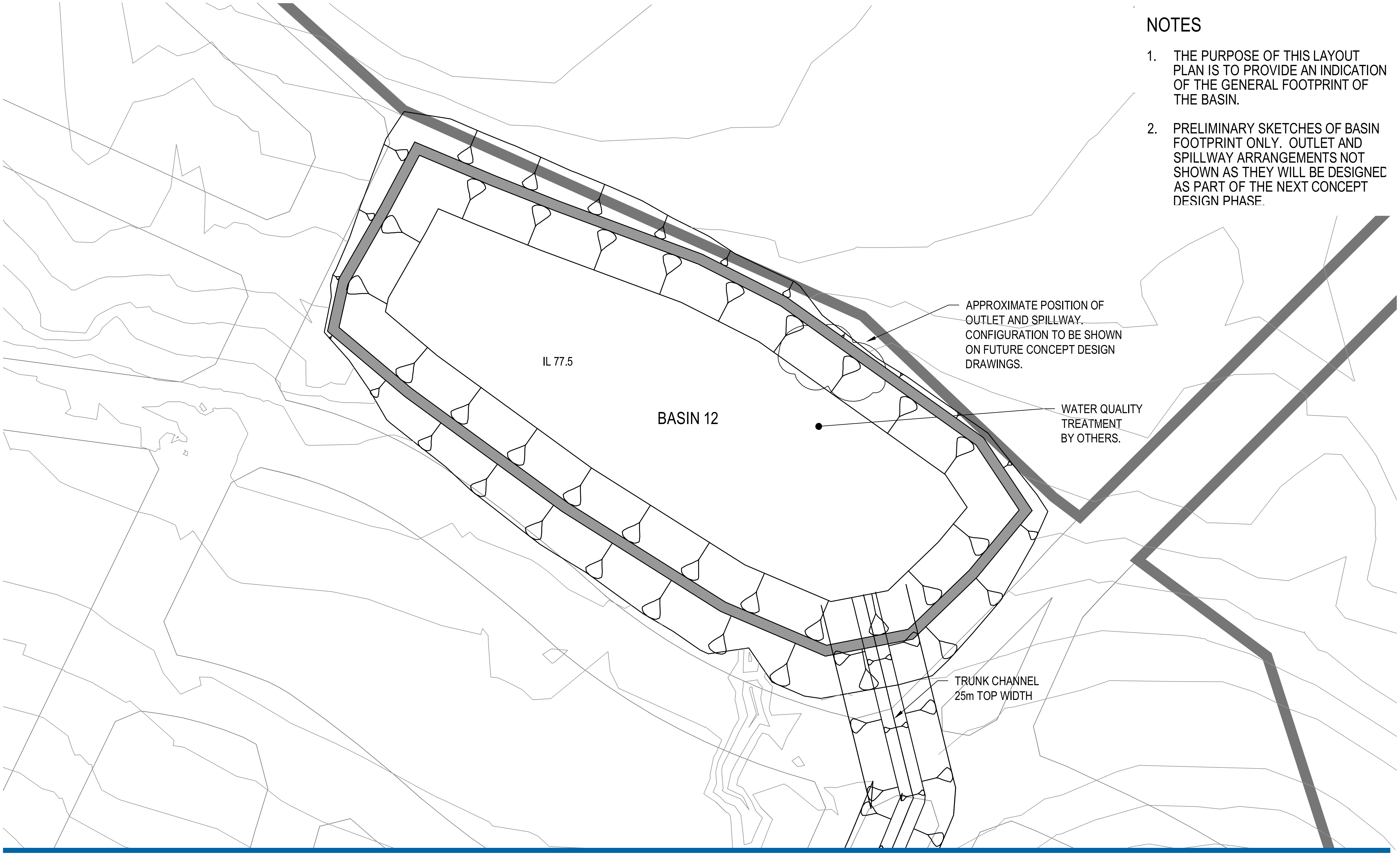
Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 8 February 2010 - 12:07 PM   Plotted by: Wilson C. Lee   Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG001.dwg

NOTES

1. THE PURPOSE OF THIS LAYOUT PLAN IS TO PROVIDE AN INDICATION OF THE GENERAL FOOTPRINT OF THE BASIN.

2. PRELIMINARY SKETCHES OF BASIN FOOTPRINT ONLY. OUTLET AND SPILLWAY ARRANGEMENTS NOT SHOWN AS THEY WILL BE DESIGNED AS PART OF THE NEXT CONCEPT DESIGN PHASE.



0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

GHD
CLIENTS | PEOPLE | PERFORMANCE

Campbelltown City Council/Landcom
Menangle Park

Basin 12
Indicative Layout Plan

Job Number	21-15581
Revision	A
Date	Mar 2010

Figure 010

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 6 April 2010 - 11:48 AM   Plotted by: Wilson C. Lee   Cad File No: G:\21\15581\CADD\Drawings\21-15581-FIG001.dwg

Appendix G - Preliminary Cost Estimate

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sydmail@ghd.com
Tel. +61 2 9239 7100 Fax. +61 2 9239 7197
133 Castlereagh St Sydney NSW 2000

Menangle Park

Campbelltown City Council/Landcom

PRELIMINARY COST ESTIMATE SUMMARY

NOTE: The preliminary cost estimates presented in this section have been developed solely for the purpose of comparing and evaluating competing options. They are sufficiently accurate to serve this purpose. They cannot be used for budget-setting purposes as common elements between options may have been omitted and/or the works not fully scoped. A functional design is recommended if a budget estimate is required.

ITEM	DESCRIPTION	AMOUNT	
1	**Basin 2**		
1.1	Preliminaries	$	20,000
1.2	Earthworks	$	237,740
1.3	High Flow Spillway	$	7,589
1.4	Low Flow Outlet Pipe	$	45,340
1.5	High Flow Outlet Box Culvert	$	263,200
1.6	Inlet from Road Drainage (to be advised)	$	25,080
1.7	Landscaping and Planting	$	143,649
1.8	Supervision, Project Management & Contractor On-Costs	$	222,779
1.9	Contingencies	$	222,779
		$	**1,188,000**
2	**Basin 4**		
2.1	Preliminaries	$	20,000
2.2	Earthworks	$	212,698
2.3	High Flow Spillway	$	8,535
2.4	Low Flow Outlet Pipe	$	69,660
2.5	High Flow Outlet Box Culvert	$	253,800
2.6	Inlet from Road Drainage (to be advised)	$	25,080
2.7	Landscaping and Planting	$	114,586
2.8	Supervision, Project Management & Contractor On-Costs	$	211,308
2.9	Contingencies	$	211,308
		$	**1,127,000**
3	**Basin 4a**		
3.1	Preliminaries	$	20,000
3.2	Earthworks	$	128,318
3.3	High Flow Spillway	$	6,480
3.4	Low Flow Outlet Pipe	$	44,140
3.5	High Flow Outlet Box Culvert	$	154,400
3.6	Inlet from Road Drainage (to be advised)	$	25,080
3.7	Landscaping and Planting	$	82,682
3.8	Supervision, Project Management & Contractor On-Costs	$	138,330
3.9	Contingencies	$	138,330
		$	**738,000**
4	**Basin 5**		
4.1	Preliminaries	$	20,000
4.2	Earthworks	$	133,280
4.3	High Flow Spillway	$	6,206
4.4	Low Flow Outlet Pipe	$	45,640
4.5	High Flow Outlet Box Culvert	$	154,400
4.6	Inlet from Road Drainage (to be advised)	$	25,080
4.7	Landscaping and Planting	$	75,397
4.8	Supervision, Project Management & Contractor On-Costs	$	138,001
4.9	Contingencies	$	138,001
		$	**736,000**

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5	**Basin 6**		
5.1	Preliminaries	$	20,000
5.2	Earthworks	$	139,105
5.3	High Flow Spillway	$	6,227
5.4	Low Flow Outlet Pipe	$	69,660
5.5	High Flow Outlet Box Culvert	$	226,800
5.6	Inlet from Road Drainage (to be advised)	$	25,080
5.7	Landscaping and Planting	$	54,472
5.8	Supervision, Project Management & Contractor On-Costs	$	162,403
5.9	Contingencies	$	162,403
		$	**866,000**
6	**Basin 7**		
6.1	Preliminaries	$	20,000
6.2	Earthworks	$	229,135
6.3	High Flow Spillway	$	8,784
6.4	Low Flow Outlet Pipe	$	45,640
6.5	High Flow Outlet Box Culvert	$	259,600
6.6	Inlet from Road Drainage (to be advised)	$	25,080
6.7	Landscaping and Planting	$	108,330
6.8	Supervision, Project Management & Contractor On-Costs	$	208,971
6.9	Contingencies	$	208,971
		$	**1,115,000**
7	**Basin 8**		
7.1	Preliminaries	$	20,000
7.2	Earthworks	$	177,467
7.3	High Flow Spillway	$	6,978
7.4	Low Flow Outlet Pipe	$	70,260
7.5	High Flow Outlet Box Culvert	$	599,200
7.6	Inlet from Road Drainage (to be advised)	$	25,080
7.7	Landscaping and Planting	$	90,062
7.8	Supervision, Project Management & Contractor On-Costs	$	296,714
7.9	Contingencies	$	296,714
		$	**1,582,000**
8	**Basin 9**		
8.1	Preliminaries	$	20,000
8.2	Earthworks	$	141,679
8.3	High Flow Spillway	$	7,335
8.4	Low Flow Outlet Pipe	$	68,460
8.5	High Flow Outlet Box Culvert	$	299,200
8.6	Inlet from Road Drainage (to be advised)	$	33,180
8.7	Landscaping and Planting	$	71,992
8.8	Supervision, Project Management & Contractor On-Costs	$	192,554
8.9	Contingencies	$	192,554
		$	**1,027,000**
9	**Basin 11**		
9.1	Preliminaries	$	20,000
9.2	Earthworks	$	134,811
9.3	High Flow Spillway	$	7,285
9.4	Low Flow Outlet Pipe	$	48,040
9.5	High Flow Outlet Box Culvert	$	226,800
9.6	Inlet from Road Drainage (to be advised)	$	25,080
9.7	Landscaping and Planting	$	76,141
9.8	Supervision, Project Management & Contractor On-Costs	$	161,447
9.9	Contingencies	$	161,447
		$	**861,000**

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10	**Basin 12**		
10.1	Preliminaries	$	20,000
10.2	Earthworks	$	403,560
10.3	High Flow Spillway	$	8,031
10.4	Low Flow Outlet Pipe	$	117,100
10.5	High Flow Outlet Box Culvert	$	371,600
10.6	Inlet from Road Drainage (to be advised)	$	25,080
10.7	Landscaping and Planting	$	129,623
10.8	Supervision, Project Management & Contractor On-Costs	$	322,498
10.9	Contingencies	$	322,498
		$	**1,720,000**
11	**Basin 13**		
11.1	Preliminaries	$	20,000
11.2	Earthworks	$	334,861
11.3	High Flow Spillway	$	6,707
11.4	Low Flow Outlet Pipe	$	70,260
11.5	High Flow Outlet Box Culvert	$	226,800
11.6	Inlet from Road Drainage (to be advised)	$	25,080
11.7	Landscaping and Planting	$	104,106
11.8	Supervision, Project Management & Contractor On-Costs	$	236,344
11.9	Contingencies	$	236,344
		$	**1,261,000**
	SUBTOTAL ITEMS 1-11	**$**	**12,221,000**
12	**Trunk Drainage 12**		
12.1	Preliminaries	$	20,000
12.2	Earthworks	$	263,321
12.3	Landscaping and Planting	$	590,595
12.4	Supervision, Project Management & Contractor On-Costs	$	262,175
12.5	Contingencies	$	262,175
		$	**1,398,000**
	SUBTOTAL ITEM 12	**$**	**1,398,000**
	TOTAL (Exl-GST)	**$**	**13,619,000**

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Menangle Park
Detention Basin 11
PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES

Revision: Draft

NOTE: The preliminary cost estimates presented in this section have been developed solely for the purpose of comparing and evaluating competing options. They are sufficiently accurate to serve this purpose. They cannot be used for budget-setting purposes as common elements between options may have been omitted and/or the works not fully scoped. A functional design is recommended if a budget estimate is required.

SCHEDULE OF ESTIMATED QUANTITIES

PAY ITEM	DESCRIPTION OF WORK	QTY	UNIT	RATE	AMOUNT	NOTES
1	**Preliminaries**					
1.1	Establishment	1	item	10000	$ 10,000	Allowance only
1.2	Erosion and sediment control	1	item	10000	$ 10,000	Allowance only
	SUBTOTAL				**$ 20,000**	
2	**Earthworks**					
2.1	Clearing and grubbing	0.7	ha	2900	$ 1,953	Assuming medium density bushland
2.2	Demolition - break up and remove existing works on site	50.0	m2	54	$ 2,700	Disposal extra
2.3	Dewatering - system to reduce water level by 1.0m	-	m2	60	$ -	Approximate only
2.4	Desilting - strip soil to 0.5m deep and dispose of excavated material to tip within 10km	-	m2	14	$ -	Approximate only
2.5	Topsoil - excavate to average 150mm deep and deposit in spoil heaps within 500m for later use: light soil	1,010	m3	5	$ 5,050	Assuming light soil (not clay)
2.6	Fill - place and compact imported fill	239	m3	57	$ 13,625	-
2.7	Excavate to reduce levels and deposit, spread, level and compact to 90% within 1km, in Light Soil	2,533	m3	11	$ 27,867	-
2.8	Access Road: excavate to reduce levels and deposit in spoil heaps within 10km, in Light Soil	164	m3	9	$ 1,479	
2.9	Access Road: place and compact imported fill	164	m3	13	$ 2,137	
2.10	Allowance: Over excavation to restore soil profile				$ 10,000	
2.11	Allowance: Treatment of dispersive soils with gypsum (or similar)				$ 50,000	
2.12	Allowance: Separate and place select clay in embankment core				$ 20,000	
	SUBTOTAL				**$ 134,811**	
3	**High Flow Spillway**					
3.1	Form spillway crest in embankment	38	m3	20	$ 750	-
3.2	Geotextile Fabric - non woven polypropylene/ polyethylene 2.8mm thick (310g/sqm)	150	m2	5	$ 750	-
3.3	Reinforced Turf - supply, deliver, lay turf, roll and water	445	m2	13	$ 5,785	
	SUBTOTAL				**$ 7,285**	
4	**Low Flow Outlet Pipe**					
4.1	Pit - Supply, deliver, lay and join 900mm square pit with grated inlet	2	item	3500	$ 7,000	-
4.2	Pipe - Supply, deliver, lay and join 600mm RCP (Class 2)	30	m	260	$ 7,800	Rubber ring joint; excavation excluded
4.2	Pipe - Supply, deliver, lay and join 600mm RCP (Class 2)	30	m	260	$ 7,800	Rubber ring joint; excavation excluded
4.3	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 600mm pipe	2	each	480	$ 960	-
4.4	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$ 1,200	Approximate only
4.5	Excavate 2000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	60	m	360	$ 21,600	Assuming clay soil
4.6	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$ 1,680	
	SUBTOTAL				**$ 48,040**	
5	**High Flow Outlet Box Culvert**					
5.1	Box Culvert - Supply, deliver, lay and join 2.4m (span) x 0.9m (height) box culvert	90	m	1800	$ 162,000	Excavation Excluded
5.2	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 2.4m (span) x 0.9m (height) box culvert: 1 cell	3	each	5500	$ 16,500	Approximate only
5.3	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$ 1,200	Approximate only
5.4	Excavate 3000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	90	m	430	$ 38,700	Assuming ligt soil
5.5	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	60	m2	140	$ 8,400	
	SUBTOTAL				**$ 226,800**	
6	**Inlet from Road Drainage**					
6.1	Pipe - Supply, deliver, lay and join 375mm RCP (Class 2)	90	m	130	$ 11,700	Rubber ring joint; excavation excluded
6.2	Excavate 1200mm wide trench by machine, backfill with same material and compact, up to 2.0m deep	90	m	130	$ 11,700	Assuming clay soil
6.3	GPT - Supply, deliver and install CDS 1009	-	each	30000	$ -	Subject to final design
6.4	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$ 1,680	
	SUBTOTAL				**$ 25,080**	
7	**Landscaping and Planting**					
7.1	Topsoil - excavate from spoil heap, cart not exceeding 500m and spread and level average 150mm thick: light soil - battered areas	1,010	m3	6	$ 6,060	
7.2	Lawn turf - spread and grade 50mm topsoil, lay turf, roll and water	4,689	m2	10	$ 46,890	-
7.3	Landscaping - supply, deliver and plant approved plants	610	m2	38	$ 23,191	-
	SUBTOTAL				**$ 76,141**	
	SUBTOTAL ITEMS 1-7				**$ 538,157**	
8	**Supervision, Project Management & Contractor On-Costs**					
8.1	Supervision, Project Management & Contractor On-Costs	30	%	-	$ 161,447	-
	SUBTOTAL				**$ 161,447**	
9	**Contingencies**					
9.1	Contingencies - General	30	%	-	$ 161,447	-
	SUBTOTAL				**$ 161,447**	
	TOTAL				**$ 861,000**	

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Menangle Park
Detention Basin 12
PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES

Revision: Draft

NOTE: The preliminary cost estimates presented in this section have been developed solely for the purpose of comparing and evaluating competing options. They are sufficiently accurate to serve this purpose. They cannot be used for budget-setting purposes as common elements between options may have been omitted and/or the works not fully scoped. A functional design is recommended if a budget estimate is required.

SCHEDULE OF ESTIMATED QUANTITIES

PAY ITEM	DESCRIPTION OF WORK	QTY	UNIT	RATE	AMOUNT	NOTES
1	**Preliminaries**					
1.1	Establishment	1	item	10000	$ 10,000	Allowance only
1.2	Erosion and sediment control	1	item	10000	$ 10,000	Allowance only
	SUBTOTAL				**$ 20,000**	
2	**Earthworks**					
2.1	Clearing and grubbing	2.3	ha	2900	$ 6,640	Assuming medium density bushland
2.2	Demolition - break up and remove existing works on site	50.0	m2	54	$ 2,700	Disposal extra
2.3	Dewatering - system to reduce water level by 1.0m	-	m2	60	$ -	Approximate only
2.4	Desilting - strip soil to 0.5m deep and dispose of excavated material to tip within 10km	-	m2	14	$ -	Approximate only
2.5	Topsoil - excavate to average 150mm deep and deposit in spoil heaps within 500m for later use: light soil	3,434	m3	5	$ 17,172	Assuming light soil (not clay)
2.6	Excavate to reduce levels and deposit surplus cut in spoil heaps within 10km, in Light Soil	30,618	m3	9	$ 275,560	-
2.7	Excavate to reduce levels and deposit, spread, level and compact to 90% within 1km, in Light Soil	1,276	m3	11	$ 14,041	-
2.8	Access Road: excavate to reduce levels and deposit in spoil heaps within 10km, in Light Soil	338	m3	9	$ 3,046	
2.9	Access Road: place and compact imported fill	338	m3	13	$ 4,400	
2.10	Allowance: Over excavation to restore soil profile				$ 10,000	
2.11	Allowance: Treatment of dispersive soils with gypsum (or similar)				$ 50,000	
2.12	Allowance: Separate and place select clay in embankment core				$ 20,000	
	SUBTOTAL				**$ 403,560**	
3	**High Flow Spillway**					
3.1	Form spillway crest in embankment	38	m3	20	$ 750	-
3.2	Geotextile Fabric - non woven polypropylene/ polyethylene 2.8mm thick (310g/sqm)	150	m2	5	$ 750	-
3.3	Reinforced Turf - supply, deliver, lay turf, roll and water	502	m2	13	$ 6,531	
	SUBTOTAL				**$ 8,031**	
4	**Low Flow Outlet Pipe**					
4.1	Pit - Supply, deliver, lay and join 900mm square pit with grated inlet	5	item	3500	$ 17,500	-
4.2	Pipe - Supply, deliver, lay and join 600mm RCP (Class 2)	60	m	260	$ 15,600	Rubber ring joint; excavation excluded
4.2	Pipe - Supply, deliver, lay and join 525mm RCP (Class 2)	90	m	220	$ 19,800	Rubber ring joint; excavation excluded
4.3	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 600mm pipe	5	each	480	$ 2,400	-
4.4	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	6	m3	600	$ 3,600	Approximate only
4.5	Excavate 2000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	150	m	360	$ 54,000	Assuming clay soil
4.6	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	30	m2	140	$ 4,200	
	SUBTOTAL				**$ 117,100**	
5	**High Flow Outlet Box Culvert**					
5.1	Box Culvert - Supply, deliver, lay and join 2.4m (span) x 0.9m (height) box culvert	150	m	1800	$ 270,000	Excavation Excluded
5.2	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 2.4m (span) x 0.9m (height) box culvert: 1 cell	5	each	5500	$ 27,500	Approximate only
5.3	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$ 1,200	Approximate only
5.4	Excavate 3000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	150	m	430	$ 64,500	Assuming ligt soil
5.5	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	60	m2	140	$ 8,400	
	SUBTOTAL				**$ 371,600**	
6	**Inlet from Road Drainage**					
6.1	Pipe - Supply, deliver, lay and join 375mm RCP (Class 2)	90	m	130	$ 11,700	Rubber ring joint; excavation excluded
6.2	Excavate 1200mm wide trench by machine, backfill with same material and compact, up to 2.0m deep	90	m	130	$ 11,700	Assuming clay soil
6.3	GPT - Supply, deliver and install CDS 1009	-	each	30000	$ -	Subject to final design
6.4	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$ 1,680	
	SUBTOTAL				**$ 25,080**	
7	**Landscaping and Planting**					
7.1	Topsoil - excavate from spoil heap, cart not exceeding 500m and spread and level average 150mm thick: light soil - battered areas	3,434	m3	6	$ 20,607	
7.2	Lawn turf - spread and grade 50mm topsoil, lay turf, roll and water	10,902	m2	10	$ 109,016	-
7.3	Landscaping - supply, deliver and plant approved plants	-	m2	38	$ -	-
	SUBTOTAL				**$ 129,623**	
	SUBTOTAL ITEMS 1-7				**$ 1,074,995**	
8	**Supervision, Project Management & Contractor On-Costs**					
8.1	Supervision, Project Management & Contractor On-Costs	30	%	-	$ 322,498	-
	SUBTOTAL				**$ 322,498**	
9	**Contingencies**					
9.1	Contingencies - General	30	%	-	$ 322,498	-
	SUBTOTAL				**$ 322,498**	
	TOTAL				**$ 1,720,000**	

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Menangle Park
Detention Basin 13
PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES

Revision: Draft

NOTE: The preliminary cost estimates presented in this section have been developed solely for the purpose of comparing and evaluating competing options. They are sufficiently accurate to serve this purpose. They cannot be used for budget-setting purposes as common elements between options may have been omitted and/or the works not fully scoped. A functional design is recommended if a budget estimate is required.

SCHEDULE OF ESTIMATED QUANTITIES

PAY ITEM	DESCRIPTION OF WORK	QTY	UNIT	RATE	AMOUNT	NOTES
1	**Preliminaries**					
1.1	Establishment	1	item	10000	$ 10,000	Allowance only
1.2	Erosion and sediment control	1	item	10000	$ 10,000	Allowance only
	SUBTOTAL				**$ 20,000**	
2	**Earthworks**					
2.1	Clearing and grubbing	1.1	ha	2900	$ 3,117	Assuming medium density bushland
2.2	Demolition - break up and remove existing works on site	50.0	m2	54	$ 2,700	Disposal extra
2.3	Dewatering - system to reduce water level by 1.0m	-	m2	60	$ -	Approximate only
2.4	Desilting - strip soil to 0.5m deep and dispose of excavated material to tip within 10km	-	m2	14	$ -	Approximate only
2.5	Topsoil - excavate to average 150mm deep and deposit in spoil heaps within 500m for later use: light soil	1,612	m3	5	$ 8,062	Assuming light soil (not clay)
2.6	Excavate to reduce levels and deposit surplus cut in spoil heaps within 10km, in Light Soil	19,549	m3	9	$ 175,945	-
2.7	Excavate to reduce levels and deposit, spread, level and compact to 90% within 1km, in Light Soil	5,445	m3	11	$ 59,897	-
2.8	Access Road: excavate to reduce levels and deposit in spoil heaps within 10km, in Light Soil	234	m3	9	$ 2,103	
2.9	Access Road: place and compact imported fill	234	m3	13	$ 3,037	
2.10	Allowance: Over excavation to restore soil profile				$ 10,000	
2.11	Allowance: Treatment of dispersive soils with gypsum (or similar)				$ 50,000	
2.12	Allowance: Separate and place select clay in embankment core				$ 20,000	
	SUBTOTAL				**$ 334,861**	
3	**High Flow Spillway**					
3.1	Form spillway crest in embankment	38	m3	20	$ 750	-
3.2	Geotextile Fabric - non woven polypropylene/ polyethylene 2.8mm thick (310g/sqm)	150	m2	5	$ 750	-
3.3	Reinforced Turf - supply, deliver, lay turf, roll and water	401	m2	13	$ 5,207	
	SUBTOTAL				**$ 6,707**	
4	**Low Flow Outlet Pipe**					
4.1	Pit - Supply, deliver, lay and join 900mm square pit with grated inlet	3	item	3500	$ 10,500	-
4.2	Pipe - Supply, deliver, lay and join 600mm RCP (Class 2)	30	m	260	$ 7,800	Rubber ring joint; excavation excluded
4.2	Pipe - Supply, deliver, lay and join 525mm RCP (Class 2)	60	m	220	$ 13,200	Rubber ring joint; excavation excluded
4.3	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 600mm pipe	3	each	480	$ 1,440	-
4.4	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	4	m3	600	$ 2,400	Approximate only
4.5	Excavate 2000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	90	m	360	$ 32,400	Assuming clay soil
4.6	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	18	m2	140	$ 2,520	
	SUBTOTAL				**$ 70,260**	
5	**High Flow Outlet Box Culvert**					
5.1	Box Culvert - Supply, deliver, lay and join 2.4m (span) x 0.9m (height) box culvert	90	m	1800	$ 162,000	Excavation Excluded
5.2	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 2.4m (span) x 0.9m (height) box culvert: 1 cell	3	each	5500	$ 16,500	Approximate only
5.3	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$ 1,200	Approximate only
5.4	Excavate 3000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	90	m	430	$ 38,700	Assuming ligt soil
5.5	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	60	m2	140	$ 8,400	
	SUBTOTAL				**$ 226,800**	
6	**Inlet from Road Drainage**					
6.1	Pipe - Supply, deliver, lay and join 375mm RCP (Class 2)	90	m	130	$ 11,700	Rubber ring joint; excavation excluded
6.2	Excavate 1200mm wide trench by machine, backfill with same material and compact, up to 2.0m deep	90	m	130	$ 11,700	Assuming clay soil
6.3	GPT - Supply, deliver and install CDS 1009	-	each	30000	$ -	Subject to final design
6.4	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$ 1,680	
	SUBTOTAL				**$ 25,080**	
7	**Landscaping and Planting**					
7.1	Topsoil - excavate from spoil heap, cart not exceeding 500m and spread and level average 150mm thick: light soil - battered areas	1,612	m3	6	$ 9,675	
7.2	Lawn turf - spread and grade 50mm topsoil, lay turf, roll and water	5,998	m2	10	$ 59,977	-
7.3	Landscaping - supply, deliver and plant approved plants	907	m2	38	$ 34,454	-
	SUBTOTAL				**$ 104,106**	
	SUBTOTAL ITEMS 1-7				**$ 787,813**	
8	**Supervision, Project Management & Contractor On-Costs**					
8.1	Supervision, Project Management & Contractor On-Costs	30	%	-	$ 236,344	-
	SUBTOTAL				**$ 236,344**	
9	**Contingencies**					
9.1	Contingencies - General	30	%	-	$ 236,344	-
	SUBTOTAL				**$ 236,344**	
	TOTAL				**$ 1,261,000**	

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Menangle Park
Trunk Drainage 12
PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES

Revision: Draft

NOTE: The preliminary cost estimates presented in this section have been developed solely for the purpose of comparing and evaluating competing options. They are sufficiently accurate to serve this purpose. They cannot be used for budget-setting purposes as common elements between options may have been omitted and/or the works not fully scoped. A functional design is recommended if a budget estimate is required.

SCHEDULE OF ESTIMATED QUANTITIES

PAY ITEM	DESCRIPTION OF WORK	QTY	UNIT	RATE	AMOUNT	NOTES
1	**Preliminaries**					
1.1	Establishment	1	item	10000	$ 10,000	Allowance only
1.2	Erosion and sediment control	1	item	10000	$ 10,000	Allowance only
	SUBTOTAL				**$ 20,000**	
2	**Earthworks**					
2.1	Clearing and grubbing	1.5	ha	2900	$ 4,403	Assuming medium density bushland
2.2	Demolition - break up and remove existing works on site	50.0	m2	54	$ 2,700	Disposal extra
2.3	Dewatering - system to reduce water level by 1.0m	759	m2	60	$ 45,547	Approximate only
2.4	Desilting - strip soil to 0.5m deep and dispose of excavated material to tip within 10km	759	m2	14	$ 10,628	Approximate only
2.5	Topsoil - excavate to average 150mm deep and deposit in spoil heaps within 500m for later use: light soil	2,277	m3	5	$ 11,387	Assuming light soil (not clay)
2.6	Excavate to reduce levels and deposit surplus cut in spoil heaps within 10km, in Light Soil	12,410	m3	9	$ 111,687	-
2.7	Excavate to reduce levels and deposit, spread, level and compact to 90% within 1km, in Light Soil	376	m3	11	$ 4,139	-
2.8	Access Road: excavate to reduce levels and deposit in spoil heaps within 10km, in Light Soil	380	m3	9	$ 3,416	-
2.9	Access Road: place and compact imported fill	380	m3	13	$ 4,934	-
2.10	Rip Rap - supply, deliver and place rip rap scour protection at channel inlet, 250mm dia	32	m2	140	$ 4,480	
2.11	Allowance: Over excavation to restore soil profile				$ 10,000	
2.12	Allowance: Treatment of dispersive soils with gypsum (or similar)				$ 50,000	
	SUBTOTAL				**$ 263,321**	
3	**Landscaping and Planting**					
3.1	Topsoil - excavate from spoil heap, cart not exceeding 500m and spread and level average 150mm thick: light soil - battered areas	2,277	m3	6	$ 13,664	
3.2	Landscaping - supply, deliver and plant approved plants	15,182	m2	38	$ 576,931	-
	SUBTOTAL				**$ 590,595**	
	SUBTOTAL ITEMS 1-7				**$ 873,916**	
4	**Supervision, Project Management & Contractor On-Costs**					
4.1	Supervision, Project Management & Contractor On-Costs	30	%	-	$ 262,175	-
	SUBTOTAL				**$ 262,175**	
5	**Contingencies**					
5.1	Contingencies - General	30	%	-	$ 262,175	-
	SUBTOTAL				**$ 262,175**	
	TOTAL				**$ 1,398,000**	

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Menangle Park
Detention Basin 2
PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES

Revision: Draft

NOTE: The preliminary cost estimates presented in this section have been developed solely for the purpose of comparing and evaluating competing options. They are sufficiently accurate to serve this purpose. They cannot be used for budget-setting purposes as common elements between options may have been omitted and/or the works not fully scoped. A functional design is recommended if a budget estimate is required.

SCHEDULE OF ESTIMATED QUANTITIES

PAY ITEM	DESCRIPTION OF WORK	QTY	UNIT	RATE	AMOUNT	NOTES
1	**Preliminaries**					
1.1	Establishment	1	item	10000	$ 10,000	Allowance only
1.2	Erosion and sediment control	1	item	10000	$ 10,000	Allowance only
	SUBTOTAL				$ 20,000	
2	**Earthworks**					
2.1	Clearing and grubbing	1.5	ha	2900	$ 4,469	Assuming medium density bushland
2.2	Demolition - break up and remove existing works on site	50.0	m2	54	$ 2,700	Disposal extra
2.3	Dewatering - system to reduce water level by 1.0m	-	m2	60	$ -	Approximate only
2.4	Desilting - strip soil to 0.5m deep and dispose of excavated material to tip within 10km	-	m2	14	$ -	Approximate only
2.5	Topsoil - excavate to average 150mm deep and deposit in spoil heaps within 500m for later use: light soil	2,312	m3	5	$ 11,559	Assuming light soil (not clay)
2.6	Excavate to reduce levels and deposit surplus cut in spoil heaps within 10km, in Light Soil	13,004	m3	9	$ 117,032	-
2.7	Excavate to reduce levels and deposit, spread, level and compact to 90% within 1km, in Light Soil	1,438	m3	11	$ 15,820	-
2.8	Access Road: excavate to reduce levels and deposit in spoil heaps within 10km, in Light Soil	280	m3	9	$ 2,520	
2.9	Access Road: place and compact imported fill	280	m3	13	$ 3,640	
2.10	Allowance: Over excavation to restore soil profile				$ 10,000	
2.11	Allowance: Treatment of dispersive soils with gypsum (or similar)				$ 50,000	
2.12	Allowance: Separate and place select clay in embankment core				$ 20,000	
	SUBTOTAL				$ 237,740	
3	**High Flow Spillway**					
3.1	Form spillway crest in embankment	38	m3	20	$ 750	-
3.2	Geotextile Fabric - non woven polypropylene/ polyethylene 2.8mm thick (310g/sqm)	150	m2	5	$ 750	-
3.3	Reinforced Turf - supply, deliver, lay turf, roll and water	468	m2	13	$ 6,089	
	SUBTOTAL				$ 7,589	
4	**Low Flow Outlet Pipe**					
4.1	Pit - Supply, deliver, lay and join 900mm square pit with grated inlet	2	item	3500	$ 7,000	-
4.2	Pipe - Supply, deliver, lay and join 600mm RCP (Class 2)	30	m	260	$ 7,800	Rubber ring joint; excavation excluded
4.3	Pipe - Supply, deliver, lay and join 450mm RCP (Class 2)	30	m	170	$ 5,100	Rubber ring joint; excavation excluded
4.4	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 600mm pipe	2	each	480	$ 960	-
4.5	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$ 1,200	Approximate only
4.6	Excavate 2000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	60	m	360	$ 21,600	Assuming clay soil
4.7	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$ 1,680	
	SUBTOTAL				$ 45,340	
5	**High Flow Outlet Box Culvert**					
5.1	Box Culvert - Supply, deliver, lay and join 2.1m (span) x 0.9m (height) box culvert	120	m	1500	$ 180,000	Excavation Excluded
5.2	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 2.1m (span) x 0.9m (height) box culvert: 1 cell	4	each	5500	$ 22,000	Approximate only
5.3	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$ 1,200	Approximate only
5.4	Excavate 3000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	120	m	430	$ 51,600	Assuming ligt soil
5.5	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	60	m2	140	$ 8,400	
	SUBTOTAL				$ 263,200	
6	**Inlet from Road Drainage**					
6.1	Pipe - Supply, deliver, lay and join 375mm RCP (Class 2)	90	m	130	$ 11,700	Rubber ring joint; excavation excluded
6.2	Excavate 1200mm wide trench by machine, backfill with same material and compact, up to 2.0m deep	90	m	130	$ 11,700	Assuming clay soil
6.3	GPT - Supply, deliver and install CDS 1009	-	each	30000	$ -	Subject to final design
6.4	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$ 1,680	
	SUBTOTAL				$ 25,080	
7	**Landscaping and Planting**					
7.1	Topsoil - excavate from spoil heap, cart not exceeding 500m and spread and level average 150mm thick: light soil - battered areas	2,312	m3	6	$ 13,870	
7.2	Lawn turf - spread and grade 50mm topsoil, lay turf, roll and water	8,408	m2	10	$ 84,076	-
7.3	Landscaping - supply, deliver and plant approved plants	1,203	m2	38	$ 45,703	-
	SUBTOTAL				$ 143,649	
	SUBTOTAL ITEMS 1-7				$ 742,598	
8	**Supervision, Project Management & Contractor On-Costs**					
8.1	Supervision, Project Management & Contractor On-Costs	30	%	-	$ 222,779	-
	SUBTOTAL				$ 222,779	
9	**Contingencies**					
9.1	Contingencies - General	30	%	-	$ 222,779	-
	SUBTOTAL				$ 222,779	
	TOTAL				**$ 1,188,000**	

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Menangle Park
Detention Basin 4
PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES

Revision: Draft

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SCHEDULE OF ESTIMATED QUANTITIES

PAY ITEM	DESCRIPTION OF WORK	QTY	UNIT	RATE	AMOUNT	NOTES
1	**Preliminaries**					
1.1	Establishment	1	item	10000	$ 10,000	Allowance only
1.2	Erosion and sediment control	1	item	10000	$ 10,000	Allowance only
	SUBTOTAL				$ 20,000	
2	**Earthworks**					
2.1	Clearing and grubbing	1.5	ha	2900	$ 4,483	Assuming medium density bushland
2.2	Demolition - break up and remove existing works on site	50.0	m2	54	$ 2,700	Disposal extra
2.3	Dewatering - system to reduce water level by 1.0m	-	m2	60	$ -	Approximate only
2.4	Desilting - strip soil to 0.5m deep and dispose of excavated material to tip within 10km	-	m2	14	$ -	Approximate only
2.5	Topsoil - excavate to average 150mm deep and deposit in spoil heaps within 500m for later use: light soil	2,319	m3	5	$ 11,595	Assuming light soil (not clay)
2.6	Excavate to reduce levels and deposit surplus cut in spoil heaps within 10km, in Light Soil	4,010	m3	9	$ 36,087	-
2.7	Excavate to reduce levels and deposit, spread, level and compact to 90% within 1km, in Light Soil	6,495	m3	11	$ 71,449	-
2.8	Access Road: excavate to reduce levels and deposit in spoil heaps within 10km, in Light Soil	290	m3	9	$ 2,612	
2.9	Access Road: place and compact imported fill	290	m3	13	$ 3,773	
2.10	Allowance: Over excavation to restore soil profile				$ 10,000	
2.11	Allowance: Treatment of dispersive soils with gypsum (or similar)				$ 50,000	
2.12	Allowance: Separate and place select clay in embankment core				$ 20,000	
	SUBTOTAL				$ 212,698	
3	**High Flow Spillway**					
3.1	Form spillway crest in embankment	38	m3	20	$ 750	-
3.2	Geotextile Fabric - non woven polypropylene/ polyethylene 2.8mm thick (310g/sqm)	150	m2	5	$ 750	-
3.3	Reinforced Turf - supply, deliver, lay turf, roll and water	541	m2	13	$ 7,035	
	SUBTOTAL				$ 8,535	
4	**Low Flow Outlet Pipe**					
4.1	Pit - Supply, deliver, lay and join 900mm square pit with grated inlet	3	item	3500	$ 10,500	-
4.2	Pipe - Supply, deliver, lay and join 600mm RCP (Class 2)	30	m	260	$ 7,800	Rubber ring joint; excavation excluded
4.2	Pipe - Supply, deliver, lay and join 525mm RCP (Class 2)	60	m	220	$ 13,200	Rubber ring joint; excavation excluded
4.3	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 600mm pipe	3	each	480	$ 1,440	-
4.4	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	3	m3	600	$ 1,800	Approximate only
4.5	Excavate 2000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	90	m	360	$ 32,400	Assuming clay soil
4.6	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	18	m2	140	$ 2,520	
	SUBTOTAL				$ 69,660	
5	**High Flow Outlet Box Culvert**					
5.1	Box Culvert - Supply, deliver, lay and join 2.7m (span) x 0.9m (height) box culvert	90	m	2100	$ 189,000	Excavation Excluded
5.2	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 2.7m (span) x 0.9m (height) box culvert: 1 cell	3	each	5500	$ 16,500	Approximate only
5.3	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$ 1,200	Approximate only
5.4	Excavate 3000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	90	m	430	$ 38,700	Assuming ligt soil
5.5	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	60	m2	140	$ 8,400	
	SUBTOTAL				$ 253,800	
6	**Inlet from Road Drainage**					
6.1	Pipe - Supply, deliver, lay and join 375mm RCP (Class 2)	90	m	130	$ 11,700	Rubber ring joint; excavation excluded
6.2	Excavate 1200mm wide trench by machine, backfill with same material and compact, up to 2.0m deep	90	m	130	$ 11,700	Assuming clay soil
6.3	GPT - Supply, deliver and install CDS 1009	-	each	30000	$ -	Subject to final design
6.4	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$ 1,680	
	SUBTOTAL				$ 25,080	
7	**Landscaping and Planting**					
7.1	Topsoil - excavate from spoil heap, cart not exceeding 500m and spread and level average 150mm thick: light soil - battered areas	2,319	m3	6	$ 13,914	
7.2	Lawn turf - spread and grade 50mm topsoil, lay turf, roll and water	10,067	m2	10	$ 100,672	-
7.3	Landscaping - supply, deliver and plant approved plants	-	m2	38	$ -	-
	SUBTOTAL				$ 114,586	
	SUBTOTAL ITEMS 1-7				$ 704,359	
8	**Supervision, Project Management & Contractor On-Costs**					
8.1	Supervision, Project Management & Contractor On-Costs	30	%	-	$ 211,308	-
	SUBTOTAL				$ 211,308	
9	**Contingencies**					
9.1	Contingencies - General	30	%	-	$ 211,308	-
	SUBTOTAL				$ 211,308	
	TOTAL				**$ 1,127,000**	

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Menangle Park
Detention Basin 4a

PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES

Revision: Draft

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SCHEDULE OF ESTIMATED QUANTITIES

PAY ITEM	DESCRIPTION OF WORK	QTY	UNIT	RATE		AMOUNT	NOTES
1	**Preliminaries**						
1.1	Establishment	1	item	10000	$	10,000	Allowance only
1.2	Erosion and sediment control	1	item	10000	$	10,000	Allowance only
	SUBTOTAL				$	20,000	
2	**Earthworks**						
2.1	Clearing and grubbing	0.7	ha	2900	$	1,980	Assuming medium density bushland
2.2	Demolition - break up and remove existing works on site	50.0	m2	54	$	2,700	Disposal extra
2.3	Dewatering - system to reduce water level by 1.0m	-	m2	60	$	-	Approximate only
2.4	Desilting - strip soil to 0.5m deep and dispose of excavated material to tip within 10km	-	m2	14	$	-	Approximate only
2.5	Topsoil - excavate to average 150mm deep and deposit in spoil heaps within 500m for later use: light soil	1,024	m3	5	$	5,120	Assuming light soil (not clay)
2.6	Excavate to reduce levels and deposit surplus cut in spoil heaps within 10km, in Light Soil	3,511	m3	9	$	31,599	-
2.7	Excavate to reduce levels and deposit, spread, level and compact to 90% within 1km, in Light Soil	266	m3	11	$	2,927	-
2.8	Access Road: excavate to reduce levels and deposit in spoil heaps within 10km, in Light Soil	182	m3	9	$	1,634	
2.9	Access Road: place and compact imported fill	182	m3	13	$	2,360	
2.10	Allowance: Over excavation to restore soil profile				$	10,000	
2.11	Allowance: Treatment of dispersive soils with gypsum (or similar)				$	50,000	
2.12	Allowance: Separate and place select clay in embankment core				$	20,000	
	SUBTOTAL				$	128,318	
3	**High Flow Spillway**						
3.1	Form spillway crest in embankment	38	m3	20	$	750	-
3.2	Geotextile Fabric - non woven polypropylene/ polyethylene 2.8mm thick (310g/sqm)	150	m2	5	$	750	-
3.3	Reinforced Turf - supply, deliver, lay turf, roll and water	383	m2	13	$	4,980	
	SUBTOTAL				$	6,480	
4	**Low Flow Outlet Pipe**						
4.1	Pit - Supply, deliver, lay and join 900mm square pit with grated inlet	2	item	3500	$	7,000	-
4.2	Pipe - Supply, deliver, lay and join 525mm RCP (Class 2)	30	m	220	$	6,600	Rubber ring joint; excavation excluded
4.2	Pipe - Supply, deliver, lay and join 450mm RCP (Class 2)	30	m	170	$	5,100	Rubber ring joint; excavation excluded
4.3	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 600mm pipe	2	each	480	$	960	-
4.4	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$	1,200	Approximate only
4.5	Excavate 2000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	60	m	360	$	21,600	Assuming clay soil
4.6	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$	1,680	
	SUBTOTAL				$	44,140	
5	**High Flow Outlet Box Culvert**						
5.1	Box Culvert - Supply, deliver, lay and join 2.4m (span) x 0.9m (height) box culvert	60	m	1800	$	108,000	Excavation Excluded
5.2	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 2.4m (span) x 0.9m (height) box culvert: 1 cell	2	each	5500	$	11,000	Approximate only
5.3	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$	1,200	Approximate only
5.4	Excavate 3000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	60	m	430	$	25,800	Assuming ligt soil
5.5	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	60	m2	140	$	8,400	
	SUBTOTAL				$	154,400	
6	**Inlet from Road Drainage**						
6.1	Pipe - Supply, deliver, lay and join 375mm RCP (Class 2)	90	m	130	$	11,700	Rubber ring joint; excavation excluded
6.2	Excavate 1200mm wide trench by machine, backfill with same material and compact, up to 2.0m deep	90	m	130	$	11,700	Assuming clay soil
6.3	GPT - Supply, deliver and install CDS 1009	-	each	30000	$	-	Subject to final design
6.4	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$	1,680	
	SUBTOTAL				$	25,080	
7	**Landscaping and Planting**						
7.1	Topsoil - excavate from spoil heap, cart not exceeding 500m and spread and level average 150mm thick: light soil - battered areas	1,024	m3	6	$	6,144	
7.2	Lawn turf - spread and grade 50mm topsoil, lay turf, roll and water	4,457	m2	10	$	44,569	-
7.3	Landscaping - supply, deliver and plant approved plants	841	m2	38	$	31,969	-
	SUBTOTAL				$	82,682	
	SUBTOTAL ITEMS 1-7				$	461,100	
8	**Supervision, Project Management & Contractor On-Costs**						
8.1	Supervision, Project Management & Contractor On-Costs	30	%	-	$	138,330	-
	SUBTOTAL				$	138,330	
9	**Contingencies**						
9.1	Contingencies - General	30	%	-	$	138,330	-
	SUBTOTAL				$	138,330	
	TOTAL				**$**	**738,000**	

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Menangle Park
Detention Basin 5
PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES

Revision: Draft

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SCHEDULE OF ESTIMATED QUANTITIES

PAY ITEM	DESCRIPTION OF WORK	QTY	UNIT	RATE	AMOUNT	NOTES
1	**Preliminaries**					
1.1	Establishment	1	item	10000	$ 10,000	Allowance only
1.2	Erosion and sediment control	1	item	10000	$ 10,000	Allowance only
	SUBTOTAL				**$ 20,000**	
2	**Earthworks**					
2.1	Clearing and grubbing	0.7	ha	2900	$ 2,059	Assuming medium density bushland
2.2	Demolition - break up and remove existing works on site	50.0	m2	54	$ 2,700	Disposal extra
2.3	Dewatering - system to reduce water level by 1.0m	-	m2	60	$ -	Approximate only
2.4	Desilting - strip soil to 0.5m deep and dispose of excavated material to tip within 10km	-	m2	14	$ -	Approximate only
2.5	Topsoil - excavate to average 150mm deep and deposit in spoil heaps within 500m for later use: light soil	1,065	m3	5	$ 5,324	Assuming light soil (not clay)
2.6	Excavate to reduce levels and deposit surplus cut in spoil heaps within 10km, in Light Soil	2,396	m3	9	$ 21,561	-
2.7	Excavate to reduce levels and deposit, spread, level and compact to 90% within 1km, in Light Soil	1,614	m3	11	$ 17,757	-
2.8	Access Road: excavate to reduce levels and deposit in spoil heaps within 10km, in Light Soil	176	m3	9	$ 1,587	
2.9	Access Road: place and compact imported fill	176	m3	13	$ 2,293	
2.10	Allowance: Over excavation to restore soil profile				$ 10,000	
2.11	Allowance: Treatment of dispersive soils with gypsum (or similar)				$ 50,000	
2.12	Allowance: Separate and place select clay in embankment core				$ 20,000	
	SUBTOTAL				**$ 133,280**	
3	**High Flow Spillway**					
3.1	Form spillway crest in embankment	38	m3	20	$ 750	-
3.2	Geotextile Fabric - non woven polypropylene/ polyethylene 2.8mm thick (310g/sqm)	150	m2	5	$ 750	-
3.3	Reinforced Turf - supply, deliver, lay turf, roll and water	362	m2	13	$ 4,706	
	SUBTOTAL				**$ 6,206**	
4	**Low Flow Outlet Pipe**					
4.1	Pit - Supply, deliver, lay and join 900mm square pit with grated inlet	2	item	3500	$ 7,000	-
4.2	Pipe - Supply, deliver, lay and join 525mm RCP (Class 2)	30	m	220	$ 6,600	Rubber ring joint; excavation excluded
4.2	Pipe - Supply, deliver, lay and join 525mm RCP (Class 2)	30	m	220	$ 6,600	Rubber ring joint; excavation excluded
4.3	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 600mm pipe	2	each	480	$ 960	-
4.4	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$ 1,200	Approximate only
4.5	Excavate 2000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	60	m	360	$ 21,600	Assuming clay soil
4.6	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$ 1,680	
	SUBTOTAL				**$ 45,640**	
5	**High Flow Outlet Box Culvert**					
5.1	Box Culvert - Supply, deliver, lay and join 2.4m (span) x 0.9m (height) box culvert	60	m	1800	$ 108,000	Excavation Excluded
5.2	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 2.4m (span) x 0.9m (height) box culvert: 1 cell	2	each	5500	$ 11,000	Approximate only
5.3	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$ 1,200	Approximate only
5.4	Excavate 3000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	60	m	430	$ 25,800	Assuming ligt soil
5.5	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	60	m2	140	$ 8,400	
	SUBTOTAL				**$ 154,400**	
6	**Inlet from Road Drainage**					
6.1	Pipe - Supply, deliver, lay and join 375mm RCP (Class 2)	90	m	130	$ 11,700	Rubber ring joint; excavation excluded
6.2	Excavate 1200mm wide trench by machine, backfill with same material and compact, up to 2.0m deep	90	m	130	$ 11,700	Assuming clay soil
6.3	GPT - Supply, deliver and install CDS 1009	-	each	30000	$ -	Subject to final design
6.4	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$ 1,680	
	SUBTOTAL				**$ 25,080**	
7	**Landscaping and Planting**					
7.1	Topsoil - excavate from spoil heap, cart not exceeding 500m and spread and level average 150mm thick: light soil - battered areas	1,065	m3	6	$ 6,389	
7.2	Lawn turf - spread and grade 50mm topsoil, lay turf, roll and water	4,093	m2	10	$ 40,926	-
7.3	Landscaping - supply, deliver and plant approved plants	739	m2	38	$ 28,082	-
	SUBTOTAL				**$ 75,397**	
	SUBTOTAL ITEMS 1-7				**$ 460,003**	
8	**Supervision, Project Management & Contractor On-Costs**					
8.1	Supervision, Project Management & Contractor On-Costs	30	%	-	$ 138,001	-
	SUBTOTAL				**$ 138,001**	
9	**Contingencies**					
9.1	Contingencies - General	30	%	-	$ 138,001	-
	SUBTOTAL				**$ 138,001**	
	TOTAL				**$ 736,000**	

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Menangle Park
Detention Basin 7
PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES

Revision: Draft

NOTE: The preliminary cost estimates presented in this section have been developed solely for the purpose of comparing and evaluating competing options. They are sufficiently accurate to serve this purpose. They cannot be used for budget-setting purposes as common elements between options may have been omitted and/or the works not fully scoped. A functional design is recommended if a budget estimate is required.

SCHEDULE OF ESTIMATED QUANTITIES

PAY ITEM	DESCRIPTION OF WORK	QTY	UNIT	RATE	AMOUNT		NOTES
1	**Preliminaries**						
1.1	Establishment	1	item	10000	$	10,000	Allowance only
1.2	Erosion and sediment control	1	item	10000	$	10,000	Allowance only
	SUBTOTAL				**$**	**20,000**	
2	**Earthworks**						
2.1	Clearing and grubbing	1.6	ha	2900	$	4,560	Assuming medium density bushland
2.2	Demolition - break up and remove existing works on site	50.0	m2	54	$	2,700	Disposal extra
2.3	Dewatering - system to reduce water level by 1.0m	-	m2	60	$	-	Approximate only
2.4	Desilting - strip soil to 0.5m deep and dispose of excavated material to tip within 10km	-	m2	14	$	-	Approximate only
2.5	Topsoil - excavate to average 150mm deep and deposit in spoil heaps within 500m for later use: light soil	2,358	m3	5	$	11,792	Assuming light soil (not clay)
2.6	Excavate to reduce levels and deposit surplus cut in spoil heaps within 10km, in Light Soil	9,837	m3	9	$	88,536	-
2.7	Excavate to reduce levels and deposit, spread, level and compact to 90% within 1km, in Light Soil	3,253	m3	11	$	35,778	
2.8	Access Road: excavate to reduce levels and deposit in spoil heaps within 10km, in Light Soil	262	m3	9	$	2,360	
2.9	Access Road: place and compact imported fill	262	m3	13	$	3,409	
2.10	Allowance: Over excavation to restore soil profile				$	10,000	
2.11	Allowance: Treatment of dispersive soils with gypsum (or similar)				$	50,000	
2.12	Allowance: Separate and place select clay in embankment core				$	20,000	
	SUBTOTAL				**$**	**229,135**	
3	**High Flow Spillway**						
3.1	Form spillway crest in embankment	38	m3	20	$	750	-
3.2	Geotextile Fabric - non woven polypropylene/ polyethylene 2.8mm thick (310g/sqm)	150	m2	5	$	750	-
3.3	Reinforced Turf - supply, deliver, lay turf, roll and water	560	m2	13	$	7,284	
	SUBTOTAL				**$**	**8,784**	
4	**Low Flow Outlet Pipe**						
4.1	Pit - Supply, deliver, lay and join 900mm square pit with grated inlet	2	item	3500	$	7,000	-
4.2	Pipe - Supply, deliver, lay and join 300mm RCP (Class 2)	150	m	88	$	13,200	Rubber ring joint; excavation excluded
4.3	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 600mm pipe	2	each	480	$	960	-
4.4	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$	1,200	Approximate only
4.5	Excavate 2000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	60	m	360	$	21,600	Assuming clay soil
4.6	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$	1,680	
	SUBTOTAL				**$**	**45,640**	
5	**High Flow Outlet Box Culvert**						
5.1	Box Culvert - Supply, deliver, lay and join 1.5m (span) x 0.9m (height) box culvert	150	m	1200	$	180,000	Excavation Excluded
5.2	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 1.5m (span) x 0.9m (height) box culvert: 1 cell	1	each	5500	$	5,500	Approximate only
5.3	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$	1,200	Approximate only
5.4	Excavate 3000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	150	m	430	$	64,500	Assuming ligt soil
5.5	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	60	m2	140	$	8,400	
	SUBTOTAL				**$**	**259,600**	
6	**Inlet from Road Drainage**						
6.1	Pipe - Supply, deliver, lay and join 375mm RCP (Class 2)	90	m	130	$	11,700	Rubber ring joint; excavation excluded
6.2	Excavate 1200mm wide trench by machine, backfill with same material and compact, up to 2.0m deep	90	m	130	$	11,700	Assuming clay soil
6.3	GPT - Supply, deliver and install CDS 1009	-	each	30000	$	-	Subject to final design
6.4	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$	1,680	
	SUBTOTAL				**$**	**25,080**	
7	**Landscaping and Planting**						
7.1	Topsoil - excavate from spoil heap, cart not exceeding 500m and spread and level average 150mm thick: light soil - battered areas	2,358	m3	6	$	14,151	
7.2	Lawn turf - spread and grade 50mm topsoil, lay turf, roll and water	9,418	m2	10	$	94,180	-
7.3	Landscaping - supply, deliver and plant approved plants	-	m2	38	$	-	-
	SUBTOTAL				**$**	**108,330**	
	SUBTOTAL ITEMS 1-7				**$**	**696,568**	
8	**Supervision, Project Management & Contractor On-Costs**						
8.1	Supervision, Project Management & Contractor On-Costs	30	%	-	$	208,971	-
	SUBTOTAL				**$**	**208,971**	
9	**Contingencies**						
9.1	Contingencies - General	30	%	-	$	208,971	-
	SUBTOTAL				**$**	**208,971**	
	TOTAL				**$**	**1,115,000**	

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Menangle Park
Detention Basin 8
PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES

Revision: Draft

NOTE: The preliminary cost estimates presented in this section have been developed solely for the purpose of comparing and evaluating competing options. They are sufficiently accurate to serve this purpose. They cannot be used for budget-setting purposes as common elements between options may have been omitted and/or the works not fully scoped. A functional design is recommended if a budget estimate is required.

SCHEDULE OF ESTIMATED QUANTITIES

PAY ITEM	DESCRIPTION OF WORK	QTY	UNIT	RATE	AMOUNT	NOTES
1	**Preliminaries**					
1.1	Establishment	1	item	10000	$ 10,000	Allowance only
1.2	Erosion and sediment control	1	item	10000	$ 10,000	Allowance only
	SUBTOTAL				$ 20,000	
2	**Earthworks**					
2.1	Clearing and grubbing	1.3	ha	2900	$ 3,713	Assuming medium density bushland
2.2	Demolition - break up and remove existing works on site	50.0	m2	54	$ 2,700	Disposal extra
2.3	Dewatering - system to reduce water level by 1.0m	-	m2	60	$ -	Approximate only
2.4	Desilting - strip soil to 0.5m deep and dispose of excavated material to tip within 10km	-	m2	14	$ -	Approximate only
2.5	Topsoil - excavate to average 150mm deep and deposit in spoil heaps within 500m for later use: light soil	1,921	m3	5	$ 9,604	Assuming light soil (not clay)
2.6	Excavate to reduce levels and deposit surplus cut in spoil heaps within 10km, in Light Soil	5,104	m3	9	$ 45,936	-
2.7	Excavate to reduce levels and deposit, spread, level and compact to 90% within 1km, in Light Soil	2,765	m3	11	$ 30,412	
2.8	Access Road: excavate to reduce levels and deposit in spoil heaps within 10km, in Light Soil	232	m3	9	$ 2,087	
2.9	Access Road: place and compact imported fill	232	m3	13	$ 3,014	
2.10	Allowance: Over excavation to restore soil profile				$ 10,000	
2.11	Allowance: Treatment of dispersive soils with gypsum (or similar)				$ 50,000	
2.12	Allowance: Separate and place select clay in embankment core				$ 20,000	
	SUBTOTAL				$ 177,467	
3	**High Flow Spillway**					
3.1	Form spillway crest in embankment	38	m3	20	$ 750	-
3.2	Geotextile Fabric - non woven polypropylene/ polyethylene 2.8mm thick (310g/sqm)	150	m2	5	$ 750	-
3.3	Reinforced Turf - supply, deliver, lay turf, roll and water	421	m2	13	$ 5,478	
	SUBTOTAL				$ 6,978	
4	**Low Flow Outlet Pipe**					
4.1	Pit - Supply, deliver, lay and join 900mm square pit with grated inlet	3	item	3500	$ 10,500	-
4.2	Pipe - Supply, deliver, lay and join 600mm RCP (Class 2)	30	m	260	$ 7,800	Rubber ring joint; excavation excluded
4.2	Pipe - Supply, deliver, lay and join 525mm RCP (Class 2)	60	m	220	$ 13,200	Rubber ring joint; excavation excluded
4.3	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 600mm pipe	3	each	480	$ 1,440	-
4.4	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	4	m3	600	$ 2,400	Approximate only
4.5	Excavate 2000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	90	m	360	$ 32,400	Assuming clay soil
4.6	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	18	m2	140	$ 2,520	
	SUBTOTAL				$ 70,260	
5	**High Flow Outlet Box Culvert**					
5.1	Box Culvert - Supply, deliver, lay and join 4.2m (span) x 0.9m (height) box culvert	120	m	4300	$ 516,000	Excavation excluded
5.2	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 4.2m (span) x 0.9m (height) box culvert: 1 cell	4	each	5500	$ 22,000	Approximate only
5.3	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$ 1,200	Approximate only
5.4	Excavate 3000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	120	m	430	$ 51,600	Assuming ligt soil
5.5	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	60	m2	140	$ 8,400	
	SUBTOTAL				$ 599,200	
6	**Inlet from Road Drainage**					
6.1	Pipe - Supply, deliver, lay and join 375mm RCP (Class 2)	90	m	130	$ 11,700	Rubber ring joint; excavation excluded
6.2	Excavate 1200mm wide trench by machine, backfill with same material and compact, up to 2.0m deep	90	m	130	$ 11,700	Assuming clay soil
6.3	GPT - Supply, deliver and install CDS 1009	-	each	30000	$ -	Subject to final design
6.4	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$ 1,680	
	SUBTOTAL				$ 25,080	
7	**Landscaping and Planting**					
7.1	Topsoil - excavate from spoil heap, cart not exceeding 500m and spread and level average 150mm thick: light soil - battered areas	1,921	m3	6	$ 11,524	
7.2	Lawn turf - spread and grade 50mm topsoil, lay turf, roll and water	6,263	m2	10	$ 62,628	-
7.3	Landscaping - supply, deliver and plant approved plants	419	m2	38	$ 15,910	-
	SUBTOTAL				$ 90,062	
	SUBTOTAL ITEMS 1-7				$ 989,047	
8	**Supervision, Project Management & Contractor On-Costs**					
8.1	Supervision, Project Management & Contractor On-Costs	30	%	-	$ 296,714	-
	SUBTOTAL				$ 296,714	
9	**Contingencies**					
9.1	Contingencies - General	30	%	-	$ 296,714	-
	SUBTOTAL				$ 296,714	
	TOTAL				$ 1,582,000	

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Menangle Park
Detention Basin 9
PRELIMINARY SCHEDULE OF ESTIMATED QUANTITIES

Revision: Draft

NOTE: The preliminary cost estimates presented in this section have been developed solely for the purpose of comparing and evaluating competing options. They are sufficiently accurate to serve this purpose. They cannot be used for budget-setting purposes as common elements between options may have been omitted and/or the works not fully scoped. A functional design is recommended if a budget estimate is required.

SCHEDULE OF ESTIMATED QUANTITIES

PAY ITEM	DESCRIPTION OF WORK	QTY	UNIT	RATE	AMOUNT	NOTES
1	**Preliminaries**					
1.1	Establishment	1	item	10000	$ 10,000	Allowance only
1.2	Erosion and sediment control	1	item	10000	$ 10,000	Allowance only
	SUBTOTAL				$ 20,000	
2	**Earthworks**					
2.1	Clearing and grubbing	1.1	ha	2900	$ 3,323	Assuming medium density bushland
2.2	Demolition - break up and remove existing works on site	50.0	m2	54	$ 2,700	Disposal extra
2.3	Dewatering - system to reduce water level by 1.0m	-	m2	60	$ -	Approximate only
2.4	Desilting - strip soil to 0.5m deep and dispose of excavated material to tip within 10km	-	m2	14	$ -	Approximate only
2.5	Topsoil - excavate to average 150mm deep and deposit in spoil heaps within 500m for later use: light soil	1,719	m3	5	$ 8,593	Assuming light soil (not clay)
2.6	Excavate to reduce levels and deposit surplus cut in spoil heaps within 10km, in Light Soil	91	m3	9	$ 819	-
2.7	Excavate to reduce levels and deposit, spread, level and compact to 90% within 1km, in Light Soil	3,775	m3	11	$ 41,528	-
2.8	Access Road: excavate to reduce levels and deposit in spoil heaps within 10km, in Light Soil	214	m3	9	$ 1,929	
2.9	Access Road: place and compact imported fill	214	m3	13	$ 2,787	
2.10	Allowance: Over excavation to restore soil profile				$ 10,000	
2.11	Allowance: Treatment of dispersive soils with gypsum (or similar)				$ 50,000	
2.12	Allowance: Separate and place select clay in embankment core				$ 20,000	
	SUBTOTAL				$ 141,679	
3	**High Flow Spillway**					
3.1	Form spillway crest in embankment	38	m3	20	$ 750	-
3.2	Geotextile Fabric - non woven polypropylene/ polyethylene 2.8mm thick (310g/sqm)	150	m2	5	$ 750	-
3.3	Reinforced Turf - supply, deliver, lay turf, roll and water	449	m2	13	$ 5,835	
	SUBTOTAL				$ 7,335	
4	**Low Flow Outlet Pipe**					
4.1	Pit - Supply, deliver, lay and join 900mm square pit with grated inlet	3	item	3500	$ 10,500	-
4.2	Pipe - Supply, deliver, lay and join 525mm RCP (Class 2)	30	m	220	$ 6,600	Rubber ring joint; excavation excluded
4.2	Pipe - Supply, deliver, lay and join 525mm RCP (Class 2)	60	m	220	$ 13,200	Rubber ring joint; excavation excluded
4.3	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 600mm pipe	3	each	480	$ 1,440	-
4.4	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	3	m3	600	$ 1,800	Approximate only
4.5	Excavate 2000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	90	m	360	$ 32,400	Assuming clay soil
4.6	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	18	m2	140	$ 2,520	
	SUBTOTAL				$ 68,460	
5	**High Flow Outlet Box Culvert**					
5.1	Box Culvert - Supply, deliver, lay and join 2.4m (span) x 0.9m (height) box culvert	120	m	1800	$ 216,000	Excavation Excluded
5.2	Headwall - Supply, deliver, lay and join precast unit; including toe excavation - to suit 2.4m (span) x 0.9m (height) box culvert: 1 cell	4	each	5500	$ 22,000	Approximate only
5.3	Concrete - reinforced, cast in-situ 25MPa to form cut-off wall	2	m3	600	$ 1,200	Approximate only
5.4	Excavate 3000mm wide trench by machine, backfill with same material and compact, up to 3.0m deep	120	m	430	$ 51,600	Assuming ligt soil
5.5	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	60	m2	140	$ 8,400	
	SUBTOTAL				$ 299,200	
6	**Inlet from Road Drainage**					
6.1	Pipe - Supply, deliver, lay and join 525mm RCP (Class 2)	90	m	220	$ 19,800	Rubber ring joint; excavation excluded
6.2	Excavate 1200mm wide trench by machine, backfill with same material and compact, up to 2.0m deep	90	m	130	$ 11,700	Assuming clay soil
6.3	GPT - Supply, deliver and install CDS 1009	-	each	30000	$ -	Subject to final design
6.4	Rip Rap - supply, deliver and place rip rap scour protection, 250mm dia	12	m2	140	$ 1,680	
	SUBTOTAL				$ 33,180	
7	**Landscaping and Planting**					
7.1	Topsoil - excavate from spoil heap, cart not exceeding 500m and spread and level average 150mm thick: light soil - battered areas	1,719	m3	6	$ 10,311	
7.2	Lawn turf - spread and grade 50mm topsoil, lay turf, roll and water	6,168	m2	10	$ 61,681	-
7.3	Landscaping - supply, deliver and plant approved plants	-	m2	38	$ -	-
	SUBTOTAL				$ 71,992	
	SUBTOTAL ITEMS 1-7				$ 641,846	
8	**Supervision, Project Management & Contractor On-Costs**					
8.1	Supervision, Project Management & Contractor On-Costs	30	%	-	$ 192,554	-
	SUBTOTAL				$ 192,554	
9	**Contingencies**					
9.1	Contingencies - General	30	%	-	$ 192,554	-
	SUBTOTAL				$ 192,554	
	TOTAL				**$ 1,027,000**	