PRESTONS TRUNK DRAINAGE

FLOODING AND DRAINAGE ASSESSMENT

Prepared for:

LIVERPOOL CITY COUNCIL

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Prestons Trunk Drainage

Flooding and Drainage Assessment

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1 EXECUTIVE SUMMARY

J. Wyndham Prince has been commissioned by Liverpool City Council (LCC) to prepare a *Flooding and Drainage Assessment* for the Prestons Trunk Drainage System.

The study area is located at Bernera Road, Prestons and generally contains open agricultural pastures with scattered isolated buildings. In recent years, the study area has been rezoned for industrial development with numerous developments having been constructed and / or currently under development.

Throughout the study area, a number of properties are currently at risk of flooding during the 1 % Annual Exceedance Probability (AEP) flood event. In particular, there is a major overland flowpath which conveys flows from the lowpoint in Kurrajong Road, through the study area before draining to a channel and ultimately onto Maxwells Creek to the North East (near the ALDI site).

A trunk drainage system (comprising of large box culverts along Bernera Road) has previously been proposed within the suburb of Prestons in order to mitigate localised flooding and convey 1 % AEP flows towards the M7 interchange and into Cabramatta Creek. We understand however that this culvert option encountered various issues such as potential clashes with existing services and large infrastructure costs.

In recent years, Liverpool City Council have developed an alternate trunk drainage concept plan to mitigate these existing flooding issues and facilitate development within the Prestons Industrial Area. This revised concept included the construction of a regional detention basin and associated trunk drainage outlet pipes.

The objective of our investigation is to build upon Council's *DRAINS* Modelling and determine an appropriately sized detention basin which will better manage existing flooding issues and provide safer flow conveyance. A *TUFLOW* modelling was then undertaken to demonstrate how the proposed mitigation works will improve flood Scenarios.

Modelling subsequently considered the following three (3) Scenarios:

- "Existing" Scenario – base case model;
- "Interim" Scenario – includes on-site detention (OSD) on all proposed industrial lots, 1200 dia pipe and easement through 38 – 46 Bernera Road and flood protection mounds where necessary; and
- "Final" Scenario – builds upon interim measures but also includes:

    (a) regional detention basin;

    (b) overland flowpath with low flow pipes from Kurrajong Road

    (c) 2 x 1200 dia basin outlet pipes; and (d) Overland flowpath downstream from basin.

    (d) Water quality measures are also included via a Gross Pollutant Trap (GPT) and a bio-retention raingarden within the Proposed Basin.

Results indicate that by adopting the "Interim" measures, all proposed industrial lots are protected from flooding during the 1 % AEP event. Flows along Bernera Road are generally increased as a result of the redirection of flows from North-East to the North (previously entered lots) with a depth of flow in the central trafficable lanes generally 0.15 m to 0.25 m deep. It is noted however that this time of inundation is considered to be relatively short term and is unlikely to impact on traffic conditions.

Results indicate that by adopting the "Final" measures, runoff will be collected and managed by the detention basin. All proposed industrial lots will be protected from flooding during the 1 % AEP event, together with a safer flow conveyance along Bernera Road will be achieved (classified as "Low Hazard")

The proposed works (basin and outlet pipes) provide a significant benefit over the previously adopted box culvert option (by others), given flooding is improved by managing (or attenuating) the 1 % AEP event rather than simply conveying the peak flows to a location further downstream.

The "Final" Scenario therefore significantly improves the flooding situation within the Prestons Industrial Area during the 1 % AEP when compared to the "Existing" Scenarios.

A comparison of cost estimates indicate that the revised strategy is significantly more cost effective than the original strategy (box culverts) with an estimated reduction in costs to Council and any future developers by around $2.4 million

We therefore recommend that the revised strategy is adopted since it will provide a more cost effective solution along with an overall flood management approach.

2 INTRODUCTION

J. Wyndham Prince has been commissioned by Liverpool City Council (LCC) to prepare a *Flooding and Drainage Assessment* for the Prestons Trunk Drainage System. This report details the procedures used and presents the results of investigations to support the implementation of a revised trunk drainage strategy and associated cost estimates.

The objective of our investigation is to build upon Council's *DRAINS* Modelling and determine an appropriately sized detention basin which will better manage existing flooding issues and provide safer flow conveyance where possible throughout the catchment. This proposed trunk system (basin and outlet pipe) has been sized to manage the 1 % Annual Exceedance Probability (AEP) flows, with consideration of lower AEP events. A *TUFLOW* model was then used to demonstrate flood improvements within the locality.

This investigation also includes assessment of an "interim" Scenario, which considers the construction of a 1200 dia outlet pipe and easement through 38-46 Bernera Road (Lot B in DP387519). The interim Scenario also includes implementing flood protection mounds along Yato Road and Bernera Road within the landscape setback in order to reduce the existing flood impacts.

This study has identified the required land acquisition required to implement the recommended options. An overall Preliminary Cost Estimate is also provided for all major stormwater infrastructure with comparisons made against the previous trunk box culvert option.

The following specific tasks were undertaken in five (5) stages:

Stage 1: Review of Council Existing Drainage Analysis

- Inspect site to determine existing site features relating to stormwater management;
- Review all available information including survey, CCTV inspection report of the existing drainage system and the relevant Work As Executed (WAE) drawings for the site;
- Undertake a detailed review of Council's existing drainage analysis (*DRAINS* models) for both the existing and post development Scenarios;
- Update the "existing" *DRAINS* modelling to be in accordance with the Works-As-Executed information, Council guidelines and standard engineering practice;
- Review the proposed detention basin concept design completed by Council. Provide comments and/or suggestions for its amendment prior to its inclusion in the *TUFLOW* modelling;
- Build upon the supplied *DRAINS* model and develop a "proposed" Basin concept design which includes (a) low flow pipes and surcharge flow path from the existing outlet at Kurrajong Rd; (b) Detention basin with Outlet; (c) Provision for Water Quality of the upstream catchment (d) consideration of electrical easement and tower; and
- Report findings of the peer review and results of the performance of the proposed basin design.

Results of these Stage 1 tasks are detailed in a separate J. Wyndham Prince report entitled *"Prestons Trunk Drainage – Peer Review Report".*

Stage 2: Existing Scenario TUFLOW Model Development

The “Existing” Scenario Model covers the Prestons study area which is predominately open agricultural pastures. The major overland flowpath extends from Kurrajong Road to the North – East adjacent to the M7 on ramp is included with all existing stormwater pipe networks and roadways. Tasks undertaken in this stage include:

- Develop a “Direct Rainfall” *TUFLOW* model to enable assessment of the flood impacts along Bernera Road, Kurrajong Road and to the discharge point to Cabramatta and Maxwell Creeks;
- Develop a *TUFLOW* model to include:
  - Council’s existing 3d surface model;
  - Council’s existing stormwater drainage network information (pit and pipe system), as a 1D ESTRY model. Details to be consistent with Council’s *DRAINS*;
  - Consideration of Council’s LEP maps to determine appropriate catchment roughness to emulate the various landuses currently within the catchment. Aerial photos of the catchment also used to establish the existing Scenario model;
  - Buildings modelled within the study area using the “Exterior Walls” approach;
  - Sydney Water Easement;
  - Consideration of Tailwater Conditions.
- Run the peak 10 % and 1 % AEP events as determined by the hydrological model in *TUFLOW* and create flood depth, flood level, velocity and hazard maps;
- Provide details of results and discussion on the performance of the “Existing” Scenario Modelling.

Stage 3: “Interim” Post-Developed Scenario TUFLOW Model Development

The “Interim” Scenario Model builds upon the existing Scenario model, but includes those areas which are rezoned for industrial developments. Modelling considers the introduction of on-site detention, a 1200 dia outlet pipe and easement through 38-46 Bernera Road together with flood protection mounds.

Stage 3 includes extending the *TUFLOW* Model to reflect the Post-Developed Scenarios for comparison against Existing Scenario Results. Tasks undertaken in this stage include:

- Build upon the “existing” Scenario *TUFLOW* model and update to reflect post-development Scenarios. Updates to include:
  - Regrade all proposed industrial lots to its intended low points;
  - Modify catchment roughness on all industrial lots;
  - Provide flood protection mounds (where required) to prevent flows from entering lots;
  - Include a 1200 dia pipe with easement to connect the existing box culverts under Bernera Road to the existing pipe system at the Sydney Water easement (to the East);
- Undertake an assessment in *TUFLOW* to emulate OSD on each industrial lot (refer to methodology in Appendix B). Confirm pre-post requirements are achieved for the 10 % and 1 % AEP at all industrial lots;

- Run the peak 10 % and 1 % AEP events as determined by the hydrological model in *TUFLOW* and create flood depth, flood level, velocity and hazard maps;
- Provide details of results and discussion on the performance of the “Interim” Scenario Modelling with flood difference maps.

Stage 4: “Final” Post-Developed Scenario TUFLOW Model Development

The “Final” Scenario Model builds upon the Interim model and includes a co-located raingarden / detention basin with associated 2 x 1200 dia outlet pipe(s). Tasks undertaken in this stage include:

- Develop a *DRAINS* model to maximise flows within the proposed 2 x 1200 dia basin outlet pipes under “peak volume” management Scenarios. Determine the required OSD Basin Volume and outlet arrangement to ensure a safe conveyance of flows during the 1 % AEP event along Bernera Rd;
- Build upon the Stage 3 “interim” Scenario *TUFLOW* model and update to include the proposed detention basin and outlet pipe arrangement under a “final” Scenario model;
- Run the peak 10 % and 1 % AEP events as determined by the hydrological model in *TUFLOW* and create flood depth, flood level, velocity and hazard maps;
- Provide details of results and discussion on the performance of the “Final” Scenario Modelling with flood difference mapping.

Stage 5: Cost Estimate

- Undertake a review of the trunk drainage culvert cost estimate (developed by Council in 2012) and update to current industry rates;
- Provide a detailed cost estimate of the proposed Stage 4 “Final” works;
- Undertake comparison of Box Culvert Option (original strategy) vs Basin Option (this strategy) and provide discussion.

3 PREVIOUS STUDIES

A trunk drainage system *"Yarrunga Industrial Area, Prestons – Proposed Drainage""* (Ref: D2009/005), comprising of large box culverts along Bernera Road, has previously been proposed by Liverpool City Council Design Services (LCC, 2007). The system was to mitigate localised flooding and convey 1 % AEP flows towards the M7 interchange and ultimately into Cabramatta Creek. We understand however that this culvert option encountered various issues such as potential clashes and large infrastructure costs.

LCC subsequently developed an alternate trunk drainage concept to mitigate the existing flooding issues and facilitate development within the Prestons Industrial Area. This revised concept included the construction of a regional detention basin and associated trunk drainage outlet pipes.

LCC developed the alternate trunk drainage concept via a series of *DRAINS* models. As part of Stage 1 works, J. Wyndham Prince has undertaken an assessment of LCC's models with the results summarised in the *"Prestons Trunk Drainage – Peer Review Report".*

In 2013, *Van Der Meer Consulting* prepared design plans at 38-46 Bernera Road which included a 1200 dia pipe extending from the existing Bernera Road box culverts, through the site with connection to the existing 1200 dia pipe in the Sydney Water Easement (Van Der Meer, 2013). This pipeline has been included for the "interim" Scenario. Refer to Section 7.3.4 for further discussion. These proposed works have informed the interim Scenarios that forms part of this investigation.

4 THE EXISTING ENVIRONMENT

4.1 The Study Area

The study area is located at Bernera Road, Prestons within the Liverpool City Council Local Government Area (LGA) (refer to Plate 4-1) and generally contains open agricultural pastures with scattered isolated buildings. In recent years, the study area has been rezoned for industrial development with numerous developments having been constructed and / or currently under development.

Bernera Road bisects the study area and runs South-North with connection to the M7 interchange to the North. Kurrajong Road and Yato Road both run West-East and intersect with Bernera Road. Other features surrounding the study area include a large residential precinct to the South of Kurrajong Rd, several industrial / commercial developments along Yato Road (including ALDI), Sydney Water pumping station and a 60 m wide Transgrid Electrical Easement with large above ground electrical towers. Refer to Plate 4-1.

A major overland flowpath currently runs from the lowpoint in Kurrajong Rd, through the study area before draining to a channel and ultimately onto Cabramatta Creek to the North West (near ALDI). . There is an existing box culvert crossing under Bernera Road (3 x 0.9 m wide x 0.6 m high RCBC), which allows a portion of flooding to pass under the roadway to the East, whilst those remaining overland flows overtop to Bernera Road and are conveyed to the North towards to M7 interchange. Refer to Plate 4-1.

A network of existing stormwater pipe systems are scattered across Prestons including, but not limited to,Yato Road, Kurrajong Road and Bernera Road. Refer to J. Wyndham Prince's *"Prestons Trunk Drainage – Peer Review Report*" for further details.

The study area is located within the Cabramatta Creek catchment. A review of Bewsher Consulting modelling of the area (BC, 2004 and 2010) has identified the 1 % AEP tailwater Conditions which is applicable to this study. (See Section 7.0 for further details). Flows exit the study area in three (3) distinct locations at the M7 interchange, crown land to the East and to the channel to the North East (near ALDI). Refer to Appendix B for details.

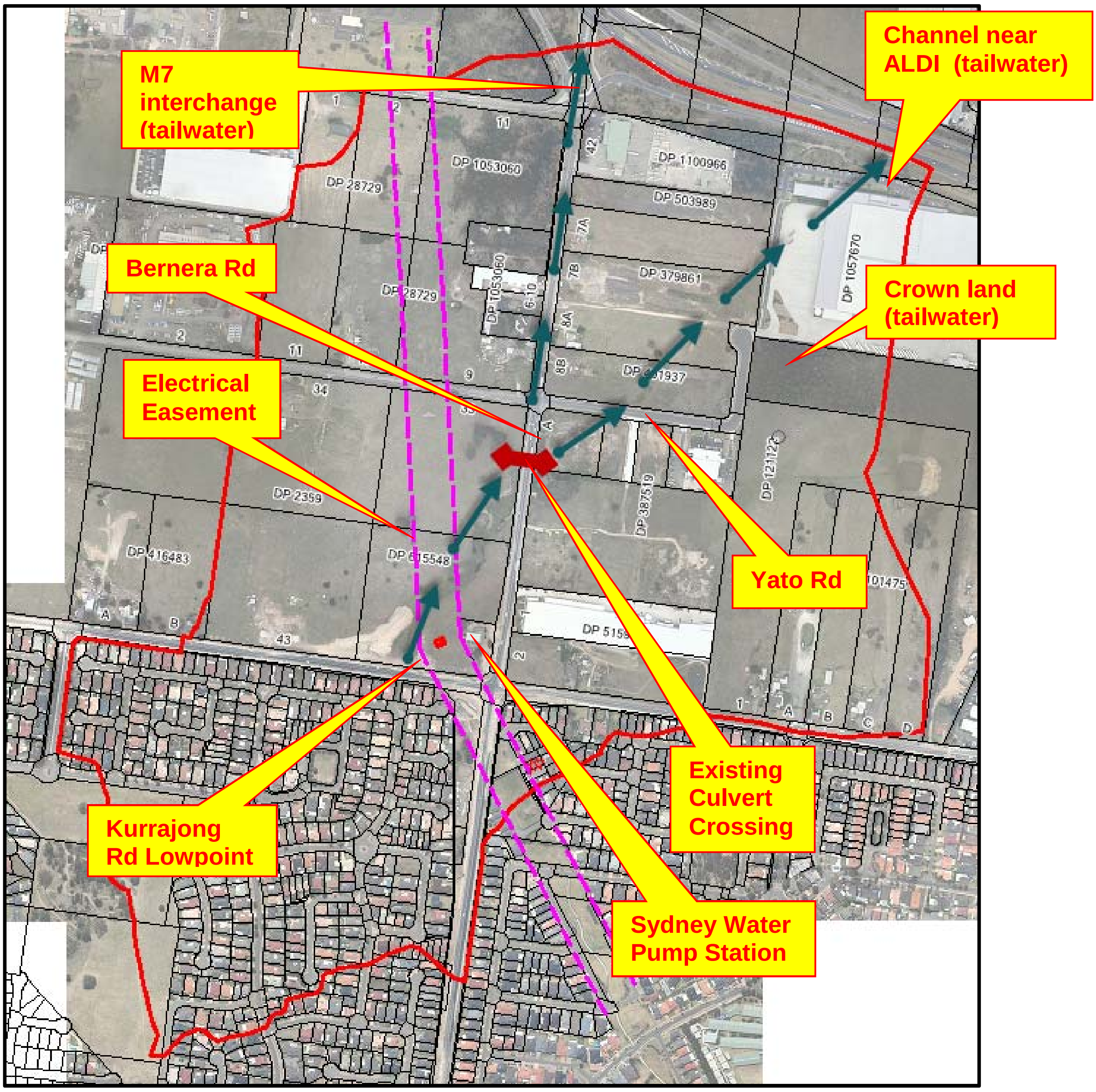

PLATE 4-1 EXISTING SITE

5 THE PROPOSED DEVELOPMENT

As discussed in Section 3.0, a trunk drainage system (comprising of large box culverts along Bernera Road) has previously proposed as part of the Section 94 contribution plans for the area. These works were to mitigate localised flooding and convey 1 % AEP flows towards the M7 interchange. J. Wyndham Prince understand however that this culvert option encountered various issues such as potential service clashes and large infrastructure costs.

LCC subsequently developed an alternate trunk drainage concept to mitigate the existing flooding issues in order to facilitate developments within the Prestons Industrial Area. This revised concept includes the construction of a regional detention basin and associated trunk drainage outlet pipes.

Importantly, the revised strategy will have a significant benefit given it will improve flood affectation in the surrounding area through the management (or attenuation) of 1 % AEP flows rather than simply conveying the peak flows to a location further downstream which potentially results in further flood impacts elsewhere.

The proposed mitigation works adopted in this study includes the following:

- Swale to convey 1 % AEP flows from the lowpoint in Kurrajong Road to the basin;
- Gross Pollutant Trap and bio-retention raingarden to provide water quality treatment of the upstream residential area. Low flow pipes within the overland flowpath to convey 3 month ARI flows to the raingarden;
- Regional detention basin with staged discharge outlet arrangement (low level piped and high level weir);
- 2 x 1200 dia basin outlet pipes from the proposed basin to connect to the existing culvert crossing under Bernera Road;
- Overland flowpath just downstream from the detention basin to manage discharges to Bernera Road;
- 1 x 1200 dia pipe and easement through 38-46 Bernera Road to connect to the existing stormwater pipe along Sydney Water Easement (to the East);
- Flood Protection Mounds along Bernera Road, Yato Road and in the vicinity of the Sydney Water Easement.

Refer to Plate 5-1 for general layout.

The proposed flood mitigation works are split into two (2) stages to reflect both “Interim” and “Final” Scenarios.

The **“Interim”** Scenario includes (a) construction of the 1200 dia pipe and easement through 38-46 Bernera Road; (b) flood protection mounds along Bernera Road and Yato Road; and (c) flood protection mounds in the vicinity of the Sydney Water Easement.

The **“Final”** Scenario builds upon those Stage 1 works to also include the construction of (a) overland flowpath with low flow pipes from Kurrajong Road; (b) regional detention basin; (c) GPT and raingarden; (d) 2 x 1200 dia basin outlet pipes; and (e) Overland flowpath downstream from basin.

This staged approach provides opportunity for those industrial developments in Prestons to proceed whilst the regional issues are approved and constructed.

The design of the detention basin has taken into consideration design issues associated with the Transgrid Easement. Refer discussion in Section 6 for further details.

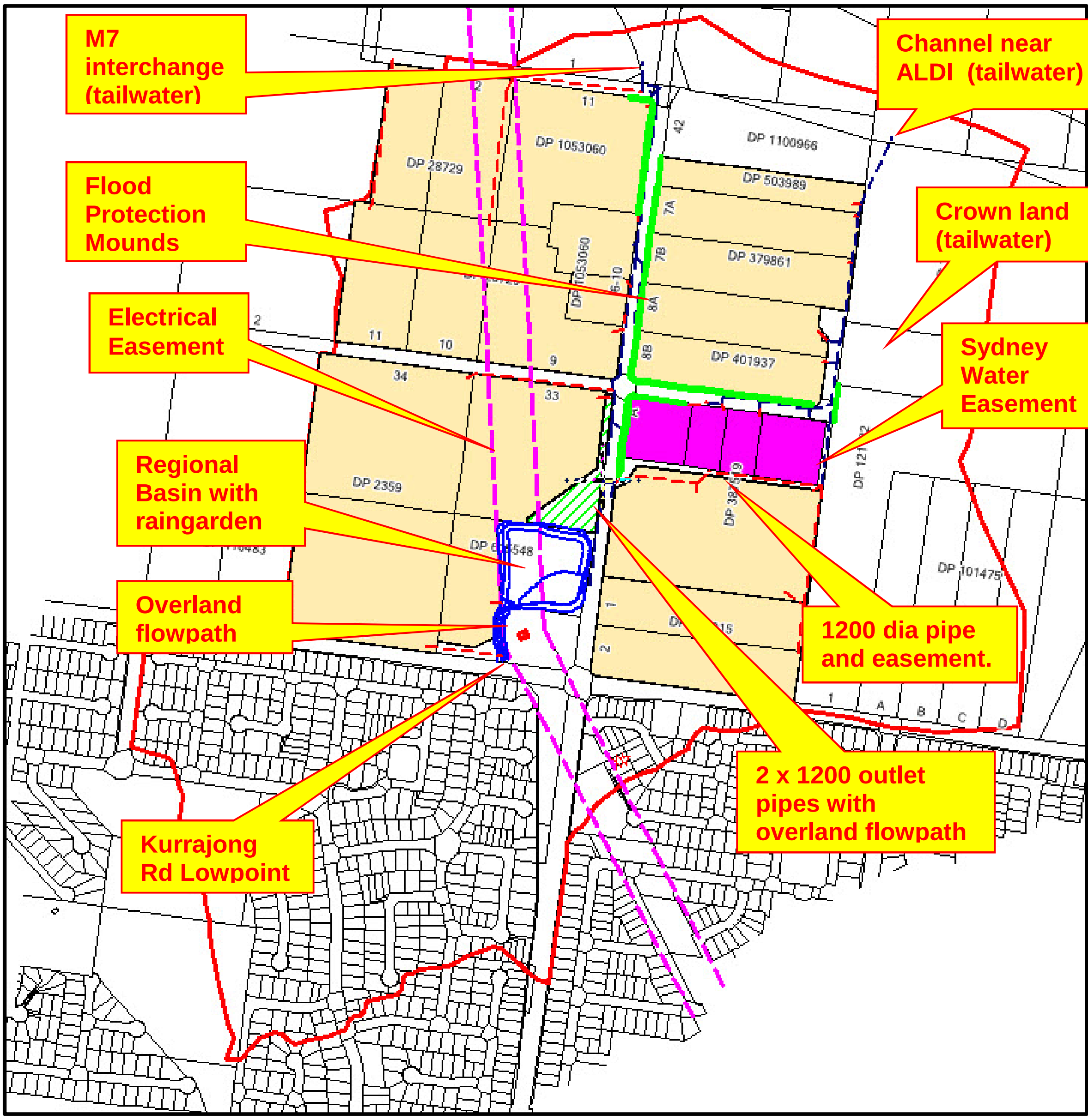

PLATE 5-1 DEVELOPED SCENARIO SITE PLAN

6 UPDATED DRAINS MODELLING

As discussed in Section 3.0, LCC previously prepared *DRAINS* modelling to support an alternate trunk drainage (Basin) concept to replace the original trunk drainage (Box Culvert) strategy.

The supplied *DRAINS* models have been fully reviewed with updates undertaken to reflect detailed site survey, CCTV footage and site inspections. As part of the review, recommendations were made on a number of key issues which need to be taken into consideration for the design of the proposed basin. Refer to the separate report entitled *“Prestons Trunk Drainage – Peer Review Report”*.

For the purposes of this study, the updated *DRAINS* models have been adopted as a base. A preliminary basin concept design was then developed with consideration of the key issues which were identified in the *“Prestons Trunk Drainage – Peer Review Report”*. Details of the proposed basin arrangement are shown on Figure 7.14 and include the following:

- The proposed layout of the basin is a dry bed detention basin with a minimum grade of 0.5 % at the base. The general layout is positioned in the location agreed with Council and considers the location of the Transgrid Easement, Cadastral boundaries and surface levels;
- The proposed basin is designed to manage 1 % AEP flows under “peak volume” management. The peak volume in the 1 % AEP event is the 2 hour duration (32819 m^3);
- The basin includes a staged outlet arrangement which consists of two (2) x 1200 dia pipes (low level) and a 20 m wide high level spillway at RL34.34. The high level spillway allows a portion of the 1 % AEP flows to exit the basin and safely be conveyed along a flowpath towards Bernera Road.
- The high level spillway also includes provision for emergency overflow via an additional 40 m width at RL 34.55 m AHD (sized to ½ PMF) for those extreme events higher than 1 % AEP;
- Two (2) x 1200 dia outlet pipes (at minimum 0.5 %) extend from the basin to the existing culvert crossing under Bernera Road (and ultimately to the approved 1200 dia pipe / easement through 38-46 Bernera Road via the 3 x 0.9 m wide x 0.6 m high box culverts under Bernera Road) to the East;
- The basin outlet modelled in *DRAINS* has been oversized in order to maximise flows being directed to the pipe system;
- Allowance is made for the spillway to drain to the North, with an overland flowpath being dedicated to convey flows to Bernera Road. This flowpath shall be formed by localised regrading / earthworks to provide a smooth transition with the intersection with Yato Road;
- Allowance is made for the proposed industrial lot located directing adjacent to the overland flowpath (i.e. downstream of the basin) to be elevated to protect from flood levels for the 1 % AEP event and above, or in case of a potential dam failure;
- A perched raingarden is proposed within the basin to provide water quality treatment for the upstream residential area. The size of the raingarden has been indicatively sized at 2900 m^2 (assumed 1 % of catchment) and is elevated (at RL 33.61 m AHD) within the basin in order to allow subsoil drainage to grade out to the basin outlet;
- A grassed swale is proposed to convey 1 % AEP flows from Kurrajong Road to the Basin. This swale has an overall width of 15 m (5 m wide base with 1 in 4 side

slopes, 1.25 m depth) and a longitudinal grade of 0.5 %. Provision is made for three (3) x 600 dia low flow pipes to convey 3 month ARI flows to the raingarden;

- Consideration has been given to the Transgrid easement. In particular:
  - No filling is proposed within the easement so as to eliminate possible impacts on minimum clearances to the wires. In particular, the top of embankment is restricted to RL35.04.
  - Proposed channel works are restricted to ensure that they do not encroach within 15 m of the nearby Transgrid pylon.

6.1 DRAINS Modelling Results

The proposed basin arrangement has been assessed in *DRAINS* which includes:

- Detention Volume = 14369 m^3 (1 % AEP);
- Crest Spillway = RL 34.34 m AHD (20m wide) and RL34.55 m AHD (40m wide);
- Top of Embankment = RL 35.04 m AHD;
- 0.5 m freeboard to top of embankment;
- 15 m wide Grassed swale conveying inflows from Kurrajong Road (Inflow);
- 2 x 1200 dia outlet pipes extending from the basin to the 3 x 0.9 x 0.6m box culverts under Bernera Road (Outflow).

Results of the assessment conclude that:

- In the 1 % AEP 2 hour event, the peak flowrate to the basin is 15.9 m^3/s (total volume 32819 m^3), with the basin restricting flows to approximately 6 m^3/s through the outlet configuration;
- Peak top water level (TWL) and flow over the weir, as listed in Table 6.1.

TABLE 6.1 BASIN RESULTS

AEP	Peak TWL (m AHD)	Volume Used (m^3)	Overflow (m^3/s)	Piped (m^3/s)
1%	34.54	14369	3.06	3.09
2%	34.41	12860	0.66	3
5%	34.25	10974	0	2.93
10%	33.94	7426	0	2.63

The capacity of the basin to the crest (without overtopping) is therefore just under the 2 % AEP;

- Maximum Depth in 1 % AEP = 1.82 m;
- As a preliminary check, the velocity – depth of flows overtopping the spillway is limited to 0.4 (which is safe for pedestrians). Refer to Appendix A.

Results therefore indicate that the proposed basin arrangement will achieve the design intent of collecting and managing the 1 % AEP events in order to mitigate localised flooding issues in the Preston area, in particular Bernera Road. A detailed *TUFLOW* assessment has been undertaken (see Section 7.4) to demonstrate the performance of the basin in alleviating flood affectation of properties and providing a safe conveyance of overland flows within the 1 % AEP event.

7 FLOOD MODELLING

The 2D flood modelling of the Prestons Study Area was undertaken using *TUFLOW* (Two-Dimensional Unsteady Flow). *TUFLOW* is a computational engine that provides two-dimensional (2D) and one-dimensional (1D) solutions of the free-surface flow equations to simulate flood and tidal wave propagation (*TUFLOW* 2010). TUFLOW is specifically beneficial where the hydrodynamic behaviour in coastal waters, estuaries, rivers, floodplains and urban drainage environments have complex 2D flow patterns that would be difficult to represent using traditional 1D network models.

All overland flows within the study area were modelled as 2D flows. A 2D model provides a better estimation of the effects of momentum transfer between in-bank and overbank flows and the energy losses due to meanders or bends in flowpaths. MapInfo, a GIS based software tool, was used for interrogating and plotting the results as well as creating the flood extents maps and the flood level difference maps.

The modelling approach adopted for the "*Prestons Trunk Drainage - Flooding and Drainage Assessment*" includes rainfall being applied directly to the hydraulic model. With the "direct rainfall" approach, all the rainfall losses are processed by *TUFLOW* whilst flood routing is undertaken in the hydraulic model.

Flood modelling within *TUFLOW* is provided for the "Existing", "Interim" and "Final" Scenarios. The *TUFLOW* assessment tests the performance of the existing system and demonstrates that the proposed basin design (undertaken in *DRAINS*) will deliver the desired flood mitigation objectives.

7.1 Existing Scenario Flood Modelling

7.1.1 Model Development and Assumptions

A *TUFLOW* model was setup to represent the "Existing" Scenario (including buildings, roads and stormwater infrastructure). As with any flood modelling, a number of assumptions are necessary to allow for the modelling process to proceed. The assumptions adopted in the existing model developed are summarised in Appendix B.

The "Existing" *TUFLOW* model was developed based on the DTM supplied by Council and adopted a 2 m grid to provide a precise representation of existing Scenarios. The existing stormwater drainage networks were represented by a one-dimensional (1D) ESTRY model with each pit assigned an inlet capacity, while pipe sizes and inverts were assigned based on Works-As-Executed (WAE) information. All buildings were applied via the creation of exterior walls on three sides of the building with a break provided on the low side whilst Manning's Roughness was assigned based on aerial imagery.

The model has been run under "Direct Rainfall" with flows being applied to the grid and tailwater conditions being adopted as per Bewsher Consulting's "*Cabramatta Creek Flood Study and Basin Strategy Review*" (BC 2010)

In order to differentiate between sheet flow and flooding a "Map Cutoff depth" of 75 mm has subsequently been applied across each Scenario. That is, surface flows which are less than 75 mm depth are considered in the modelling but are not illustrated on the figures for clarity.

7.1.2 Flood Modelling Results

The "Existing" Scenario *TUFLOW* results demonstrate that flooding affects properties by travelling from the lowpoint in Kurrajong Road, through the study area before draining to a channel and ultimately onto Maxwells Creek to the North East (near ALDI).

Results indicate that a portion of existing flows (3.4 m^3/s) are conveyed through the existing box culvert crossing under Bernera Road (to the East), with remaining flows overtopping Bernera Road and being conveyed to the North towards to M7 interchange. Refer to Appendix D for the overall catchment plan and Appendix E for Existing Scenario Results.

A detailed comparison of flows and velocities across the catchment has been undertaken.. The results of the "Plot Output lines" (PO) are tabulated in Table 7.1 below, whilst comparison locations are shown on Figure 4.1 in Appendix D. It is noted that the tabulated peak flows are "overland" and exclude those which are contained within pipes.

TABLE 7.1 FLOW COMPARISON

		Peak Flow (m^3/s)	
ID	**Locations**	**10% AEP**	**1% AEP**
1	Michelago Circuit	2.4	3.8
2	Michelago Circuit	2.9	4.8
3	Drainage Reserve 1	1.7	3.8
4	Michelago Circuit	1.3	2.2
5	Michelago Circuit	1.6	2.6
6	Drainage Reserve 2	0.5	0.8
7	Kurrajong Rd	0.2	1.5
8	Kurrajong Rd	2.1	3.1
9	Brogo Place	0.8	1.1
10	U/S Channel	0.2	0.3
11	Bernera Rd	0.6	1.0
12	Kurrajong Rd	0.6	0.8
13	Existing Channel from Kurrajong Rd	7.0	12.3
14	Bernera Rd	0.4	0.7
15	Existing Channel at Future Basin	7.6	13.3
16	U/S side of culvert under Bernera Rd	3.2	4.3
17	D/S side of culvert under Bernera Rd	2.9	3.3
18	U/S side Overtopping Bernera Rd	4.8	10.3
19	D/S side Overtopping Bernera Rd	1.3	5.1
20	Bernera Rd / Yato Rd intersection 1	3.6	5.6
21	Bernera Rd / Yato Rd intersection 2	0.2	0.3
22	Bernera Rd / Yato Rd intersection 3	0.3	0.6
23	Bernera Rd / Yato Rd intersection 4	2.0	2.8
24	Yato Rd flows from intersection	0.3	0.6
25	Yato Rd flows from culvert	4.4	8.9
26	Yato Rd	2.5	6.2
27	Yato Rd	0.9	1.6
28	Flows through lots from Yato Rd	3.1	7.0
29	Flows to drainage reserve from Yato Rd lowpoint	2.0	4.2
30	Flows exiting model via drainage reserve from Yato Rd lowpoint	2.0	3.6
31	Flows from Yato Rd piped system	2.5	2.9
32	D/S channel	2.7	3.3
33	D/S channel exiting model	3.5	7.2
34	Bernera Rd	1.3	2.9
35a	Bernera Rd - concrete channel	0.0	0.9
35b	Bernera Rd - roadway	0.0	2.0
36	Bernera Rd to m7	1.5	3.8
37a	Bernera Rd - concrete channel (Network D)	0.8	1.4
37b	Bernera Rd - roadway to m7	0.7	2.1
38	m7 interchange	2.5	5.3
39	m7 interchange - channel	4.4	7.4
40	m7 interchange exiting model	9.9	17.8
41	Yarrawa Rd	0.1	0.2
42	Bernera Rd / Yato Rd intersection 4	1.2	2.3
43	70m D/S of culvert under Bernera Rd	2.8	3.5
44	Kurrajong Rd East	0.3	0.5
45	Kurrajong Rd East	0.4	0.6
46	Just Upstream of Sydney Water Easement	0.4	0.6
47	Sydney Water Easement	0.1	0.1
48	Sydney Water Easement	0.0	0.1
49	Yato Rd	0.7	1.1

7.2 SENSITIVITY ANALYSIS

For the purposes of a sensitivity check, critical locations were selected in Table 7.1 at the following locations Refer to Figure 4.1 in Appendix D:

- ID 3 – Drainage Reserve draining to Kurrajong Road (from the existing residential area to the South);
- ID 13 – Existing Channel from sag in Kurrajong Road;
- ID 15 – Existing Channel at Future Basin Outlet Location.

As a check, a comparison of flows have been performed between the *TUFLOW* results, empirical methods and the previously updated *DRAINS* models (refer to Table 7.2)

TABLE 7.2 SENSITIVITY CHECKS

			Flows (m^3/s)		
Location	**ID**	**Upstream Area (Ha)**	**Empirical**	**DRAINS**	**TUFLOW**
Kurrajong Rd Swale	13	29	9.7	12.8	12.3
Future Basin Outlet	15	37	12.3	15.9 (including new area being developed as industrial)	13.3
Drainage Reserve (west)	3	16	5.3	7.14 (o/land and piped)	6.1 (3.8 overland)

Results indicate that the flows estimated via the direct rainfall method in *TUFLOW* (Table 7.1) are within a reasonable order of magnitude compared to the results obtained in the earlier *DRAINS* models. This would suggest that the catchment roughness assumptions are representative of the run off characteristic for the catchment.

7.3 "Interim" Scenario Flood Modelling

The "Interim" Scenario *TUFLOW* Model includes those lots which have recently been rezoned for industrial developments. Various stormwater infrastructure / measures are also included to ensure that the proposed lots are not flood affected during the 1 % AEP event prior to the detention basin being constructed (i.e Final Option).

7.3.1 Model Development and Assumptions

A *TUFLOW* model was setup to represent the "Interim" Scenarios. The development of this model has built upon the "Existing" Model, but also includes the assumptions listed in Appendix B.

The key features in the "Interim" Scenario include:

- Stormwater detention system on proposed industrial lots;
- 1200 dia pipe and easement through 38 – 46 Bernera Road connecting the culverts under Bernera Road to the existing stormwater pipe along Sydney Water Easement to the East; and
- Flood Protection Mounds along Bernera Road and Yato Road to ensure that redirected flows do not enter the existing properties;

7.3.2 Pre-Post Comparison of Flows

On site detention (OSD) will be required for all proposed industrial lots in Prestons (with the exception of six (6) lots fronting Yato Road – refer to Figure 7.7 in Appendix F).

The methodology used to emulate OSD on industrial lots under direct rainfall Scenarios included:

- Regrade each lot to a new discharge point (at the lowest corner);
- Apply a lower Manning's Value (i.e n = 0.017) to reflect developed Scenarios;
- Provide a pit with pipe outlet at lowpoint of each lot;
- Determine existing flows exiting the site by Rational Method Calculations;
- By iteration, size the outlet pipe to restrict post to pre development level.

Refer to Section B.2 of Appendix B for further details.

A comparison of pre-post development flows was undertaken within *TUFLOW*. The assessment considered 19 proposed industrial lots based upon LEP and cadastral boundaries (refer Figure 7.7). Tables 7.3 and 7.4 show results for the 10 % and 1 % AEP events respectively.

TABLE 7.3 10 % AEP PRE-POST OSD COMPARISON

Lot	10% AEP Existing Flows from Rational Method (m^3/s)	Interim Piped flow exiting lot in TUFLOW (m^3/s)
1	0.23	n/a
2	0.56*	0.52
3	0.42	0.40
4	0.16	0.15
5	0.09	0.09
6	0.30	0.27
7	0.27	0.25
8	0.54	0.52
9	0.40	0.39
10	0.55	0.53
11	0.17	0.16
12	0.23	0.21
13	0.44 #	0.40
14	0.50	0.48
15	0.19	0.17
16	0.39	0.35
17	0.19	0.18
18	0.11	0.11
19	0.28	0.25

* Drains flows from both lot 2 and 7. Total existing = 0.28 + 0.27 = 0.56
# Drains flows from both lot 12 and 13. Total existing = 0.23 + 0.21 = 0.44

TABLE 7.4 1 % AEP PRE-POST OSD COMPARISON

Lot	1% AEP Existing Flows from Rational Method (m^3/s)	Interim Piped flow exiting lot in TUFLOW (m^3/s)
1	0.35	
2	0.87*	0.87
3	0.68	0.64
4	0.25	0.25
5	0.09	0.09
6	0.47	0.46
7	0.43	0.42
8	0.84	0.83
9	0.65	0.54
10	0.87	0.87
11	0.28	0.27
12	0.37	0.36
13	0.71 #	0.71
14	0.8^	
15	0.30	0.30
16	0.62	0.60
17	0.30	0.29
18	0.18	0.18
19	0.45	0.45
* Drains flows from both lot 2 and 7. Total existing = 0.44 + 0.43 = 0.87		
# Drains flows from both lot 12 and 13. Total existing = 0.37 + 0.34 = 0.71		
^ Excluded from direct rainfall model		

Results indicate that post development flows are restricted to pre development flows at each of the proposed industrial lots and is within 10-20 % of the peak (i.e. no over attenuation). Therefore, the proposed methodology accurately represents OSD at each of the proposed industrial lots.

7.3.3 Flood Modelling Results

Results of the "Interim" Scenario Model indicate that flows along Bernera Road are generally increased as a result of the redirection of flows from North-East to the North (previously entered lots). Refer to Appendix F for a full set of Figures.

Several key comparison locations were assessed for the 1 % AEP and are summarised in Table 7.5. Refer to Figure 4.1 in Appendix D for ID locations.

Due to the redirection of flows along Bernera Road in the 1 % AEP event, the proposed strategy subsequently includes **flood protection mounds** along Bernera Road and Yato Road to protect proposed industrial lots from flooding. It is anticipated that these mounds could be located within the required landscape setback of the proposed industrial lots. Refer to Figures 7.8 to 7.10 in Appendix F for flood protection mound locations and the corresponding 1 % AEP top water level.

TABLE 7.5 COMPARISON OF 1% AEP FLOWS (TUFLOW)

		1% AEP Top Water Level		1% AEP Peak Flow (m^3/s)	
ID	**Locations**	**Existing**	**Interim**	**Existing**	**Interim**
15	Existing Channel at Future Basin	34.01	33.73	13.3	12.5
16	U/S side of culvert under Bernera Rd	33.38	33.24	4.3	1.9
18	U/S side Overtopping Bernera Rd	32.95	32.93	10.3	8.7
19	D/S side Overtopping Bernera Rd	32.41	0##	5.1	0##
20	Bernera Rd / Yato Rd intersection 1	32.19	32.33	5.6	9.8
21	Bernera Rd / Yato Rd intersection 2	32.07	32.13	0.3	0.3
22	Bernera Rd / Yato Rd intersection 3	31.87	32.12	0.6	2.6
23j	Bernera Rd / Yato Rd intersection 4	31.58	31.72	2.8	9.0
24	Yato Rd flows from intersection	31.36	31.96	0.6	2.6
28	U/S Channel	29.76	0##	7.0	0##
34	Bernera Rd	29.55	29.68	2.9	8.3
36	Bernera Rd to m7	28.16	28.20	3.8	8.2
38	m7 interchange	27.69	27.77	5.3	8.5
39	m7 interchange - channel	27.34	27.37	7.4	10.9
42	Bernera Rd / Yato Rd intersection 4	31.45	0##	2.3	0##

flows no longer enter property due to mounds.

As a check, a comparison of flood levels and flows at critical locations is also provided. Results show that the flows at key locations (ID 30, 33 and 39) are within a reasonable order of magnitude (9.5 %) between pre and post development conditons..

TABLE 7.6 SUMMARY OF FLOWS

Flow (m^3/s)		
ID	**Existing**	**Interim**
30	3.6	2.3
33	7.2	5.9
39	7.4	10.9
Total	18.2	19.1

7.3.4 Sydney Water Easement

The existing Sydney Water easement is approximately 5 m wide and includes a 1 m high wall along its Western side, a 200-300 mm high kerb along its Eastern side together with a 1200 dia pipe line. The 1200 dia pipe collects flows from those industrial lots to the South and conveys them towards Yato Road before eventually draining (via a 2.4 m x 1.5 m RCBC) to the existing channel near ALDI.

The proposed strategy uses this outlet pipe system (in conjunction with other flood mitigation measures) to better convey flows towards to nearby Creek systems.

In the interim conditon, a new 1200 dia pipe has been constructed from the existing Bernera Road box culverts, through lot 38-46 Bernera Road with connection to the 1200 dia pipe in the Sydney Water Easement. The connecting pit is sealed with provision made for those flows in excess of the pipe system to be conveyed to Yato Road via the access place (Van Der Meer, 2013). In the final Scenario, this system will drain flows from the regional basin (refer Section 7.3) along with outflows from the industrial lots.

The following comments are provided:

- The "Existing" Scenario shows flows in the Sydney Water easement (refer Figure 7.3);
- In the "Interim" Scenario, there is also evidence of flows in the Sydney Water easement (slight increase in depths which vary along the length of the easement). Refer to Figure 7.9. This localised ponding is generally associated with (a) direct rainfall over the easement; and (b) runoff from the Sydney Water corner lot (which does not include OSD);
- The proposed pit at the head of the Sydney Water easement is sealed. Thus there is no surcharge of flows from the 1200 dia pipe in the "Interim" Scenario;
- In the "Existing" Scenario, the pit at the head of the Sydney Water Easement allows flows to enter into the pipe system. Whilst in the "Interim" Scenario, flows which are conveyed overland from lots to the South no longer have the ability to enter this pit and increases run-off with only minor impact on flow within the Sydney Water Easement;
- The "Interim" Scenario will require a 200 mm high flood protection mound (or equivalent kerb / raise in levels) to ensure flows do not breakout to the East and are instead directed to Yato Road. Refer to Figures 7.8 and 7.9 for results.

Final results for the "Interim" Scenario are shown on Figures 7.7 to 7.10 in Appendix E. which indicate that there is no required amendment to the existing infrastructure in the easement, however a mound (or kerb) is required just north of the easement to ensure flows do not breakout to the East into private land.

7.4 Final Scenario - Flood Mitigation Option

The “Final” Scenario *TUFLOW* Model builds upon those earlier modelling and includes various stormwater infrastructure / measures to mitigate flood affectation across the Prestons Study Area during the 1 % AEP event. Infrastructure includes a co-located raingarden / detention basin with associated 2 x 1200 dia outlet pipe(s).

7.4.1 “Final” Scenario Flood Modelling

The *DRAINS* Modelling outlined in Section 6.0 identified a size of a regional detention basin which will collect and manage the 1 % AEP Event in order to mitigate those localised flooding issues with the study area.

Testing within *TUFLOW* has subsequently been undertaken to confirm the performance of the proposed basin and to ensure that Council’s primary objective of removing the flood affectation of proposed industrial lots is achieved.

7.4.2 Model Development and Assumptions

A *TUFLOW* model was setup to represent the “Final” Scenario. Development of the model builds upon the “Interim” model, but also includes the amendments detailed in Appendix B.

7.4.3 Flood Modelling Results

Results of the “Final” Scenario Model demonstrate flows are managed within the basin, whilst a portion of flows during the 1 % AEP are conveyed along Bernera Road. Refer to Figures in Appendix G.

A summary of comparison locations are included in Table 7.7. These results show that by introducing the basin (and associated works), flows are significantly decreased across the Prestons study area. Refer to Figure 4.1 in Appendix D for locations.

TABLE 7.7 COMPARISON OF 1% AEP FLOWS (TUFLOW)

TUFLOW ID	Description	"Existing" Scenario Flow (m^3/s)	"Final" Scenario Flow (m^3/s)	Increase
15	Existing Channel at Future Basin	13.34	1.93	-86%
16	U/S side of culvert under Bernera Rd (Network D)	4.32	0.00	-100%
17	D/S side of culvert under Bernera Rd (Network D)	3.31	0.05	-99%
18	U/S side Overtopping Bernera Rd (Network D)	10.27	0.30^	-97%
19	D/S side Overtopping Bernera Rd (Network D)	5.09	0.00*	-100%
20	Bernera Rd / Yato Rd intersection 1 (Network D)	5.56	1.68	-70%
21	Bernera Rd / Yato Rd intersection 2 (Network D)	0.33	0.07	-79%
22	Bernera Rd / Yato Rd intersection 3 (Network D)	0.62	0.40	-35%
23	Bernera Rd / Yato Rd intersection 4 (Network D)	2.79	2.81	1%
24	Yato Rd flows from intersection (Network A)	0.62	0.42	-33%
28	Flows through lots from Yato Rd (Network A)	6.98	0.00*	-97%
34	Bernera Rd (Network D)	2.92	2.18	-25%
36	Bernera Rd to m7 (Network D)	3.77	2.02	-46%
38	m7 interchange (Network D)	5.27	3.16	-40%
39	m7 interchange - channel (Network D)	7.41	5.25	-29%
40a	m7 interchange exiting model (Network D)	17.78	5.50	-69%
42	Bernera Rd / Yato Rd intersection 4 (Network D)	2.26	0.00*	-100%
43	70m D/S of culvert under Bernera Rd (Network D)	3.5	0.05	-99%

7.4.4 Sensitivity of Results

TUFLOW results indicate that in the 1 % AEP Event, the performance of the basin is providing similar results to those predicted in the *DRAINS* modelling. In particular:

- The top water level in the proposed basin is marginally lower in the *TUFLOW* assessment (see below Table 7.8) which demonstrates that the proposed detention volume is appropriate.

TABLE 7.8 COMPARISON OF BASIN TOP WATER LEVEL (DRAINS VS TUFLOW)

Basin Top Water Level (m AHD)		
Location	**DRAINS**	**TUFLOW**
Basin	34.54	34.51

- Flow exits the detention basin via the low level 2 x 1200 dia pipes at 3.09 m^3/s (which is consistent with *DRAINS*) and conveys these flows to the existing culvert crossing under Bernera Rd. Refer to Table 7.9.

TABLE 7.9 COMPARISON OF BASIN PERFORMANCE (DRAINS VS TUFLOW)

	Flow over Spillway (m^3/s)		Flow in Outlet Pipes (m^3/s)	
Location	**DRAINS**	**TUFLOW**	**DRAINS**	**TUFLOW**
Basin	3.06	1.93	3.09	3.09

- The flow conveyance through the existing culvert crossing and the 1200 dia pipe in the easement (constructed in the interim Scenario) is slightly lower than those estimated in *DRAINS* by approximately 12-16 %. That is, around 2.5 - 2.6 m^3/s TUFLOW vs 3 m^3/s *DRAINS*, however this is considered a reasonable match between two different software packages.
- A portion of flows overtop the high level spillway during the 1 % AEP event. Whilst this flow rate is approximately 37 % lower than those estimated in *DRAINS*, the same objective is achieved with flows safely being conveyed to Bernera Road. Refer to Table 7.8 below.

TUFLOW results therefore support the design works which were undertaken in *DRAINS*.

7.5 Hazard Categories

Hazard can be considered to be a measure of the impact that floodwater may have on both people and/or property. Hazard mapping was undertaken for 10% and 1% AEP flood events from all the *TUFLOW* runs completed as part of this study.

Hazard grids are developed directly out of the *TUFLOW* model and have been used to produce the Hazard plans presented in this report. The floodplain has been divided into three Hazard categories (consistent with the NSW Floodplain Development Manual (FDM, 2005) as follows.

- Low Hazard;
- Transitional Hazard; and
- High Hazard.

Hazards maps are useful to obtain an appreciation of the relative depth and velocity of floodwater within a locality and are a critical element in determining:

- The locations of critical public infrastructure such as hospitals and aged care facilities;
- The areas in the floodplain for which public safety is “at risk”; and
- Assist in the Flood Emergency response and Evacuation Management process.

7.5.1 Hazard Categorisation Mapping

Flood hazard category maps have been determined for the three (3) Scenarios and are detailed on the Figures 7.5 – 7.6 in Appendix E, Figures 7.11 – 7.12 in Appendix F and Figures 7.19 – 7.20 in Appendix G.

The “Existing” Assessment results show low to high hazards extending through properties within the Prestons Study Area (refer to Figures 7.5 – 7.6).

The “Interim” Assessment shows increased flood hazards along Bernera Road along with the removal of all hazards through proposed industrial lots (refer Figures 7.11 – 7.12). The time of inundation for the hazard is considered to be relatively short term and is unlikely to impact on traffic conditions since this would only occur in extreme events.

The "Final" Assessment results show a significant reduction in flooding through the Prestons study area in both the 1 % and 10 % AEP Flood Events (refer Figures 7.19 and 7.20). It is noted that the flows conveyed along Bernera Road are associated with:

- localised direct rainfall;
- flows overtopping the spillway; and
- flows exiting the industrial lots.

Importantly, the "Final" hazard results indicate that by introducing the detention basin, the flood hazard category along the length of Bernera Road is defined as **"Low hazard".** This supports the velocity * depth estimates which were derived in the preliminary design in Section 6.1.

7.6 Flood Difference Mapping

Flood Difference maps have been prepared to demonstrate the difference in both the 10 % and 1 % AEP flood levels arising between the "Existing" Scenario and the "Final" Scenarios. Refer to Figures in Appendix H.

Results demonstrate that the flood mitigation works proposed within "Final" Scenario (i.e. basin and outlet) will significantly reduce 1% AEP flood depths across the Prestons study area. In particular, the existing flowpath which previously conveyed flows to the North-East is now collected by the basin, managed and released slowly towards the M7 interchange.

Results demonstrate flood depths for the 1% AEP Flood are generally decreased across the study area with only minor isolated increases occurring from the existing Scenario. These isolated increases are shown in the vicinity of the headwall discharge north of ALDI (0.05m) along with isolated areas along Kurrajong Road (0.11m) and Bernera Road (0.07m).

7.7 Dam Break Considerations

The Dam Safety Committee (DSC) guidelines require that all detention storages, no matter the size of the storage or embankment height, need to be referred to the DSC for a determination on an appropriate Flood Consequence Category for each basin.

This referral would be undertaken in conjunction with the detailed design at Development Application stage. A PMF analysis of the flood Scenarios at the future detailed design stage would provide the basis of estimating "Population At Risk" (PAR) and could be used as the start point for future assessment of the likely impacts of a dam failure on industrial areas downstream from the basin.

It would be our expectation that as the land is zoned both "General Industrial" and "Heavy Industrial" that the likelihood of the proposed basin being "prescribed" is small, however formal advice/concurrence should be sought from the DSC at some point in the future.

7.8 Conclusion

Results demonstrate that "Existing" flooding affects a large number of properties by travelling from the lowpoint in Kurrajong Road, through the study area before draining to a channel and ultimately onto Maxwells Creek to the North East (near ALDI). A portion of existing flows (3.4 m^3/s) are conveyed through the existing box culvert crossing under Bernera Road (to the East), with remaining flows overtopping Bernera Road and being conveyed to the North towards to M7 interchange.

The "Interim" Scenario modelling includes various stormwater infrastructure / measures to ensure that the proposed lots are not flood affected during the 1 % AEP event prior to the detention basin being constructed. These measures include OSD on proposed industrial lots, 1200 dia pipe and easement through 38 – 46 Bernera Road and flood protection mounds in various locations.

Results indicate that by adopting the "Interim" measures, all proposed industrial lots are protected from flooding during the 1 % AEP event. Flows along Bernera Road are generally increased as a result of the redirection of flows from North-East to the North (previously entered lots) with a depth of flow in the central trafficable lanes generally 0.15 m to 0.25 m deep. It is noted however that this time of inundation is considered to be relatively short term and is unlikely to impact on traffic conditions.

Results demonstrate that the proposed flood mitigation works under the "Final" Scenario (basin and outlet pipes), will achieve the overall objectives to better manage existing flooding issues and provide safer flow conveyance. In particular, all of the proposed industrial areas are shown to be clear of flooding during the 1 % AEP event.

The proposed works (basin and outlet pipes) provide a significant benefit over the previous box culvert option, given flooding is improved by managing (or attenuating) the 1 % AEP event rather than just conveying the peak flows to a location further downstream.

The "Final" hazard results indicate that by introducing the detention basin (and outlet pipes), flooding associated with the 1 % AEP across the Prestons Study Area is significantly improved from both the "Existing" and "Interim" Scenarios. Those flows which overtop the basin spillway are conveyed along the length of Bernera Road are classified as **"Low Hazard**".

8 WATER QUALITY ANALYSIS

A stormwater quality analysis has not currently been undertaken for the Prestons Trunk Drainage study and is recommended to be undertaken as part of the DA works.

In accordance with standard engineering practice, it is anticipated that the 'treatment train' required to remove pollutants in accordance with statutory requirements will likely consist of a Gross Pollutant Trap (GPT) at the sag in Kurrajong Road (prior to discharge of the street system to the new swale) and a bio-retention raingarden.

8.1.1 Gross Pollutant Traps

GPT devices operate as a primary treatment to remove litter, vegetative matter, free oils, grease and coarse sediments prior to discharge to downstream treatment devices. The high flow bypass is generally set to the 3 month ARI flowrate of the receiving catchment.

The proposed strategy for Prestons Trunk Drainage makes allowance for a GPT to be positioned at the existing sag in Kurrajong Road in order to treat flows from the residential catchment prior to entering the co-located basin / raingarden.

8.1.2 Bio-retention Raingardens

Water Quality Treatment within bio-retention raingardens is attained by detaining flows to promote sedimentation, direct filtration of particulate matter and nutrient stripping by bio-films which establish on the surface of the media bed and within the gravel layer. The organic sandy loam bed and plant system minimises evaporation losses and the raingarden will be constructed with an impermeable barrier to prevent seepage losses and aid in avoiding groundwater salinity issues.

The media beds of the bio-retention systems are typically 500 – 600 mm deep with an average particle size of 0.5 mm, a minimum hydraulic conductivity of 100 mm/hr and minimum depth of storage above the media of 300 mm. Flows in excess of the 3 month ARI storm event generally bypass the raingardens.

The proposed strategy makes allowance for a raingarden to be co-located within the proposed detention basin. Provision is made in the concept design for the raingarden to have a filter area size of 2900 m^2 (based on a rule of thumb – 1 % of the contributing catchment) and is to be perched within the basin for appropriate subsoil drainage and to minimise the depth of flooding over the device. This raingarden will then receive 3 month ARI flows via the low flow pipes in the proposed channel, with those larger events flowing straight to the basin.

It is assumed that trash and gross sediments will be effectively removed prior to entering the raingardens by the proposed GPT unit in order to reduce the ongoing maintenance requirements for this device.

9 COST ESTIMATES

An estimate of quantities and preliminary cost estimate for the "Final" Scenario has been prepared (JWP estimate for these works is approximately $3.9 million) for those works shown on Figure 7.14. This estimate includes basin works, new pipe work / swale extending from Kurrajong Road and the 2 x 1200 dia basin outlet pipes extending to the Bernera Road culvert crossing. By taking into consideration Land Acquisition costs, the total estimate is increased to $6.9 million. Refer to table C.1 in Appendix C for further details.

The largest cost item ($1.67M) is associated with excess fill material from the basin formation works that will need to be disposed "offsite". We have used a rate of $75 / m^3 (estimate of tipping fee), however this rate considers the removal, cartage and disposal of material which would otherwise be suitable for construction or filling of the adjoining Industrial Lot. If Council are able to identify nearby areas which require filling then this cost item could significantly be decreased.

9.1 Peer review of Cost Estimates

The estimate of quantities and preliminary cost estimate for the "Box Culvert" Option (provided by Council) has been reviewed and updated in accordance with 2014 rates. Refer to Table C.2 in Appendix C. The review has identified the following:

- The total box culvert length extending from Kurrajong Road to the M7 interchange is approximately 900 m, however allowance has only been made for one (1) pit along its length. It is anticipated that along this length there would be at least 4-5 pits together with a new headwall outlet to the channel at the M7 interchange;
- It is anticipated that the box culverts cannot entirely be constructed in the road verge and would likely encroach on the roadway pavement. Pavement / kerb reconstruction costs are therefore included in our revised cost;
- Provision should also be made to reconstruct the existing concrete channel on the Western side of Bernera Road along with existing driveway crossings after the box culverts are constructed;
- There is a high risk of significant service relocation costs given the size of the proposed box culverts (i.e. total of approx. 5m x 1.2m deep) and the associated deep construction. In particular, there is a high risk of services clashes due to the close proximity to electrical substations, Sydney Water Pump Station and large existing Stormwater Infrastructure. Allowances for service adjustments has therefore been increased in our estimate;
- No provision has been made for Water Quality. A GPT has subsequently been added to the cost estimate;
- Provision for Traffic Management should be increased given the anticipated works in the roadway;
- It is unclear how the *"excavation for stormwater drainage culverts and channel"* has been determined. The notation indicates it is for *"Earth < 1.5 m deep",* however given the specified box culverts are *"1.2 m high*" this would provide almost no cover since 1.2 m is actually the internal nominal height of a culvert. Provision should therefore be made for at least 2 m deep excavation;
- The supplied sketch shows proposed works for the downstream length from "*F0 to F1*" as an *"Open Channel Base Width 2.4m x 1.2m Height with 1:4 side slopes*", however it is unclear whether this is proposed or existing. J. Wyndham Prince observe that (a) there is an existing channel alongside the M7 interchange generally

in this location; and (b) the cost estimate does not appear to include any channel construction costs.

For the purposes of this assessment, it is assumed that the channel from *"F0 to F1"* does not form part of the required works;

- The culvert length extending from "F9 to F8" has been adjusted to match to the lowpoint of Kurrajong Road (where pipes currently discharge to). This reduces the length of culverts required by around 60 m;
- Both Rocla and Humes were contacted in March 2014 to obtain current unit prices for box culverts (supply only). For the purposes of comparison, the cheaper quoted price (Humes) was included in the assessment. Installation costs were subsequently then added on top of this rate;
- No allowance has been made for Consultancy and Project Management Fees, Government Agency Approvals, Council DA Fees, planFIRST Levy and PCA Fees;
- Land acquisition is listed as a separate item.

9.2 Comparison of Cost Estimates

Comparison of the estimates (Table C.1 and C.2 in Appendix C) indicates that the revised strategy is significantly more cost effective with a reduction in construction costs by around **$2.4 million**

It is noted that this difference in costs could be even higher due to the following:

- The uncertainties of service relocations;
- assessment has currently assumed road reconstruction is required for 50 % of the culvert width. This could however be increased up to 100 % of the culvert widths due to site constraints; and
- Reconstruction of the channel has been excluded from calculations.

We therefore recommend that the revised strategy is adopted since it will provide a more cost effective solution along with an improved stormwater management outcome for the Prestons Industrial Area.

10 SUMMARY & CONCLUSION

J. Wyndham Prince has prepared the *Flooding and Drainage Assessment* for the Prestons Trunk Drainage System on behalf of Liverpool City Council. This report details the procedures used and presents the results of investigations to support the implementation of a revised trunk drainage strategy and informs a of Section 94 cost estimates for the works.

The overall objectives of the study is to (a) better managing existing flooding issues; (b) remove flood affectation of proposed industrial lots during the 1 % AEP; (c) provide safer flow conveyance; and (d) reduce construction costs. The revised trunk drainage strategy to achieve these objectives includes:

- Swale to convey 1 % AEP flows from the lowpoint in Kurrajong Road;
- Gross Pollutant Trap and bio-retention raingarden to provide water quality treatment of the upstream residential area. Low flow pipes within the overland flowpath to convey 3 month ARI flows to the raingarden;
- Regional detention basin with staged discharge outlet arrangement (low level piped and high level weir);
- 2 x 1200 dia basin outlet pipes from the proposed basin to connect to the existing culvert crossing under Bernera Road;
- Overland flowpath just downstream from the detention basin to transition levels and discharge flows to Bernera Road;
- 1 x 1200 dia pipe and easement through 38-46 Bernera Road to connect to the Sydney Water Easement to the East;
- Flood Protection Mounds along Bernera Road, Yato Road and in the vicinity of the Sydney Water Easement.

The proposed flood mitigation works are split into two (2) stages to reflect both “Interim” and “Final” Scenarios.

The configuration of the proposed detention basin and outlet configuration has been sized within *DRAINS* and tested in *TUFLOW.* The 2D Flood Modelling results within *TUFLOW* demonstrate that the Trunk Drainage Works proposed under the “Final” Scenario, will achieve the overall objectives.

The revised strategy will provide a significant benefit over the previous box culvert option, given flooding is improved by managing (or attenuating) the 1 % AEP event rather than just conveying the peak flows to a location further downstream**.**

The “Final” hazard results indicate that by introducing the detention basin (and outlet pipes), flooding associated with the 1 % AEP across the Prestons Study Area is significantly improved from both the “Existing” and “Interim” Scenarios. Those flows which overtop the basin spillway are conveyed along the length of Bernera Road are classified as **“Low Hazard**”.

A comparison of cost estimates indicate that the revised strategy is significantly more cost effective than the original strategy (box culverts) with an estimated reduction in costs to Council and any future developers by around $2.4 million.

We therefore recommend that the revised strategy is adopted since it will provide a more cost effective solution along with an overall flood management approach.

11 REFERENCES

- Bewsher Consulting (July 2010) *Cabramatta Creek Flood Study and Basin Strategy Review* – Final Draft Report.
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- BMT WBM Pty Ltd (2008). TUFLOW User Manual
- Engineers Australia (2006). Australian Runoff Quality – A Guide To Water Sensitive Urban Design
- Landcom (2004). Managing Urban Stormwater – Soils and Construction – 4th Edition
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- Liverpool City Council (2003) *NSW Development Design Specification D5 – Stormwater Drainage Design*
- Liverpool City Council Design Services (2007) *"Yarrunga Industrial Area, Prestons – Proposed Drainage"* Section 94 Drainage Plan (Ref: D2009/005),
- NSW Government (2005). *Floodplain Development Manual*
- Van Der Meer Consulting (2013) *Design Plans DA011 rev L, DA012 rev F and DA014 rev E (dated May 2013)*

12 GLOSSARY OF TERMS

12D Model is a powerful terrain modelling, surveying and civil engineering software package used to develop the underlying surface for the 2D modelling.

Airborne Laser Survey (ALS) is a technique for obtaining a definition of the surface elevation (ground, buildings, power lines, trees, etc.) by pulsing a laser beam at the ground from an airborne vehicle (generally a plane) and measuring the time taken for the laser beam to return to a scanning device fixed to the plane. The time taken is a measure of the distance which, when ground truthed, is generally accurate to + 150mm.

Annual Exceedance Probability (AEP) means the probability that a given rainfall total over a given duration will be exceeded in any one year.

Average Recurrence Interval (ARI) means the average statistical interval (in years) between occurrences of floods, storms and flows of a particular magnitude. This has recently been replaced by the AEP (see above).

Australian Rainfall and Runoff (AR&R) refers to the current edition of Australian Rainfall and Runoff published by the Institution of Engineers, Australia.

Council refers to Liverpool City Council

Digital Terrain Model (DTM) is a spatially referenced three-dimensional (3D) representation of the ground surface represented as discrete point elevations where each cell in the grid represents an elevation above an established datum.

DRAINS is a computer program that enables designing urban stormwater drainage systems and analysing their flooding behaviour. As well as modelling piped drainage systems, DRAINS describes detention basins, open channels, rural and urban catchments.

Floodplain Development Manual (FDM) and Guidelines (April 2005), the FDM is a document issued by DECCW that provides a strategic approach to floodplain management. The guidelines have been issued by the NSW DoP to clarify issues regarding the setting of FPL's.

Hydrograph is a graph that shows how the stormwater discharge changes with time at any particular location.

Hydrology The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.

J. Wyndham Prince Pty Ltd (JWP) Consultant Civil Infrastructure Engineers and Project Managers undertaking these investigations

MUSIC is a modelling package designed to help urban stormwater professionals visualise possible strategies to tackle urban stormwater hydrology and pollution impacts. MUSIC stands for Model for Urban Stormwater Improvement Conceptualisation and has been developed by Cooperative Research Centre (CRC),

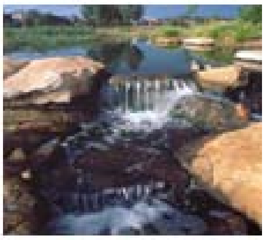
Peak Discharge is the maximum stormwater runoff that occurs during a flood event

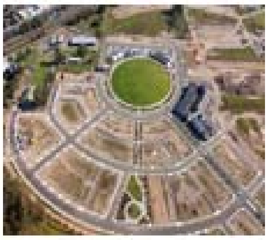
Probable Maximum Flood (PMF) is the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends." largest flood that could be

Triangular Irregular Network (TIN) is a technique used in the created DTM by developing a mass of interconnected triangles. For each triangle, the ground level is defined at each of the three vertices, thereby defining a plane surface over the area of the triangle

TUFLOW is a computer program that provides two-dimensional (2D) and one-dimensional (1D) solutions of the free surface flow equations to simulate flood and tidal wave propagation. It is specifically beneficial where the hydrodynamic behaviour, estuaries, rivers, floodplains and urban drainage environments have complex 2D flow patterns that would be awkward to represent using traditional 1D network models.

XP-RAFTS runoff routing model that uses the Laurenson non-linear runoff routing procedure to develop a sub catchment stormwater runoff hydrograph from either an actual event (recorded rainfall time series) or a design storm utilising Intensity-Frequency-Duration data together with dimensionless storm temporal patterns as well as standard AR&R 1987 data.





APPENDIX A – DRAINS MODELLING

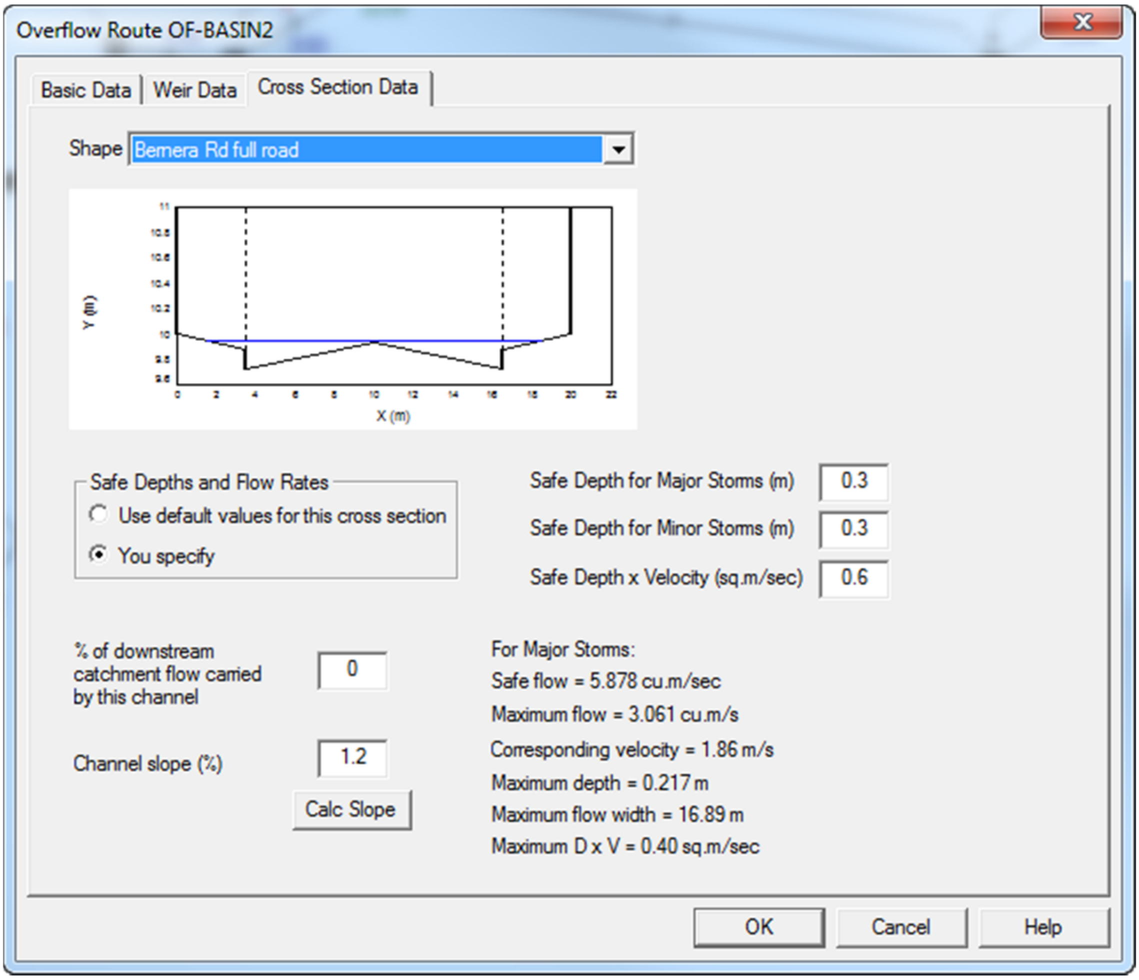


Plate A-1 – Velocity Depth downstream from Basin.

PIT / NODE DETAILS Version 11

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss	Inflow Hydrograph
N33	Node					28.65		0		303291.999	6242685.03		2313990		
Dmy 1	Node					35.9		0		303211.868	6242238.516		9307920		
1.AG	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		4	35.843		0	0.2	303217.434	6242238.168	No	4	1 x Ku	No
2.AG	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		1.6	34.206		0	0.2	303226.591	6242306.837	No	7	1 x Ku	No
Pit-VE6	OnGrade	900 x 900 SIP	1% Grade, Without Kerb		0.6	32.6		0	0	303247.565	6242476.222	Yes	197828210	1 x Ku	No
3.AG	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		0.6	30.52		0	0.2	303251.879	6242478.397	Yes	11	1 x Ku	No
4.AG	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		0.7	30.135		0	0.2	303263.245	6242566.685	No	15	1 x Ku	No
7.F	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		1.1	29.86		0	0.2	303264.256	6242591.593	No	18	1 x Ku	No
8.F	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		0.7	29.2		0	0.2	303272.589	6242652.363	No	20	1 x Ku	No
9.F	Sag	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade	16	0.7	29.01	0.2	0	0.5	303276.801	6242682.797	No	21	1 x Ku	No
10.F	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		0.4	29.2		0	0.2	303280.226	6242689.951	No	22	1 x Ku	No
11.F	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		0.2	29.25		0	0.2	303281.476	6242701.119	No	24	1 x Ku	No
12.F	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		0.9	27.881		0	0.2	303294.552	6242795.309	No	26	1 x Ku	No
13.F	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		0.8	27.16		0	0.2	303303.913	6242862.394	No	28	1 x Ku	No
14.F	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		1	28.66		0	0.2	303306.846	6242878.339	No	29	1 x Ku	No
15.F	Node					26.686		0		303352.045	6242976.243		30		
Dmy 2	Node					34.3		0		303220.681	6242304.782		9307922		
Dmy 4.A	Node					30.245		0		303257.527	6242567.006		14985286		
Dmy 1.J	Node					29.45		0		303254.609	6242654.44		20361657		
2.J	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		4	29.25		0	0.2	303260.929	6242654.127	No	17	1 x Ku	No
Dmy 1.K	Node					28.867		0		303289.567	6242795.922		27674749		
Dmy 1.L	Node					27.2		0		303299.081	6242863.242		28745839		
Dmy 1.M	Node					28.707		0		303296.415	6242879.688		28745865		
HW 1.F	Headwall				0.5	30.96		0		303085.384	6242594.398		32927013		
2.F	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		0.6	30.84		0	0.2	303088.009	6242596.535	No	2	1 x Ku	No
3.F	Sag	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade	10	2.5	30.61	0.2	0	0.2	303107.108	6242594.705	No	3	1 x Ku	No
4.F	Sag	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade	10	2.5	30.6	0.2	0	0.2	303109.279	6242606.235	No	6	1 x Ku	No
5.F	Sag	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade	10	0.9	30.57	0.2	0	0.2	303163.685	6242598.777	No	10	1 x Ku	No
1.H	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade		4	30.25		0	0.2	303232.978	6242577.341	No	9	1 x Ku	No
HW I.1	Headwall				0.5	29		0		303257.288	6242690.181		39002769		
3.I	Sag	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA1 (Type 2) - 3% longitudinal grade	10.6	0.5	29	0.2	0	0.5	303264.708	6242684.753	No	19	1 x Ku	No
13.A-100yr	Node					34.842		0		302789.45	6242296.288		197828192		
1.D6	OnGrade	Unlimited DRpit	Unlimited DRsize		0	34.55		0	0	302901.587	6242393.163	No	63727930	1 x Ku	No
2.D6	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA2 (Type 5) - 3% longitudinal grade		0.6	34.6		0	0.2	302925.384	6242409.633	Yes	14	1 x Ku	No
3.D6	OnGrade	NSW RTA SA Inlet, 3% crossfall, 3% grade	SA2 (Type 5) - 3% longitudinal grade		2.5	33.9		0	0.2	302938.506	6242485.617	Yes	16	1 x Ku	No
Pit-VE1	OnGrade	900 x 900 SIP	1% Grade, Without Kerb		0.6	33.65		0	0	302956.563	6242483.627	Yes	197828200	1 x Ku	No
Pit-VE2	OnGrade	900 x 900 SIP	1% Grade, Without Kerb		0.6	34.13		0	0	302976.635	6242496.196	Yes	197828201	1 x Ku	No
Pit-VE3	OnGrade	900 x 900 SIP	1% Grade, Without Kerb		0.6	32.95		0	0	303074.169	6242483.08	Yes	197828202	1 x Ku	No
Pit-VE4	OnGrade	900 x 900 SIP	1% Grade, Without Kerb		0.6	32.5		0	0	303094.357	6242497.085	No	197828203	1 x Ku	No
Pit-VE5	OnGrade	900 x 900 SIP	1% Grade, Without Kerb		0.2	33.55		0	0	303171.235	6242486.587	Yes	197828204	1 x Ku	No
OSD 1	Node					33		0		303076.086	6242476.006		197828217		
OSD 3	Node					35		0		303171.892	6242319.608		197828223		
OSD 2	Node					32.7		0		303232.618	6242470.317		197828253		
Bernera Rd	Node					33		0		302944.602	6242520.819		197828293		
13.A-50yr	Node					34.482		0		302771.182	6242331.219		242770491		
13.A-20yr	Node					34.482		0		302765.284	6242372.511		242770492		
13.A-10yr	Node					34.482		0		302760.973	6242399.963		242770493		
13.A-5yr	Node					34.482		0		302761.2	6242408.357		242770494		
13.A-50y3h	Node					34.482		0		302771.908	6242323.278		243970108		
13A-100y3h	Node					34.842		0		302800.676	6242283.348		244371959		
13A-20y3h	Node					34.842		0		302767.326	6242362.528		244371965		

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Init Vol. (cu.m)	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Length(m)	id
Basin2	32.72	0	0	Culvert	0.5					302896.864	6242390.223	No			3465168
	32.8	332													
	32.9	1253													
	33	2625													
	33.1	4024													
	33.2	5699													
	33.3	7009													
	33.4	7354													
	33.5	7507													
	33.6	7657													
	33.7	10744													
	33.8	10889													
	33.9	11031													
	34	11171													
	34.1	11307													
	34.2	11434													
	34.3	11549													
	34.4	11664													
	34.5	11779													
	34.52	11826													
	34.6	11895													
	34.7	12011													
	34.8	12128													
	34.9	12245													
	35	12363													
	35.04	12466													

SUB-CATCHMENT DETAILS

Name	Pit or	Total	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Lag Time

	Node	Area	Area	Area	Area	Time	Time	Time	Length	Length	Length	Slope(%)	Slope	Slope	Rough	Rough	Rough	or Factor
		(ha)	%	%	%	(min)	(min)	(min)	(m)	(m)	(m)	%	%	%				
C74	Dmy 1	2.14	90	10	0	6.5	9	0										0
C26	7.F	0.068	95	5	0	5	5	0										0
C27	8.F	0.074	95	5	0	5	5	0										0
C28	9.F	0.037	95	5	0	5	5	0										0
C30	10.F	0.157	90	10	0	8	12	0										0
C75	Dmy 2	2.021	90	10	0	7	9.5	0										0
C25	Dmy 4.A	0.904	90	10	0	5	6	0										0
C64	Dmy 1.J	1.958	90	10	0	8	12	0										0
C65	2.J	0.057	95	5	0	5	5	0										0
C69	Dmy 1.K	2.147	90	10	0	8	12	0										0
C70	Dmy 1.L	1.984	90	10	0	8	12	0										0
C71	Dmy 1.M	1.221	90	10	0	8	12	0										0
C56	HW 1.F	0.946	90	10	0	5	6	0										0
C58	3.F	0.467	95	5	0	5	5	0										0
C59	4.F	0.106	95	5	0	5	5	0										0
C62	5.F	0.513	95	5	0	5	5	0										0
C63	1.H	0.075	95	5	0	5	5	0										0
C66	HW I.1	1.825	90	10	0	8	12	0										0
C68	3.I	0.023	95	5	0	5	5	0										0

PIPE DETAILS

Name	From	To	Length	U/S IL	D/S IL	Slope	Type	Dia	I.D.	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg	Rl	Chg	RL
			(m)	(m)	(m)	(%)		(mm)	(mm)						(m)	(m)	(m)	(m)
Pipe2454	Dmy 1	1.AG	5	31.23	31.18	1	Concrete, under roads	1050	1070	0.013	New	1	Dmy 1	0				
Pipe-72	1.AG	2.AG	69.277	31.18	30.487	1	Concrete, under roads	1050	1070	0.013	New	1	1.AG	0	6.16512	35.897	6.77849	35.882
Pipe-73	2.AG	Pit-VE6	173.414	30.487	28.753	1	Concrete, under roads	1200	1200	0.013	New	1	2.AG	0	9.49146	33.996	11.0208	33.962
Pipe13041	Pit-VE6	3.AG	4.83	28.794	28.746	0.99	Concrete, under roads	1200	1200	0.013	New	1	Pit-VE6	0				
Pipe-24	3.AG	4.AG	89.017	28.746	28.35	0.44	Concrete, under roads	1200	1200	0.013	New	1	3.AG	0	0.257128	30.473	0.643251	30.555
Pipe-25	4.AG	7.F	24.928	28.35	27.61	2.97	Concrete, under roads	1200	1200	0.013	New	1	4.AG	0	0.311265	29.947	0.888711	29.931
Pipe-26	7.F	8.F	61.338	27.61	26.5	1.81	Concrete, under roads	1200	1200	0.013	New	1	7.F	0	23.7873	29.574	24.4949	29.567
Pipe-27	8.F	9.F	30.724	26.5	25.93	1.86	Concrete, under roads	1200	1200	0.013	New	1	8.F	0	0.0697207	29.16	10.2427	29.102
Pipe-28	9.F	10.F	7.932	25.93	25.73	2.52	Concrete, under roads	1200	1200	0.013	New	1	9.F	0	1.01358	29.061	1.05563	29.064
Pipe-29	10.F	11.F	11.238	25.73	25.48	2.22	Concrete, under roads	1200	1200	0.013	New	1	10.F	0	1.86766	29.07	5.9048	29.103
Pipe-30	11.F	12.F	95.093	25.48	25.08	0.42	Concrete, under roads	1500	1524	0.013	New	1	11.F	0	0.659308	29.166	7.7355	29.214
Pipe-31	12.F	13.F	67.735	25.08	24.91	0.25	Concrete, under roads	1500	1524	0.013	New	1	12.F	0	4.34972	27.775	6.46398	27.755
Pipe-32	13.F	14.F	16.213	24.91	24.83	0.49	Concrete, under roads	1500	1524	0.013	New	1	13.F	0	3.12362	27.11	3.44196	27.069
Pipe-33	14.F	15.F	107.835	24.83	24.69	0.13	Box Culverts	2.4W x 1.5H		0.012	Existing	1	14.F	0	1.29756	28.5	1.33471	28.496
Pipe2455	Dmy 2	2.AG	5	30.54	30.49	1	Concrete, under roads	1050	1070	0.013	New	1	Dmy 2	0				
Pipe52	Dmy 4.A	4.AG	6	28.47	28.35	2	Concrete, under roads	1200	1200	0.013	New	1	Dmy 4.A	0				
Pipe-62	Dmy 1.J	2.J	6.258	26.68	26.62	0.96	Concrete, under roads	1050	1070	0.013	New	1	Dmy 1.J	0	0.747958	29.401	2.20383	29.393
Pipe-63	2.J	8.F	11.793	26.62	26.5	1.02	Concrete, under roads	1050	1070	0.013	New	1	2.J	0	0.067744	29.312	0.113286	29.303
Pipe-67	Dmy 1.K	12.F	5.017	25.87	25.08	15.75	Concrete, under roads	1050	1070	0.013	New	1	Dmy 1.K	0	3.38555	27.871	4.86905	27.893
Pipe-68	Dmy 1.L	13.F	4.846	25.21	24.91	6.19	Concrete, under roads	1050	1070	0.013	New	1	Dmy 1.L	0	0.0840055	27.095	1.19329	27.194
Pipe-69	Dmy 1.M	14.F	10.452	25.33	24.83	4.78	Concrete, under roads	1050	1070	0.013	New	1	Dmy 1.M	0	0.565986	28.949	0.710109	29
Pipe-54	HW 1.F	2.F	3.386	30.21	29.92	8.56	Concrete, under roads	375	375	0.013	NewFixed	1	HW 1.F	0	0.284574	30.805	2.34891	30.827
Pipe-55	2.F	3.F	19.186	29.92	29.83	0.47	Concrete, under roads	375	375	0.013	New	1	2.F	0	0.972433	30.791	1.08397	30.785
Pipe-56	3.F	4.F	11.733	29.83	29.21	5.28	Concrete, under roads	375	375	0.013	New	1	3.F	0	4.67586	30.711	5.39627	30.729
Pipe-57	4.F	5.F	54.917	29.21	28.93	0.51	Concrete, under roads	450	450	0.013	New	1	4.F	0	1.64531	30.672	4.4442	30.686
Pipe-58	5.F	1.H	71.669	28.93	28.68	0.35	Concrete, under roads	600	600	0.013	New	1	5.F	0	1.91797	30.666	3.0454	30.668
Pipe-59	1.H	7.F	29.686	28.68	27.61	3.6	Concrete, under roads	600	600	0.013	New	1	1.H	0	1.41554	30.316	2.31403	30.311
Pipe-64	HW I.1	3.I	5.808	26.398	26.34	1	Concrete, under roads	225	225	0.013	NewFixed	1	HW I.1	0	0.562175	28.827	2.47929	28.528
Pipe-66	3.I	9.F	12.219	26.28	25.93	2.86	Concrete, under roads	1050	1070	0.013	New	1	3.I	0	0.311551	28.992	0.332763	28.981
Pipe Basin 2 - 1D6	Basin2	1.D6	4	32.721	32.701	0.5	Concrete, under roads	1200	1200	0.013	NewFixed	4	Basin2	0				
Pipe 1D6-2D6	1.D6	2.D6	18	32.701	32.611	0.5	Concrete, under roads	1200	1200	0.013	NewFixed	2	1.D6	0				
Pipe 2D6-3D6	2.D6	3.D6	76.26	32.611	32.23	0.5	Concrete, under roads	1200	1200	0.013	New	2	2.D6	0				
Pipe 3D6-VE1	3.D6	Pit-VE1	18.1	32.23	32.21	0.11	Box Culverts	0.9W x 0.6H		0.012	Existing	3	3.D6	0				
Pipe VE1-VE2	Pit-VE1	Pit-VE2	23.68	32.1	31.98	0.51	Concrete, under roads	1200	1200	0.013	New	1	Pit-VE1	0				
Pipe VE2-VE3	Pit-VE2	Pit-VE3	98.4	31.98	31.01	0.99	Concrete, under roads	1200	1200	0.013	New	1	Pit-VE2	0				
Pipe VE3-VE4	Pit-VE3	Pit-VE4	24.57	31	30.66	1.38	Concrete, under roads	1200	1200	0.013	New	1	Pit-VE3	0				
Pipe VE4-VE5	Pit-VE4	Pit-VE5	77.62	30.66	30.32	0.44	Concrete, under roads	1200	1200	0.013	New	1	Pit-VE4	0				
Pipe VE5-VE6	Pit-VE5	Pit-VE6	77	30.32	29.94	0.49	Concrete, under roads	1200	1200	0.013	New	1	Pit-VE5	0				
Pipe OSD1-VE3	OSD 1	Pit-VE3	7.33	32.2	31.1	15.01	Concrete, under roads	675	675	0.013	New	1	OSD 1	0				
Pipe13042	OSD 3	2.AG	56.77	33.71	33.43	0.49	Concrete, under roads	450	450	0.013	New	1	OSD 3	0				
Pipe OSD2-VE6	OSD 2	Pit-VE6	16	31.3	31.1	1.25	Concrete, under roads	575	500	0.013	New	1	OSD 2	0				

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg	Bottom	Height of Service	Chg	Bottom	Height of Service	Chg	Bottom	Height of Service	etc
	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc

CHANNEL DETAILS

Name	From	To	Type	Length	U/S IL	D/S IL	Slope	Base Width	L.B. Slope	R.B. Slope	Manning	Depth	Roofed
				(m)	(m)	(m)	(%)	(m)	(1:?)	(1:?)	n	(m)	

OVERFLOW ROUTE DETAILS

Name	From	To	Travel	Spill	Crest	Weir	Cross	Safe Depth	SafeDepth	Safe	Bed	D/S Area	id
			Time	Level	Length	Coeff. C	Section	Major Storms	Minor Storms	DxV	Slope	Contributing	
			(min)	(m)	(m)			(m)	(m)	(sq.m/sec)	(%)	%	
B74	1.AG	2.AG	0.6				Drainage Easement Access Road	0.3	0.3	0.6	2.4	0	107
B75	2.AG	Pit-VE6	1.44				Drainage Easement Access Road	0.3	0.3	0.6	2.1	0	104
OF11062	Pit-VE6	3.AG	0.1				Dummy used to model flow across road low points	0.2	0.05	0.6	1	0	197828308
B24	3.AG	4.AG	0.74				Drainage Easement Access Road	0.3	0.3	0.6	0.4	0	100
B25	4.AG	7.F	0.2				Drainage Easement Access Road	0.3	0.3	0.6	1.1	0	96
B26	7.F	8.F	0.51				Bernera Rd	0.3	0.3	0.6	1.1	0	93
B27	8.F	9.F	0.25				Bernera Rd	0.3	0.3	0.6	0.6	0	91
B28	9.F	N33	0.2				Dummy used to model flow across road low points	0.2	0.05	0.6	1	0	90

OF58	10.F	N33	0.2				Dummy used to model flow across road low points	0.2	0.05	0.6	1	0	2313992
B30	11.F	12.F	0.8				Drainage Easement Access Road	0.3	0.3	0.6	1.4	0	87
B31	12.F	13.F	0.56				Drainage Easement Access Road	0.3	0.3	0.6	1.1	0	85
B32	13.F	15.F	1.03				Drainage Easement Access Road	0.3	0.3	0.6	0.4	0	83
B33	14.F	15.F	0.9				Drainage Easement Access Road	0.3	0.3	0.6	1.8	0	82
B65	2.J	3.I	0.25				Bernera Rd	0.3	0.3	0.6	0.8	0	94
B56	HW 1.F	2.F	0.1	30.96	5	1.7	Dummy used to model flow across road low points	0.2	0.05	0.6	1	0	110
B57	2.F	3.F	0.16				Bernera Rd	0.3	0.3	0.6	1.2	0	109
B58	3.F	5.F	0.46				Bernera Rd	0.3	0.3	0.6	0.1	0	108
B59	4.F	5.F	0.46				Bernera Rd	0.3	0.3	0.6	0.1	0	105
B62	5.F	1.H	0.6				Bernera Rd	0.3	0.3	0.6	0.4	0	106
B61	1.H	2.J	0.67				Bernera Rd	0.3	0.3	0.6	1.3	0	97
OF10558	HW I.1	3.I	0.1	29	5	1.7	Dummy used to model flow across road low points	0.2	0.05	0.6	2.4	0	39002783
B68	3.I	9.F	0.1				Dummy used to model flow across road low points	0.2	0.05	0.6	1	0	92
OF-Dmy13A	13.A-100yr	Basin2	0.35				Dummy used to model flow across road low points	0.2	0.05	0.6	1	0	77
OF-BASIN2	Basin2	3.D6	0.1	34.34	20	1.7	Bernera Rd full road	0.3	0.3	0.6	1.2	0	50680664
OF-1D6	1.D6	2.D6	0.15				Dummy used to model flow across road low points	0.3	0.3	0.6	1	0	63727946
OF12344	2.D6	3.D6	1				Half road	0.3	0.3	0.4	1	0	199267306
OF-3D6	3.D6	Bernera Rd	1				Bernera Rd full road	0.3	0.3	0.6	1	0	197828298
OF-VE1	Pit-VE1	Pit-VE2	0.2				Drainage Easement Access Road	0.3	0.3	0.6	1	0	197828304
OF-VE2	Pit-VE2	Pit-VE3	0.82				Drainage Easement Access Road	0.3	0.3	0.6	1.2	0	197828305
OF-VE3	Pit-VE3	Pit-VE4	0.21				Drainage Easement Access Road	0.3	0.3	0.6	1.8	0	197828306
OF Access Place	Pit-VE4	3.F	2				Drainage Easement Access Road	0.3	0.3	0.6	1.9	0	197828302
OF-VE5	Pit-VE5	Pit-VE6	0.64				Drainage Easement Access Road	0.3	0.3	0.6	1.2	0	197828307








APPENDIX B – TUFLOW MODELLING ASSUMPTIONS

A *TUFLOW* model was setup to represent the "Existing" Scenario (including buildings, roads and stormwater infrastructure). As with any flood modelling, a number of assumptions are necessary to allow for the modelling process to proceed. The assumptions adopted in the existing model developed are summarised below:

- **Digital Terrain Model (DTM)** – The adopted DTM was supplied by Council and has been used as the basis for modelling. A 2 m grid has been adopted across this DTM to provide a precise representation of existing Scenarios. Additional elements were then also added to ensure the model accurately reflects key locations, these include:
  - "Z shape" lines at all entry and exit locations of headwalls to match to Works-As-Executed (WAE) information;
  - Retaining wall at the interface of the residential area with Kurrajong Road has been modelled to reflect WAE information using "Z shape" lines;
  - An assumed gully line has been incorporated at the North-East corner of Network A (near the ALDI warehouse) to ensure that flows exiting the existing headwall at "Pit 15-F" grade out to the nearby existing channel. In this location the DTM was shown higher than the outlet level;
  - "Z shape gully" lines have been adopted at the invert of existing channels (from Kurrajong Road and near M7) to match WAE levels;
  - "Z shape gully" line has also been adopted to reflect the concrete channel running along the western side of Bernera Road near the M7 interchange;
  - "Z shape" lines adopted along the Eastern side of the Sydney Water Easement to represent the existing kerb height.

- **1D Network -** The existing stormwater drainage systems for Networks A, C and D were represented in *TUFLOW* as a one-dimensional (1D) ESTRY model. Each pit was assigned an inlet capacity based on industry standard pit inlet capacities while pipe sizes and invert levels were assigned based on WAE information. The pipe network has adopted 20 % blockages on all on grade pits and 50 % blockages for all sag pits throughout all assessments.

- **Buildings** – All existing buildings in the *TUFLOW* model were modelled using the "exterior walls" technique.

  This technique has been applied via the creation of exterior walls on three side of the building, with a break provided on the low side of the building (refer to the attached Figure 10-11. Source: *ARR Project 15 November 2012 report*). Under direct rainfall, a lower Manning's value is then assigned inside the building limits to reflect a faster runoff from roof areas, whilst the walls provide an obstruction to upstream flows and direct flows around the building perimeter.

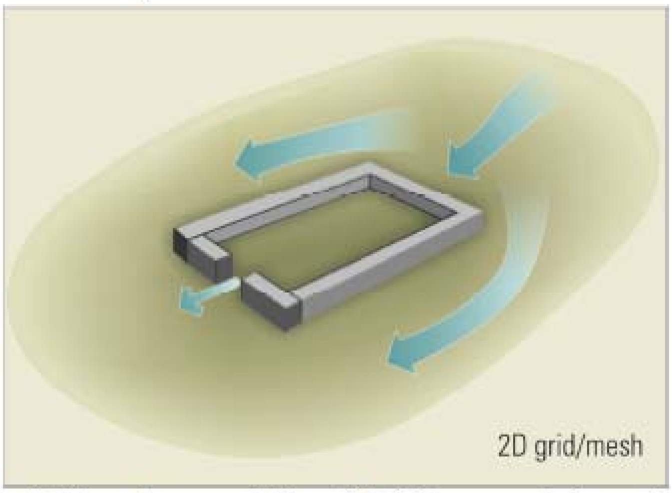


Figure 10-11 Representation of Buildings as exterior walls only

In accordance with *ARR Project 15 November 2012 Report*, all building structures have been modelled based on their proximity to flooded areas (refer to Figure 4.1):

- "Outside flooded areas" have a low Manning's value = 0.015
- "Within flooded areas" have a high Manning's value = 0.1

- **Boundary Scenarios –** A "HQ" (Height versus Flow) boundary utilises information from the underlying terrain and develops a discharge hydrograph based on the downstream channel slope. The existing model has adopted several HQ boundaries based on the existing terrain. Refer to Figure 4.1 for locations.
- **Manning's Roughness** – Aerial imagery provided by Council was assessed in order to classify the various landuses under existing Scenarios across the overall catchment. Each landuse was then assigned both Manning's Roughness and Initial / Continuing Loss Parameters to emulate its associated catchment response. Refer to the Table B.1 below.

TABLE B.1 – LANDUSE PARAMETERS

Material	Manning' "n"	Initial Loss (mm), Continuing Loss (mm/hr)	Description
1	0.035	15,2.5	Default Floodplain
2	0.015	1,0	buildings (outside flooded areas in direct rainfall)
3	0.1	1,0	buildings (within flooded areas)
4	0.035	15,2.5	Open Space
5	0.015	1,0	Asphaltic Concrete Surfaces
6	0.02	2,1.5	Road reserve (combination sealed and verge)
7	0.05	15,2.5	Light Vegetation
8	0.08	15,2.5	Medium Vegetation
9	0.03	10,2.5	Gardens
10	0.015	1,0	Concrete Surfaces
14	0.05	15,2.5	Rural Zoning

- **Flows** – The *TUFLOW* model has been run under "Direct Rainfall" with flows being applied to the 2 m grid. The hyetograph used in the modelling was built upon the IFD table isted in Liverpool City Council guidelines an applying to the Temporal pattern for ARI > 30 years as listed in the Australian Rainfall and Runoff (2 hour duration in 24 periods of 5 minutes)
-

The critical duration for the 1 % AEP event is the 120 minute event. We confirm that based on the management of flows within the basin, the 120 min duration is also the critical event for both the 10 % and 2 % AEP events. *TUFLOW* modelling has consequently been completed for the 120 minute duration for the full range of AEP events.

- **Tailwater Conditions** – As discussed in Section 2.0, the study area is located within the Cabramatta Creek catchment. Following review of previous studies (Bewsher, 2004 and 2010) and discussions with Council, Tailwater conditions were adopted in *TUFLOW* by setting the "Initial Water Level" at the three (3) locations shown in Table B.2.
  It is noted that this is a conservative approach, since it assumes that there is a coincidence of flooding for the peak events - which is unlikely. Similarly in the absence of information, the 1 % AEP tailwater level has conservatively been adopted for those lower AEP events.

TABLE B.2 – TAILWATER CONDITIONS

Location	1 % AEP Tailwater Level (RL m AHD)
M7 interchange	27.3
Existing Channel (near ALDI)	25.36
Crown Land (to the East)	25.94

- Under direct rainfall, the hyetograph is applied to every cell across the catchment, which can show widespread very shallow water depths. In order to differentiate between sheet flow and flooding a “Map Cutoff depth” of 75 mm has subsequently been applied. That is, surface flows which are less than 75 mm depth are considered in the modelling but are not illustrated on the figures for clarity.

- A series of “Plot output lines” (PO) were included within each of the TUFLOW model runs in order to track the peak flows and velocities. The PO function enables all flows, which pass through the cross section during a TUFLOW run to be recorded, which subsequently ensures that the maximum value (i.e flowrate or flood level) can be accurately determined at the relevant location.

Model Development and Assumptions (Interim)

A *TUFLOW* model was setup to represent the "Interim" Proposed Scenario. The development of this model has built upon the "Existing" Model, but also includes the following:

- **Detention on Proposed Industrial Lots** – On site detention (OSD) will be required for all proposed industrial lots in Prestons (with the exception of six (6) lots fronting Yato Road – refer Figure 7.7). In order to reflect pre-post requirements imposed by OSD under a direct rainfall model, the following methodology was adopted:
  - Using standard Rational Calculations, determine the 10 % AEP "existing" runoff generated from each lot which is to be developed (based on LEP / cadastral layout).
  - In *TUFLOW*, apply an average Manning's value (0.017) across all proposed industrial lots.

TABLE B.2 – MANNINGS

	Concrete/ Building	Grassed	Average
Manning's	0.015	0.035	0.017
Impervious	90%	10%	

  - Regrade all proposed industrial lots to a new discharge point (at the lowest corner).
  - Provide a pit with piped outlet (i.e 1D ESTRY) to the nearest pit in Council's street system and apply an artificial wall along the boundary.
  - Run the *TUFLOW* model for the 10 % AEP event and determine the equivalent pipe size to achieve pre-post at each lot.
  - Repeat steps and apply for the 1 % AEP event.

  By applying this methodology, the direct rainfall being applied on the lot will drain to a common discharge point (as it will likely under development Scenarios). Whilst the introduction of the artificial wall will emulate the likely on-site detention that will be required for these lot and will charge the pipe system to it's intended 1 % and 10 % AEP capacity.

- **38 – 46 Bernera Road** – The proposed development at 38 – 46 Bernera Road is currently under construction and has been included in the model. Features site include (a) 1200 dia pipe and easement connecting the culverts under Bernera Road to the Sydney Water Easement to the East; (b) Three (3) On Site Detention Tanks; and (c) provision for overflow to Yato Road via the access place. The *TUFLOW* Model has adopted the following:
  - Lot area is locally removed from direct rainfall model;
  - Hydrographs from the *DRAINS* model provided by *Van Der Meer Consulting* has been applied into *TUFLOW* at each of the three (3) OSD tanks direct to the 1D ESTRY network;
  - The 1200 dia pipe location and levels adopted as per *Van Der Meer Consulting* Plans;
  - The access place has been added to the DTM based on WAE Information.

- **Digital Terrain Model (DTM)** – Additional elements were then also added to ensure the model accurately reflects key locations, these include:
  - Flood Protection Mounds were applied wherever required using "Z shape" lines, to ensure that redirected flooding is conveyed along Bernera Road and does not enter proposed lots

Model Development and Assumptions (Final)

A *TUFLOW* model was setup to represent the “Final” Proposed Scenario. Development of the model builds upon the “Interim” model, but also includes the following:

- **Digital Terrain Model (DTM)** – Detailed 3d surface modelling has been undertaken in 12d software to represent the proposed basin concept (Refer to Figure 7.14). This modelling includes the detention basin, swale from Kurrajong Road and the overland flowpath to Bernera Rd. The updated DTM was adopted in the model with a 2 m grid applied.

  The industrial lot located directly adjacent to the overland flowpath (i.e. downstream from the basin) was elevated using “Z-Shape” files to protect from potential dam failures or events greater than the basin capacity.

- **1D Network** – The proposed 2 x 1200 dia outlet pipes (at minimum 0.5 %) were added to the 1D ESTRY Model.

- **Basin Outlet** - The staged outlet was modelled via a 1d-network and a 1d-xs. The cross section profile of the spillway was applied at 20 m width (RL 34.35), with an additional width of 40 m at RL 34.55 (sized to the ½ PMF event). The inlet to the low level piped outlet (2 x 1200 dia pipes) is represented by a SX connection to emulate an oversized inlet arrangement that would form part of the detailed design process. This has been modelled in this way to maximise flows exiting the basin to ensure that the outlet pipes are the constraint and not any inlet arrangement.








APPENDIX C – ESTIMATE OF QUANTITIES

PRELIMINARY COST ESTIMATE

PROJECT: Prestons Trunk Drainage

CLIENT: Liverpool City Council

Concept Basin, Channel and associated drainage

NO.	ITEM	QTY.	UNIT	RATE Exc GST$	AMOUNT Exc GST$
1	**BASIN**				
	Establishment (5%)	1	item	$275,000.00	$275,000.00
	Clearing (Allowance Only)	1	item	$25,000.00	$25,000.00
	Strip & stockpile topsoil	14,810	sq.m.	$1.50	$22,215.00
	Respread topsoil (elsewhere on site)	14,810	sq.m.	$2.50	$37,025.00
	Earthworks - Cut and Fill on Site	540	cu.m.	$5.00	$2,700.00
	Earthworks - Cut and Dispose off site	22,240	cu.m.	$75.00	$1,668,000.00
	Trim and Compact	14,810	sq.m.	$1.00	$14,810.00
	Planting (incl maintenance for 2 years)	11,710	sq.m.	$9.50	$111,245.00
	Rock Lined Weir and Spillway (incl 50 yr maint) (10m long x 20m wide)	200	sq.m.	$250.00	$50,000.00
	Reinforced Turfing on 1/2 PMF Spillway (10m long x 40m wide less Rock Lined area)	400	sq.m.	$25.00	$10,000.00
	2x 1200 mm dia RRJ2	190	ln.m	$600.00	$114,000.00
	Main Basin Outlet Structure	1	item	$15,000.00	$15,000.00
	Soil & Water Management (Allowance Only)	1	item	$25,000.00	$25,000.00
	Special Pit	3	item	$10,000.00	$30,000.00
				SUBTOTAL	**$2,400,000.00**
2	**DRAINAGE CHANNEL**				
	Establishment (Allowance Only)		Item	$10,000.00	
	Clearing & Desilt (Allowance Only)		Item	$10,000.00	
	Strip, Stockpile & Respread Topsoil	1,400	sq.m.	$4.00	$5,600.00
	Earthworks - Excavate and Dispose of Unsound Material		cu.m.	$200.00	
	Earthworks - Cut to Fill On Site		cu.m.	$5.00	
	Earthworks - Import material		cu.m.	$7.50	
	Earthworks - Cut to Dispose off Site (incl. disposal fees)	2,710	cu.m.	$75.00	$203,250.00
	Trim and Compact	1,400	sq.m.	$1.00	$1,400.00
	Planting (incl maintenance for 2 years)	1,400	sq.m.	$9.50	$13,300.00
	Hydromulch Temporary Batters	1,900	sq.m.	$1.00	$1,900.00
	Rock Lined Channel Protection at Culvert Outlets (assumed)	100	sq.m.	$250.00	$25,000.00
	Soil & Water Management (Allowance Only)		item	$15,000.00	
	Retaining wall (assumed 0.5m high)	85	sq.m.	$600.00	$51,000.00
	2x 600mm RRJ Low Flow Pipes	190	ln.m	$200.00	$38,000.00
				SUBTOTAL	**$340,000.00**
3	**BIO-RETENTION RAINGARDEN**				
	Raingarden (incl. media bed & subsoil drainage)	2,900	sq.m.	$180.00	$522,000.00
	Raingarden Planting	2,900	sq.m.	$45.00	$130,500.00
	Construction of Maintenance Access	1	each	$10,000.00	$10,000.00
	GPT device and Associated Drainage Infrastructure	1	item	$200,000.00	$200,000.00
	Retaining wall (assumed 1m high)	250	sq.m.	$600.00	$150,000.00
				SUBTOTAL	**$863,000.00**
				TOTAL FOR ITEMS 1, 2 & 3	**$3,603,000.00**
4	**PLANT & CONTINGENCIES**				
	7% Contingency		item		$250,000.00
				SUBTOTAL WITH CONTINGENCY	**$3,853,000.00**

TOTAL ESTIMATED COST without land acquistion	**$3,853,000.00**
Land acquisition (Area = 23200m^2)	$2,999,530
TOTAL ESTIMATED COST with land acquistion	**$6,852,530**

CLARIFICATIONS

The following clarifications and assumptions have been adopted:

1 This Cost Estimate is based on J. Wyndham Prince's experience and judgment as a firm of practicing professional civil engineers familiar with the construction industry and that the cost estimate can not be guaranteed as we have no control over Contractor’s prices, market forces, material supply costs, competitive bids from tenderers and specific site conditions that may be encountered but not yet investigated.

2 This Cost Estimate is based on the information supplied by the client prior to the date of preparation and is subject to traffic investigation and modelling, geotechnical investigation and design and detail civil design works.

3 The Cost Estimate is based on present day costs (2014).

4 The Cost Estimate has been prepared for the purposes of preliminary costing to assist in the decision making process. They are provided in good faith and intended to be preliminary only. Refer to "Preliminary Concept" sketch dated 9/01/2014.

5 Establishment Costs have been assumed to be approximately 5% of the Construction Works of the elements (including additional contingencies).

6 Clearing Costs are indicative only and are based on assumptions after assessing recent aerial photography of the area.

7 A drainage channel with low flow pipes will convey flows from Kurrajong Road to the basin. Exact size and configuration to be determined in modelling and design stage.

8 Excavation in rock has not been considered. Geotechnical Investigations to confirm site conditions in future detailed design stage.

9 The basin outlet will be staged and include both a high level rock spillway and a low level piped outlet. Preliminary sizing has identified a 20m wide spillway and assumes a length of 10m. Walling and base (floor) armoured protection is provided.

10 The basin outlet structure will be oversized to ensure that the outlet pipe is fully utilised. Exact size to be confirmed during modelling and design.

11 The 1/2 PMF spillway includes Reinforced Turfing and is assumed to utilise 18mm 3D synthetic matting, which will be placed on the weir and the downstream side of Spillways from the weir to the finished ground level, for the full width of the spillway and weir. This 1/2 PMF spillway is assumed at 40m wide and will be confirmed in Stage 2 design works.

12 Soil & Water Management costs have been assumed to be based on a general allowance involving generic erosion protection measures.

13 Raingarden costs include the excavation, placement of subsoil drainage system, placement of drainage media and 500mm deep treatment filter media layer. Planting has been excluded from the general cost, but has been itemised in the following line item.

14 GPT devices cost are assumed to includes supply and placement of device and also includes the provision for a diversion splitter pit and related pipework.

15 Provision is made for one (1) GPT upstream of the grassed swale alongside Kurrajong Road. This GPT will be receiving flows from the nearby Residential Area (approximately 37 ha). The GPT is costed based on a CDS Unit and assumed at the rates shown below.

- <10Ha at $25,000 unit Cost
- 10Ha at $50,000 unit Cost
- 10Ha to 20Ha at $100,000 unit Cost
- 21Ha to 50Ha at $200,000 unit Cost

16 Rock Erosion Protection costs include placement of rock armouring downstream of the GPT into the channel. Includes rock ramps and energy dissipaters.

17 No allowance has been accounted for the following costs: Consultancy and Project Management Fees, Government Agency Approvals, Council DA Fees, planFIRST Levy and PCA Fees.

18 Land acquisition have been advised by Liverpool City Council (email dated 16th April 2014)

19 Contingency amount is supplied by Liverpool City Council (email dated 1/8/14)

Liverpool City Council Design Services Estimate Sheet (Box Culvert Option)

Description	Quantity	Unit	Unit Rate	Price	Subtotals
PROJECT PRELIMINARIES					$ 722,245.00
Site Establishment, Disestablishment and Cleanup	5	item	$ 10,000.00	$ 50,000.00	
Supply, install and removal of project signboard	10	each	$ 2,000.00	$ 20,000.00	
Survey setout	15	item	$ 2,000.00	$ 30,000.00	
Control of traffic	1	item	$ 200,000.00	$ 200,000.00	
Temporary erosion and sedimentation control	6	item	$ 6,000.00	$ 36,000.00	
Clearing and grubbing					
Removal of trees outside limits of clearing	50	tree	$ 1,500.00	$ 75,000.00	
Fence					
Fence	250	lin m	$ 195.00	$ 48,750.00	
Fence relocation	500	lin m	$ 100.00	$ 50,000.00	
Landscaping					
Spread and level topsoil to depth of 50mm	3570	m^2	$ 2.50	$ 8,925.00	
Provide hydroseeding by hydro-mulching	3570	m^2	$ 1.00	$ 3,570.00	
Services Adjustment					
Services Adjustment	1	each	$ 200,000.00	$ 200,000.00	
DRAINAGE					$ 6,742,840.00
Excavation for stormwater drainage culverts only					
Earth <2 m deep, cartage surplus material of site	16000	m^3	$ 75.00	$ 1,200,000.00	
Backfilling Trenches					
~~Clean sand~~		~~m^3~~	~~$ 43.50~~	~~$~~	
Light Soil	2540	m^3	$ 33.75	$ 85,725.00	
~~20mm crushed rock~~		~~m^3~~	~~$ 100.50~~	~~$~~	
Box culverts					
Supply all materials and construct R.C.B.C to details including sealing of all joints and backfilling:					
(a) Compaction and preparation of subgrade	5900	m^2	$ 2.50	$ 14,750.00	
(b) Backfill to subgrade with crushed sandstone (assumed 150mm thick)	885	m^3	$ 11.00	$ 9,735.00	
(c) 2.4 x 1.2m precast RCBC (Humes - 2.45m length)	392	each	$ 5,140.00	$ 2,014,880.00	
(d) 3 x 1.2m precast RCBC (Humes - 2.45m length)	173	each	$ 6,700.00	$ 1,159,100.00	
(e) 2.4 x 1.2m precast baseslab (Humes - 2.45m length)	392	each	$ 3,320.00	$ 1,301,440.00	
(f) 3 x 1.2m precast base slab (Humes - 2.45m length)	173	each	$ 4,800.00	$ 830,400.00	
Reconstruct large pit 3mx3mx2m depth	1	each	$ 10,000.00	$ 10,000.00	
Pipe extensions					
scour protection at the start and end	2	ln.m	$ 10,000.00	$ 20,000.00	
Subsoil drainage					
subsoil drain pipe - 100mm dia slotted corrugated plastic pipe (each side)	2766	ln.m	$ 35.00	$ 96,810.00	
				SUBTOTAL:	$ 7,465,085.00
ADDITIONAL ITEMS					$ 1,221,350.00
Demolition					
Sawcut, demolish and dispose of existing concrete kerb	620	ln.m	$ 40.00	$ 24,800.00	
Demolish and dispose of existing concrete slabs, driveways and asphalt pavement	3440	m^2	$ 15.00	$ 51,600.00	
Drainage Structures					
Excavate in all classes of material, supply all materials and construct new pit (up to 2 metres in depth) including sub-soil drainage connections and trench drainage facilities:					
(a) Large Junction Pit (Cast In Situ)	4	each	$ 10,000.00	$ 40,000.00	
Excavate in all classes of material, supply all materials and construct headwall to suit RCBC:					
(a) Rock headwall with wing walls	1	each	$ 10,000.00	$ 10,000.00	
Supply and install GPT Device	1	each	$ 200,000.00	$ 200,000.00	
Road Re-construction					
Supply all materials and construct kerbs and gutters to Council standards:					
(a) 150mm kerb & gutter including vehicular crossings and kerb ramps	455	ln.m	$ 48.00	$ 21,840.00	
(b) 150mm flush kerb	165	ln.m	$ 42.00	$ 6,930.00	
Reconstruct road pavement over box culverts. Supply and place deeplift pavement as follows:					
(a) 100mm thick DGB20 basecourse	2760	m^2	$ 10.50	$ 28,980.00	
(b) Polymer modified asphaltic concrete (AC10) min 50mm thickness.	2760	m^2	$ 35.00	$ 96,600.00	
(c) 2 x 170mm compacted thick layers AC14	2760	m^2	$ 240.00	$ 662,400.00	
Reconstruction of Concrete Driveways and Flowpath					
Reconstruct all disturbed driveways. Supply all materials and construct concrete pavement 185mm thick including SL92 reinforcing, 40Mpa concrete, jointing and approved surface treatment (assumed 7 based on aerial imagery)	100	m^2	$ 115.00	$ 11,500.00	
Reconstruct disturbed concrete swale / flowpath. Supply all materials and construct concrete pavement 150mm thick including SL82 reinforcing, jointing and 25mm thick sand bedding (assumed 165 m long based on aerial imagery)	580	m^2	$ 115.00	$ 66,700.00	
SUBTOTAL					$ 8,686,435.00
Contingency (7%)					$ 608,100.00
TOTAL ESTIMATED COST					**$ 9,294,535.00**

**Original Cost Estimate provided by Council. Updates undertaken by J.Wyndham Prince marked ir green.

HYDROLOGY DESIGN SHEET

	PIT NAME	RETURN PERIOD	TOTAL AREA (ha)	IMPERVIOUS AREA (ha)	IMPERVIOUS C	CRITICAL Tc (min)	RAINFALL INTENSITY (mm/hr)	LOCAL RUNOFF (cms)	OUTGOING PIPE FLOW (cms)
A	A3	20	3.640	3.276	0.945	59.102	57.208	0.517	0.517
	A2	20	2.030	1.827	0.945	62.935	55.265	0.279	0.796
	A1	20	2.460	2.214	0.945	64.293	54.828	0.335	1.131
B	B5	20	0.800	0.720	0.945	9.715	139.936	0.278	0.278
	B4	20	3.640	3.276	0.945	27.283	92.574	0.837	2.025
	B3	20	2.020	1.818	0.945	27.834	91.963	0.462	2.490
	B2	20	0.500	0.050	0.945	28.718	90.980	0.062	4.482
	B1	20	6.300	5.670	0.945	32.255	87.048	1.363	5.636
	B9	20	3.960	3.560	0.945	10.496	135.758	1.335	1.335
	B8	20	2.020	1.818	0.945	11.831	130.830	0.657	1.992
	B7	20	1.920	1.728	0.945	23.671	96.590	0.461	0.461
	B6	20	1.920	1.728	0.945	25.338	94.737	0.452	0.913
	B10	20	4.640	4.176	0.945	20.496	100.118	1.154	1.154
C	C3	20	1.010	0.909	0.945	11.965	130.334	0.327	0.327
	C2	20	4.451	4.006	0.945	21.060	99.491	1.100	1.427
	C1	20	1.010	0.909	0.945	22.182	98.244	0.247	2.312
	C4	20	1.580	1.422	0.945	6.965	162.572	0.638	0.638
D	D5	20	1.013	0.911	0.945	16.965	111.874	0.281	0.282
	D4	20	0.150	0.135	0.945	17.315	110.582	0.041	0.322
	D3	20	6.450	5.805	0.945	18.982	104.429	1.674	1.996
	D2	20	0.830	0.747	0.945	19.336	103.122	0.213	2.209
	D1	20	1.600	1.440	0.945	20.158	100.495	0.400	2.609
E	E3	20	2.030	1.827	0.945	16.965	111.874	0.564	1.221
	E2	20	2.030	1.827	0.945	18.544	106.045	0.535	2.426
	E1	20	3.800	3.420	0.945	19.507	102.489	0.968	3.394
	E4	20	2.030	1.827	0.945	11.060	133.675	0.674	0.674
	E5	20	2.030	1.827	0.945	11.965	130.334	0.657	0.657
F	F9	100	29.800	15.360	1.000	37.611	104.504	6.571	6.571
	F8	100	4.304	3.874	1.000	39.219	102.210	1.161	7.732
	F7	100	4.304	3.874	1.000	40.801	99.952	1.136	10.322
	F6	100	3.100	2.790	1.000	41.550	98.882	0.809	11.131
	F5	100	0.205	0.022	1.000	41.787	98.544	0.031	11.161
	F4	100	0.330	0.297	1.000	42.020	98.212	0.086	11.247
	F3	100	0.350	0.297	1.000	42.267	97.859	0.088	11.335
	F2	100	0.350	0.297	1.000	42.499	97.528	0.088	11.423
	F1	100	3.320	2.988	1.000	43.045	96.748	0.848	12.271
	F10	100	4.304	3.874	1.000	21.208	127.915	1.454	1.453
G	G8	20	2.250	2.025	0.945	16.965	111.874	0.625	0.626
	G7	20	2.250	2.025	0.945	18.034	107.930	0.604	1.229
	G6	20	5.250	4.725	0.945	19.306	103.232	1.347	2.576
	G5	20	3.300	2.970	0.945	19.961	100.814	0.827	3.403
	G4	20	3.000	2.700	0.945	20.436	100.185	0.747	4.150
	G3	20	2.250	2.025	0.945	21.036	99.519	0.556	4.706
	G2	20	2.250	2.025	0.945	21.565	98.930	0.553	5.256
	G1	20	2.250	2.025	0.945	22.270	98.147	0.549	5.805
H	H7	20	3.500	3.150	0.945	16.965	111.874	0.973	0.973
	H6	20	1.050	0.945	0.945	17.740	109.013	0.284	1.257
	H5	20	1.050	0.945	0.945	18.314	106.896	0.279	1.536
	H4	20	1.050	0.945	0.945	19.180	103.696	0.271	1.807
	H3	20	1.050	0.945	0.945	19.968	100.790	0.263	2.070
	H2	20	3.100	1.860	0.945	21.904	98.553	0.631	2.700
	H1	20	2.800	2.520	0.945	23.282	97.022	0.675	3.376

DATE OF COMPLETION	SURVEYOR / DESIGNER			
DATE OF RELEASE	DESIGN SERVICES MANAGER			
DATE OF ACCEPTANCE	CLIENT / ASSET OWNER			
DATE OF RELEASE	CONTRACTS ENGINEER			
ISSUE	DATE	REASON FOR ISSUE	DRAWN	SIGNED	APPROV	CLIENT

LIVERPOOL CITY COUNCIL DESIGN SERVICES

1 HOXTON PARK ROAD, LIVERPOOL, NSW 2170
Ph (02) 9821 9264 Fax (02) 9821 9333

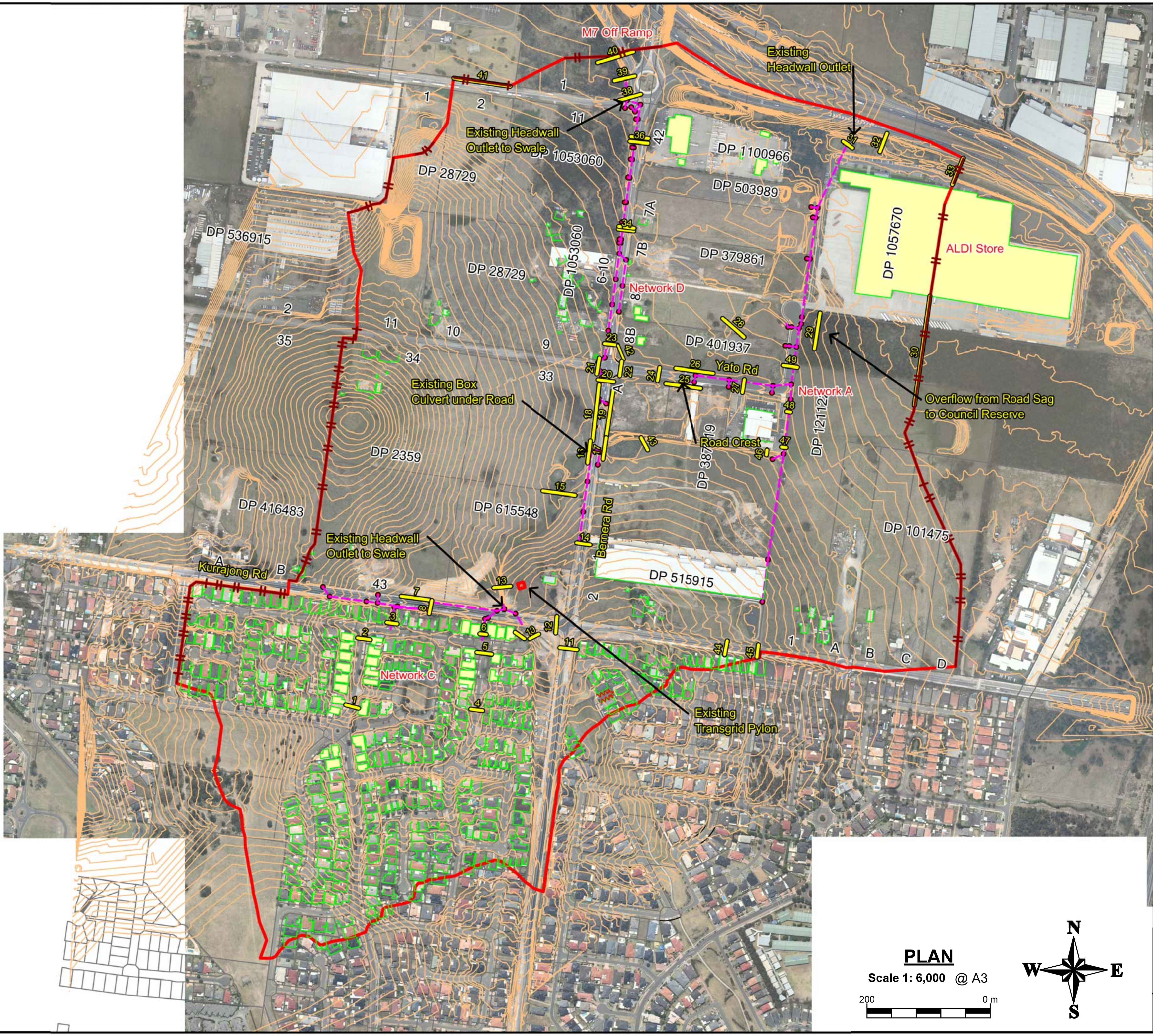
SURVEYED D.M./G.B. DATE	DATUM A.H.D./I.S.G.
DESIGNED P.B DATE 19.04.07	CHECKED V.C. DATE
DRAWN P.B DATE 19.04.07	CAD FILE XPEF·

DRAWING TITLE
YARRUNGA INDUSTRIAL AREA , PRESTON
SECTION 94 DRAINAGE PLAN
PROPOSED DRAINAGE PLAN
CLIENT:LIVERPOOL CITY COUNCIL - SECTION 94

SHEET No 3 OF 6 SHEETS
SCALES 1:4000
JOB No
ISSUE No A
CONTRACT No
PLAN No

APPENDIX D – OVERALL CATCHMENT PLAN

APPENDIX D



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LEGEND

- Existing Council Stormwater
- Existing Building (Inside Flooded Areas)
- Existing Building (Outside Flooded Areas)
- TUFLOW Boundary
- Flood Comparison Locations (PO)
- Boundary Condition (HQ)

9634 Figure 4.1
Prestons Trunk Drainage Flood Study

Overall Catchment Plan

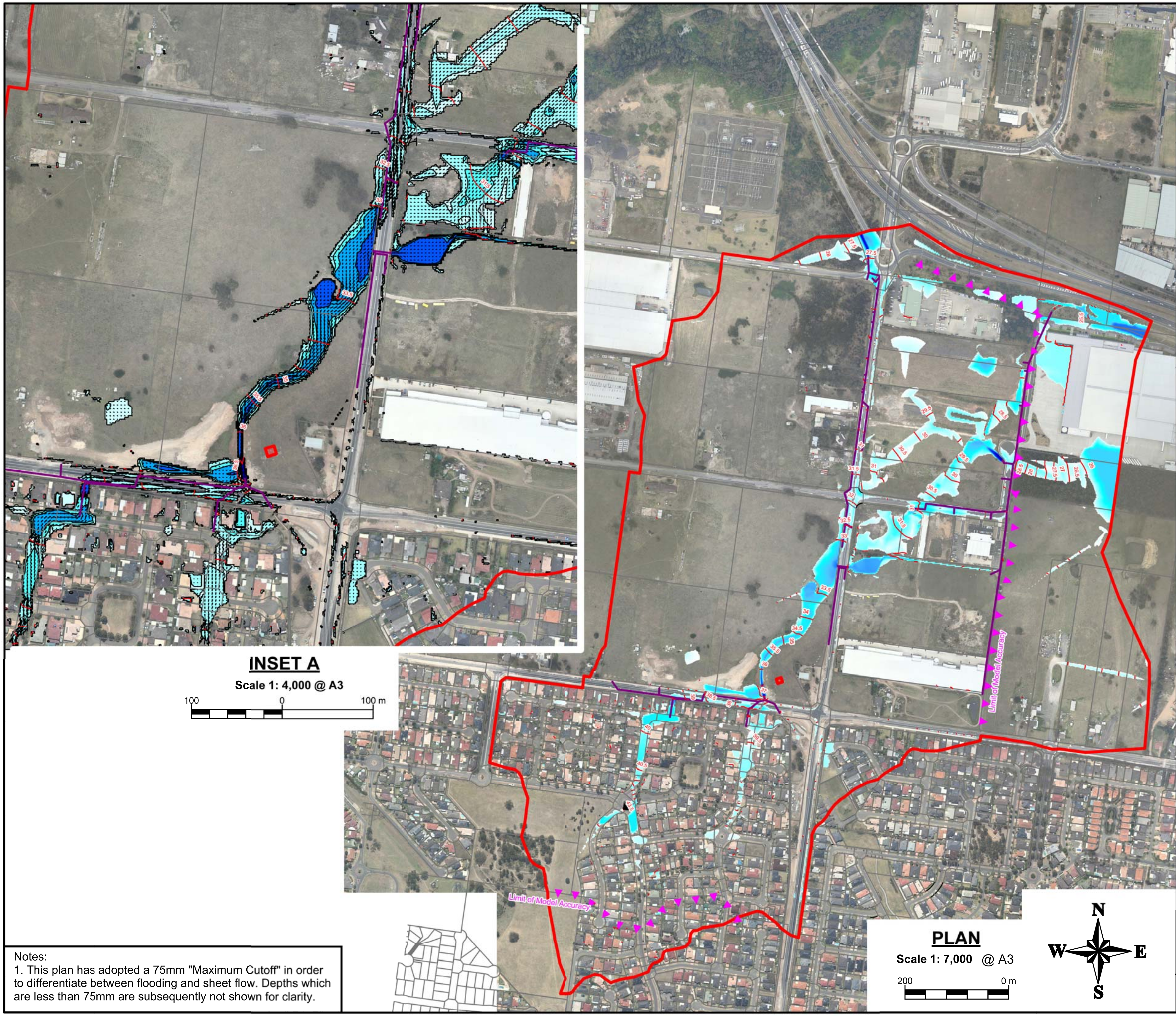
File Name: 9634 Fig 4.1 - Catchment
Date : 19/05/14
Issue : 3








APPENDIX E – EXISTING SCENARIO FIGURES



Notes:
1. This plan has adopted a 75mm "Maximum Cutoff" in order to differentiate between flooding and sheet flow. Depths which are less than 75mm are subsequently not shown for clarity.

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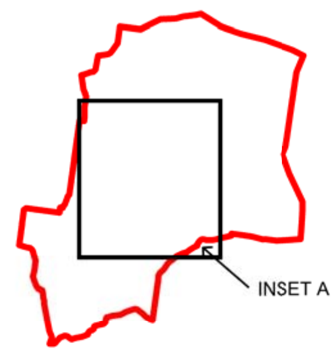


LEGEND

- Existing Council Stormwater
- TUFLOW Boundary
- Flood Level (m AHD)
- Velocity Vectors

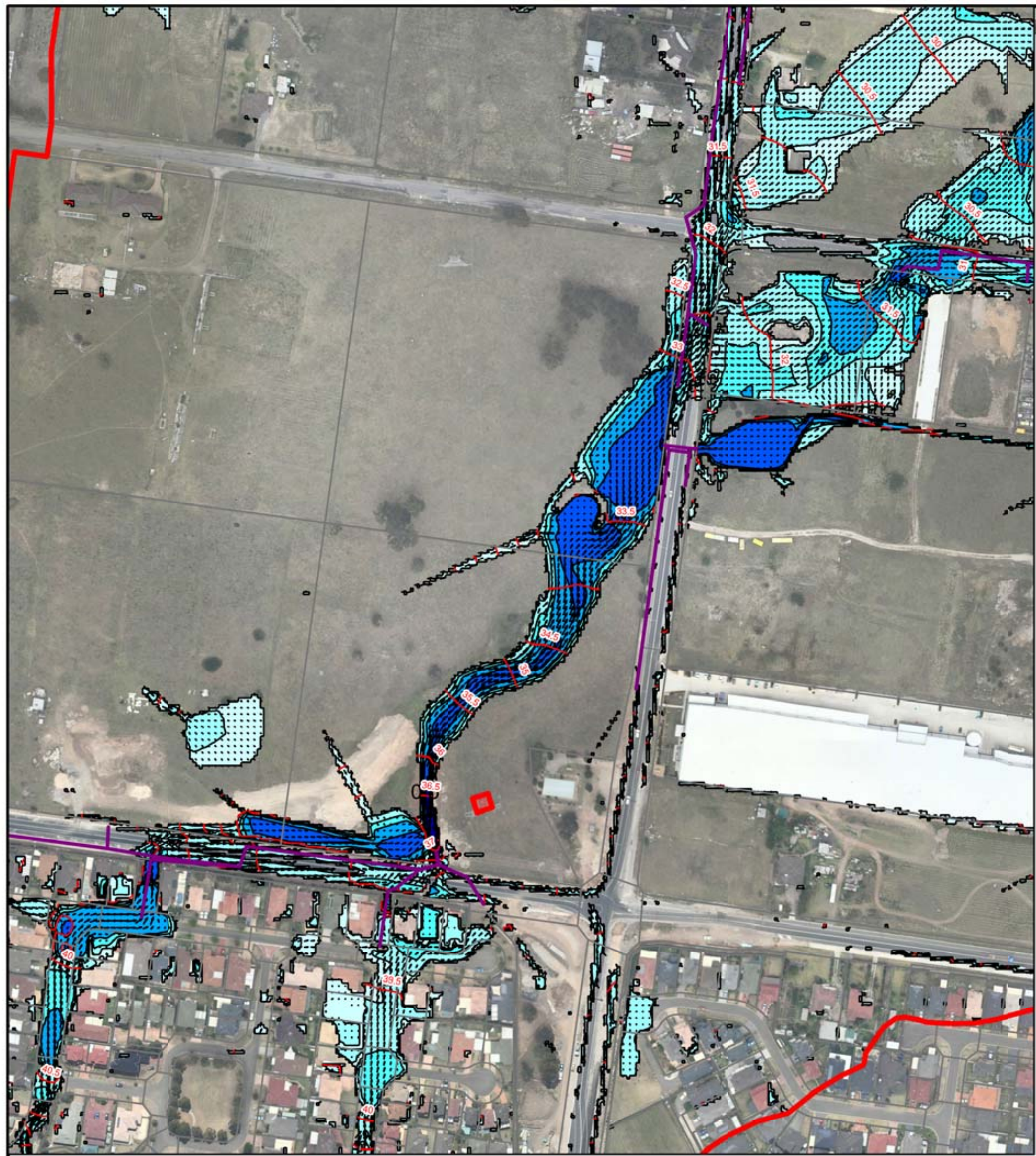
FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

9634 Figure 7.1
Prestons Trunk Drainage Flood Study

Existing
Flood Depth & Velocities
10% AEP

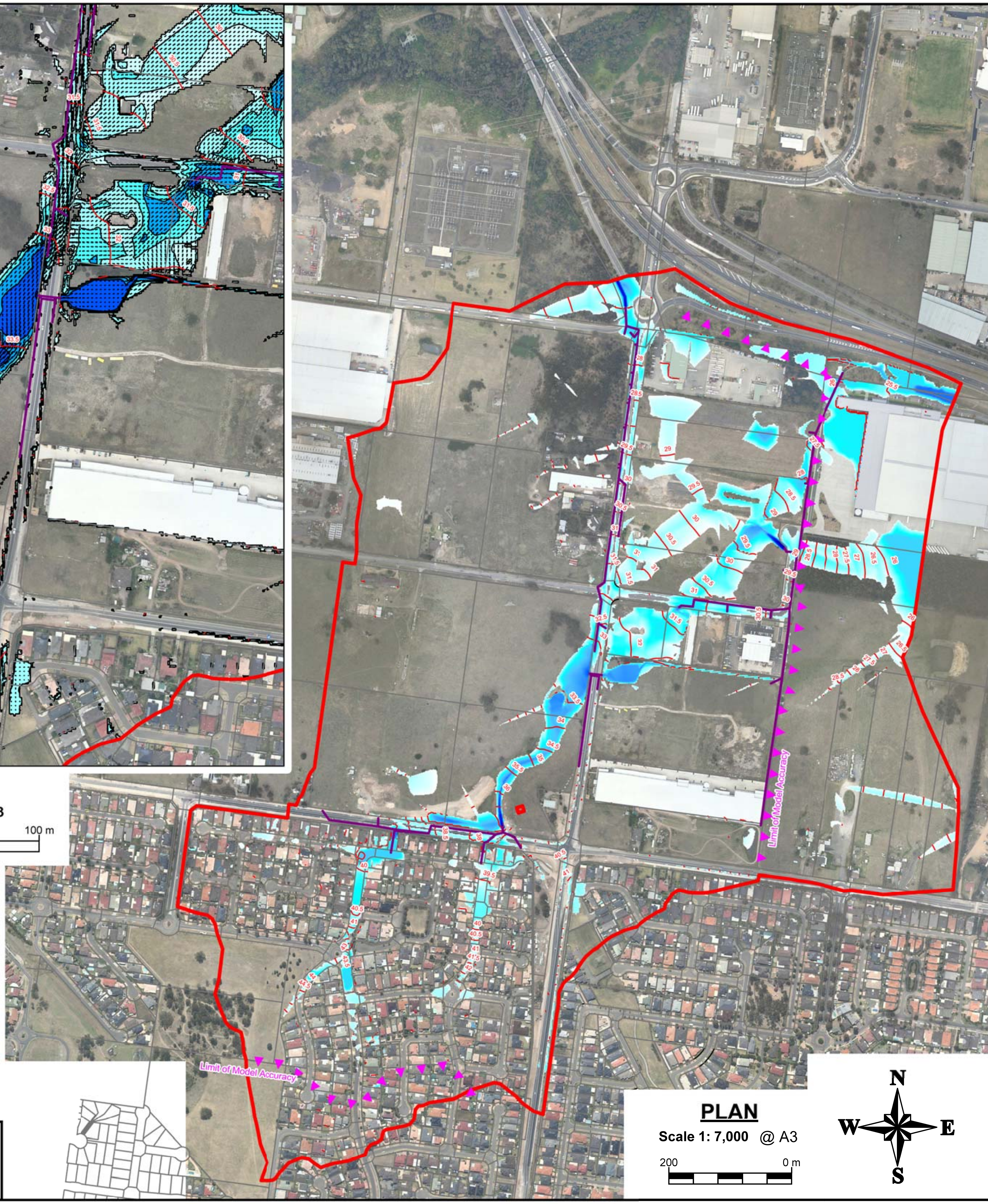
File Name: 9634 Fig 7.1 - Exi 10%AEP Depth
Date : 19/05/14
Issue : 3



INSET A

Scale 1: 4,000 @ A3

100 0 100 m



PLAN

Scale 1: 7,000 @ A3

200 0 m

N
W E
S

Notes:
1. This plan has adopted a 75mm "Maximum Cutoff" in order to differentiate between flooding and sheet flow. Depths which are less than 75mm are subsequently not shown for clarity.

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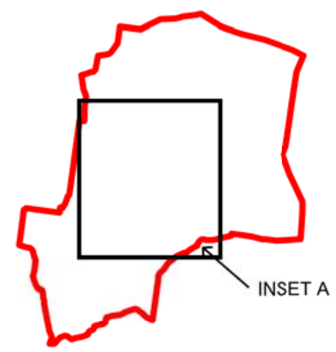


LEGEND

- Existing Council Stormwater
- TUFLOW Boundary
- Flood Level (m AHD)
- Velocity Vectors

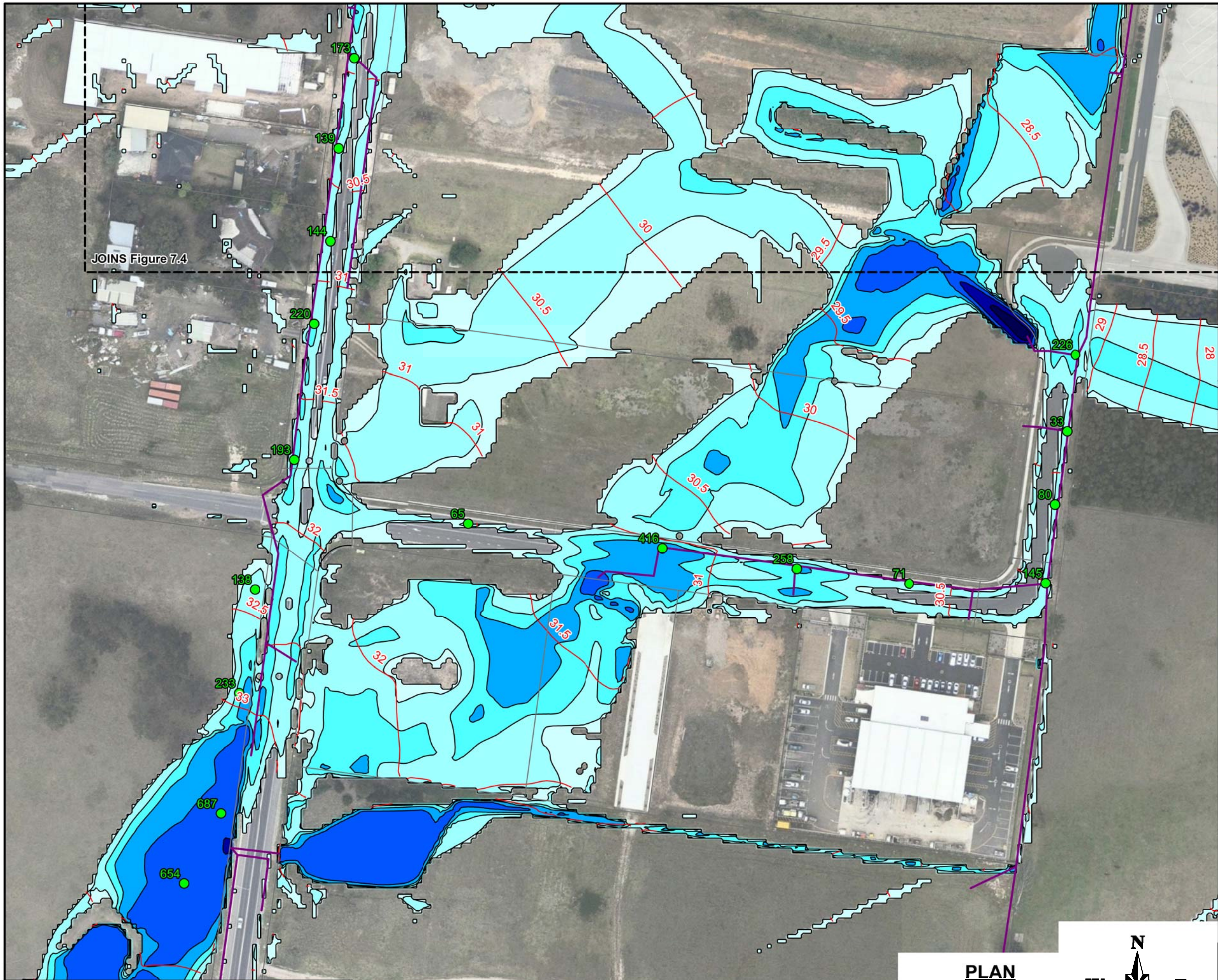
FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

9634 Figure 7.2
Prestons Trunk Drainage Flood Study

Existing
Flood Depth & Velocities
1% AEP

File Name: 9634 Fig 7.2 - Exi 1%AEP Depth
Date : 19/05/14 Issue : 3



PLAN

Scale 1: 1,500 @ A3

50 0 m

N W E S

Notes:
1. This plan has adopted a 75mm "Maximum Cutoff" in order to differentiate between flooding and sheet flow. Depths which are less than 75mm are subsequently not shown for clarity.

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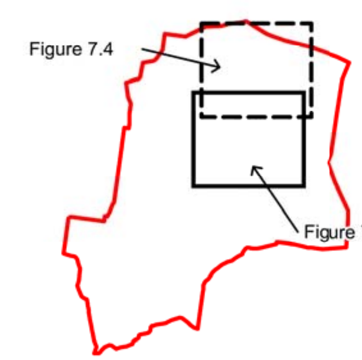


LEGEND

- Existing Council Stormwater
- 211 Existing Flood Depth (mm)
- 28.5 Flood Level (m AHD)

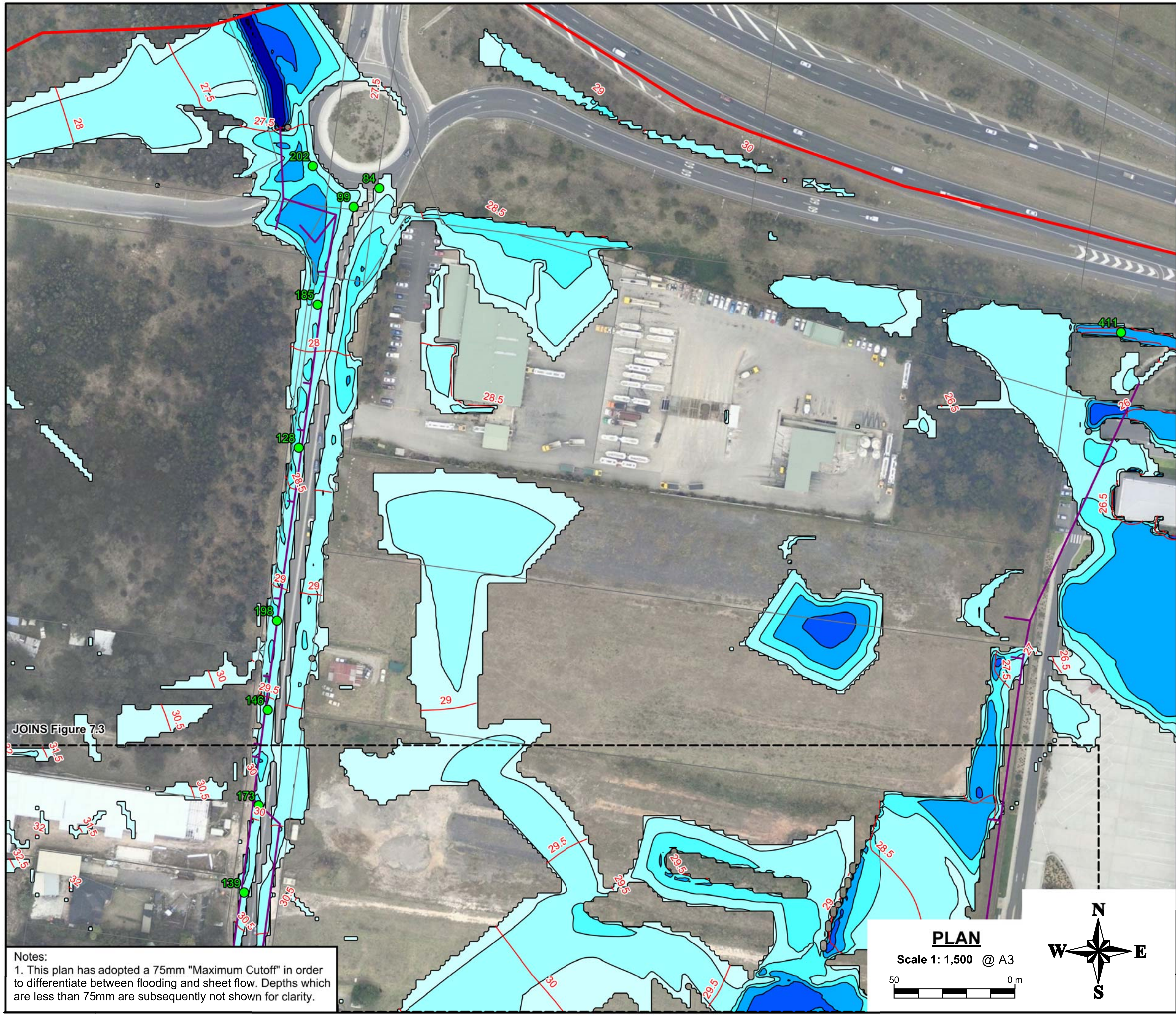
FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

9634 Figure 7.3 Prestons Trunk Drainage Flood Study

Existing Flood Depth 1% AEP

File Name:9634 Fig 7.3 - Exi 1%AEP Depth (1)
Date : 19/05/2014 Issue : 3



Notes:
1. This plan has adopted a 75mm "Maximum Cutoff" in order to differentiate between flooding and sheet flow. Depths which are less than 75mm are subsequently not shown for clarity.

PLAN

Scale 1: 1,500 @ A3

50 0 m

N W E S

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LEGEND

- Existing Council Stormwater
- 211 Existing Flood Depth (mm)
- 28.5 Flood Level (m AHD)
- TUFLOW Boundary

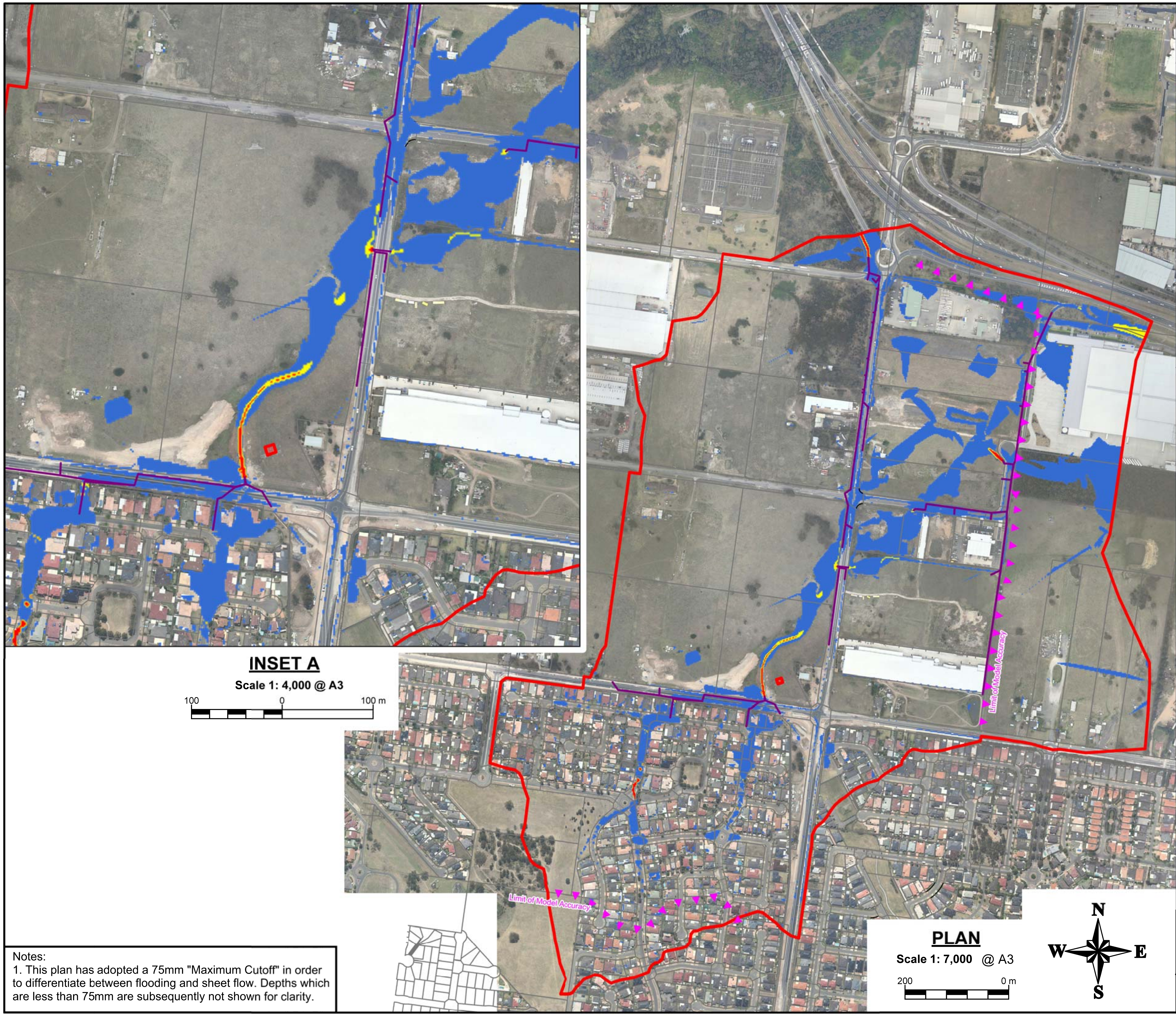
FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

9634 Figure 7.4
Prestons Trunk Drainage Flood Study

Existing Flood Depth 1% AEP

File Name:9634 Fig 7.4 - Exi 1%AEP Depth (2)
Date : 19/05/2014 Issue : 3



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INSET A

LEGEND

- Existing Council Stormwater
- TUFLOW Boundary

HAZARD CATEGORISATION

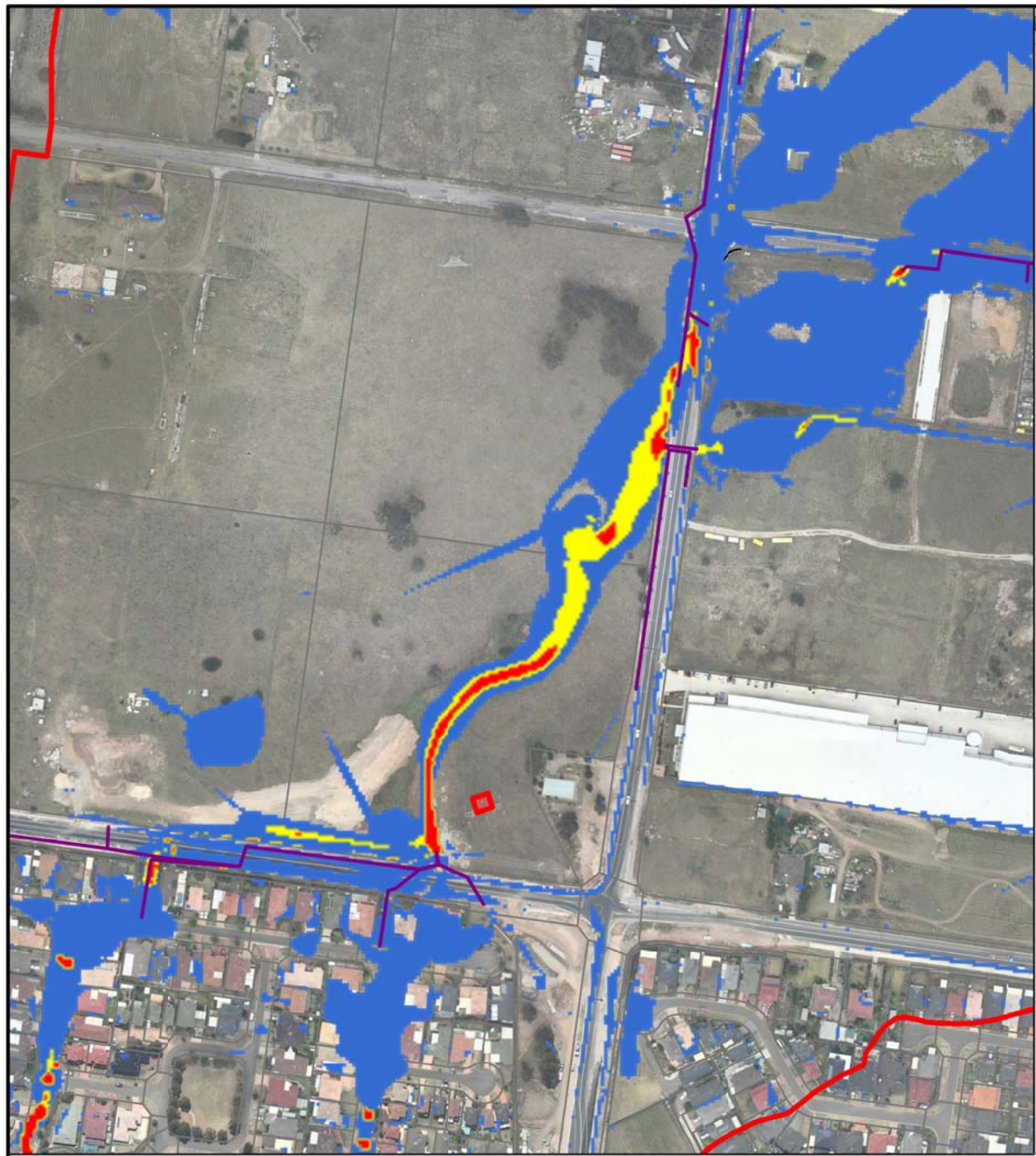
- LOW HAZARD
- TRANSITION HAZARD
- HIGH HAZARD

9634 Figure 7.5
Prestons Trunk Drainage Flood Study

Existing Flood Hazard 10% AEP

File Name: 9634 Fig 7.5 - Exi 10%AEP Hazard
Date : 19/05/14
Issue : 3

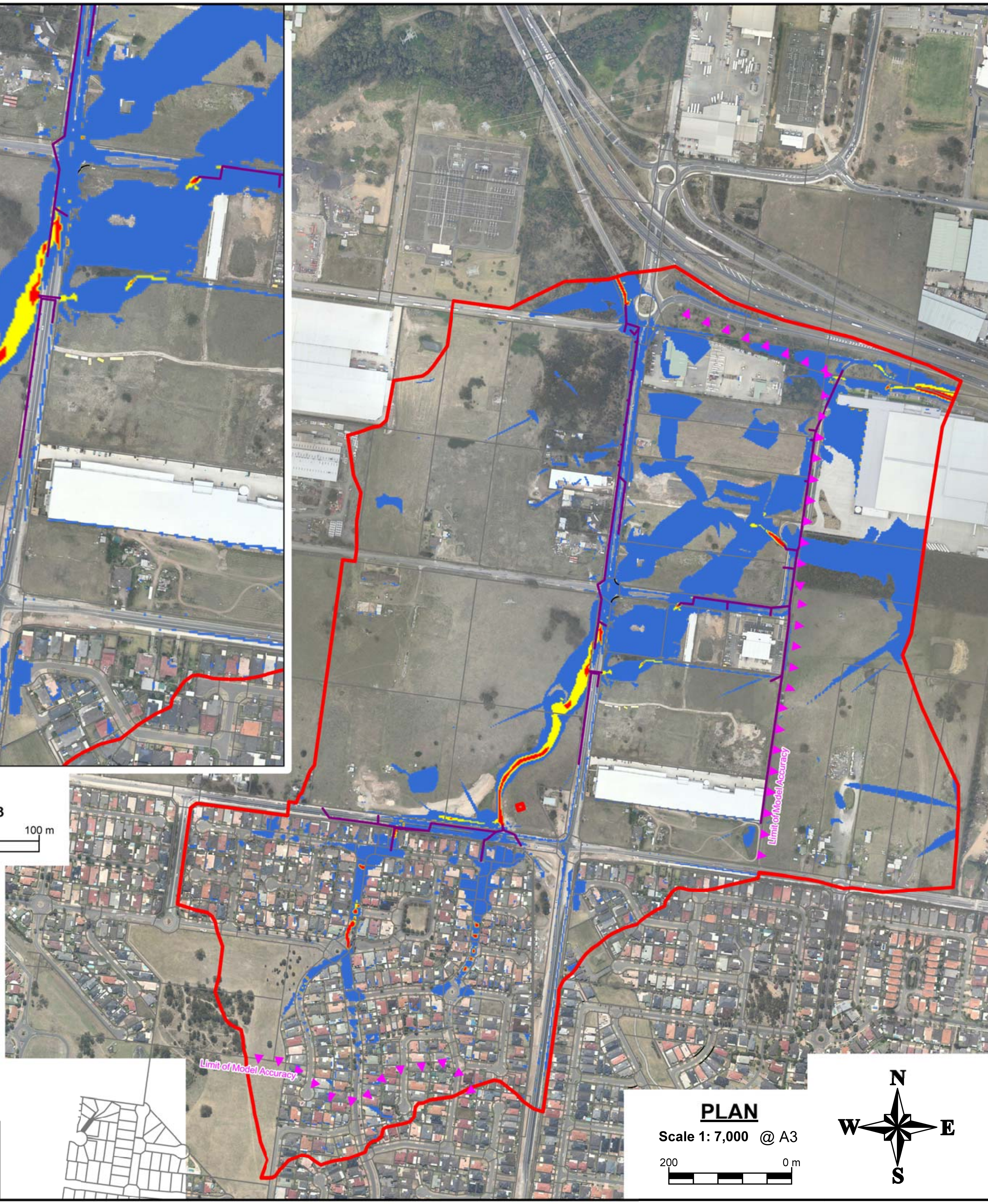
Notes:
1. This plan has adopted a 75mm "Maximum Cutoff" in order to differentiate between flooding and sheet flow. Depths which are less than 75mm are subsequently not shown for clarity.



INSET A

Scale 1: 4,000 @ A3

100 0 100 m



PLAN

Scale 1: 7,000 @ A3

200 0 m

Notes:
1. This plan has adopted a 75mm "Maximum Cutoff" in order to differentiate between flooding and sheet flow. Depths which are less than 75mm are subsequently not shown for clarity.

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INSET A

LEGEND

- Existing Council Stormwater
- TUFLOW Boundary

HAZARD CATEGORISATION

- LOW HAZARD
- TRANSITION HAZARD
- HIGH HAZARD

9634 Figure 7.6
Prestons Trunk Drainage Flood Study

Existing Flood Hazard 1% AEP

File Name: 9634 Fig 7.6 - Exi 1%AEP Hazard
Date : 19/05/14
Issue : 3

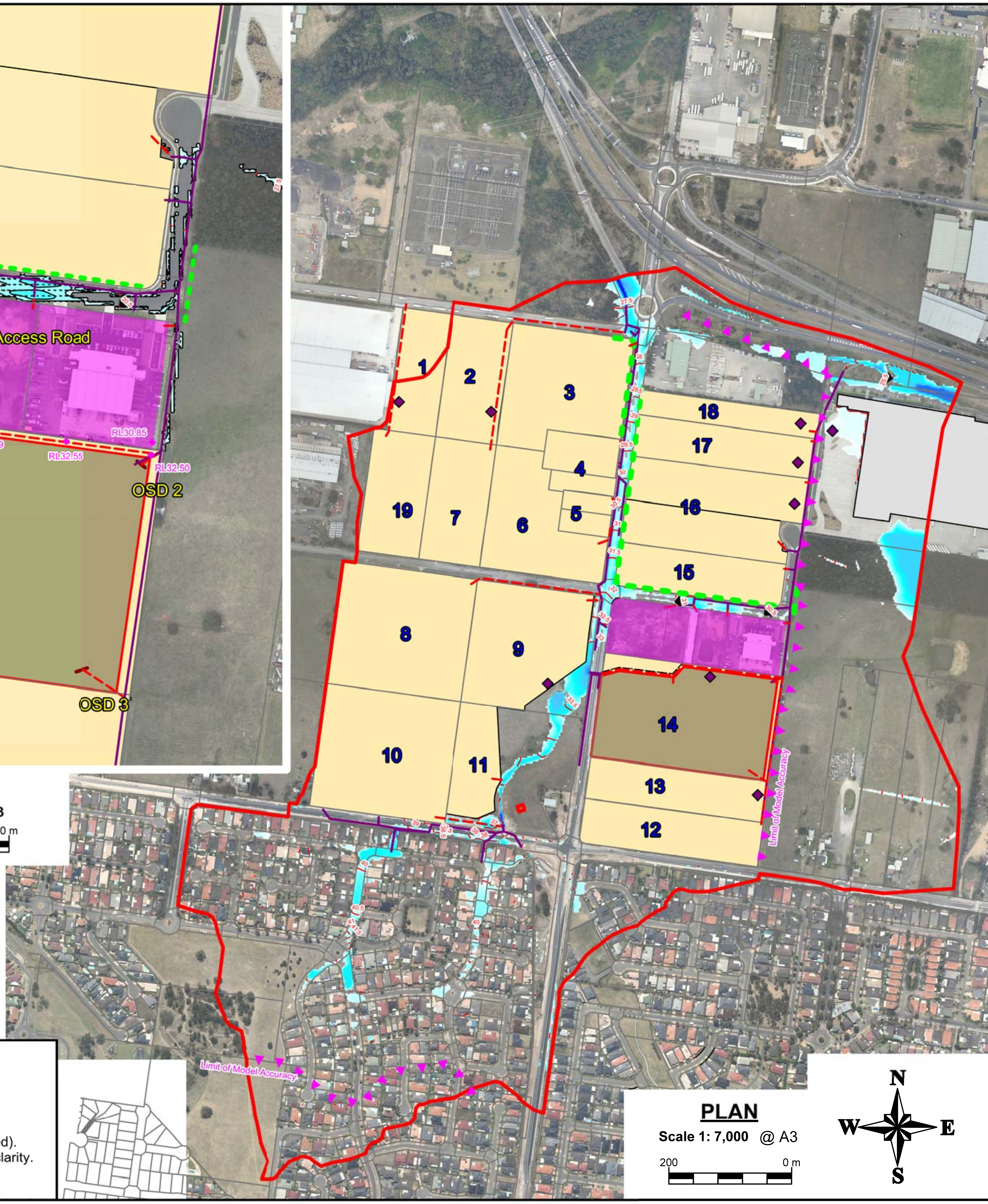
APPENDIX F – INTERIM SCENARIO FIGURES

APPENDIX F

INSET A

Scale 1: 3,000 @ A3

100 0 m



PLAN

Scale 1: 7,000 @ A3

200 0 m

N
W E
S

Notes:
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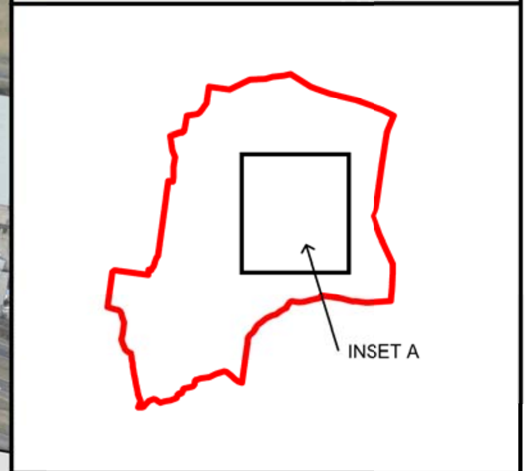


LEGEND

- Existing Council Stormwater
- Interm Stormwater Pipes
- Proposed Flood Protection Mound
- TUFLOW Boundary
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- A Comparison Lot Number
- Areas to consider easements
- 4.5 Flood Level (m AHD)
- Velocity Vectors

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

9634 Figure 7.7
Prestons Trunk Drainage Flood Study

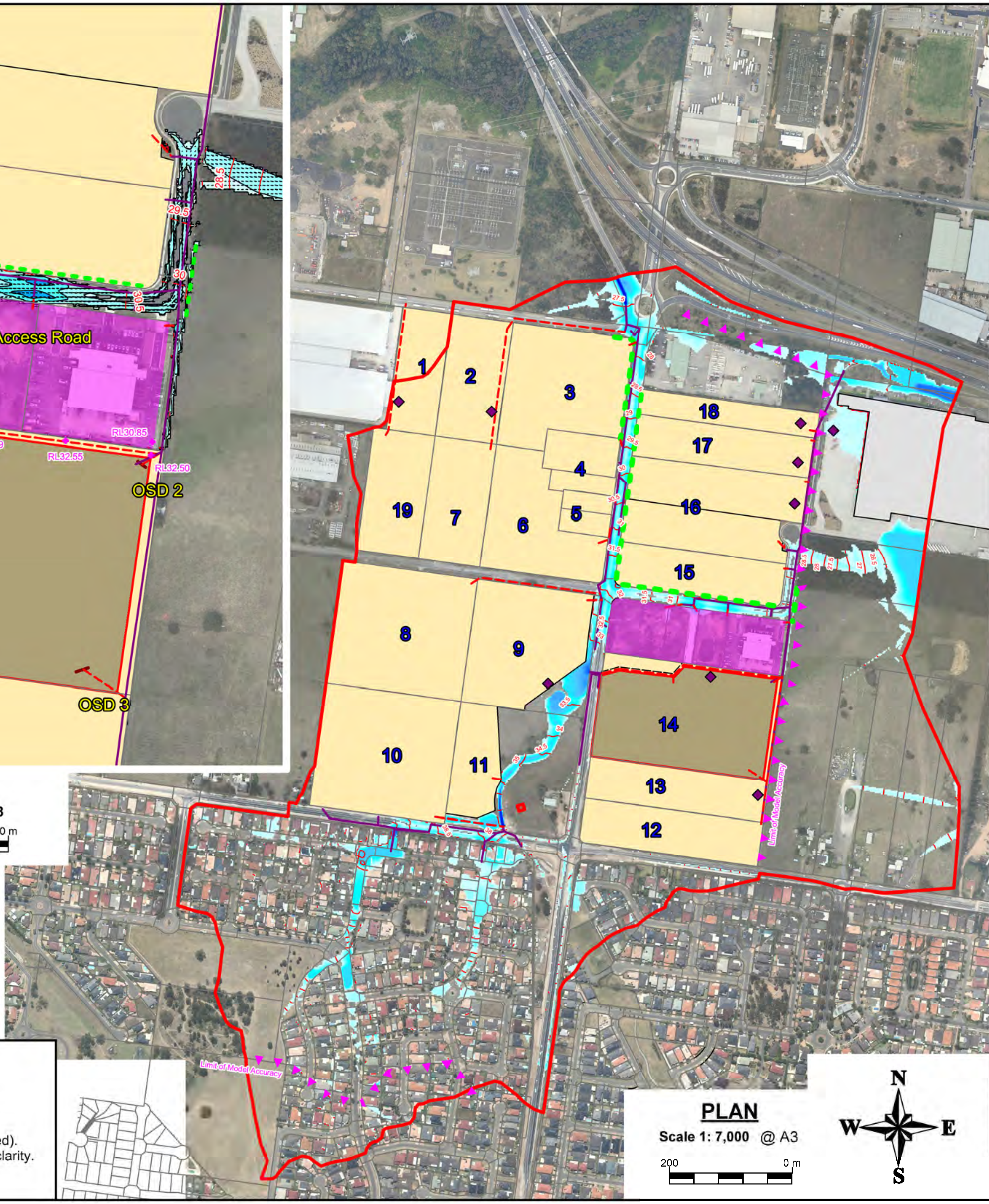
Interim
Flood Depth & Velocities 10% AEP

File Name: 9634 Fig 7.7 - Int 10%AEP Depth
Date : 19/05/14 Issue : 3

INSET A

Scale 1: 3,000 @ A3

100 0 m



PLAN

Scale 1: 7,000 @ A3

200 0 m

N
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Notes:
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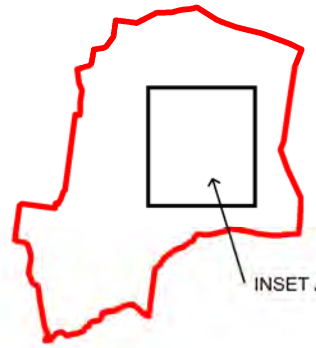

LEGEND

- Existing Council Stormwater
- Interm Stormwater Pipes
- Proposed Flood Protection Mound
- TUFLOW Boundary
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- Comparison Lot Number
- Areas to consider easements
- Flood Level (m AHD)
- Velocity Vectors

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

9634 Figure 7.8
Prestons Trunk Drainage Flood Study

Interim
Flood Depth & Velocities
1% AEP

File Name: 9634 Fig 7.8 - Int 1%AEP Depth
Date : 04/08/14 Issue : 4

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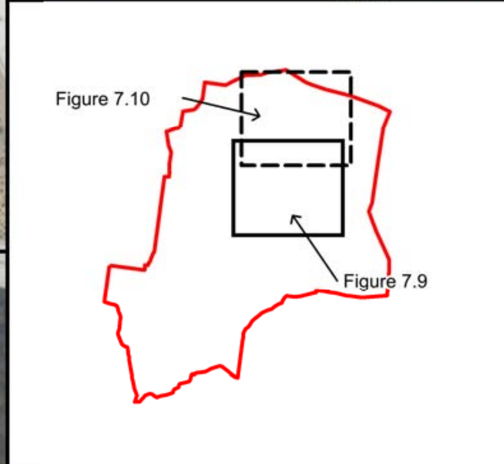


LEGEND

- Existing Council Stormwater
- Interim Stormwater Pipes
- Proposed Flood Protection Mound
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- 211 Interim Flood Depth (m)
- 4.5 Flood Level (m AHD)

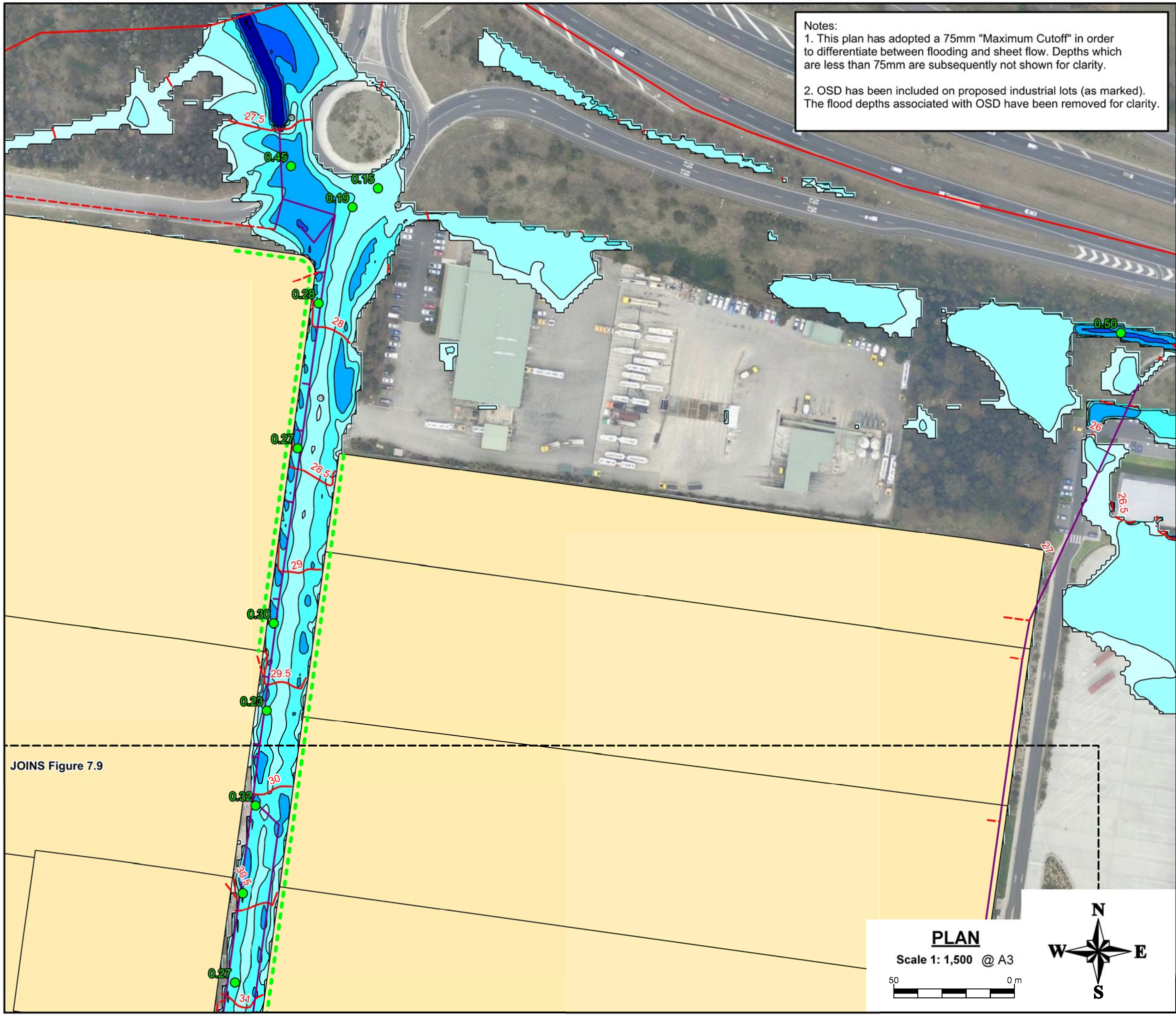
FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

9634 Figure 7.9
Prestons Trunk Drainage Flood Study

Interim Flood Depths 1% AEP

File Name: 9634 Fig 7.9 - Int 1%AEP Depth (1)
Date : 04/08/14 Issue : 4



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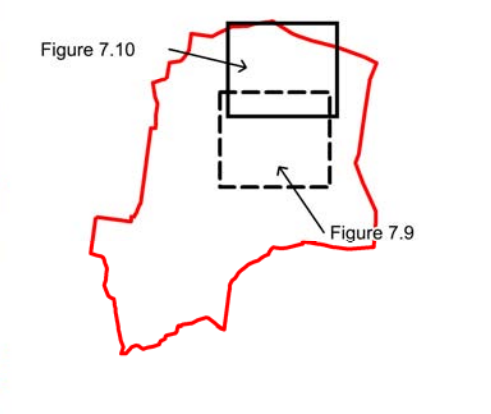

LEGEND

- Existing Council Stormwater
- Interim Stormwater Pipes
- TUFLOW Boundary
- Proposed Industrial Lots (With OSD)
- 0.22 Interim Flood Depth (m)
- 28.5 Flood Level (m AHD)

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

9634 Figure 7.10
Prestons Trunk Drainage Flood Study

Interim
Flood Depths
1% AEP

File Name: 9634 Fig 7.10 - Int 1%AEP Depth (2)
Date : 04/08/14 Issue : 4

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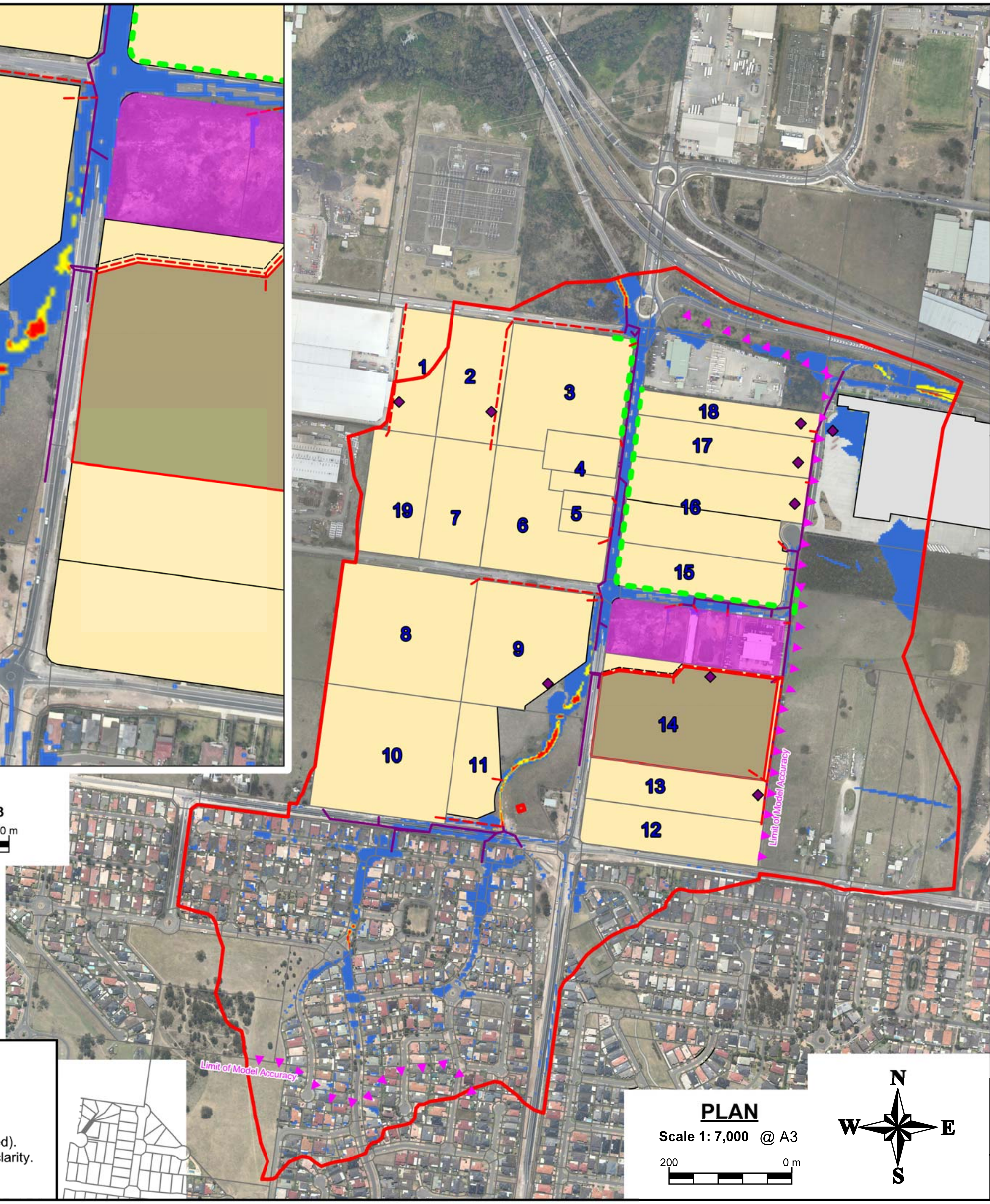
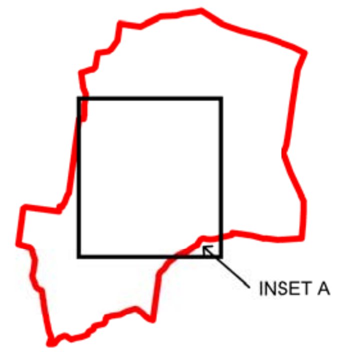
INSET A

Scale 1: 3,000 @ A3

100 0 m





PLAN

Scale 1: 7,000 @ A3

200 0 m

N
W E
S

LEGEND

- Existing Council Stormwater
- TUFLOW Boundary
- Interim Stormwater Pipes
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- A Comparison Lot Number
- Areas to consider easements

HAZARD CATEGORISATION

- LOW HAZARD
- TRANSITION HAZARD
- HIGH HAZARD

Notes:
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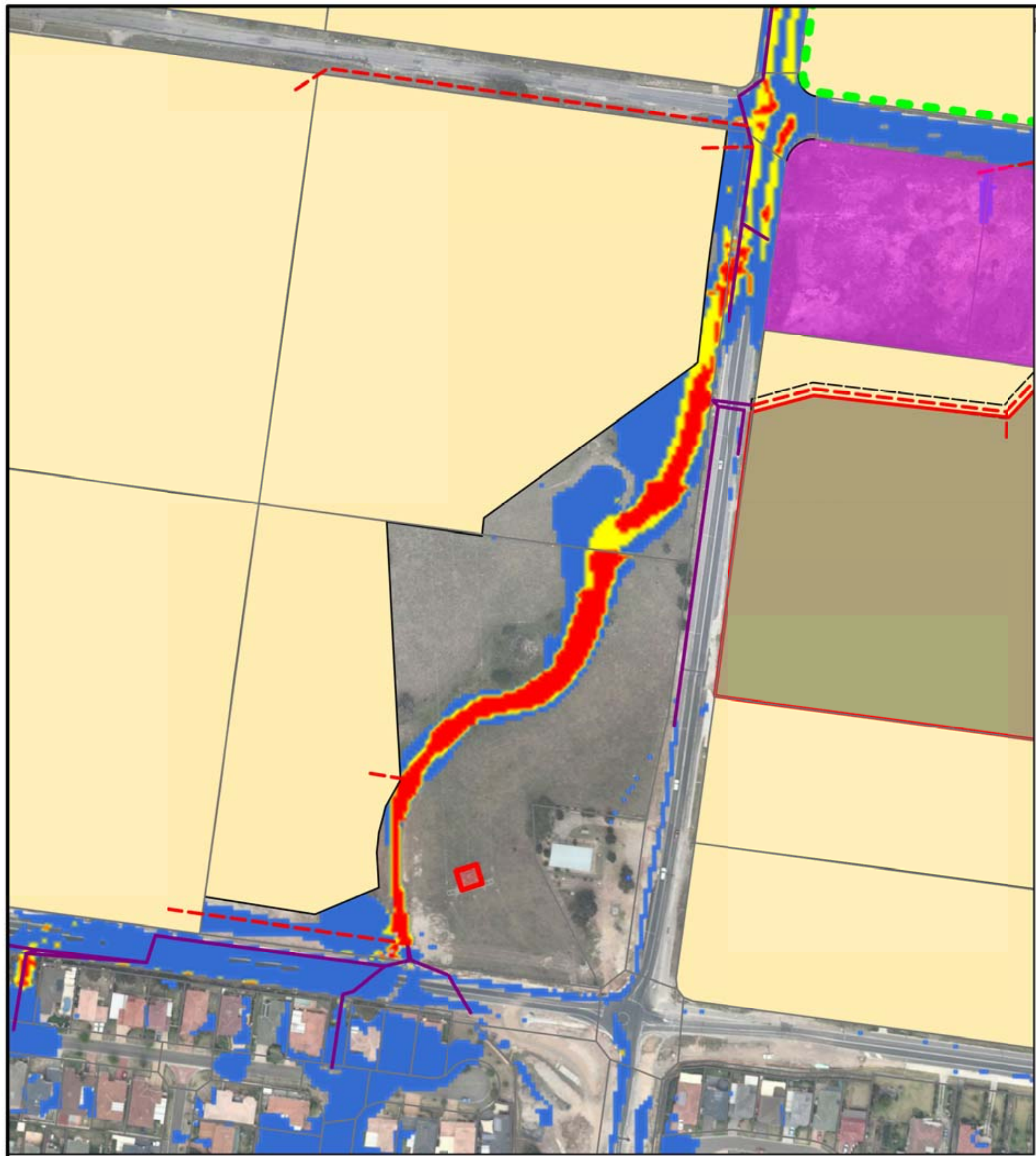
9634 Figure 7.11
Prestons Trunk Drainage Flood Study

Interim
Flood Hazard
10% AEP

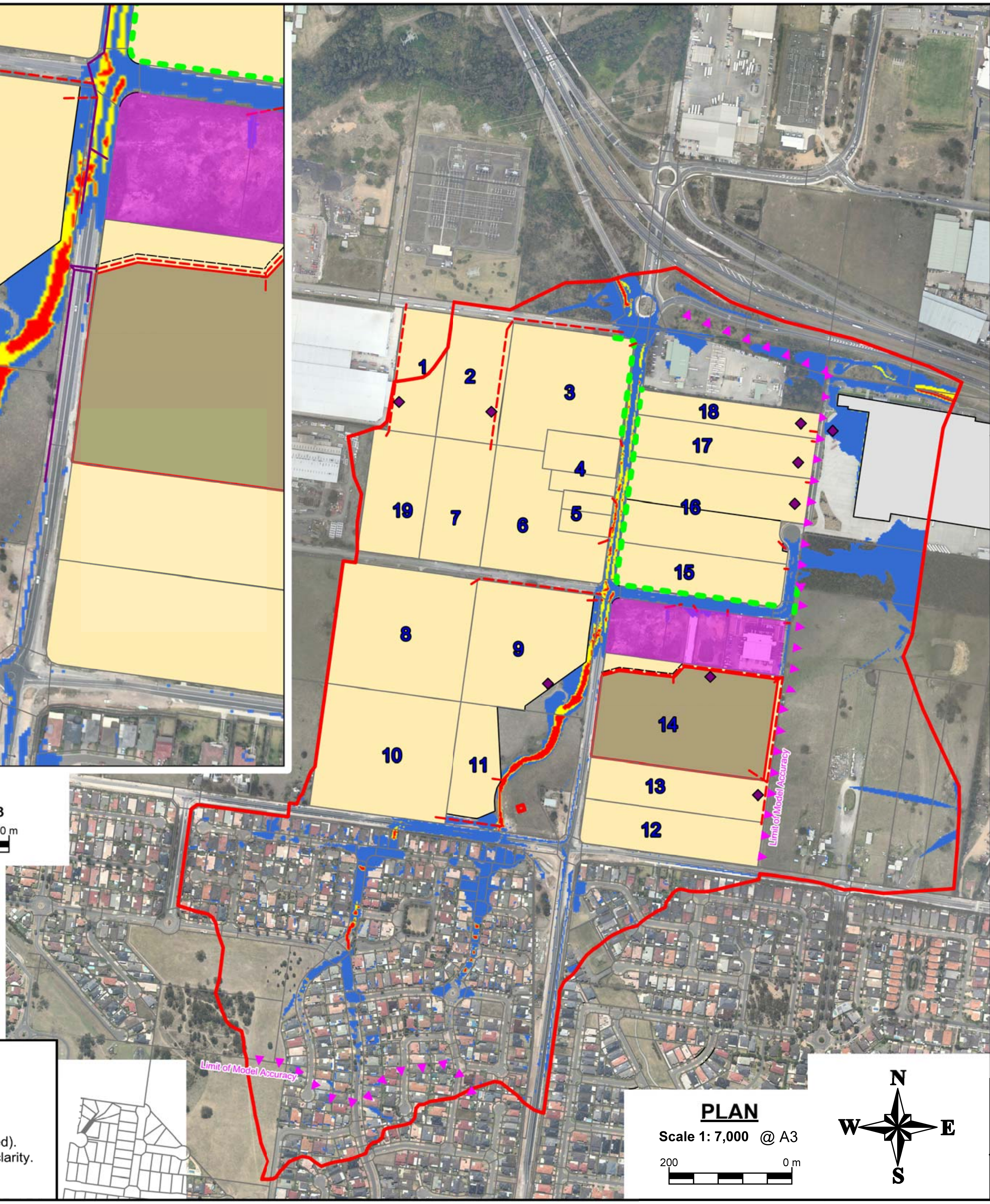
File Name: 9634 Fig 7.11 - Int 10%AEP Hazard
Date : 19/05/14 Issue : 3



INSET A

Scale 1: 3,000 @ A3

100 0 m



PLAN

Scale 1: 7,000 @ A3

200 0 m

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1. This plan has adopted a 75mm "Maximum Cutoff" in order to differentiate between flooding and sheet flow. Depths which are less than 75mm are subsequently not shown for clarity.

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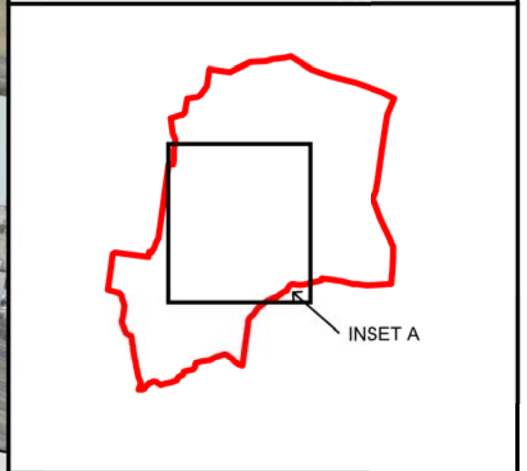


LEGEND

- Existing Council Stormwater
- TUFLOW Boundary
- Interim Stormwater Pipes
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- A Comparison Lot Number
- Areas to consider easements

HAZARD CATEGORISATION

- LOW HAZARD
- TRANSITION HAZARD
- HIGH HAZARD

9634 Figure 7.12 Prestons Trunk Drainage Flood Study

Interim Flood Hazard 1% AEP

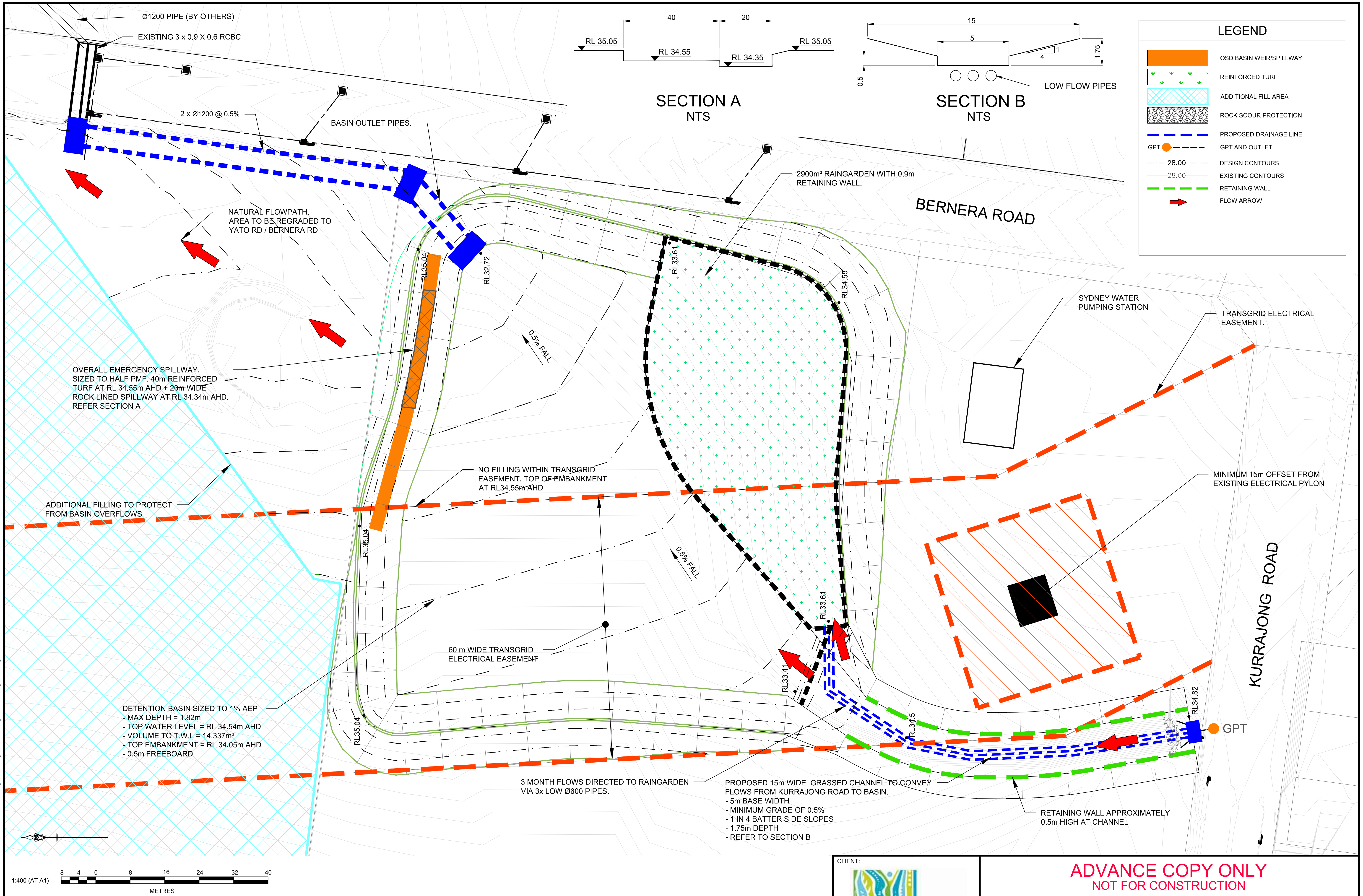
File Name: 9634 Fig 7.12 - Int 1%AEP Hazard
Date : 19/05/14
Issue : 3








APPENDIX G – FINAL SCENARIO FIGURES



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B	ISSUE FOR CLIENT REVIEW	CR	CR	DC	DC	19/05/14
A	DRAFT ISSUE FOR CLIENT REVIEW	CR	NT	DC	DC	14/03/14
	AMENDMENT	DES	DRN	CKD	APR	DATE

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DATUM:
ORIGIN:

CLIENT:
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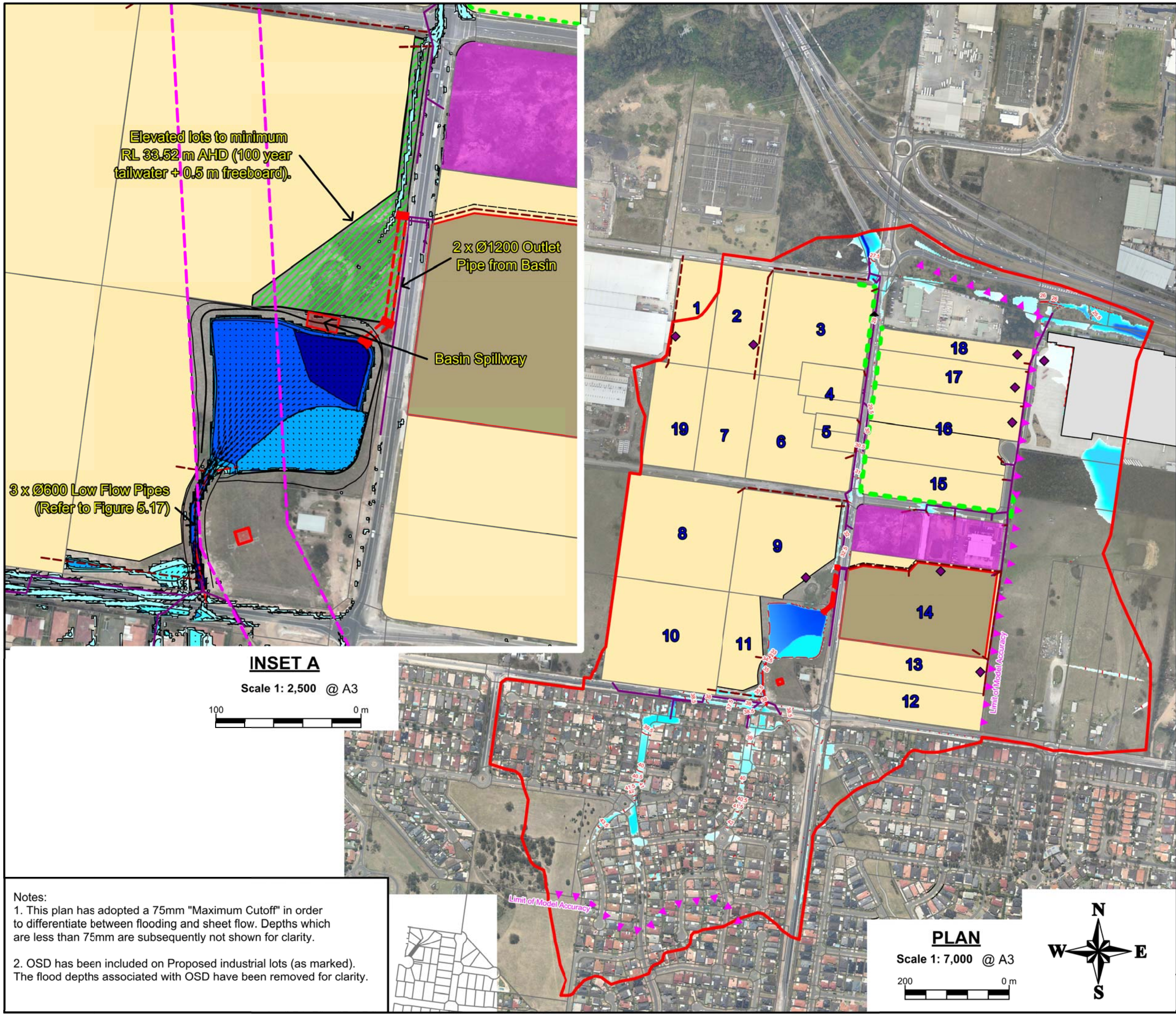
ADVANCE COPY ONLY
NOT FOR CONSTRUCTION

PRESTONS TRUNK DRAINAGE

PROPOSED BASIN DESIGN

PLAN No: 9634/Fig7.14 A
FILE No: 9634Fig7.14
SHEET SIZE: A1 ORIGINAL



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LEGEND

- Existing Council Stormwater
- Interim Stormwater Pipes
- Final Stormwater Pipes
- Proposed Flood Protection Mound
- Transgrid Easement
- TUFLOW Boundary
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- Regrading to Create Overland Flowpath
- A Comparison Lot Number
- Areas to consider easements
- 4.5 Flood Level (m AHD)
- Velocity Vectors

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

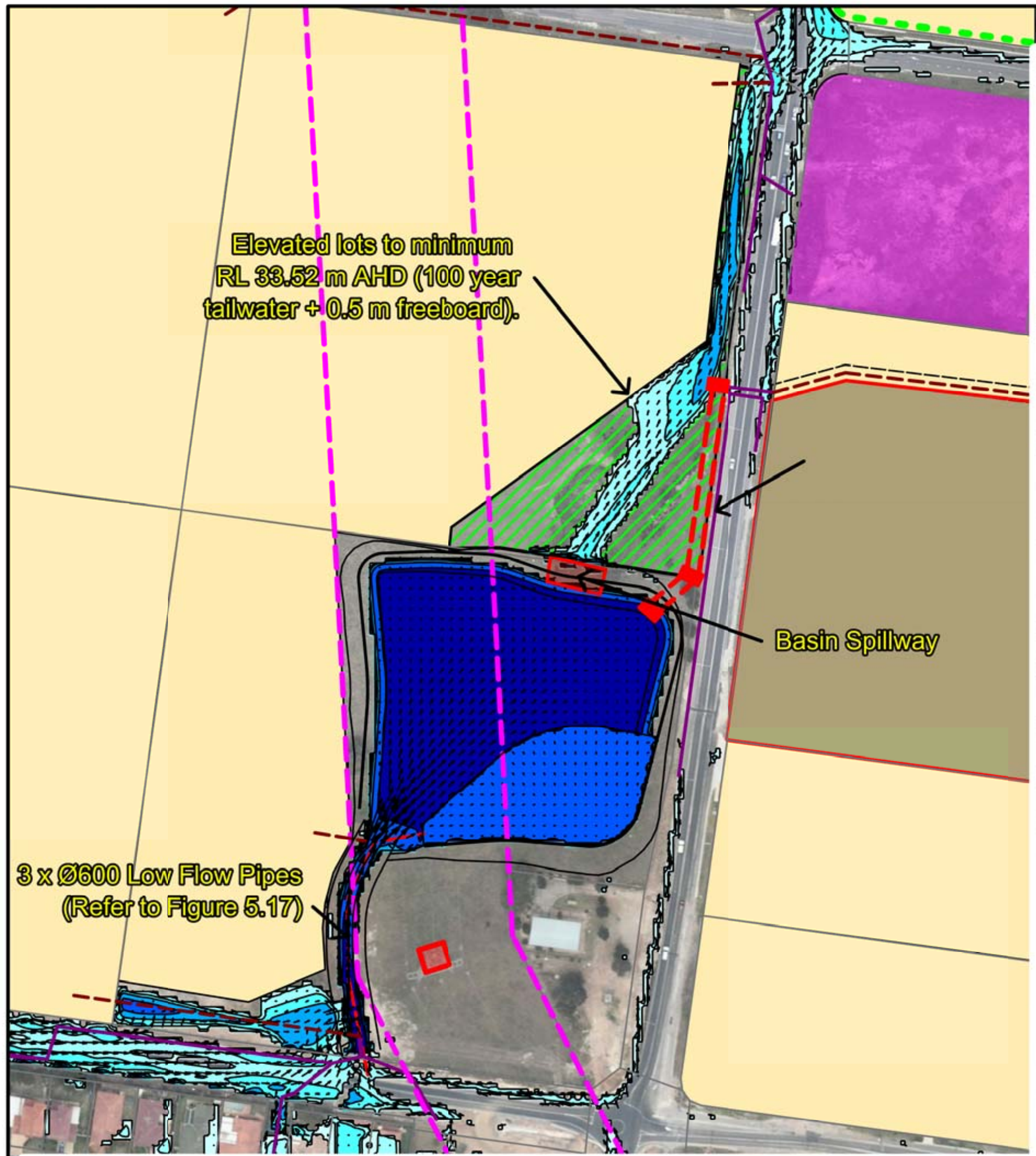
Notes:
1. This plan has adopted a 75mm "Maximum Cutoff" in order to differentiate between flooding and sheet flow. Depths which are less than 75mm are subsequently not shown for clarity.

2. OSD has been included on Proposed industrial lots (as marked). The flood depths associated with OSD have been removed for clarity.

9634 Figure 7.15
Prestons Trunk Drainage Flood Study

Final
Flood Depth & Velocities 10% AEP

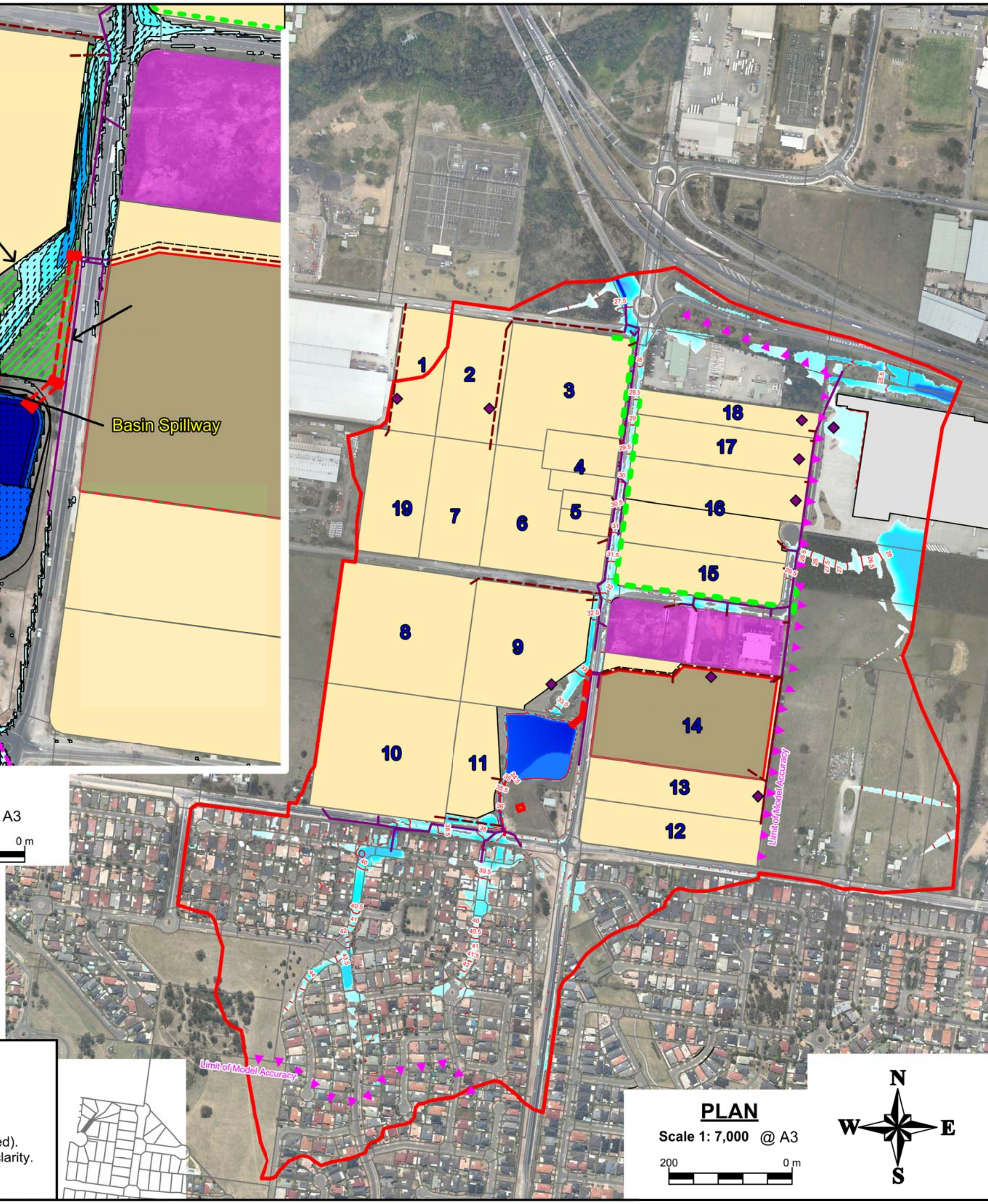
File Name: 9634 Fig 7.15 - Exi 10%AEP
Date : 19/05/14
Issue : 3



INSET A

Scale 1: 2,500 @ A3

100 0 m



PLAN

Scale 1: 7,000 @ A3

200 0 m

N
W E
S

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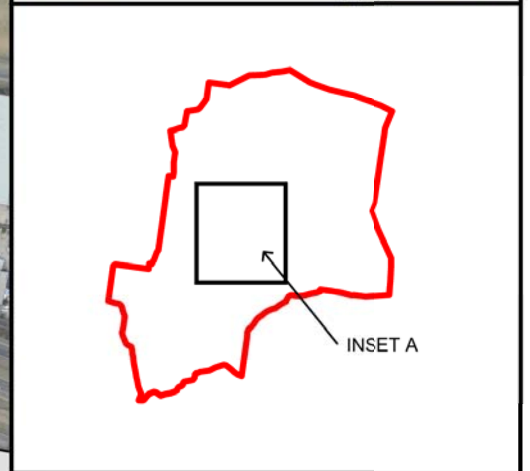

LEGEND

- Existing Council Stormwater
- Interim Stormwater Pipes
- Final Stormwater Pipes
- Proposed Flood Protection Mound
- Transgrid Easement
- TUFLOW Boundary
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- Regrading to Create Overland Flowpath
- A Comparison Lot Number
- Areas to consider easements
- 4.5 Flood Level (m AHD)
- Velocity Vectors

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

9634 Figure 7.16 Prestons Trunk Drainage Flood Study

Final Flood Depth & Velocities 1% AEP

File Name: 9634 Fig 7.16 - Exi 1%AEP
Date : 19/05/14 Issue : 3

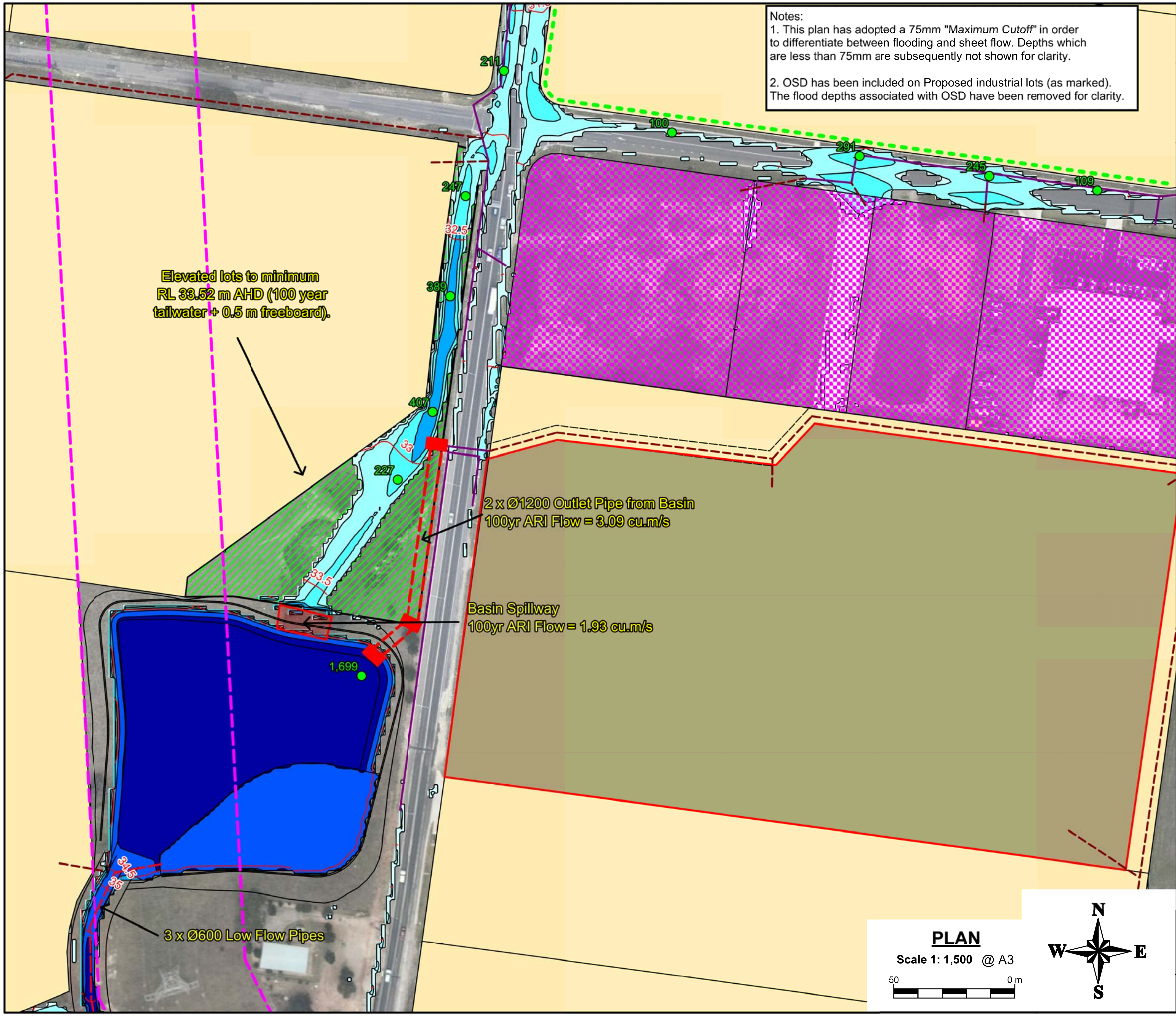

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Figure 7.18
Figure 7.17

LEGEND

- Existing Council Stormwater
- Interim Stormwater Pipes
- Final Stormwater Pipes
- Proposed Flood Protection Mound
- Transgrid Easement
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- Regrading to Create Overland Flowpath
- 211 Final Flood Depth (mm)
- 4.5 Flood Level (m AHD)

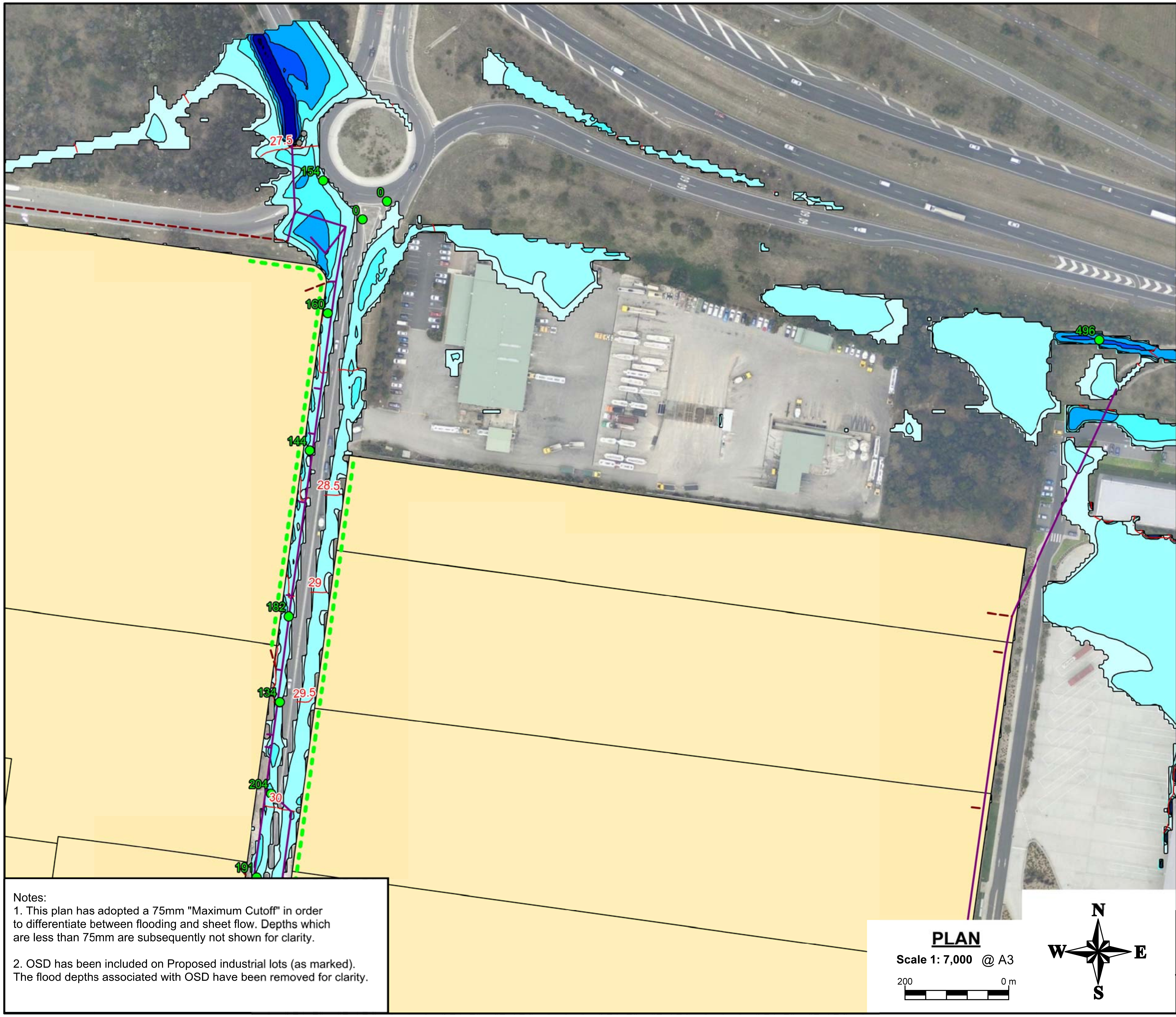
FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

9634 Figure 7.17
Prestons Trunk Drainage Flood Study

Final
Flood Depths
1% AEP

File Name: 9634 Fig5.17 - Prop1%AEP Depth (1)
Date : 19/05/14
Issue : 3



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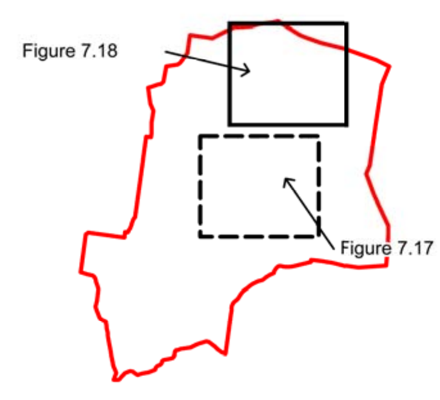


LEGEND

- Existing Council Stormwater
- Interim Stormwater Pipes
- Final Stormwater Pipes
- Proposed Flood Protection Mound
- Proposed Industrial Lots (With OSD)
- TUFLOW Boundary
- 211 Final Flood Depth (mm)
- 28.5 Flood Level (m AHD)

FLOOD DEPTH (m)

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

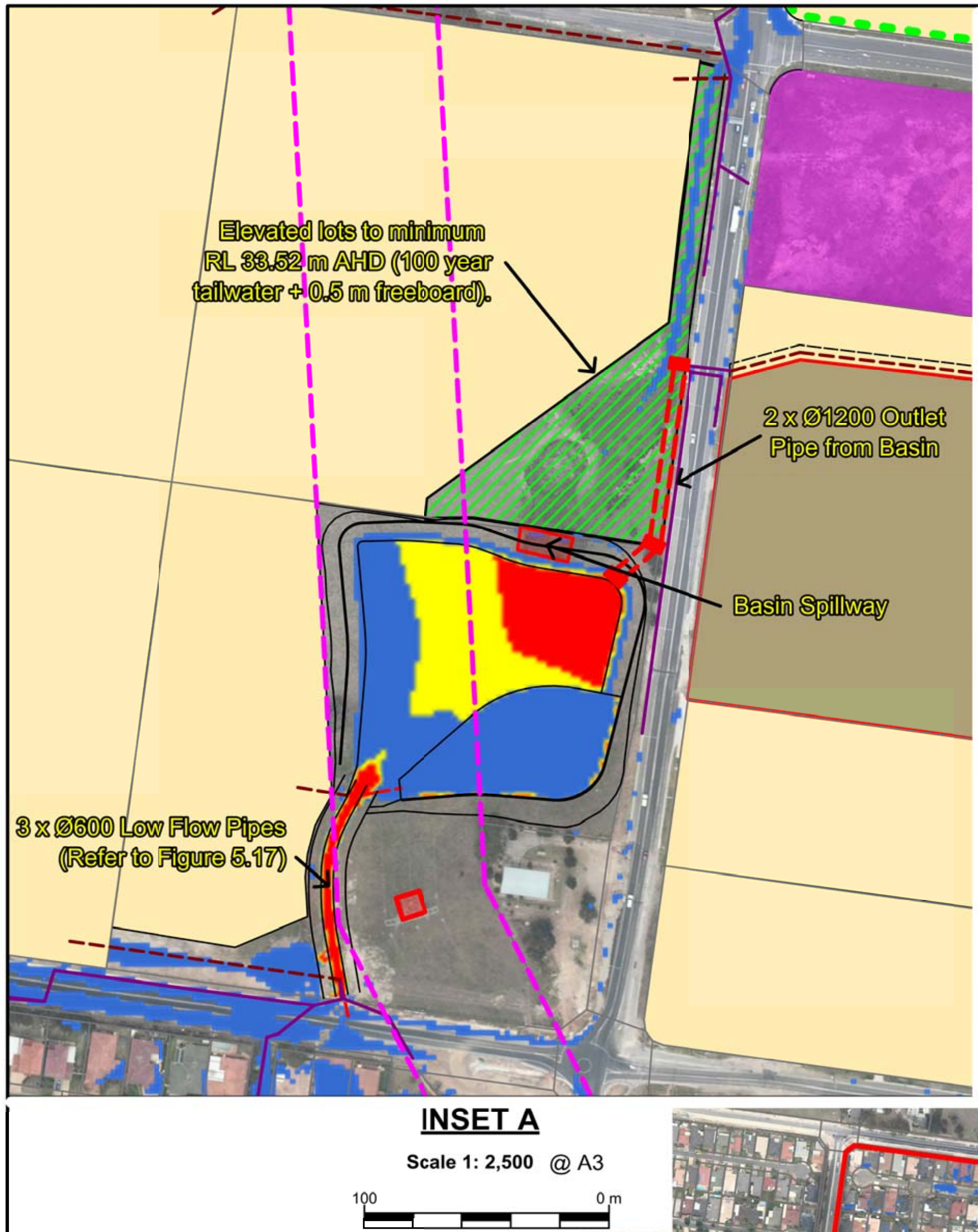
PLAN
Scale 1: 7,000 @ A3
200 0 m

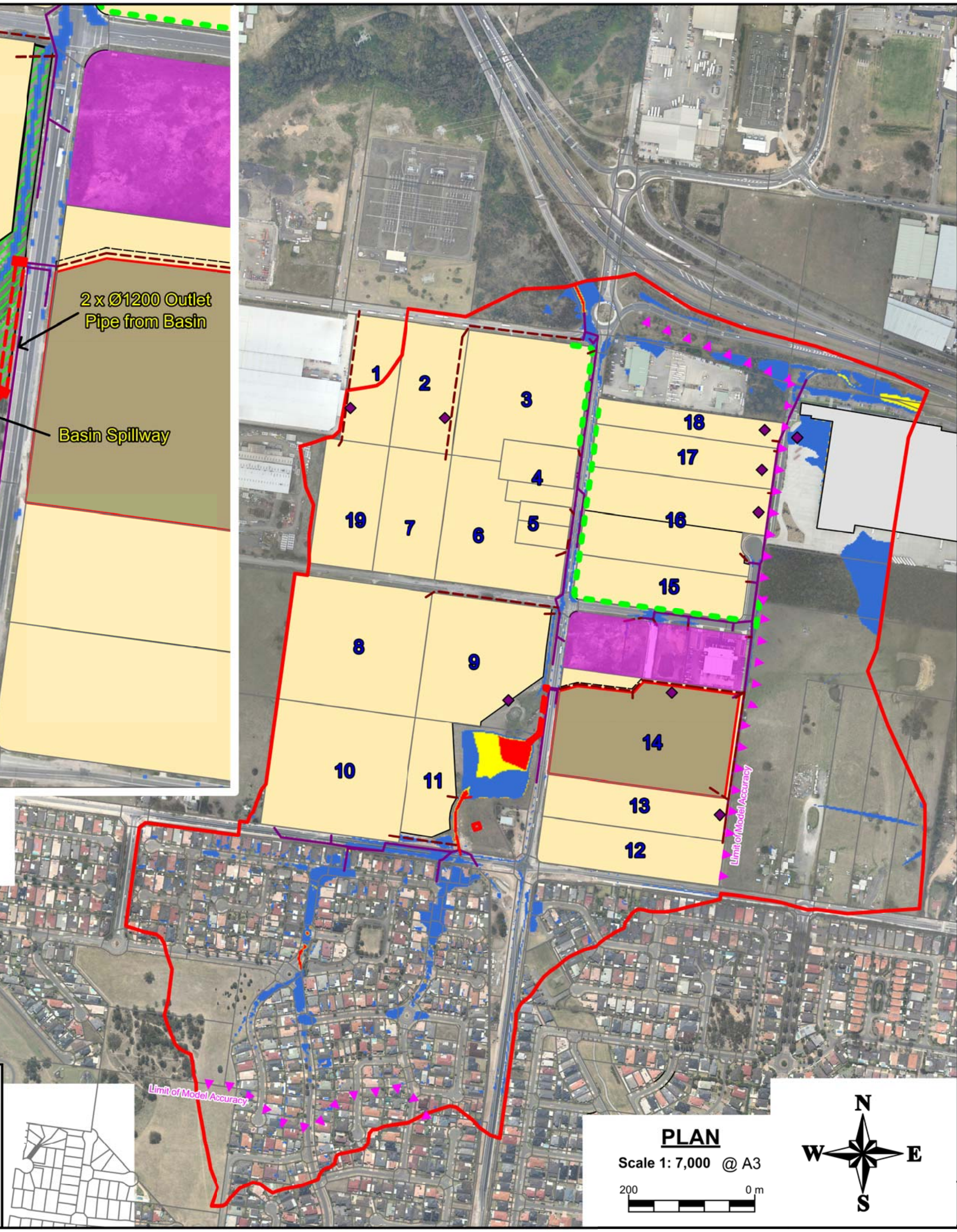
N W E S

9634 Figure 7.18 Prestons Trunk Drainage Flood Study

Final Flood Depths 1% AEP

File Name: 9634 Fig 7.18 - 1%AEP Depth (2)
Date : 19/05/14 Issue : 3





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INSET A

LEGEND

- Existing Council Stormwater
- TUFLOW Boundary
- Velocity Vectors
- Interim Stormwater Pipes
- Final Stormwater Pipes
- Transgrid Easement
- Regrading to Create Overland Flowpath
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- A Comparison Lot Number
- Areas to consider easements

HAZARD CATEGORISATION

- LOW HAZARD
- TRANSITION HAZARD
- HIGH HAZARD

9634 Figure 7.19
Prestons Trunk Drainage Flood Study

Final
Flood Hazard
10% AEP

File Name: 9634 Fig 7.15 - Exi 10%AEP
Date : 19/05/14 Issue : 3

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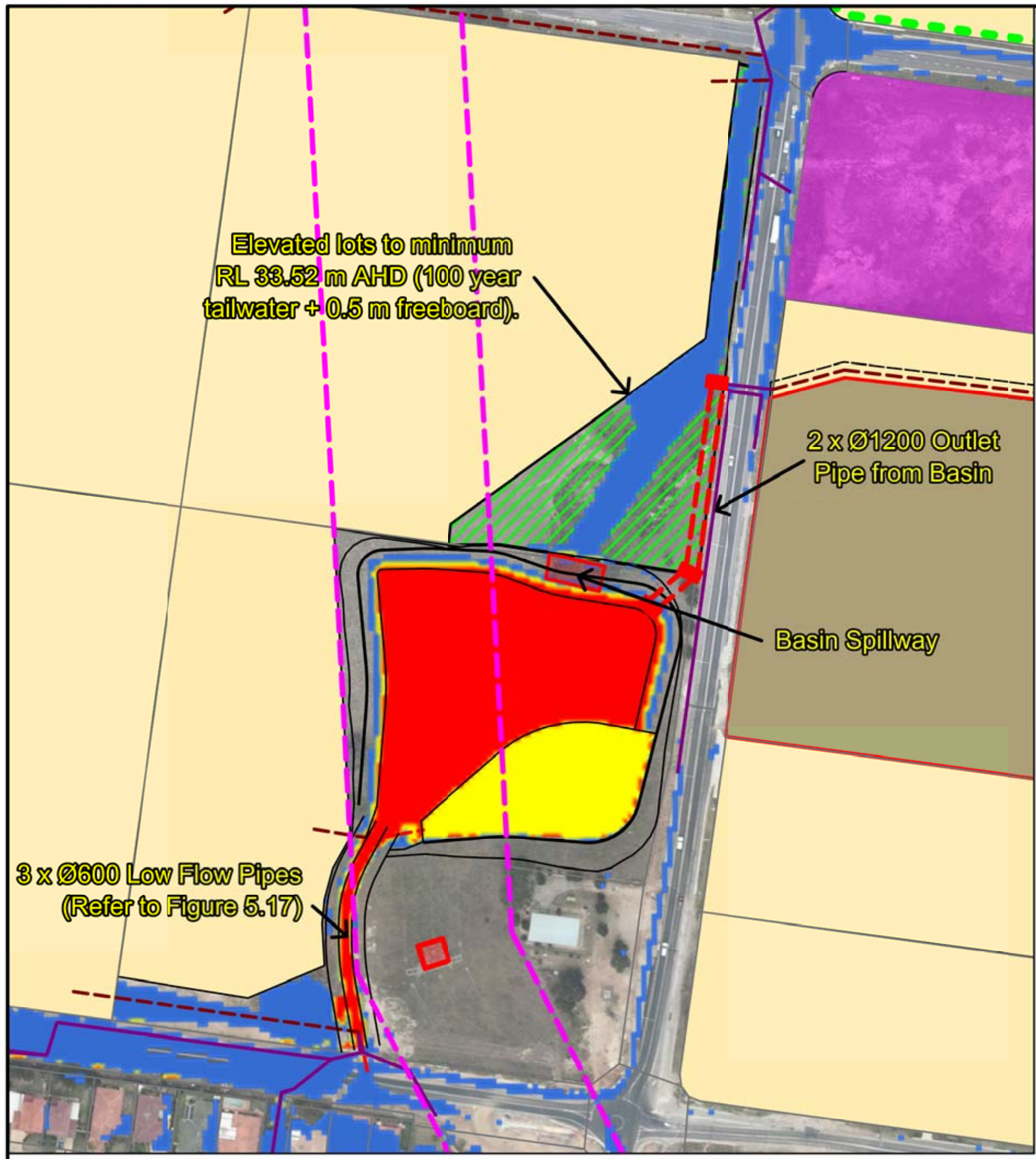
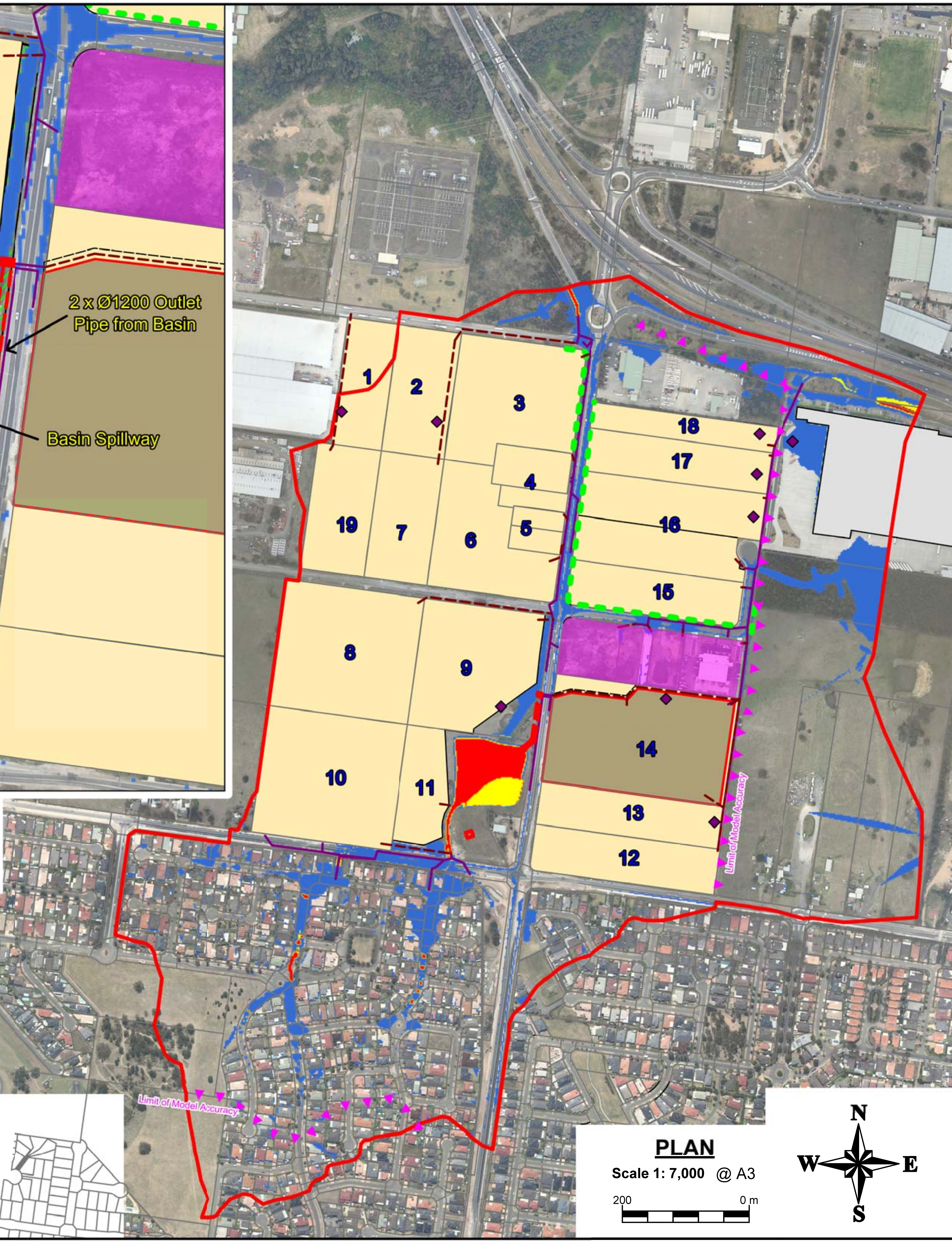


INSET A

Scale 1: 2,500 @ A3

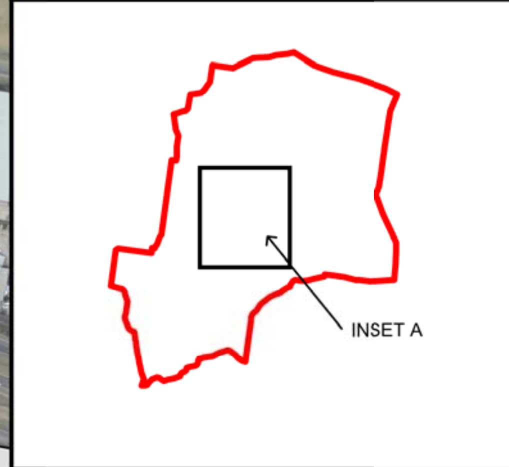
100 0 m



PLAN

Scale 1: 7,000 @ A3

200 0 m



LEGEND

- Existing Council Stormwater
- TUFLOW Boundary
- Velocity Vectors
- Interim Stormwater Pipes
- Final Stormwater Pipes
- Transgrid Easement
- Regrading to Create Overland Flowpath
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- A Comparison Lot Number
- Areas to consider easements

HAZARD CATEGORISATION

- LOW HAZARD
- TRANSITION HAZARD
- HIGH HAZARD

Notes:
1. This plan has adopted a 75mm "Maximum Cutoff" in order to differentiate between flooding and sheet flow. Depths which are less than 75mm are subsequently not shown for clarity.

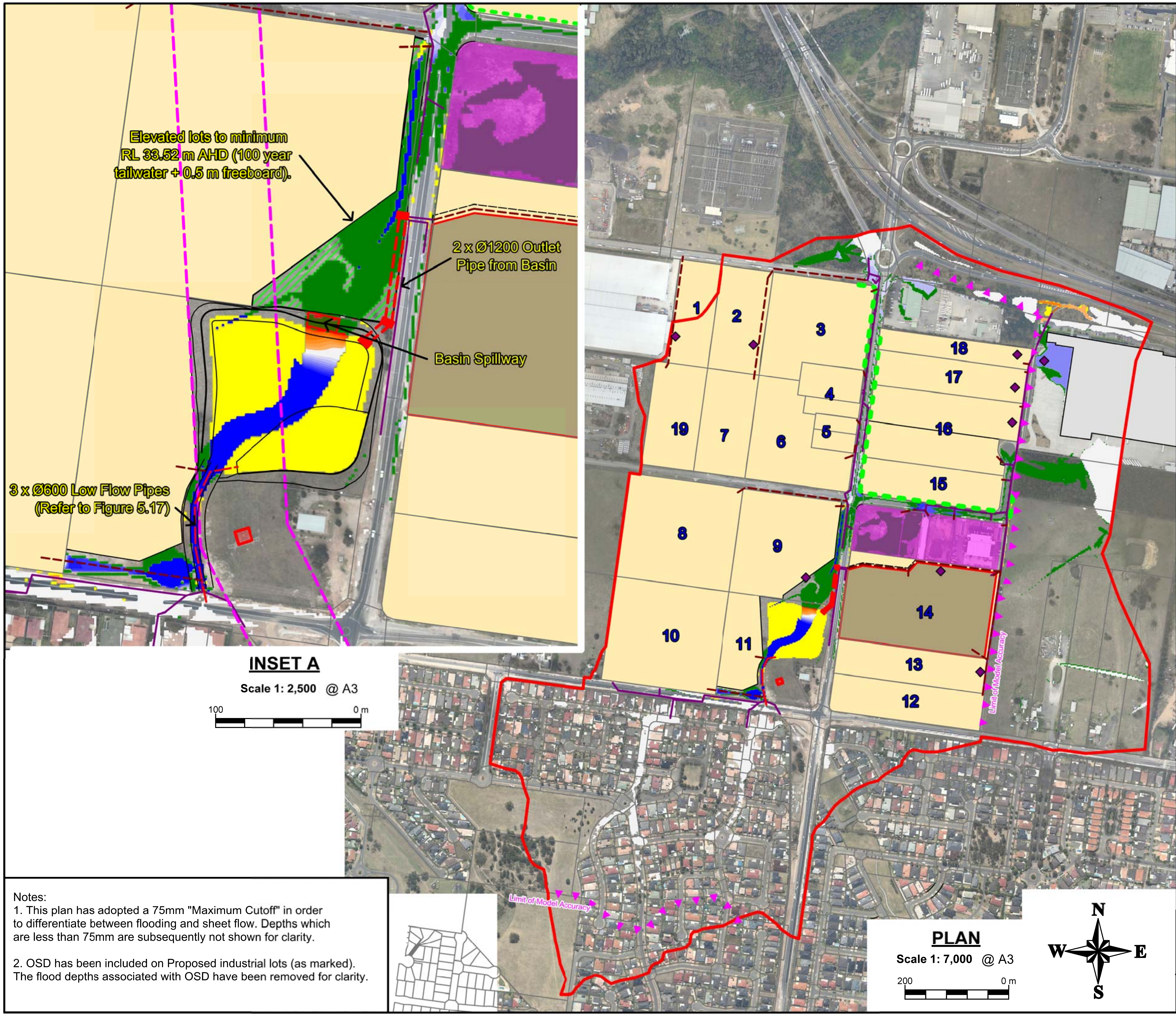
2. OSD has been included on Proposed industrial lots (as marked). The flood depths associated with OSD have been removed for clarity.

9634 Figure 7.20 Prestons Trunk Drainage Flood Study

Final Flood Hazard 1% AEP

File Name: 9634 Fig 7.20 - Prop 1%AEP Hazard
Date : 19/05/14 Issue : 3

APPENDIX H – FLOOD DIFFERENCE FIGURES



Notes:
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LEGEND

- Existing Council Stormwater
- Interim Stormwater Pipes
- Final Stormwater Pipes
- Proposed Flood Protection Mound
- Transgrid Easement
- TUFLOW Boundary
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- Regrading to Create Overland Flowpath
- A Comparison Lot Number
- Areas to consider easements
- 4.5 Flood Level (m)
- Velocity Vectors

INCREASE IN FLOOD LEVELS (m)

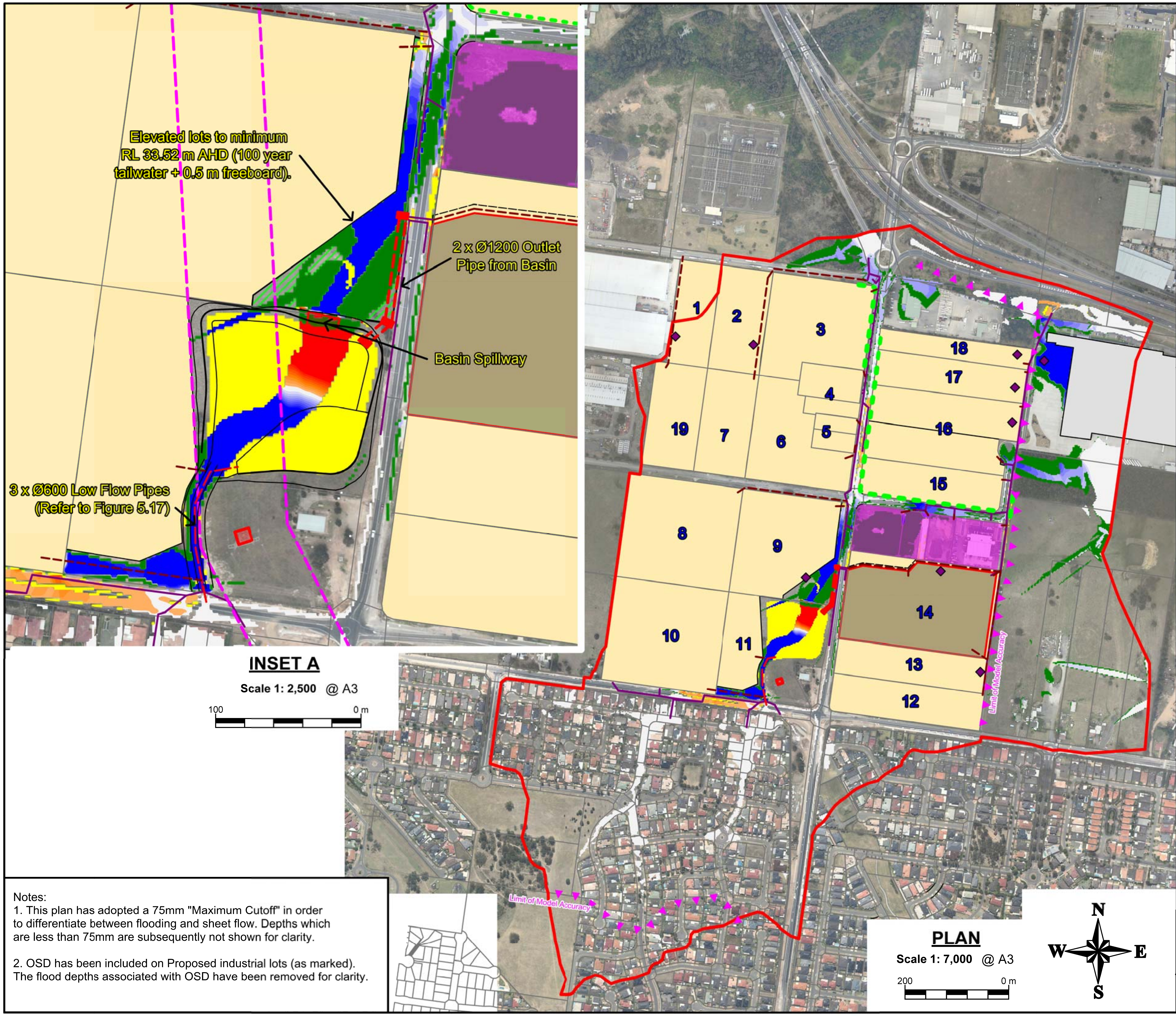
-0.2+	0.02
-0.18	0.04
-0.16	0.06
-0.14	0.08
-0.12	0.10
-0.10	0.12
-0.08	0.14
-0.06	0.16
-0.04	0.18
-0.02	0.2+

- -0.02 to 0.02
- Area Flood Free in Modelled Event
- Area Flood Affected in Modelled Event

9634 Figure 7.21
Prestons Trunk Drainage Flood Study

Final
Flood Difference
10% AEP

File Name: 9634 Fig 7.21 - 10%AEP Diff
Date : 19/05/14
Issue : 3



Notes:
1. This plan has adopted a 75mm "Maximum Cutoff" in order to differentiate between flooding and sheet flow. Depths which are less than 75mm are subsequently not shown for clarity.

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LEGEND

- Existing Council Stormwater
- Interim Stormwater Pipes
- Final Stormwater Pipes
- Proposed Flood Protection Mound
- Transgrid Easement
- TUFLOW Boundary
- Proposed Industrial Lots (With OSD)
- Lot Excluded From Direct Rainfall Model
- Proposed Industrial Lots (No OSD)
- Regrading to Create Overland Flowpath
- A Comparison Lot Number
- Areas to consider easements
- 4.5 Flood Level (m)
- Velocity Vectors

INCREASE IN FLOOD LEVELS (m)

-0.2+	0.02
-0.18	0.04
-0.16	0.06
-0.14	0.08
-0.12	0.10
-0.10	0.12
-0.08	0.14
-0.06	0.16
-0.04	0.18
-0.02	0.2+

- -0.02 to 0.02
- Area Flood Free in Modelled Event
- Area Flood Affected in Modelled Event

9634 Figure 7.22
Prestons Trunk Drainage Flood Study

Final
Flood Difference
1% AEP

File Name: 9634 Fig 7.22 - 1%AEP Diff
Date : 19/05/14
Issue : 3