Job No: W03066.07

26 September 2006

Stockland Development Pty Ltd
C/- Don Fox Planning Pty Ltd
PO Box 230
PENNANT HILLS NSW 1715

Dear Sir

RE: SANDON POINT PROJECT – RESPONSE TO AUTHORITY COMMENTS

I refer to the letter dated 1 September 2006 and associated documents forwarded to us for comment and review from the Department of Planning. We have reviewed the various Authority comments and have provided the following advice.

Hewitts Creek Floodplain Risk Management Plan not fully addressed.

The Hewitts Creek Floodplain Risk Management Plan was developed in accordance with the Floodplain Development Manual (or its predecessor) and although not specifically discussed in the Stormwater Report, the issues covered in the Manual are included in the report. Hewitts Creek Floodplain Risk Management Plan prepared by Wollongong City Council recommended that the following actions, that directly impact the site, should be undertaken. Comments on how these proposed works impact the site and the proposed creek corridors are included.

Hewitts Creek – Scheme HA

- Zone 1.00, opening policy at ocean outfall. No impact, if any would reduce flood levels. Outside of site boundaries, unaffected by the proposed subdivision. The outcomes of this may impact on standing waterlevels within the creek.
- Zone 1.02, levee on northern bank adjacent to Corbett Avenue. May increase flood levels upstream, in the short term. Unaffected by the proposed subdivision.
- Zones 1.03 and 1.04, no mitigation works proposed in these sections. This is the area of the creek that is within the site.

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Woodlands Creek – Scheme WA

- Zone 2.01, re-divert the creek to Tramway Creek. Outside of site boundaries, unaffected by the proposed subdivision.
- Zone 2.01a, channel enlargement and stabilisation. Outside of site boundaries, unaffected by the proposed subdivision.
- Zone 2.02, no mitigation works proposed in this section. This is the area of the creek is within the site.
- Zone 2.03, high flow culvert/bridge under railway line. This is a proposed 6m wide opening augmenting the existing culvert. There is adequate space to place this structure immediately to the south of the existing culvert, within the proposed corridor. The augmented culvert would create a wider flow path which would integrate with the proposed channel for Woodlands Creek (currently a buried pipe in this location). The final detail design would ensure that this occurs. Appropriate engineering practices will ensure the long term stability of these works and this will be subject to engineering certification at design and construction stages.

Tramway Creek – Scheme TB1

- Zone 3.01, opening policy at ocean outfall. No impact, if any would reduce flood levels. Outside of site boundaries, unaffected by the proposed subdivision. The outcomes of this may impact on standing waterlevels within the creek only.
- Zone 3.02, no mitigation works proposed in this section. This is the area of the creek is within the site.
- Zone 3.03, high flow culvert/bridge under railway line. This is a proposed 6m wide opening augmenting the existing culvert. There is adequate space to place this structure immediately to the north of the existing culvert, within the proposed corridor.

From the above it is evident that the proposed subdivision does not preclude the works proposed under the flood mitigation scheme being undertaken. It should also be highlighted that no creek widening or stabilisation works are considered to be required on the creeks within the site boundaries, as part of the flood mitigation strategy.

All the proposed creek corridors have been conceptually designed to convey the maximum flows through the corridor prior to any flood mitigation works external to the site being undertaken. These flows are generally in the 'Epoch 2' case in the report. This is the mixed mode condition with blockages and diversions optimised to create highest or worse case flow conditions through the creeks. The peak flows used in this modelling are generally comparable to those used in the Hewitts Creek Flood Study and Floodplain Risk Management Plan.

Please note that in Table 3.2 of our Report, incorrect values for the peak flows in Hewitts Creek are quoted. In the *Hewitts Creek Flood Study* December 2002, Table 6.3 states the peak flows in

Zone 1.03 as 117.7 m^3/s and Zone 1.02 as 122.3 m^3/s (whereas our table quotes these flows as 110.7 m^3/s and 115.3 m^3/s respectively). Although the incorrect values are shown in the table, the flood study values for the peak mixed 100 year ARI flows were used in the hydraulic modelling of the existing and proposed creek, see Appendix B of the Report, for verification.

Flood maps from the Hewits Creek Flood Study have been attached to show the pre development flood extents, this informataion is shown on the drawings Appendix 5.12 and 5.13. Please note that the flooding depicted on these maps are for the mixed mode flood scenario, where various drainage structures are left either open or closed to maximise the worse case scenario.

This is important to be considered in the case of Woodlands Creek and the impact of flooding on the site. In the adopted worse case scenario the piped section of Woodlands Creek through the site is considered to be blocked and this forces all the water to surcharge and flow overland across the site. It is proposed to remove these pipes as part of the redevelopment of the site and that the water will remain within the creek corridor.

Flood maps for the post development flood extents for Hewitts and Woodlands Creek have also been attached for the 1% AEP (100 year ARI) and PMF events, Figures 11 and 12. Please note that the post development flooding extents for Tramway Creek are shown in Fidure SK02 in Appendix D of our stormwater concept plan report. Maps showing the maximum proposed future flood extents adjacent to Tramway Creek are also attached.

Flooding basis of selection of Roughness Values

The selection of the various roughness values for the 3 epochs of the development was determined in conjunction with Dr Mark Taylor of Macquarie Research, a fluvial geomorphologist. The selection of these values is discussed in further detail as part of the Stockland submission to the Commission of Inquiry.

These roughness values are also generally consistent with the roughness values used in the Hewitts Creek Flood Study, see Table 5.1. It should be noted that the proposed creek corridors were also analysed using an overbank roughness of 0.2 and the results are shown for Hewitts Creek in Appendix B of the Report and Woodlands Creek in Appendix C of the Report.

The selection of Mannings 'n' values has been an issue of considerable controversy during the development process at Sandon Point. Many meetings have been held with DNR and its predecessor Departments. The Department has consistently called for the use of a roughness value of 0.2 but has never been able to justify why this value should be used, in scientific terms.

The selection of an upper limit of a roughness of 0.2 goes against current published information and appears to be an overly conservative upper limit. The Brisbane City Council Natural Channel Design Guidelines describe the vegetation community associated with a 'n' of 0.15 as *'trees and shrubs at 1m spacing, some vines, low branches, fallen trees, difficult and slow to walk through.'* This vegetation does not correspond to typical densities associated with sub-tropical rainforest where competition for light precludes the establishment of such plant densities. Review of various international and national guidelines suggests that an 'n' of 0.15 on the overbank sections is a practicable upper limit.

Stability of the creek corridors

The creek corridors have been designed to be stable in storm events up to the 5 year ARI event. In events up to this size the shear stresses and stream power in the creek are within acceptable levels and the corridors can be protected by the proposed vegetation. In storms greater than this the potential for the damage of the corridors would increase. It was generally accepted that there may be substantial damage to the vegetative cover in the 100 year and larger events. In such rare situations, the extent of damage would be commensurate with that associated with natural creeks in the area and where necessary can be addressed with standard maintenance works to maintain the creek in a stable condition.

The detailed design of the creek corridors has not been undertaken. As part of the detail design process at the construction certificate stage the energy in the creek will be reduced to as low as practicable to improve the stability in larger storm events. This approach was discussed at meeting with DNR and WCC in December 2003 and was generally agreed upon. Notwithstanding this approach represents best practice.

Consistency with Riparian Corridor Management Strategy

This Strategy determined the management objectives for the various creeks through the site and recommended that the following categories apply:

- Hewitts Creek Category 2 – terrestrial and aquatic habitat
- Woodlands Creek Category 1 – environmental corridor
- Cooksons Creek Category 1 – environmental corridor
- Tramway Creek Category 2 – terrestrial and aquatic habitat

The corridor for Hewitts Creek has been widened to provide the required buffers for the Category 2 stream. The status and width of Woodlands Creek has always been under dispute. While DNR at various stages prior to Stockland purchasing the site and during the Court proceedings for Stages 2 to 6 formed a position, an alternate position was put to the CoI and has

been reiterated in their response to the subject application. The width of the Woodlands Creek corridor reflects the agreed negotiated corridor as shown in the Deed of Agreement between Stockland and DNR. This Deed of Agreement is considered to reflect the aims of the Riparian Corridor Management Strategy with regard to the special circumstances of Woodlands Creek, being disturbed and partially piped but with potential for reconstruction to benefit the general community.

Consultation with DNR during preparation of EAR or Hill Report

DNR had not been specifically contacted during the preparation of the EAR or our response to the Hill Report, as DNR's views and position on the various creeks within the site are particularly well known by the Stockland Project Team. These views culminated with the preparation of the Riparian Corridor Management Strategy in 2004 and this Strategy is consistent with their previous advice.

Leading up to the Commission of Inquiry on the site, substantial consultation was undertaken with the Department between 1999 and 2003, with many meetings and exchange of correspondence being undertaken.

Compensatory measures for loss of floodplain storage areas.

The area of the site between Hewitts and Woodlands Creeks is shown as a medium flood risk precinct The flooding of this area is caused by water escaping from the Woodlands Creek system and flowing into Hewitts Creek. This water then quickly flows down Hewitts Creek to the ocean. As a result the storage of flood waters in this area is minimal. This area would be more characterised as part of the floodway, where the maintenance of conveyance would be paramount over flood storage

Previous modelling of the area indicated that the provision of additional storage in the area east of the railway line is undesirable as it delays the peak flows from the site and actually increases the depth of flooding downstream near Corbett Avenue.

The construction of the Woodlands Creek corridor will provide adequate compensatory flood storage for the loss of overbank storage.

Consideration of the design of additional culverts under the railway at Woodlands Creek

The analysis of Woodlands Creek for the design of the proposed corridor has been undertaken assuming that all the flows in the creek are conveyed under the railway line, i.e. no diversions or detention. As previously discussed there is sufficient space to provide a 6m wide opening immediately to the south of the existing culvert.

Drainage must be adequate and not enter rail corridor.

The existing drainage patterns are not changed as part of the proposed subdivision and associated works. From review of the existing analysis the rail corridor is already substantially impacted by flood waters.

Its is understood that there are concerns with regard to the level of standing water in the Tramway Creek corridor. This issue is more readily addressed in the opening policy at the ocean recommended in the flood mitigation strategy and currently being developed as part of the esturary management plan by Wollongong Council.

The corridors will not cause flooding upstream of the railway line

In the Hewitts Creek Flood Study, the hydraulic modelling indicates that the culverts under the railway are all inlet controlled including the large Hewitts Creek opening under the railway. Where culverts are inlet controlled an increase in flood levels downstream will not be necessarily transmitted upstream.

It is assumed that in the design of the proposed openings as part of the flood mitigation scheme will retain the status quo and the culverts are designed as inlet controlled as this is a more desirable situation than having the culverts outlet controlled. However, we have not seen Council's options for the design of the culverts.

PMF should be considered

The impact of the PMF has been taken into account in the analysis and modelling of the creek corridors. The conceptual design of the corridors of Hewitts and Woodlands Creeks, as shown in Appendices B and C indicate that the PMF flow is generally contained within the corridors. Where the flow is not contained within the corridor the flow is contained within the road reserves adjacent to the corridor.

For Tramway Creek, the PMF may encoach onto the lots within the existing Lot 235, although the 100 year ARI event can be conatined within the corridor. The building pads will be kept above the PMF flood level. This will ensure that each dwelling will have floor levels higher that the minimum 100 year ARI flodd plus 0.5 metre freeboard as required by Council's DCP No. 54. Full details of the flood impact and lot designs in this area will be provided at the Project Plan Application stage.

Adopt 100y ARI flood level plus 0.5m freeboard

This has been adopted.

Music Modelling Catchment Areas

The MUSIC modelling of the water quality has utilised the whole area of the subcatchments, not just the roof areas. The modelling has been simplified for this Report and would be undertaken in more detail as part of the next stage of the development.

Stormwater design does not compromise ecological buffer

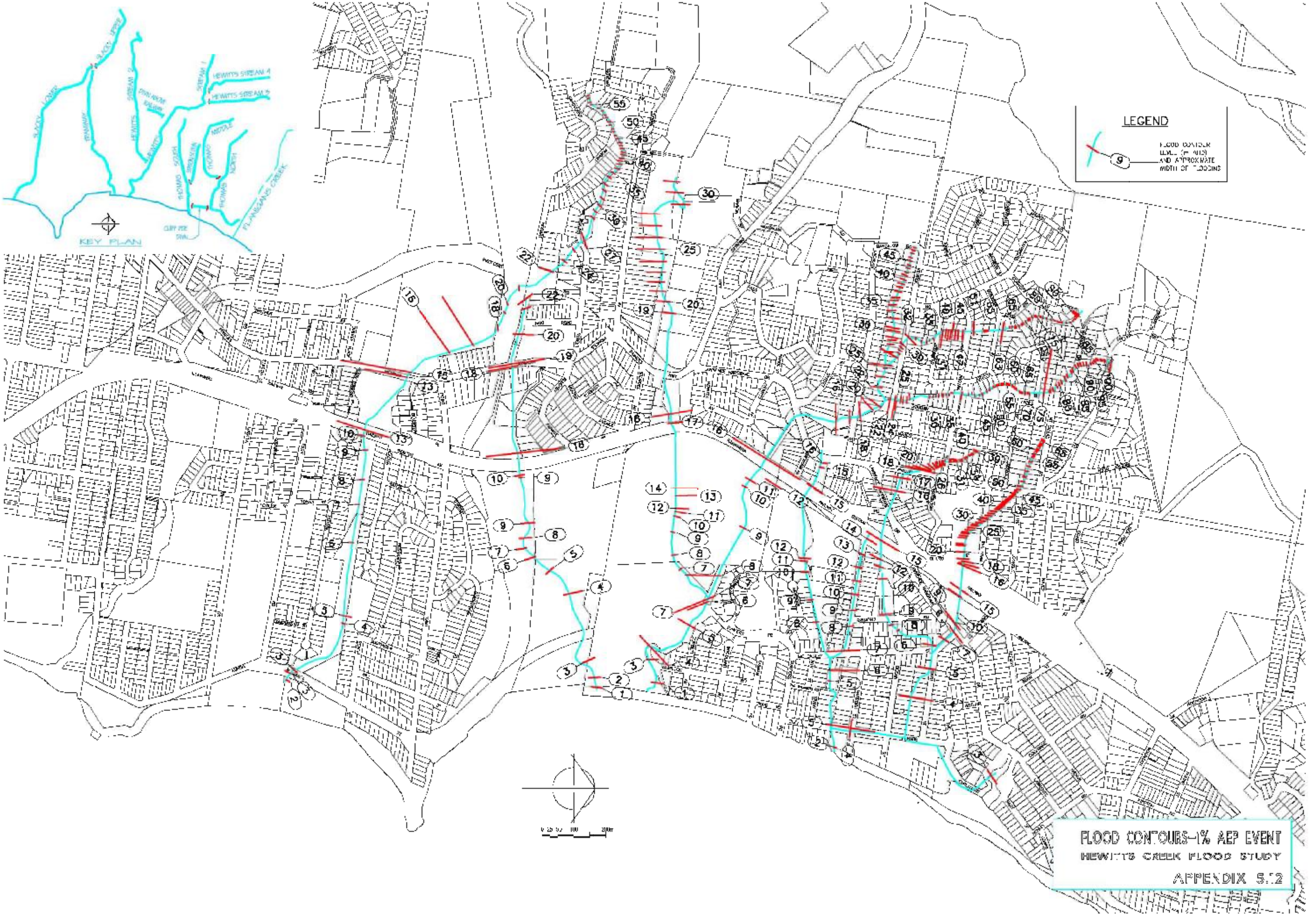
The proposed water quality basins are located outside of the proposed core riparian zones of the creeks and located within the additional buffer zones of the corridor. This is standard practice. Figure 09 in Appendix A of our report demonstrates the location of the proposed basins is within the sustainability buffer for the core riparian zones.

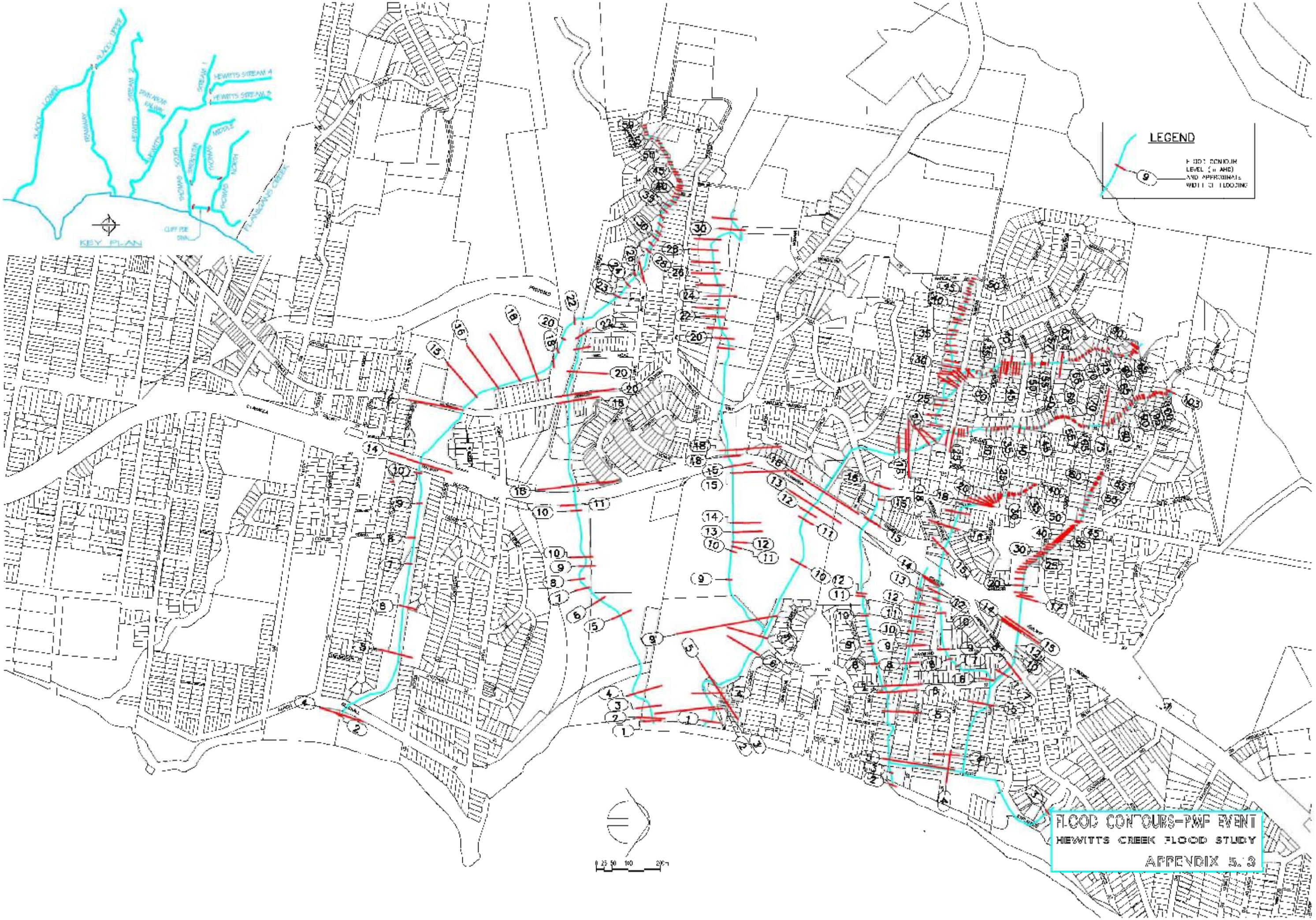
Should you require any further information please contact me on 9900 1000.

Yours faithfully,
BROWN CONSULTING (NSW) PTY LTD

Robert Peterson
Associate Director

Attached:
- Post Development 100 year ARI and PMF Flood Levels Hewitts, Woodlands Creeks and Tramway Creeks


KEY PLAN
LEGEND
FLOOD CONTOUR
LEVEL (m AHD)
AND APPROXIMATE
WIDTH OF FLOODING
FLOOD CONTOURS-1% AEP EVENT
HEWITTS CREEK FLOOD STUDY
APPENDIX 5.12


KEY PLAN
LEGEND
FLOOD CONTOUR
LEVEL (m AHD)
AND APPROXIMATE
WIDTH OF FLOODING
FLOOD CONTOURS-PMF EVENT
HEWITTS CREEK FLOOD STUDY
APPENDIX 5.3

SANDON POINT 100 YEAR ARI FLOOD LEVELS & EXTENTS POST DEVELOPMENT

NOT TO SCALE

JOB No. W03066.07

Drawing: Figure 11

Prepared by: RAP/AMK

Date: 25-09-2006

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SANDON POINT PMF FLOOD LEVELS & EXTENTS POST DEVELOPMENT

NOT TO SCALE

JOB No. W03066.07

Drawing: Figure 12

Prepared by: RAP/AMK

Date: 25-09-2006

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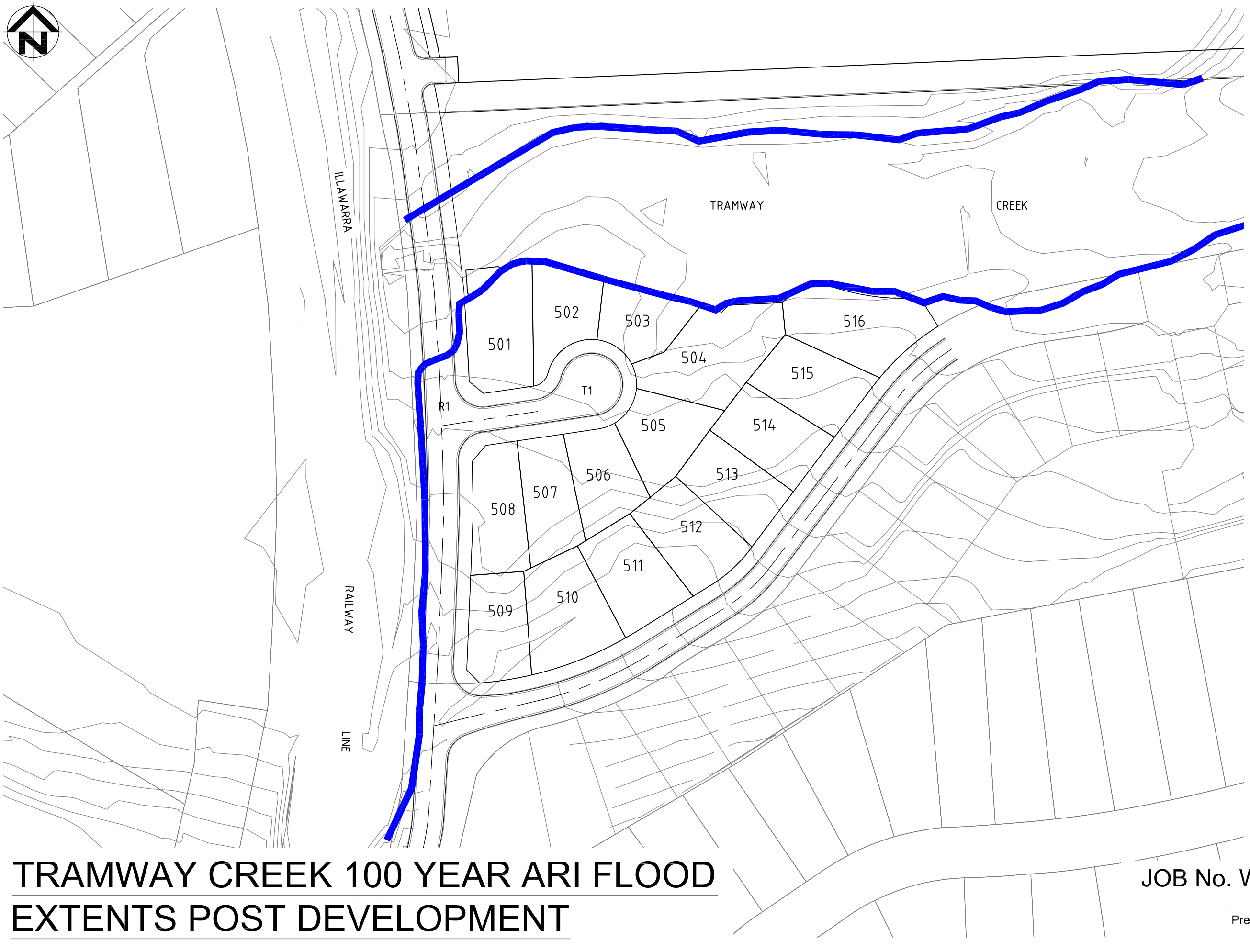

TRAMWAY CREEK 100 YEAR ARI FLOOD EXTENTS POST DEVELOPMENT

NOT TO SCALE

JOB No. W03066.07

Drawing: Figure 13

Prepared by: RAP/AMK

Date: 27-09-2006

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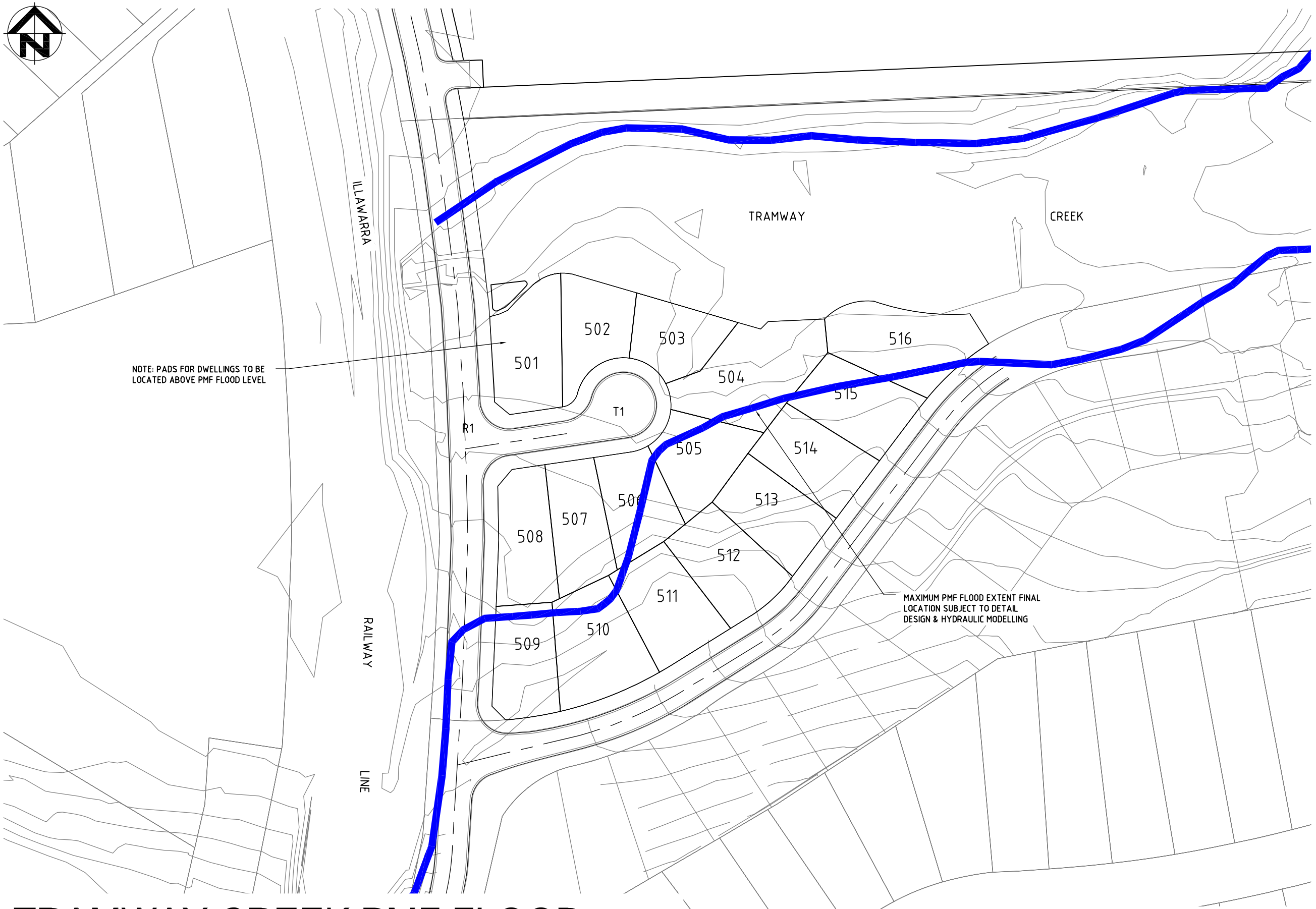

TRAMWAY CREEK PMF FLOOD EXTENTS POST DEVELOPMENT

NOT TO SCALE

JOB No. W03066.07

Drawing: Figure 14

Prepared by: RAP/AMK

Date: 27-09-2006

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