

APPENDIX E

HYDRAULIC INVESTIGATION

**CARDNO LAWSON TRELOAR PTY LTD
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BP Development Chinderah

Hydraulic Investigation

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1 Purpose of the Report

This report has been prepared by Cardno Lawson Treloar Pty Ltd (CLT), specialist hydraulic consultants, for BP, for a proposed truck parking area adjacent to the existing service station fronting the Pacific Highway at Chinderah.

This truck parking area is an extension to the Stage 1 Service Station Development and is shown as the 'Stage 2 Expansion' on the Lowenstein and Stumpo Site Layout Plan (DWG No. QB3713-CSK1). A copy of this drawing is included in the reference section of this report. The property Description is Lot 1 on DP1127741.

The purpose of this report is to assess this proposed extension against existing conditions to ensure surrounding areas are not adversely affected by the development in relation to flooding.

2 Description of the Site and Catchment

The proposed development site is situated on the western side of the BP Service Station within an industrial area of Chinderah, between Ozone Street and the Pacific Highway. Other existing development within the area is predominately bounded by Morton, Rotumah and Ozone Streets.

The site and surrounding area is extremely flat and ponding of surface water can occur on the site.

The natural surface of the site falls internally from levels of 2 to 2.5 m in the south east corner to approximately 1.5m in the east and west directions. Drainage is via stormwater conduits through the existing service station to 2/600mm diameter reinforced concrete pipes (RCPs) under the Pacific Highway or east to Kingscliff Drain.

In times of heavy rainfall, drainage of the catchment occurs generally along the streets and underground stormwater pipes before being directed into formed open channels, which then convey the waters to exit under the Pacific Highway at several locations being:

- Westwards to 2/1050 RCPs under the Pacific Highway Off ramp
- Northwards through the site and under the Highway via 2/600 RCPs
- Eastwards via Ozone Street to an open cut channel, which conveys flow to Kingscliff Drain.
- Drainage in Ozone Street, twin 900 mm diameter pipes, grading from the low point in Ozone Street east to the existing open cut channel.

All floodwaters from the catchment are then directed to the Tweed River, approximately 700m north of the Pacific Highway.

Presently, the site is generally bushland, with a dense growth of high grass.

3 Proposed Development

The proposed development of Lot 1 on DP1127741 involves filling to form a truck parking area above the local Q_{100} flood level. This truck parking area is an extension to the existing BP Service Station and is shown and described as the 'Stage 2 Expansion' on the Lowenstein and Stumpo Site Layout Plan (DWN No. QB3713-CSK1). A copy of this plan is presented in the reference section of this report along with the Lowenstein and Stumpo Grading and Drainage Concept Plan (DWN No. QB3713-CSK2).

The proposed truck parking area is to drain north towards the Pacific Highway.

Previous compensatory works, for the loss of the shallow drain draining north through the service station, have been constructed to relieve drainage in Ozone Street. These compensatory works included construction of twin 900 mm diameter pipes grading from the low point in Ozone Street east to the existing open cut channel.

4 Scope of Work

CLT has been commissioned to undertake an investigation into the existing and proposed stormwater conditions for the site and local environs, and to report on any adverse impacts associated with development of the site with respect to stormwater drainage.

CLT's approach to the investigation has been to:

- a) Modify the existing case XP RAFTS hydrologic model to derive post developed flows;
- b) Utilise our detailed existing hydraulic model of the site and environs including overland flow paths and sub-surface stormwater drainage including all exit points under the Pacific Highway and modifications for the previous BP Service Station development to establish existing flood conditions;
- c) Modify the hydraulic model to represent the Stage 2 site conditions and assess impacts;
- d) Provide a detailed report of findings.

5 Hydrologic Analysis

The hydrologic analysis was carried out using the computer software package XP RAFTS. XP RAFTS is a non-linear runoff routing software package developed by XP Software. The XP RAFTS model was constructed in accordance with *Australian Rainfall and Runoff* (1998) and the *Queensland Urban Drainage Manual* (2007).

Table 1 lists the areas and fraction imperviousness of each sub catchment in the XP RAFTS model. Figure 1 shows the existing (stage one) local catchment extents. Figure 2 shows the catchment extents for the proposed case.

Table 1: Catchment Details

Catchment	Existing (Stage 1)		Stage 2	
	Area (ha)	Fraction Imp (%)	Area (ha)	Fraction Imp (%)
A	0.72	20	0.72	20
B	1.25	20	1.25	20
C	2.32	20	2.32	20
D	1.29	20	1.29	20
E	1.40	90	1.40	90
F	1.59	90	1.59	90
G	1.97	90	1.97	90
H	0.25	90	0.25	90
I	0.79	20	0.79	20
J	1.20	90	1.20	90
K	1.36	90	1.36	90
L	1.27	90	1.27	90
M	1.44	90	1.44	90
N	1.09	20	1.09	20
O	0.30	20	0.30	20
P	0.73	69	0.73	69
Q	0.18	22	0.18	22
R	0.44	35	0.44	35
S	0.16	50	0.16	50
S2	0.22	59	0.22	59
T	0.79	20	0.79	20
U	0.37	20	1.01	89
V	0.45	20	0.45	20
W	0.77	53	0.48	90
X	1.41	20	1.22	78
Y	1.81	20	1.65	20
Y2	0.99	20	0.99	20
Z	0.29	20	0.29	20
AA	2.70	20	2.70	20
AB	3.35	20	3.35	20

Total	32.9		32.9	
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Catchments U, W, X, and Y, which are highlighted in the table above, have been modified from existing conditions to represent the proposed development.

The initial and continuing losses adopted for the RAFTS model are shown in Table 2. Table 3 lists the adopted storage routing parameters for the model.

Table 2: Initial and Continuing Losses

ARIA (yrs)	Pervious (mm)		Impervious (mm)	
	I.L	C.L	I.L	C.L
2,5	15	2.5	1.5	0
10,20	10	2.5	0	0
50,100	5	2.5	0	0

Table 3: RAFTS Model Parameters

ARI (yrs)	Bx
2	1.2
5	1.2
10	1.2
20	1.2
50	0.6
100	0.6

CLT's previous report 'BP Development Site Chinderah, Stage 1 – Hydraulic Investigation, LJ8529/R1', August 2005, validated pre-developed peak flows from the XP RAFTS model to the Rational Method. The table showing this calibration has been reproduced below.

Table 4: RAFTS Model Calibration

ARI (yrs)	Rational Flows (m ³ /s)	RAFTS Flows (m ³ /s)
2	1.3	1.7
5	1.8	2.2
10	2.1	2.6
20	2.5	2.9
50	3.2	3.3
100	3.7	3.7

6 Hydraulic Analysis Details

6.1 General

The hydraulic assessment has been performed using the hydrodynamic computer modelling software, SOBEK v2.09.004, developed by Delft Hydraulics in the Netherlands. The modelling has been undertaken in an integrated 1D and 2D modelling environment.

The advantages of two-dimensional modelling are:

- Full topographic survey terrain models are used, rather than discrete cross sections with flood storage and attenuation accurately represented;
- Flow patterns are dictated by topography and surface roughness, rather than 'forced flow paths, used in quasi-two-dimensional networks; and
- Flow directions and paths can vary with stage and low conditions (compared to 'rigid' networks forcing flow paths in quasi-two dimensional models).

To complement the advantages of the two-dimensional flow modelling, the one-dimensional elements allow for the accurate numerical modelling of one-dimensional structures, such as pipe flow and open channel flow.

Model set up has been based on survey provided by Queensland Planning and Survey Pty Ltd and civil design drawings from Lowenstein & Stumpo.

Two cases have been analysed:

- **Existing Case:** The existing case is shown on Figure 3 and includes the BP Service Station and additional stormwater drainage of 2/900mm pipes placed in Ozone Street which drain east to the Ozone Street channel.
- **Proposed Case:** This case incorporates the proposed truck parking area as shown in the reference drawings as well as associated swales and bio-retention basin areas.

6.2 Tailwater Conditions

Tailwater conditions have been previously supplied by Tweed Shire Council (2001), and are reproduced below. Intermediate levels were interpolated from these values. These tailwater levels were applied at the boundaries of the model on the downstream (northern) side of the Pacific Highway.

Table 5: Tailwater Conditions

ARI (yrs)	Level (m AHD)
2	1.18
100	1.70

6.3 Roughness

Manning's 'n' roughness values were adopted based on an inspection of the site. General roughness parameters used in the modelling are listed in the table below:

Table 6: Manning's 'n' Roughness Parameters

Type	'n'	Location
Streets and hard surfaces	0.020	General
Stormwater Pipes (aged)	0.015	Existing pipe
Cleared Overland flow	0.060	Existing site
Concrete lined drain	0.025	West of Morton Street
Concrete lined drain (silted)	0.030	Ozone Street Channel
Channels (medium vegetation)	0.060	Site channel

7 Results

7.1 Existing Situation

The existing case estimates the local catchment Q_{100} flood level in Ozone Street at 1.88 mAHD (refer Figure 3 and annex 3 for reporting point 104). The peak Q_{100} flow in the Ozone Street drain is $2.88\text{m}^3/\text{s}$ with a water surface level of 1.72 mAHD at the upstream extent of the drain. There is some transfer of flow into the site from Ozone Street until the intersection with Rotumah St where the additional capacity of the Ozone St Channel combined with bunding prevents further transfer.

The Q_{100} water surface level upstream of the twin 600mm diameter pipe culverts north of the site under the Pacific Highway is RL 2.02mAHD (refer reporting point 98 on Figure 3). Resulting Q_{100} peak flood levels at the twin 600mm diameter pipe culverts under the Highway cause flow to drain eastward through a 450mm culvert under the access ramp to the Service Station and eventually into Kingscliff Drain.

The existing buildings are not affected by Q_{100} flood based on peak WSL estimates from the existing case. The minimum level of a building platform on Ozone Street was surveyed at 2.62, well above local catchment Q_{100} flood levels.

The following Figures, included in Annex 1, show the existing results.

Figure 5 – Q_{100} Peak WSL – Existing Case

Figure 6 – Q_{100} Peak Depth and Velocity Vectors – Existing Case

Figure 7 – Q_2 Peak WSL – Existing Case

Figure 8 – Q_2 Peak Depth and Velocity Vectors – Existing Case

7.2 Developed Case – Stage 2 – Truck Parking Area

A comparison of the developed case peak flood levels to the existing case shows that the local Q_{100} flood levels along Ozone Street will decrease by 10 to 20mm and in some areas more than 20mm due to the proposal. Impacts in Morton Street and Rotumah Street are negligible and in the majority of area reductions in peak flood levels are anticipated. No increase in water level is estimated in the Kingscliff Drain at the western Pacific Highway culverts with the peak water level maintained at RL 1.71 mAHD at the upstream end of the culverts (refer reporting point 84 on Figure 11).

Impacts are estimated to occur north of the proposed fill pad between the site and the Pacific Highway. Modelling estimates the local peak Q_{100} flood levels will increase from RL 1.78 to RL 1.83 mAHD (refer reporting point 100 on Figure 11). The Pacific Highway has an elevation of 2.27 mAHD in this area, hence there is adequate freeboard of 0.44m following the Stage 2 development.

An impact is also estimated to occur between the BP Service Station and the Pacific Highway. The modelling indicates the local catchment peak Q_{100} flood level increases from RL 2.02 to RL 2.04 mAHD (refer reporting point 98 on Figure 11). This is primarily due to increased and redirected flow off the Stage 2 development. The edge of the bitumen for the off ramp in this area is 2.04 mAHD and therefore the ramp is estimated to be flood free under Q_{100} local conditions.

A small impact is also evident at the western end of Ozone Street however as there are no changes being made in this area this is believed be a model instability in this area.

In all cases, existing buildings are not affected by the impacts. The minimum level of a building platform on Ozone Street was surveyed at 2.62, well above local catchment Q_{100} flood levels.

The following Figures showing Stage 2 results are included in Annex 1.

Figure 12 – Q100 Peak WSL – Proposed Case

Figure 13 – Q100 Peak Depth and Velocity Vectors – Proposed Case

Figure 14 – Q100 Peak WSL Impacts – Proposed Case

Figure 15 – Q2 Peak WSL – Proposed Case

Figure 16 – Q2 Peak Depth and Velocity Vectors – Proposed Case

Figure 17 – Q2 Peak WSL Impacts – Proposed Case

8 Conclusion

Filling is required to ensure the truck parking area is flood free to the local Q_{100} flood level. It is estimated that the local Q_{100} flood level at the Stage 2 site is RL 1.9mAHD. Hence a fill level of RL 2.0mAHD is recommended.

As there is adequate freeboard to existing dwellings and the Pacific highway there are no adverse impacts anticipated by this proposed truck parking area.

9 Qualifications

This report has been prepared by Cardno Lawson Treloar (CLT) specifically for BP and specifically to provide hydraulic advice and assessment for the Stage 2 extension of the BP Site at Chinderah.

Our analysis and overall approach has been specifically catered for the particular requirements of BP, and may not be applicable beyond this scope. For this reason any other third parties are not authorised to utilise this report without further input and advice from CLT.

The report is based on the following studies and information prepared by others:

1. CLT has relied on survey data provided by Queensland Planning and Survey Pty Ltd.
2. CLT has relied upon design information from Sheehy and Partners for the existing BP Service Station.
3. CLT has relied upon proposed development plans provided by Lowenstein and Stumpo.
4. CLT has relied upon tailwater conditions provided by Tweed Shire Council.

The accuracy of the report is dependent upon the accuracy of this information.

While CLT's report accurately assesses peak flows from design storms, it is an ungauged catchment; consequently future observed flows may vary from that predicted.