Palm Lake Works Pty Ltd

Engineering Impact Assessment

Revision 4

24 February 2010

Opus International Consultants (Australia) Pty Ltd

ABN 79 086 342 065

1/10 Rivendell, Tweed Heads South NSW 2486

PO Box 6389, Tweed Heads South NSW 2486

+61 7 5523 1755

+61 7 5523 9664

Engineering Impact Assessment
Palm Lake Works Pty Ltd
Revision 4

LIST OF FIGURES

DOCUMENT HISTORY

REVISION / ISSUE RECORD

DATE	DESCRIPTION	REV	AUTHOR	VERIFIED
04/04/08	Engineering Impact Assessment	1	T Seresheff	M Findlater
18/07/08	Engineering Impact Assessment	2	C O'Reilly	M Findlater
02/03/09	Engineering Impact Assessment	3	Jon Lindsay	M Findlater
24/02/10	Engineering Impact Assessment	4	Jon Lindsay	M Findlater

DISTRIBUTION RECORD

	REVISION No. / Qty Issued				
RECIPIENT	**1**	**2**	**3**	**4**	**5**
Noel O-Brien--Palm Lake Works Pty Ltd	1	PDF 1 hard	PDF 1 hard	1	
Adam Smith – Planit Consulting	1			4 hard 1 CD	
Chris Sayer – Planit		PDF 4 hard	PDF 12 hard		
Opus				1	

Prepared By: **JON LINDSAY**, Civil Engineer

Approved for Issue: **MARTIN FINDLATER**, Senior Civil Engineer / Associate

1. INTRODUCTION

Palm Lake Works Pty Ltd has instructed Opus International Consultants (previously blueLAND engineers) to assess the impacts of a proposed residential subdivision development at Creek Street, Hastings Point NSW.

The assessment addresses the following issues:

- Earthworks impacts including erosion control.
- Flooding Impacts.
- Traffic generation impacts.
- Stormwater drainage impacts.
- Stormwater quality impacts.
- Water demand and Wastewater generation impacts.
- Utility Services & Solid Waste Disposal

2. DEVELOPMENT LOCATION

The site is identified as Lot 156 DP 628026, Parish of Cudgen in the Shire of Tweed. The site is currently zoned partially 2(e) Residential Tourist and a small portion of the site adjacent to Cudgera Creek is zoned 7(a) Environmental Protection (Wetland & Littoral Rainforest). The site locality and zone boundary are given in Figure 1.0.

3. EXISTING FEATURES

The site is bounded by National Park to the west, Christies Creek to the south, Cudgera Creek to the east and Creek Street to the north. There are mangroves located below the mean high water mark and a pocket of dense mangroves and Casuarina in the western portion of the site. Above the mean high water mark, the surface is grassed with scattered shrubs and the site is relatively level, with the exception of scattered depressions and hollows. The soil has a sandy profile and some filling with sand has been previously carried out, presumably with material obtained from the inlet situated in the west of the property. The site is currently vacant. The existing features are shown in Figure 2.0.

4. DESCRIPTION OF PROPOSAL

The current proposal comprises of a residential subdivision providing 34 single residential allotments, 2 integrated housing allotments, 3 potential Dual occupancy allotments and 2 tourist allotments. The proposal will provide residential allotments of a 450 m^2 minimum size, and the provision of 9 300m^2 integrated housing lots. The tourist allotments cover a combined area of 3327 m^2, with an approximate unit area of 200 m^2 the site may provide for 20 units. The layout of the proposed development is shown in Figure 1.0.

5. EARTHWORKS AND EROSION CONTROL

5.1 EARTHWORKS

5.1.1 EXISTING SITE

The filling site is relatively level, generally cleared of trees, with grass cover and with a fringe of mangroves below the mean high water mark. Apart from some scattered mounds in the eastern portion of the site, the existing natural surface is RL 1.9m AHD approximately in the central and eastern portion of the site and approximately RL 1.0m AHD in the west.

5.1.2 PROPOSED EARTHWORKS

The proposed earthworks will comprise importation and placement of fill (from approved sources) to bring the existing levels up to above RL 2.40m AHD in accordance with the approved TSC Development Control Plan(DCP) 5: Development of Flood Liable Land. Figure 3.0 outlines the extent of the proposed filling works. Accordingly fill depths are generally of the order of 0.5 to 2 metres maximum (based on the existing natural surface). The average fill height will be RL 2.80m AHD. Any batters are proposed to have maximum slopes of 1V:3H. A SEPP 14 Coastal Wetland is located adjacent to the property to the south. The approximate SEPP 14 boundary is given in Figure 3.0. No works are proposed within the wetland. No on site excavation other than stripping topsoil and trenching for services is proposed under this development application.

The recently conducted 'Tweed-Byron Coastal Creeks Flood Study' details a flood level at the site of R.L 2.5. In accordance with the adopted DCP the design flood level would be the next contour being R.L 2.6. The finished floor level as stated in the DCP would be 500mm higher than the design level being R.L 3.1m. The average fill height of R.L 2.8m would meet the flood level required by the Council's recent flood study if adopted with the same principles. Finished floor levels would be to minimum R.L 3.1m.

The type of imported fill material will preferably be of a granular nature and will be required to comply with engineering criteria to limit sensitivity due to moisture such that any dwelling foundation can be designed for an "s" or "m" soil class. Furthermore the soil required for road subgrade construction will also be specified to have certain characteristics such that the depth of road base over the fill will be kept to a minimum. There are a range of soil types available which will meet the above criteria. The applicant has advised that this material will be obtained from a council approved external source. The location will be advised prior to construction.

5.1.3 IMPACT OF EARTHWORKS

Approximately 37,000 m^3 (solid volume) of fill is required to bring the site to above RL 2.40 plus a 1.0% minimum surface cross fall to prevent ponding. Accordingly, the impacts are localised to the filling area plus the external traffic impacts discussed in Section 7.0.

A Geotechnical assessment was conducted for the site by Soils Surveys. The report provides recommendations on treating the subgrade prior to general filling (i.e. strip topsoil and proof roll) and also recommends maximum batter slopes of 1V:3H. We conclude from the findings of the report that the subsurface can support the proposed fill. The report recommends compaction

criteria and short term constraints on excavation slopes. See Appendix G for the complete geotechnical report.

5.2 ACID SULFATE SOILS

On the Department of Land & Water Conservation Acid Sulphate Soils Risk Maps Edition II – Cudgen 9641-N3 the site is designated as "High Probability of acid sulphate soils at between 1 and 3m below the surface". This site warrants a field investigation for the occurrence of Acid Sulphate Soils. A Preliminary Acid Sulphate Soil Management Plan is provided in Appendix A. An Acid Sulphate Soils investigation by Soil Surveys Engineering Pty Ltd is appended in Appendix B.

5.3 SOIL CONTAMINATION

Soil contamination test results are given in the Soil Surveys Engineering report in Appendix B. A Preliminary Soil Contamination Report has been prepared by Opus International Consultants and is appended in Appendix C. This report concluded that the site is uncontaminated and suitable for residential use.

5.4 EROSION & SEDIMENT CONTROL

5.4.1 EXISTING SITE

The existing filling site has some grass cover and is buffered from stream flows by a fringe of mangroves. There is no evidence of any erosion problems.

5.4.2 PROPOSED EROSION CONTROL

The proximity of the adjacent SEPP 14 wetland area warrants that careful attention is given to erosion control. Minimisation of sediment transfer on the filling site itself plus also retention of any runoff within sediment ponds (temporary or permanent) is needed such that mixing with external "clean" runoff is avoided both during construction and after filling is completed.

The following proposed construction sequence is recommended to meet this objective.

1. Install silt fences around the filling perimeter.

2. Clear, grub and remove topsoil from 10 metre wide strip (stockpiling topsoil for reuse) before placing imported fill bund inside perimeter silt fences including installation of outlet pipe work to suit the post development pipe outlet locations.

3. Topsoil and turf external batter and crest of initial bund.

4. Remove existing vegetation (trees and ground cover) from balance of filling site progressively ahead of filling operations such that cleared areas area generally kept less than 2 Ha.

5. Strip topsoil from cleared areas and stockpile away from drainage paths.

6. Place imported fill starting from adjacent to the perimeter bund and progressing towards the central sediment pond. Maintain 0.5% grade to direct runoff towards central sediment pond.

7. Spread stockpiled topsoil with grass seed mix (appropriate to season). Water regularly to ensure early groundcover regeneration.

A strategy to place the filling inside of a perimeter bund will essentially mean the entire site will act as a sediment pond. This will enable the site runoff water entering the downstream drainage system be released in a controlled manner. Sediment basin sizing calculations (Refer appendix D) indicate that suitable area exists within the proposed bounded site to capture sediments from runoff until vegetation is re-established.

In addition the measures recommended in the Soil and Water Management Plan (Refer Appendix E) should be implemented.

6. FLOODING

6.1 DEVELOPMENT IMPACTS – 100 YEAR EVENT

An assessment was made to determine the impacts of filling the area indicated in Figure 3.0. The 1 in 100 year design flood specified in Tweed Shire Council DCP Section 3 Flood Liable Land is RL 2.40m AHD. It is proposed to fill to a minimum level of RL 2.40m with a 1% surface grade to prevent ponding of stormwater runoff. The water surface or backwater modelling program HEC-RAS by the US Army Corps of Engineers was initially used for the study.

The Hec-Ras model incorporated the topographical Christies Creek Catchment defined from 1 :25,000 maps. This analysis did not include the downstream influence of the bridge or the inflow associated with Cudgera Creek. The Hec- Ras results indicated an average change in flood level of approximately 20mm, which is less than the overall accuracy of the model. A public meeting was held in February 2007 regarding a number of aspects of the proposal. As a consequence of concerns raised by residents with respect to flooding a more detailed flood assessment was carried out. The increased detail calculations were performed using the Computer Programme XP-Storm incorporating a 2 dimensional calculation module “tuflow”.

The model used is technically described as a 1 dimensional / 2 dimensional analysis (1d/2d).
A 1 d model (such as HEC Ras) calculates water levels and velocities along the direction of the stream. Overbank flows are considered to be parallel to the main flow. A 2d model calculates water levels, flows and velocities parallel and at 90 degrees to the main channel. Calculations are carried out on a rectangular grid covering the area of interest. The combined model uses the 1 d calculations in the mainstream where the width of flow is smaller than the grid pattern adopted and for parts of the catchment which are outside the area of detailed interest.

The initial XP-Storm 1d / 2d model incorportated the Cudgera Creek catchment, the Christies Creek catchment and contributing catchments to the north of the site. The Christies Creek and Cugera Creek catchment was defined from topographical maps. Local ground levels used in the model were based on aerial laser survey as obtained by Tweed Shire for regional flood assessment. Flows were calculated by the computer programme using hydrograph methods (flow varies with time). The total calculated inflow from the contributing catchments for the 100 year ARI storm peak hydrograph inflows was 620 m^3/s

The model incorporated the existing bridge over Cudgera Creek which was not part of the HEC Ras model. The hydraulic capacity of the bridge was checked using an alternative computer programme (Culvertw) to XP-Storm. The Culvertw model indicated that the bridge has a capacity of approximately 300 m^3/s before overtopping and would produce an upstream headwater RL of 2.46m with a downstream tailwater of RL 1.0m. The 1d/2d model produced similar results.

The initial XP-Storm study was queried by Council as a result of the recently completed regional study conducted by BMT – WBM. The 'Tweed-Byron Coastal Creeks Flood Study' was prepared by BMT-WBM for the Tweed & Byron Shire Council. The study outlines the regional flood inundation and flow conditions for a number of catchments including Cudgen Creek, Christies Creek and Cugera Creek. The study includes various flood scenarios including a range of various Average Recurrence Interval(ARI) storms and storm surge combinations and the Probable Maximum Flood (PMF) event. The BMT-WBM study highlighted interactions between the Cudgen Creek and Christies Creek catchments. The upper reach of the Christies Creek catchment appears to be diverted at the Kanes Road directing flow into Cudgen Creek at this point. This affectively halves the catchment area and inflows previously adopted.

The XP-Storm Model was recalculated to reflect the flood scenarios and outlet conditions outlined in the BMT –WBM study. The Christies Creek Catchment was reduced to reflect the diversion of the catchment at Kanes Road. The combined catchment peak outflow reduced to $257m^3/s$ for the Q100 (100 year ARI storm) event as a result of the diversion. The resulting XPSTORM peak flows were within 0% to +15% of the BMT WBM model for various storm duration comparisons. The flood scenarios modeled included; a Q100 flow in the catchments with a Q20 (20 year ARI storm) storm surge at the outlet; a Q10 (10 year ARI storm) flow in the catchments with a Q100 storm surge at the outlet; a PMF storm in the catchments with a Q100 storm surge at the outlet. The BMT WBM Storm surge profiles for the Q20 and Q100 cases were reproduced in the XPSTORM model with peaks of R.L 2.20m and R.L 2.60m respectively. XPstorm catchment peak flows were compared to the BMT WBM results to validate model output.

The sensitivity of the model to various sea levels downstream of the bridge was assessed against the storm surge scenarios. The range of sea levels modelled conform with range of suggested level increases outlined in the Department of Enviroment and Climate Change (DECC) document Flood Risk Management : Practical Consideration of Climate Change. This analysis takes into account the potential impacts associated with sea level rises as a consequence of Global Warming.

Flood modelling was conducted for existing and proposed cases. The Existing case consisted of a Digital Terrain Model (DTM) of the current ground levels and areas representing existing buildings. Building areas provide a physical block where flow cannot pass over even in high water level situations. The proposed case comprised of a DTM of the surface incorporating the proposed earthworks plus provision for buildings.

The results of the various 1d/2d model calculations are presented in Figures 5 – 11. . The figures provide calculated flood elevations, depths, hazard and flow vectors. The flow vectors show the direction of flow. The length of the flow arrow is proportional to the magnitude of the flow. The levels have a stated accuracy of +/- 0.15m.

The local residents expressed concern with flood waters from the north flowing down Creek St rather than flooding from the Christies Creek catchment. The 1d/2d model replicated the observations of the residents in that flows are shown within Creek St. in the various Figures.

When considering properties in the vicinity of the bridge and on the southern side of Creek Street the Q100 storm surge Q10 flows scenario produces levels comparable to the BMT-WBM study. Whereas the Q20 storm surge Q100 flow scenario produces levels comparable to the BMT-WBM study properties on northern side of Creek Street.

The recalculated XP-Storm model produced flood elevations which were within + 100mm of the BMT –WBM results for the Q100 & Q10 events and -150 mm for the PMF. The average difference between the XP-Storm results and BMT-WBM results for depths along the major channel was +3% for the Q100 event and -5% for the PMF event.

Our analysis and interpretation of the various calculated results reveal the following impacts.

- The proposed development and emergency access road for the Q100 storm surge Q10 flow scenario has reduced flood levels by - 20mm in Creek Street. Reduced inundation of Creek Street and the caravan park is evident as a result of the emergency access road blocking flow. There is a + 30mm increase in flood elevations on the northern side of the caravan park localised to the existing drainage channel.
- The Q20 storm surge Q100 flow scenario has increased flood elevations on the northern side of the caravan park by + 60mm and + 30mm on the north east side of the car park for the proposed case. Inundation is reduced on the eastern end of Creek Street due to the access road. There is a + 20mm increase on flood elevation on the north west end of Creek Street.
- The Q100 storm surge PMF flow scenario has produced no increase in flood elevation on the eastern end of Creek Street. There is a + 30mm increase on the north west end of Creek Street and the northern side of the caravan park with no level change through the caravan park
- The increase in flood levels to the north of the caravan park as a result of the PMF and Q100 storm flow scenarios in both cases is confined to the existing drainage channel.
- The emergency access road has reduced inundation onto Creek Street however there will still be flow from catchments on the northern side of the emergency access road. The culverts under the access road will require tide gates to be designed along with the pipe capacities at the detailed design stage to ensure that flows from Creek Street are able to flow to the creek and limit storm surge inundation.
- An examination of the flow direction and inundation area indicate that the filling has to some extent restricted the flow from Christies Creek into Creek Street without adversely affecting flood levels in the north eastern corner of the Tourist Park. There is an increase in flood levels of approximately + 30mm in the western end of Creek Street which is not zoned for development. This is not significant if the effects of natural erosion and sedimentation on the hydraulic conductivity of the bridge are taken into consideration. These factors will cause much greater variations in flood levels.
- There is a calculated increase in levels of up to + 30 mm in the main channel due to the development however the increase does not cause additional inundation to developed areas.

We conclude that the proposed development results in a reduction in water levels on the eastern end of Creek Street. It slightly increases levels in the main channel by + 20 mm to + 30 mm. It causes a minor increase in levels at the western end of Creek Street of + 20mm and the northern drainage channel + 20 to + 60mm.These increases are mathematically insignificant in the context of natural variation due to the hydraulic influence of the downstream bridge and the variability in estimating flood flows. We are of the opinion that the increase (and decrease) has no practical significance as the area is already inundated by up to 1.0m of water irrespective of the development and consequently the development is unlikely to result in a measurable increase in damage or nuisance to adjacent properties. The development reduces the impact of storm surges on the properties north of and adjacent to Creek Street.

6.2 DEVELOPMENT IMPACTS – PROBABLE MAXIMUM FLOOD EVENT

The Bureau of Meteorology's Generalised Short Duration Method (GSDM) was used to calculate the Probable Maximum Precipitation (PMP) for the Christies and Cudgera Creek Catchments. Tweed Shire Council's Flood Risk Management Policy requires a 100 year ARI (Q100) flood free access to land above the PMF for all new residential development. The applicant has incorporated a flood free access to the eastern end of Creek St. This is to be made available to the residential development in emergencies. The Flood assessment has included an analysis of the PMF and has demonstrated no additional inundation during PMF event as a result of the development. Figures 9 -10 demonstrate the PMF flood scenarios combined with a 100 year ARI Storm surge.

6.3 FLOOD HAZARD ASSESSMENT

The NSW Government Floodplain Development Manual (2005) categorises the hazard posed by the flow of floodwaters based on their depth and velocity. The degrees of flood hazard outlined in the manual are low (0 - 0.6) medium (0.6 - 0.8) and high (> 0.8) where the values given are depth multiplied by velocity. By their nature and the results of the Flood Model the site and surrounding areas are categorised as flood storage area for Q100 and PMF flood events. The results from the Flood Model were output as flood hazard maps to assess any variation between existing and post development scenarios as follows in Figures 5.2, 6.2, 7.2, 8.2, 9.2, 10.2 and 11.2.

From the figures it can be seen that the development does not change the flood hazard ratings for the developed areas surrounding the development. Developed areas and the proposed development are rated as low hazard. There is an increase in flood hazard area within the main stream however there is no additional risk to persons or properties due to the increase .

6.4 TIDAL INUNDATION

The highest astronomical tide for the site is RL 1.14m AHD. The proposed filling of the site is to a minimum level of RL 2.4m AHD and the site would not be affected by tidal inundation.

6.5 CUMULATIVE IMPACTS

The development site represents the practical extent of undeveloped zoned land in the catchment required to be filled for residential development. A large area of the site is unable to be filled due to environmental constraints. We would consider that the proposal has no cumulative impact on flooding.

6.6 FLOODING CONCLUSION

Filling of the site to the extents indicated in Figure 3.0 would result in a mathematically and practically insignificant variation in flood levels upstream of the site. We do not consider the impacts to be significant in terms of water surface elevation or change in inundated land area. The development would not result in an increased flood hazard, damage or nuisance.

7. TRAFFIC

7.1 EXISTING TRAFFIC ENVIRONMENT

Access to the site is currently from Creek Street. It is intended that this access arrangement continue for the proposed development.

7.1.1 ROAD NETWORK AND HIERARCHY

Creek Street is classified an Access Street as defined in Tweed Shire Council Design Specification D1: Road Design. It has a designated speed of 50 km/h.

Coast Road is classified as Main Road No. 450 – Wooyung – Chinderah in RTA Traffic Volume Data 2004: Hunter and Northern Regions. Tweed Shire Council officers (pers. comm.) have advised that the design speed on Coast Road in the vicinity of Creek Street is 65km/h.

7.1.2 EXISTING ROAD GEOMETRY

Creek Street is a two-way road of approximately 6m width that allows left and right turn movements into and out of Coast Road. Creek Street has no kerb and gutter and the seal terminates at the site boundary adjacent to Lot 34 DP 25777. It then becomes a gravel road for approximately 80m. It has a linear horizontal alignment and slopes gradually towards the west, away from Coast Road.

Coast Road is a two-way road of 11m kerb to kerb width. In the vicinity of Creek Street, Coast Road has a slightly grading vertical geometry and a linear horizontal geometry.

7.1.3 EXISTING TRAFFIC VOLUMES

An existing traffic volume on Creek Street has been determined using traffic generation rates from RTA's Guide to Traffic Generation (2002) and Annual Average Daily Traffic (AADT) for Coast Road was obtained from RTA Traffic Volume Data 2004: Hunter and Northern Regions and from Tweed Shire Council. These volumes are as follows:

Creek Street

Dwelling Type	Number of Dwellings	Generation Rate (trips/dwelling)	Traffic Generation (vpd)
Medium density residential flat	24	4	96
Duplex dwelling	8	4.5	36
Single dwelling house	27	9	243
		TOTAL	**375**

Coast Road

RTA AADT (2001) **= 11,915 vehicles per day**

(Norries Head – 1km N of post office)

RTA AADT (2004) **= 5,837 vehicles per day**

(Norries Head – 1km N of post office)

TSC AADT (2006) **= 5,687 vehicles per day**

(South of Creek Street)

7.1.4 EXISTING PUBLIC TRANSPORT

There are two bus routes along Coast Road. The Tweed Heads to Pottsville route runs half hourly on weekdays and hourly on weekends. The Pottsville and Bogangar Community Bus Service runs a limited service on weekdays between Kingscliff and Pottsville. There is a bus stop 50m north of the entrance to Creek Street however the closest major bus stop is Hastings Point Store, approximately 570m south of Creek Street.

7.1.5 EXISTING PEDESTRIAN ACCESS

Creek street is un-kerbed and has no formed pedestrian pathways. Coast Road contains concrete footpaths for pedestrian access, which runs north and south on the western side of the road.

7.1.6 EXISTING PARKING

On street parking along Creek street is on the verge.

7.2 PROPOSED TRAFFIC ENVIRONMENT

7.2.1 INTERNAL ROAD HIERACHY

The development is to be serviced by an internal road network consisting of two access roads forming a loop from Creek street, extensions of both access roads combine to form another loop providing access to lots in the south east end of the development. An access road joining the south east loop provides access to lots in the north east corner of the site.. An emergency exit for flood purposes is also provided. The road layout is illustrated in Figure 1.0. The proposed road geometry follows Tweed Shire Council Design Spec D1 as shown in Table 7.2.1.

Table 7.2.1– Subdivision Road Widths

ROAD TYPE	RESERVE WIDTH (m)	PAVEMENT WIDTH (m)
Access Road	13.0	6.0
Lane way	20.0*	6.0

* Existing Creek Street road reserve

7.2.2 ACCESS

Access to the subdivision is proposed from Creek Street via the road connections shown in Figure 1.0. The sight distances available at the intersection of Creek Street and Coast Road are presented in photo plates 1 and 2. Figure 14.0 shows a detail of the eastern access emergency driveway. The emergency access will be above the 100 year ARI flood level of R.L.2.4m, will provide a route to land above the PMF and will function as an emergency exit for all residents west of the low point of Creek Street. The emergency access will join Creek Street at the existing pump station access road. A portion of the access road is proposed to be reconstructed and a cul de sac constructed to separate access to the pump station and the proposed development. The Flood access provides for a 6m wide fire trail with a 4m wide clear trail and 2.5m wide cycle way. A passing bay is provided as required by NSW Rural Fire Service: Planning for bushfire protection 2001.This is the minimum requirement specified in Council's Flood Risk Management Policy section 1.4.2. Creek Street service vehicle access i.e. Refuse Truck circulation has been accounted for in the road design and truck turning paths are demonstrated in Figure 11.0 and 11.1.

Photo Plate 1 – Creek St Sight Distance – (North)

Photo Plate 2 – Creek St Sight Distance – Right (South)

The sight distances available at the intersection were assessed according to Austroads Guide to Traffic Engineering Practice Part 5: Intersections at Grade (2005) and are presented in Table 7.2.2(a).

Table 7.2.2(a) – Observed Intersection Sight Distances - Coast Rd/Creek St

Location	Safe Intersection Sight Distance (SISD) Left (m)	Safe Intersection Sight Distance (SISD) Right (m)
3m from Creek Street	149	200+
5m from Creek Street	131	200+

From Austroads Guide to Traffic Engineering Practice – Part 5 Intersections at Grade (2005) the minimum Safe Intersection Sight Distance for roads with a design speed of 65 km/hr is interpolated as 130m. The existing sight distances left and right are greater than that specified by the Austroads guide.

We conclude that the proposed development can provide suitable access for both the short and long term.

7.2.3 PARKING

Off street parking for the development can be provided within the proposed allotments, an additional 35 off street parks have been provided throughout the development. The tourist facility parking should be provided as per Tweed Shire Council DCP section A2 as detailed in Table 7.2.3 below. On Street Parking can be accommodated by the proposed road widths specified in Tweed Shire Council Design Specification D1 – Road Design.

Table 7.2.3 – Proposed Tourist Facility off Street Parking Requirements

Dwelling Type	Number of Units	Parking Required	Required Parking spaces
Tourist Facility	20	1/unit	**20**

7.2.4 PEDESTRIAN ACCESS

Pedestrian access is proposed along the Creek Street frontage and on the proposed internal access streets in accordance with Tweed Shire Council Design Specification D1 – Road Design. The proposed layout can provide for this requirement. It is also proposed to provide pedestrian access along the emergency access for residents west of the low point of Creek Street in the event of a 100 year ARI flood.

7.3 ROAD LAYOUT IMPACTS AND MITIGATING METHODS

The proposed extension of Creek Street should be designed in accordance with Tweed Shire Council Design Specification D1 – Road Design. The proposed road layout allows for vehicle circulation through the proposed subdivision. TRAFFIC GENERATION
The Road and Traffic Authority (RTA) provide data for traffic generation from residential development in their Guide to Traffic Generation (2002). The proposed traffic generation based on these rates was calculated for the development as shown in Table 7.3.1 below.

Table 7.3.1 – Proposed Traffic Generation

Dwelling Type	Number of Dwellings	Daily Trip Rate Per Dwelling	Estimated Daily Trips (vpd)
Single Dwelling	34	9	**306**
Integrated housing	9	4.5	**41**
Duplex Dwelling	3	18	**54**
Tourist Facility	20	4	**80**
		TOTAL	**481**

The proposed total design traffic generated by the development is 481 vehicles per day. Therefore the total proposed design traffic along Creek street combined with the existing traffic is 856 vpd.

7.4 CONSTRUCTION TRAFFIC

During the construction phase, heavy vehicle traffic could be expected. This would comprise of earthmoving equipment, construction plant and builder's vehicles. Importation of fill material is required for the proposed development. Based on the approximately 37,000m3 (solid volume) of fill material required to be imported, a bulking factor of 20% and a 20m3 capacity truck, approximately 4,440 vehicle trips (two-way) would be required. We estimate at maximum capacity approximately 1000m3 would be delivered /day over a 1- 2 month 6- 8 week period.

Impacts resulting from the traffic generated by construction would be mitigated by the location of the site in close proximity to the main road Coast Road. Contributions toward the impacts on pavement life as a result of importation of fill material would be levied from the proposed development under Section 94 plan no. 4 Tweed Road Contribution Plan.

7.5 INTERSECTION ANALYSIS

Austroads Guide to Traffic Engineering Practice Part 2 – Roadway Capacity (1988) provides intersection volumes below which a capacity analysis is unnecessary. The post-development design traffic volume on Creek Street is below the threshold values and does not require a detailed intersection analysis. Nonetheless an analysis has been carried out using the computer programme aa sidra. The results of the analysis are appended at Appendix F. In summary the proposal will produce a queue not exceeding one vehicle with 95% probability for both right and left turns.

A conceptual intersection treatment is also appended to demonstrate that the existing intersection can be upgraded to provide for a dedicated right turn lane in Coast Road for traffic safety reasons rather than for traffic movement delay. The turn lane length need only meet minimum length requirements. The concept Plan incorporates provision for an existing pedestrian refuge.

7.6 TRAFFIC IMPACTS AND MITIGATING MEASURES

Creek Street is classified as a Local Street. The indicative maximum traffic volume of local streets from Design Spec D1 is 1,000 vehicles per day. The current traffic on Creek Street based on RTA generation rates is 375 vehicles/day. The expected impact of 481 additional vehicles per day on Creek Street is less than the indicative maximum traffic volume in Design Spec D1. Creek Street will comply with Design Specification D1.

The traffic environment on Coast road has demonstrated a decrease in AADT of 6,078 vehicles between 2001 and 2004 due to the construction of the Chinderah-Yelgun Bypass. A further decrease of 150 vpd has been measured between 2004 and 2006. The traffic generation attributable to the proposed development is offset by these decreases.

We conclude the road network has the design capacity to cater for the proposed subdivision. The intersection of Creek St and Coast Road can be upgraded to provide a protected right turn lane for safety reasons.

8. WATER CYCLE MANAGEMENT PLAN

8.1 STORMWATER DRAINAGE

8.1.1 EXISTING DRAINAGE

The site is vacant and grassed drainage patterns in this area are well defined with a general fall towards Christies Creek to the south of the site. A 2.5m wide grass lined table drain runs along the southern side of Creek Street for its frontage to the site draining along the west of the site to Christies Creek. All site runoff drains ultimately to Christies Creek which joins Cudgera Creek adjacent to the south eastern corner of the site

Due to the slightly grading topography there is only one external catchment affected by the development (catchment C). The areas utilized by the proposed development have been divided into three sub catchments A1, A2 & B. The stormwater catchments are shown in Figure 13.0.

8.1.2 PROPOSED DRAINAGE NETWORK

Excess runoff from driveways will flow across grass to the internal drainage network. Runoff from the public roads to the west (Catchment A1 & A2) will enter inlet pits flowing onto a treatment device before being discharged to Christies creek. Runoff from roads and lots to the east (Catchment B) will be treated separately to the Catchment A runoff before being discharged to Christies creek. Roof water from allotments will drain into inter-allotment drainage pits connecting into the stormwater drainage network where suitable.

Runoff from catchment C (existing dwellings) will be collected in the concrete swale drain to the north of the emergency access driveway and discharged beneath the driveway to Christies Creek. This piped system should by designed to accommodate Q100 flows as there is no overland flow path below the flood level for this catchment. Water sensitive design features such as infiltration of roof water and the use of swale drains can be readily incorporated into the proposal if a sand fill is used. The proposed drainage is detailed in Figure 13.0.

8.1.3 DRAINAGE IMPACT

Drainage calculations have been carried out using the Rational Method as recommended by Design Specification D5 Stormwater Drainage and described in Australian Rainfall & Runoff 1987. Analysis has been carried out for the existing undeveloped case and the proposed developed case.

The resultant discharge from the internal site catchments for various return period storms is summarized as follows in Tables 8.1.3(a) and 8.1.3(b). Developed catchment calculations were determined using recommended values for Impervious Fraction and Time of Concentration from the Queensland Urban Drainage Manual (QUDM 1992).

Table 8.1.3(a) Existing undeveloped catchments

Storm ARI.	Catchment	Area (ha)	t_c (min)	I_y (mm/hr)	C_y	Q (m^3/s)
5 yr	A1	0.688	26	100.59	0.665	0.128
	A2	2.336	26	100.59	0.665	0.434
	B	2.062	26	100.59	0.665	0.383
	C	0.89	10	154.43	0.760	0.290
100 yr	A1	0.688	26	160.47	0.840	0.258
	A2	2.336	26	160.47	0.840	0.875
	B	2.062	26	160.47	0.840	0.772
	C	0.89	10	241.07	0.960	0.572

Table 8.1.3(b) Proposed developed catchments

Storm ARI.	Catchment	Area (ha)	t_c (min)	I_y (mm/hr)	C_y	Q (m^3/s)
5 yr	A1	0.627	15	130.15	0.762	0.190
	A2	2.329	15	130.15	0.762	0.643
	B	1.803	15	130.15	0.764	0.569
100 yr	A1	0.627	15	204.92	0.962	0.377
	A2	2.329	15	204.92	0.962	1.280
	B	1.803	15	204.92	0.965	1.132

Note: Catchment C remains unchanged post development.

8.1.4 STORMWATER DRAINAGE SUMMARY

The proposed development impacts on stormwater runoff rates are given in Table 8.1.4(a).

Table 8.1.4(a) Development Impact on Flow Rates

Catchment	Minor ARI Increase (%)	Major ARI Increase (%)
A1	48	46
A2	48	46
B	49	47

It can be observed from the values above that the proposed residential subdivision will have an impact on the runoff rates for the site. Stormwater detention has not been provided to maintain existing flow rates as this may have an unwanted hydraulic affect. As the development is situated at the mouth of Christies Creek and close to the mouth of Cudgera Creek the peak flow from the development catchment would arrive much sooner than that of the two creeks respective catchments. This would mean the developed catchments peak flow would dissipate prior to the arrival of the larger catchments peak flow. If the peak flow from the developed catchment is detained this may add to the peak flows of the Christies & Cudgera Creek catchments.

In the case that Stormwater detention is required the average storage requirement calculated for each allotment is $8m^3$. Calculations were carried out using the Volumetric Procedure for Determining Storages and Pump Rates (AR&R 1987) on the basis of maintaining the existing runoff rates following development. t should be noted that these per lot storage requirements could be further reduced by provision of detention structures within the public road reserve. The storage capacity required per lot for Catchments A1, A2&B is within the capacity of pre-fabricated residential rainwater tanks

Council officers (pers. comm.) have indicated that Christies Creek would be considered the lawful point of discharge for the development.

8.2 WATER QUALITY

8.2.1 EXISTING WATER QUALITY

The site is predominately undeveloped and no stormwater pollution was evident during site visits by Opus International Consultants in 2006.

8.2.2 WATER QUALITY IMPACTS

Development of the site is expected to increase the concentrations of suspended solids, nitrogen and phosphorous in stormwater runoff compared to the existing undeveloped catchment if untreated. Pollutants from residential areas generally comprise of gross pollutants (trash and sediments) biological pollutants (decaying vegetable matter and animal excreta) and nutrients (nitrogen and phosphorus). Road areas typically collect oil products and sediments from vehicles and drain rapidly to the stormwater system. As such, runoff from road areas should be treated prior to discharge from the site.

8.2.3 CONSTRUCTION PHASE GROUNDWATER

Due to the low lying nature of the existing surface of the site it is likely that groundwater will be encountered during the excavation of services trenches. The presence of Acid Sulfate Soils (Appendix B) also indicates that the ground water (and any stormwater) removed from open trenches will require treatment prior to discharge from site. The discharged water must satisfy Tweed Shire Council requirements as detailed in the Soil and Water Management Plan in Appendix E.

8.2.4 PROPOSED TREATMENT MEASURES

Roof water from allotments is to drain into Inter-Allotment Drainage (IAD) pits. IAD pits will connect directly into the stormwater drainage network as it is considered by TSC to be relatively clean water.

The runoff from driveways and paved areas on the proposed allotments is to flow across grassed areas following the drainage path to the IAD pits. Alternatively driveway runoff can flow back onto the road stormwater system. Road runoff would be collected and treated by proprietary Gross Pollutant Traps, such as a Humeceptor. Infiltration and swale drains are also reasonable alternative solutions.

The 'deemed to comply' requirements from Tweed Shire Council Design Specification D7 – Stormwater Quality are an 11m3 storage volume per impervious hectare for a proprietary device such as a Humeceptor or equivalent. The 11m3 consists of 9m3 storage for sediments and 2m3 storage for oil and grease per impervious hectare. The required proprietary device sizings are given in Table 8.2.3.

Table 8.2.3 Proprietary Treatment Device Sizing

Catchment	Impervious Area (Ha)	Sediment Storage Requirement (m^3)	Oil Storage Requirement (m^3)	Suitable Humeceptor Model
A1	0.275	2.48	0.55	STC 5
A2	0.934	8.41	1.87	STC 14
B	0.825	7.43	1.65	STC 14

We note that the size of treatment device could be reduced by providing smaller devices on separate outlets rather than a single treatment unit for each catchment. The storm water treatment measures are specified in accordance with Design Specification D7. The performance of the devices would achieve the performance criteria set by Tweed Shire Council, specified in the Tweed Urban Stormwater Quality Management Plan (2000).

8.2.5 TWEED COAST ESTUARIES MANAGEMENT PLAN 2004-2008 FOR CUDGEN, CUDGERA AND MOOBALL CREEKS

Due to the substantial productivity and biodiversity values of estuaries of Cudgen, Cudgera and Mooball Creeks, the Tweed Coast Estuaries management plan was developed. The plan proposes the adoption of the Tweed River Water Quality Objectives for all three estuaries. The recommended Water Quality Objectives for Cudgen creek and Cudgen estuary in the Management Plan are presented in Section 4.2 of the plan. The plan recommends use of the criteria adopted by Tweed Shire Council for the Tweed River, which were adopted in the Tweed Urban Stormwater Quality Management Plan (2000).

The stormwater runoff from the site is to be treated with measures in Tweed Shire Council Design Specification D7 – Stormwater Quality (2004) are deemed to comply with the water quality objectives of the Tweed Urban Stormwater Management Plan (2000). The Estuaries Management Plan was published after the Tweed Urban Stormwater Management plan and D-7 Design Spec. We consider the proposed measures are in accordance with the objectives of the Tweed Coast Estuaries Management Plan 2004-2008.

8.2.6 WATER QUALITY CONCLUSION

In conclusion, implementing pollution control structures will mitigate the potential increase in pollution attributable to development of this site. A number of measures are available.

9. WATER RETICULATION

9.1 PROPOSED WATER DEMANDS

An existing 100mm diameter water main runs along the Northern side of Creek Street. Proposed water reticulation is shown in Figure 13.0. It is not proposed to stage the water reticulation works. The proposed subdivision will result in the following demands presented in Table 9.1 below (refer Design Specification D11 – Water Supply).

Table 9.1- Water Supply Demands

No. & type of dwelling	Instantaneous Rate	Instantaneous Demand	Daily Rate	Daily Demand
34 Single	0.15 L/s	5.10 L/s	2720 L/d	92.48 kL/d
9 Integrated	0.15 L/s	1.35 L/s	2720 L/d	24.48 kL/d
2 Duplex	0.30 L/s	0.60 L/s	5440 L/d	10.88 kL/d
20 Units	0.1125 L/s	2.25 L/s	2040 L/d	40.80 kL/d
Total	---------	**9.30 L/s**	---------	**168.64 kL/d**

Council officers (pers. comm.) have advised that the existing 100mm diameter main in Creek Street would not be able to provide for the above demands. They advised however that there are 250mm and 450mm mains on the eastern side of Coast Road, near the Peninsular Street and Creek Street intersection that would be adequate to cater for the proposed development demands.

9.2 WATER CONSERVATION MEASURES

The site is relatively low lying and the sandy soil has a high water table. The ability to treat and dispose of stormwater drainage by infiltration depends on the type of material used to fill the site to its design level. If a permeable material such as sand fill is imported, allotments may be able to discharge excess roof water into an infiltration trench rather than into the piped stormwater network.

With the introduction of the BASIX model by the Department of Infrastructure, Planning and Natural Resources in July 2005, all single dwellings are required to meet particular water sensitive and energy efficient design criteria. A number of design measures are required to achieve criteria including the following:

- Eaves and shading to windows
- Native vegetation
- Wall, ceiling and floor insulation
- Gas appliances
- 3A rated toilet and showerhead

- Gas boosted solar hot water system
- Light coloured roof
- Rainwater tank connected to toilet and garden irrigation
- Grey water recycling

The BASIX model aims to achieve a 40% reduction in mains potable water consumption across the state. Dwellings constructed on the proposed allotments will be required to meet the BASIX criteria and water sensitive design measures will be incorporated. Adequate allotment sizes are proposed that allow for construction of a dwelling with sufficient area to provide a rainwater tank. The provision of this tank and other water sensitive urban design practices would be required to be implemented at the dwelling construction stage. Figures 13.1 & 13.2 show a water cycle management plan and details incorporating BASIX criteria and other water sensitive urban design features.

10. WASTEWATER

10.1 PROPOSED WASTEWATER GENERATION

The proposed sewerage reticulation is given in Figure 14.0. Design Specification D12 Sewer System and Tweed Shire Council Fees and Charges 2006-2007 contain design generation rates for assessing developments in the Tweed Shire. These generation rates have been used with the methods given in NSW Department of Public Works Manual of Practice – Sewer Design (1984). The proposed residential subdivision is estimated to create the following total wastewater demands presented in Table 10.1 (based on 3.2 persons per tenement).

Table 10.1 Proposed Development Demands

Dwelling Type	No. of Dwellings	Equivalent Tenements (TSC)	Equivalent Tenements (PWD)
Single Dwelling	34	34	27.2
Integrated Dwelling	9	7.2	5.76
Duplex Dwelling	2	6	4.8
Tourist Units	20	20	16
Total	**65**	**67.2**	**53.76**
Flow Generation (L/s)			
Average Dry Weather Flow			0.530
Peak Dry Weather Flow			1.956
Peak Wet Weather Flow			5.577

10.2 WASTEWATER IMPACTS AND MITIGATING MEASURES

The whole development can be provided with gravity sewer if the finished surface level of proposed lots numbered 1 to 17 is approximately RL 3.0 -3.6. Alternatively a lift station can be constructed. Filling is the best option economically on a capital cost and running cost option. The wastewater generated by the proposed development is to be serviced by the existing pump station adjacent to the site. It is not proposed to stage the sewerage infrastructure works. Council officers (pers. comm.) have advised that the pump station is of sufficient capacity to cater for the proposed development and connection can be made to the existing gravity reticulation on the site.

11. PUBLIC SERVICES AND INFRASTRUCTURE

11.1 ELECTRICAL AND TELECOMMUNICATIONS

Electrical and telecommunications services are available from existing cables in the Creek Street reserve. It is intended that these services be extended to provide service to the proposed allotments.

11.2 SOLID WASTE DISPOSAL

The proposed roads within the development conform to the horizontal and vertical geometric requirements of Tweed Shire Council's Design Specification D1 – Road Design. The proposed roads are suitable for manoeuvring of a garbage truck for solid waste collection. Solid waste collection services would be provided by Tweed Shire Council's solid waste contractor. Details are provided on figure 11.0 & 11.1.

11.3 PUBLIC SERVICES AND INFRASTRUCTURE CONCLUSION

We conclude that existing services are available for electrical and telecommunications. The relevant authorities will advise on the scope of works required to supply the proposed development at the construction certificate stage.

12. CONCLUSIONS

The following conclusions are made.

a) The development will have a minor impact on local and regional traffic movements. The existing local road system would require upgrading to cater for the development.

b) The proposed filling of the site will not have any measurable impact on the potential for flood damage, nuisance or hazard of adjacent properties. Flood free (100 Year ARI) access is available.

c) The development will not have any measurable impact on downstream stormwater capacity due to the on-site storage of stormwater runoff.

d) The potential increase in stormwater pollutants attributable to the proposed development will be reduced by introduction of treatment devices and water sensitive design strategies.

e) Water demand will increase under the proposed development. This additional demand is to be supplied by the existing water reticulation network and will have minor impact on the network. BASIX certificate requirements will reduce the demand by 40% for future dwellings.

f) The wastewater generated will enter the existing sewage network in Creek Street. The existing downstream sewer system has sufficient capacity to cater for the development.

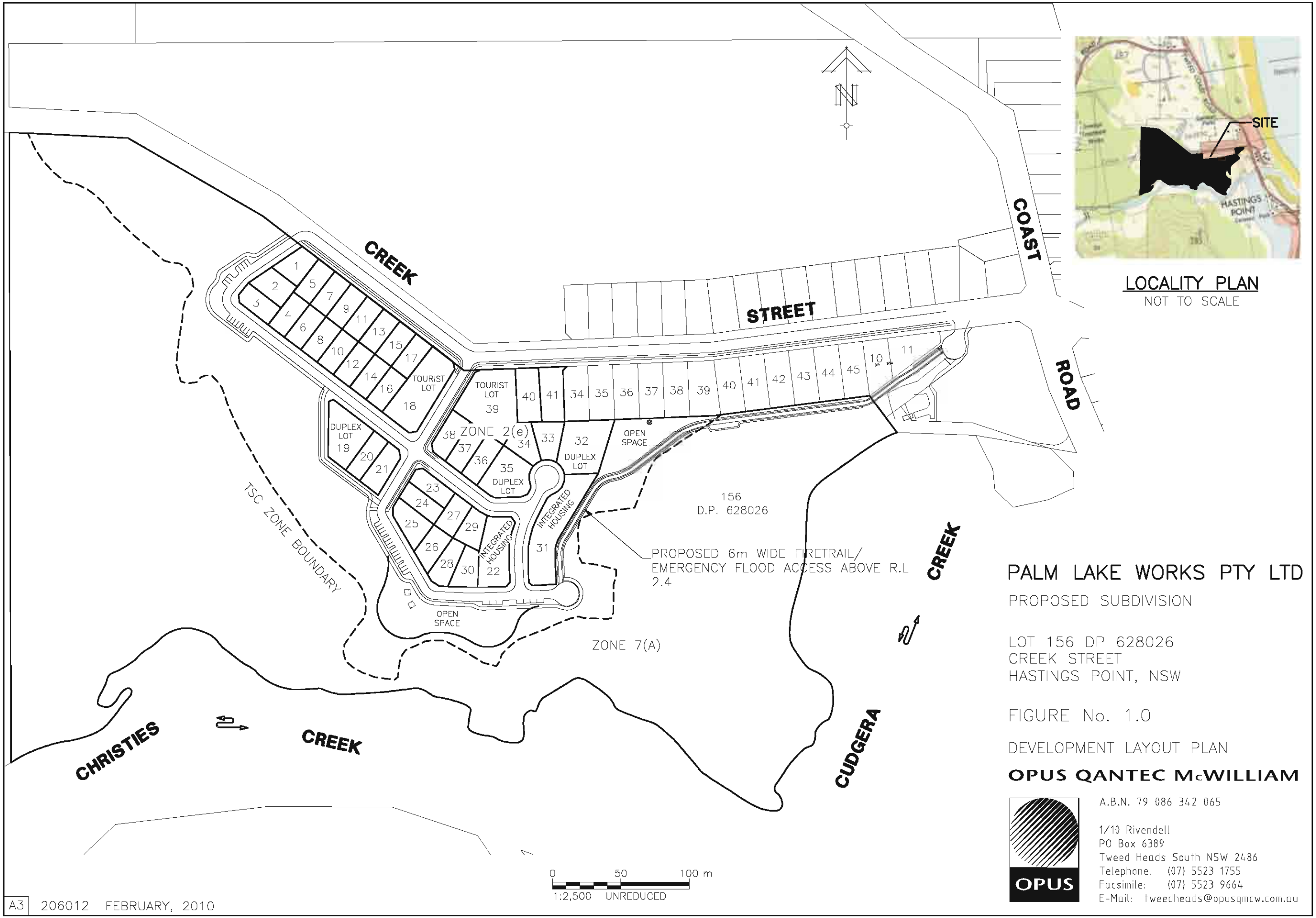
g) Electrical and telecommunications services would be supplied by connection to the existing utilities in Creek Street and Coast Road. Solid waste collection services would be provided by Tweed Shire Council's waste contractor.

13. REFERENCES

AUSTRALIAN WETLANDS	(2005)	Tweed Coast Estuaries Management Plan 2004-2008 for Cudgen, Cudgera and Mooball Creeks
AUSTROADS	(1988)	Guide to Traffic Engineering Practice. Part 2 Roadway Capacity
	(2005)	Guide to Traffic Engineering Practice. Part 5 Intersections at Grade.
BUREAU OF METEOROLOGY	(2003)	Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method
DEPARTMENT OF LAND & WATER CONSERVATION	(1997)	Acid Sulfate Soils Risk Maps Edition II - Cudgen 9641-N3
INSTITUTION OF ENGINEERS AUSTRALIA	(1987)	Australian Rainfall & Runoff: A guide to Flood Estimation
NEVILLE JONES AND ASSOCIATES	(1992)	Queensland Urban Drainage Manual
NSW GOVERNMENT	(2005)	Floodplain Development Manual
NSW RURAL FIRE SERVICE	(2001)	Planning for Bushfire Protection
PUBLIC WORKS DEPARTMENT NSW	(1984)	Manual of Practice – Sewer Design
ROADS AND TRAFFIC AUTHORITY NSW	(2002)	Guide to Traffic Generation
	(2004)	Traffic Volume Data 2004: Hunter and Northern Regions

TWEED SHIRE COUNCIL	(1999)	Development Control Plan No. 2 Site Access and Parking Code
	(2000)	Tweed Urban Stormwater Quality Management Plan
	(2004)	Development Design Specification D1 – Road Design
		Development Design Specification D5 – Road Design
		Development Design Specification D7 – Stormwater Quality
TWEED SHIRE COUNCIL	(2004)	Development Design Specification D11 - Water Supply
		Development Design Specification D12 - Sewer System
	(2006)	Development Control Plan No. 5 Flood Liable Land. Version 2.3
US ARMY CORPS OF ENGINEERS	(2005)	HEC-RAS River Analysis System Version 3.1.3
VEITCH LISTER CONSULTING PTY LTD	(1997)	Tweed Road Development Strategy.
BMT WBM PTY LTD	(2009)	Tweed Byron Coastal Creeks Flood Study Draft Report for Exhibition

FIGURES



LOCALITY PLAN
NOT TO SCALE

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 1.0

DEVELOPMENT LAYOUT PLAN

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone. (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010

LEGEND

S — EXISTING SEWER

E — EXISTING ELECTRICITY

0.5 — EXISTING CONTOURS (0.5m intervals)

HIGHEST ASTRONOMICAL TIDE (RL 1.14) APPROXIMATE ONLY

CREEK

STREET

COAST ROAD

"HASTINGS COVE" (24 UNITS)

34 35 36 37 38 39 40 41 42 43 44 45

D.P. 25777

D.P. 25096

1 D.P.749336

478 D.P. 42445

2 D.P. 1017430

EXISTING SEWER PUMP STATION

CREEK

CHRISTIES CREEK

APPROXIMATE POSITION OF M.H.W.M. (D.P. 628026)

CUDGERA

0 50 100 m

1:2,500 UNREDUCED

A3 206012 FEBRUARY, 2010

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

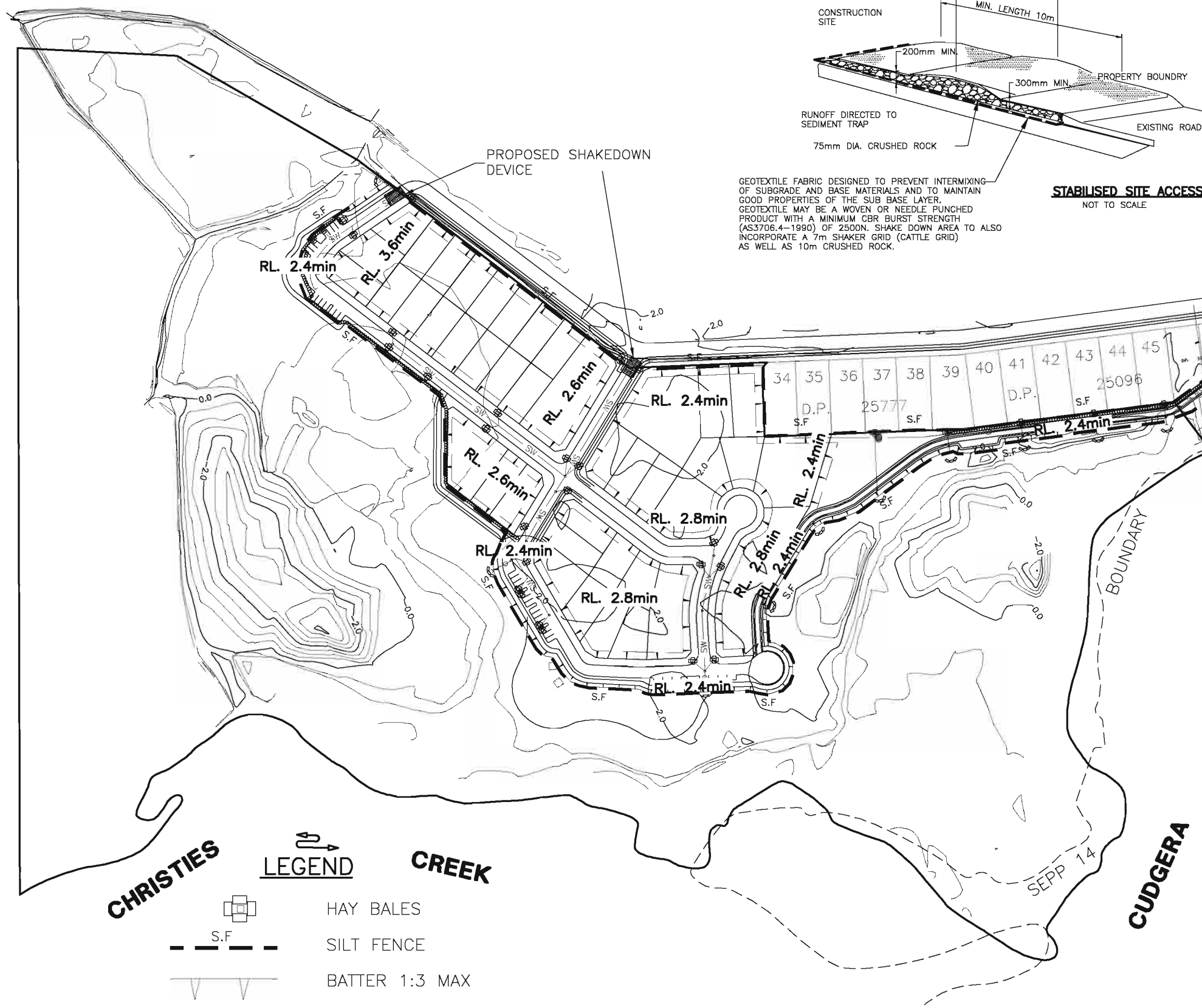
FIGURE No. 2.0

EXISTING FEATURES PLAN

OPUS QANTEC McWILLIAM

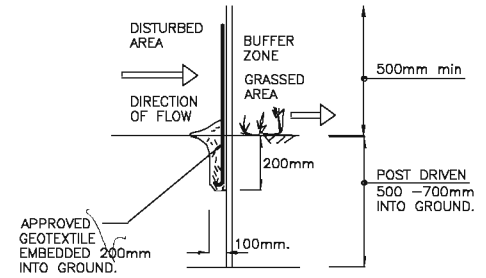
A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au



GEOTEXTILE FABRIC DESIGNED TO PREVENT INTERMIXING OF SUBGRADE AND BASE MATERIALS AND TO MAINTAIN GOOD PROPERTIES OF THE SUB BASE LAYER. GEOTEXTILE MAY BE A WOVEN OR NEEDLE PUNCHED PRODUCT WITH A MINIMUM CBR BURST STRENGTH (AS3706.4–1990) OF 2500N. SHAKE DOWN AREA TO ALSO INCORPORATE A 7m SHAKER GRID (CATTLE GRID) AS WELL AS 10m CRUSHED ROCK.

STABILISED SITE ACCESS
NOT TO SCALE



SILT FENCE
NOT TO SCALE

LEGEND

- HAY BALES
- S.F — SILT FENCE
- BATTER 1:3 MAX
- 2.0 — EXISTING CONTOURS
- PROPOSED RETAINING WALL
- R.L 2.8min — PROPOSED R.L

0 20 40 60 80m
1:2,000 UNREDUCED

A3 206012 FEBRUARY, 2010

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

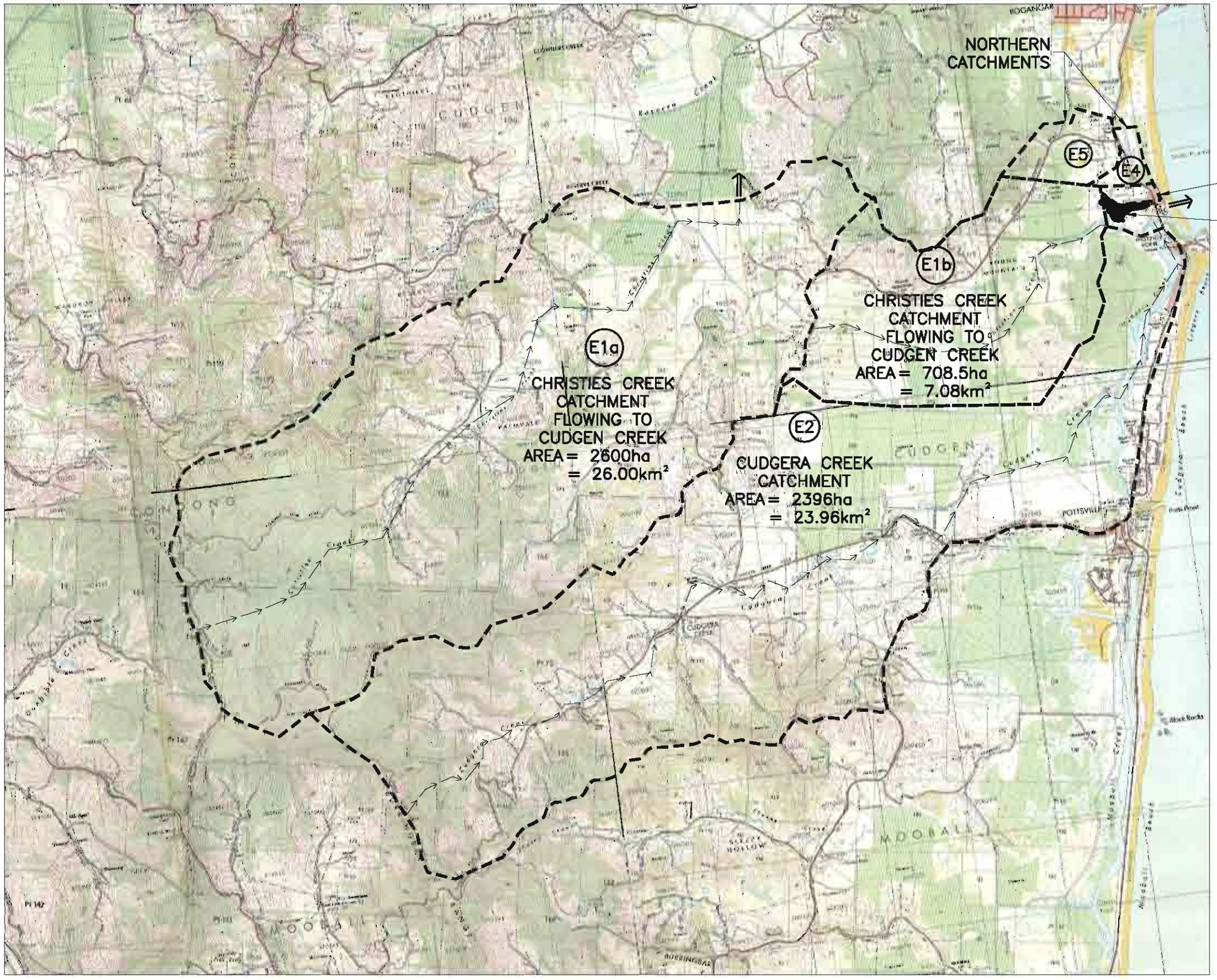
FIGURE No. 3.0

PRELIMINARY EARTHWORKS & EROSION CONTROL PLAN

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au



CATCHMENT	AREA (ha)
E3	12.4
E4	23.7
E5	77.34

LEGEND

E1 — CATCHMENT NAME

CATCHMENT BOUNDARIES

STREAM FLOW PATH

CATCHMENT FLOW

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGJRE No. 4.0

EXTERNAL CATCHMENT AREA'S

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010

LEGEND – ELEVATION (m)

5.00
4.25
2.50
1.25
0.5
0.0

2.49 SPOT FLOOD ELEVATION (LEVEL)

FLOW DIRECTION

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 5.0

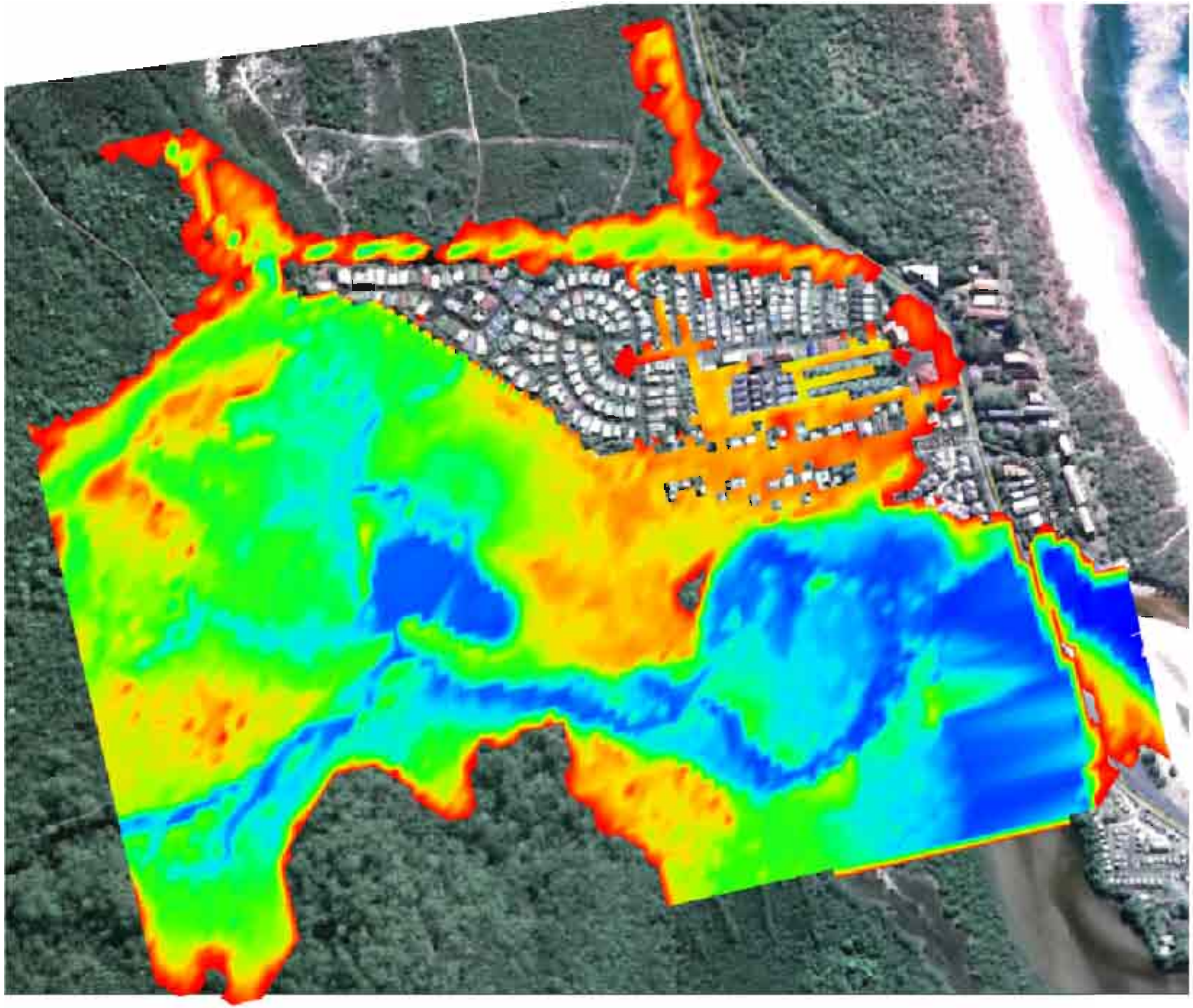
EXISTING CASE
Q100 STORM SURGE Q10 CATCHMENT
FLOW – ELEVATION

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – DEPTH (m)

2.50
2.20
1.92
1.65
1.38
1.10
0.83
0.55
0.27
0.00

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 5.1

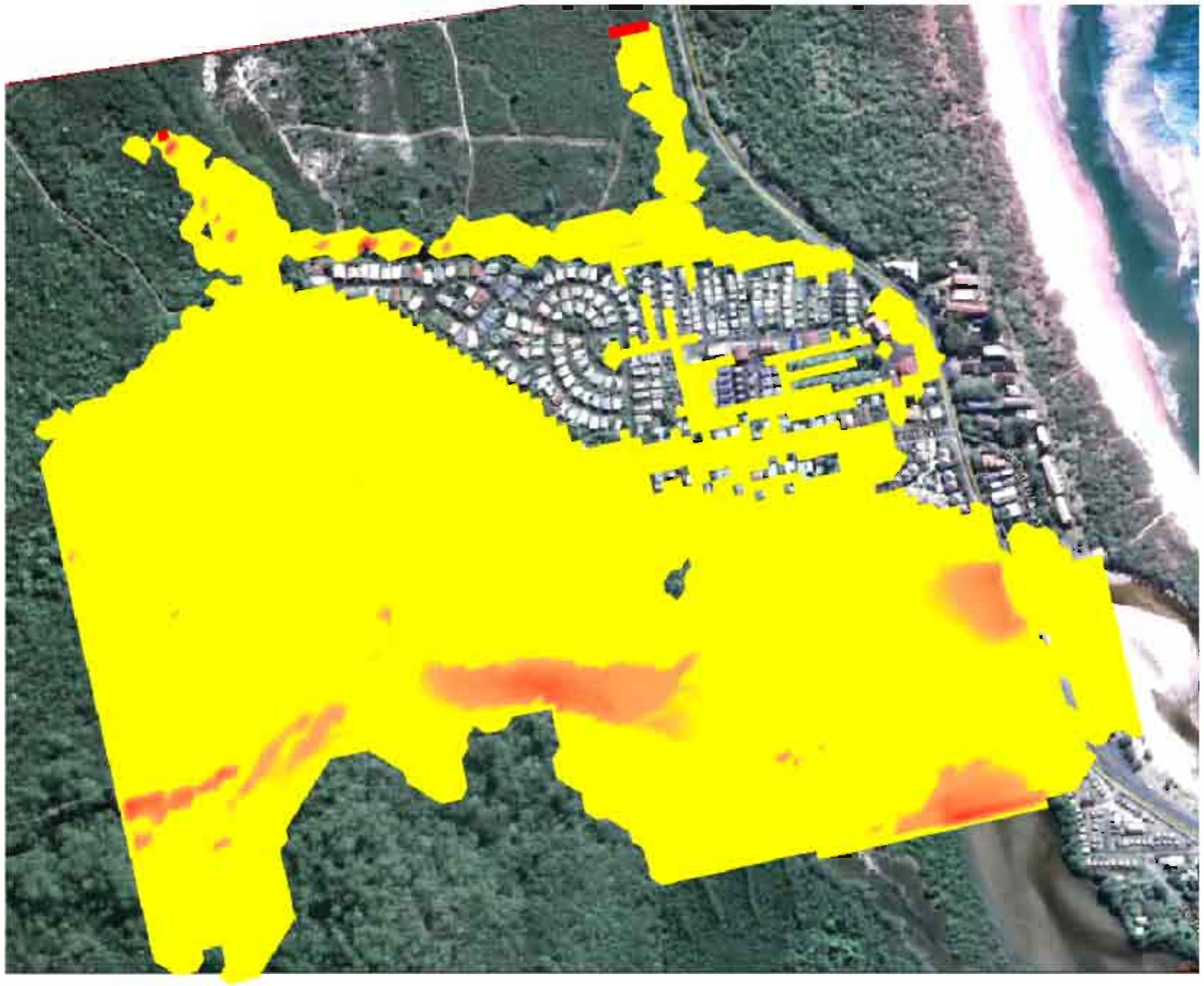
EXISTING CASE
Q100 STORM SURGE Q10 CATCHMENT
FLOW – DEPTH

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – HAZARD (m)

HIGH	3.50
MED	0.8
	0.6
LOW	0.0

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 5.2

EXISTING CASE
Q100 STORM SURGE Q10 CATCHMENT
FLOW – HAZARD

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010

LEGEND – ELEVATION (m)

5.00
4.25
2.50
1.25
0.50
0.00

2.49 SPOT FLOOD ELEVATION (LEVEL)

FLOW DIRECTION

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 6.0

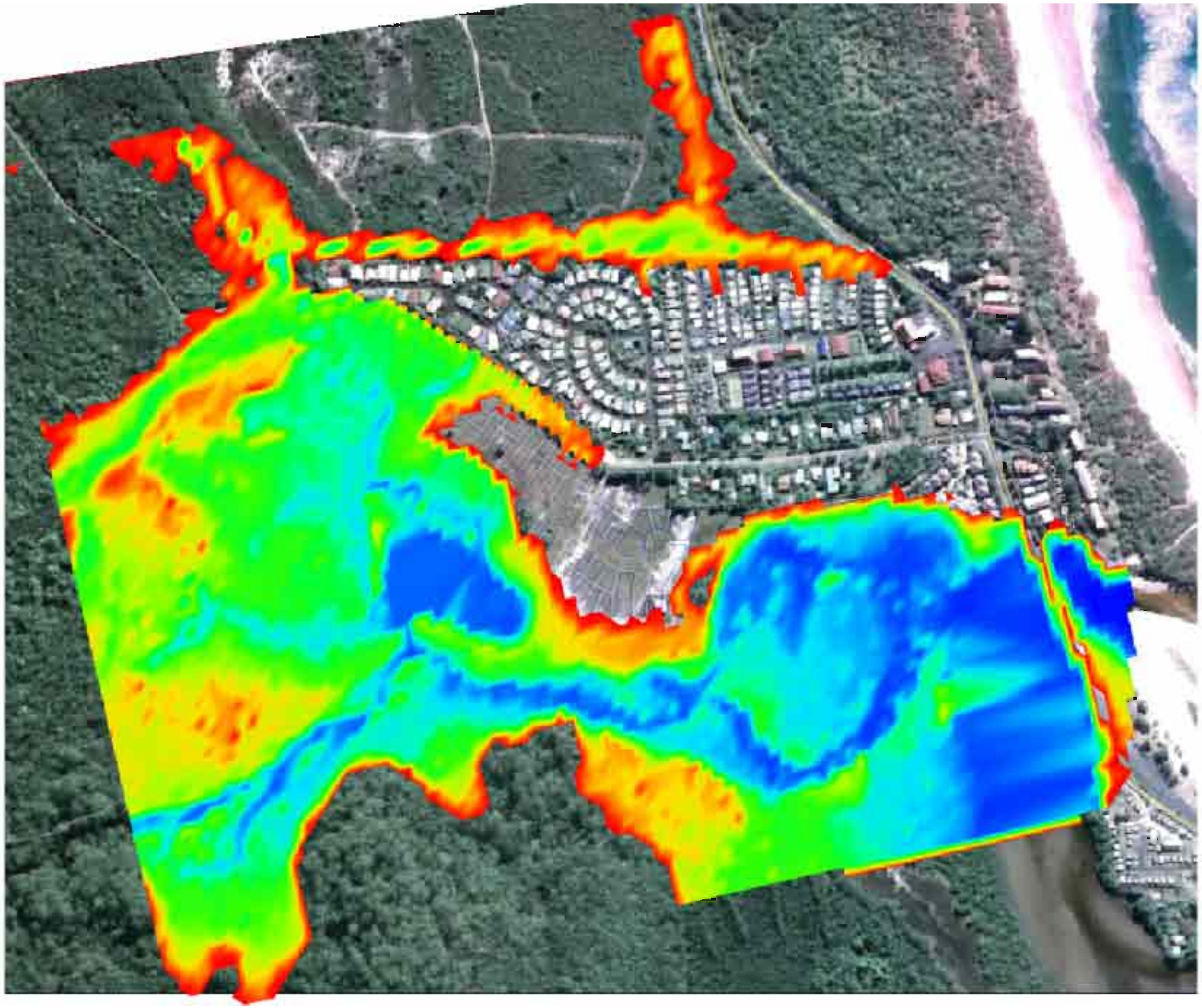
PROPOSED CASE
Q100 STORM SURGE Q10 CATCHMENT
FLOW – ELEVATION

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – DEPTH (m)

2.50
2.20
1.92
1.65
1.38
1.10
0.83
0.55
0.27
0.00

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 6.1

PROPOSED CASE
Q100 STORM SURGE Q10 CATCHMENT
FLOW – DEPTH

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone. (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010

LEGEND – HAZARD (m)

HIGH	3.50
MED	0.80
	0.60
LOW	0.00

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 6.2

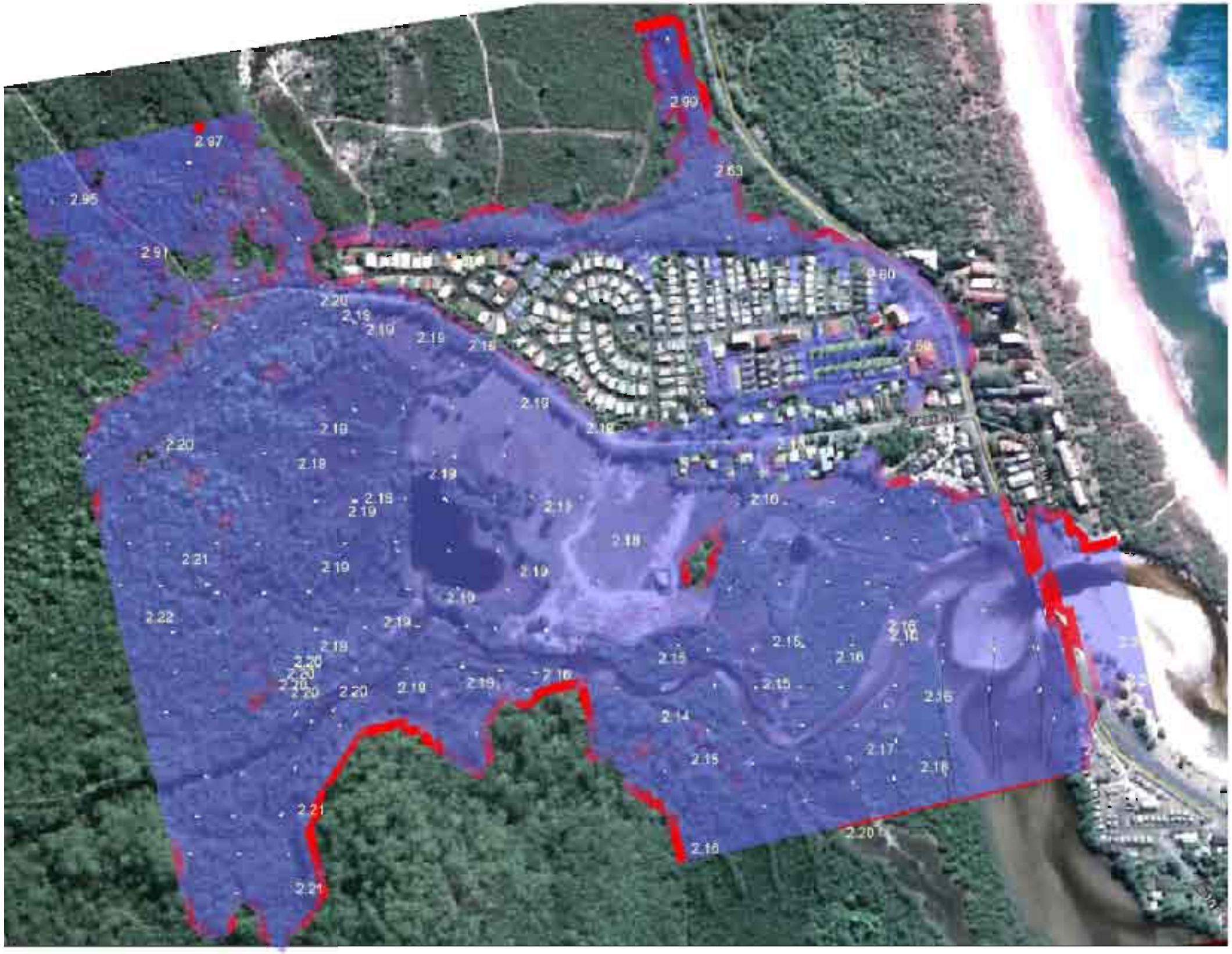
PROPOSED CASE
Q100 STORM SURGE Q10 CATCHMENT
FLOW – HAZARD

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – ELEVATION (m)

5.00
4.25
2.5
1.25
0.50
0.00

2.49 SPOT FLOOD ELEVATION (LEVEL)

FLOW DIRECTION

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 7.0

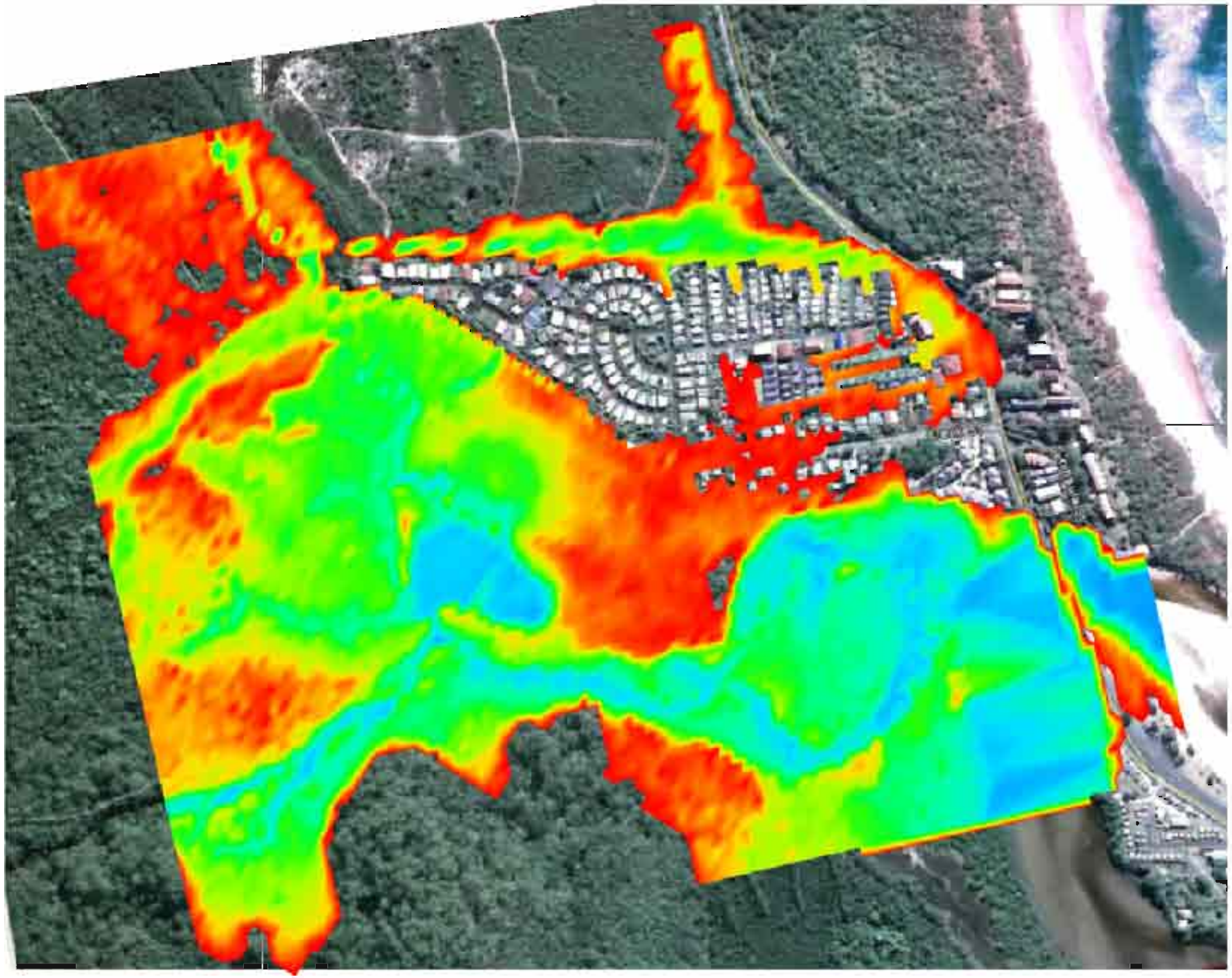
EXISTING CASE
Q20 STORM SURGE Q100 CATCHMENT
FLOW – ELEVATION

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile. (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – DEPTH (m)

2.50
2.20
1.92
1.65
1.38
1.10
0.83
0.55
0.27
0.00

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 7.1

EXISTING CASE
Q20 STORM SURGE Q100 CATCHMENT
FLOW – DEPTH

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

LEGEND – HAZARD (m)

HIGH	3.00
MED	0.80
LOW	0.60
	0.00

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 7.2

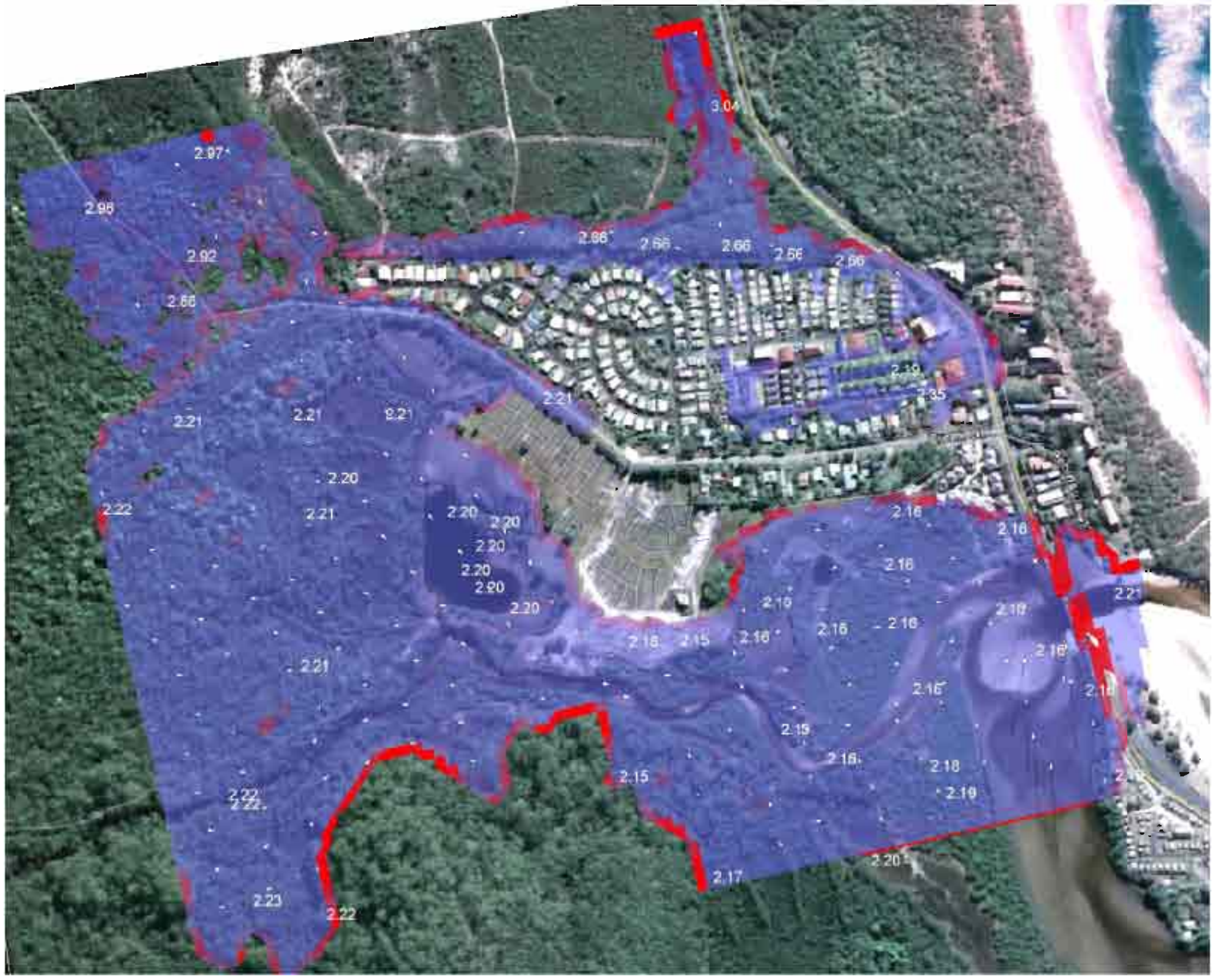
EXISTING CASE
Q20 STORM SURGE Q100 CATCHMENT
FLOW – HAZARD

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile. (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – ELEVATION (m)

5.00
4.25
2.50
1.25
0.50
0.00

2.49 SPOT FLOOD ELEVATION (LEVEL)

FLOW DIRECTION

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 8.0

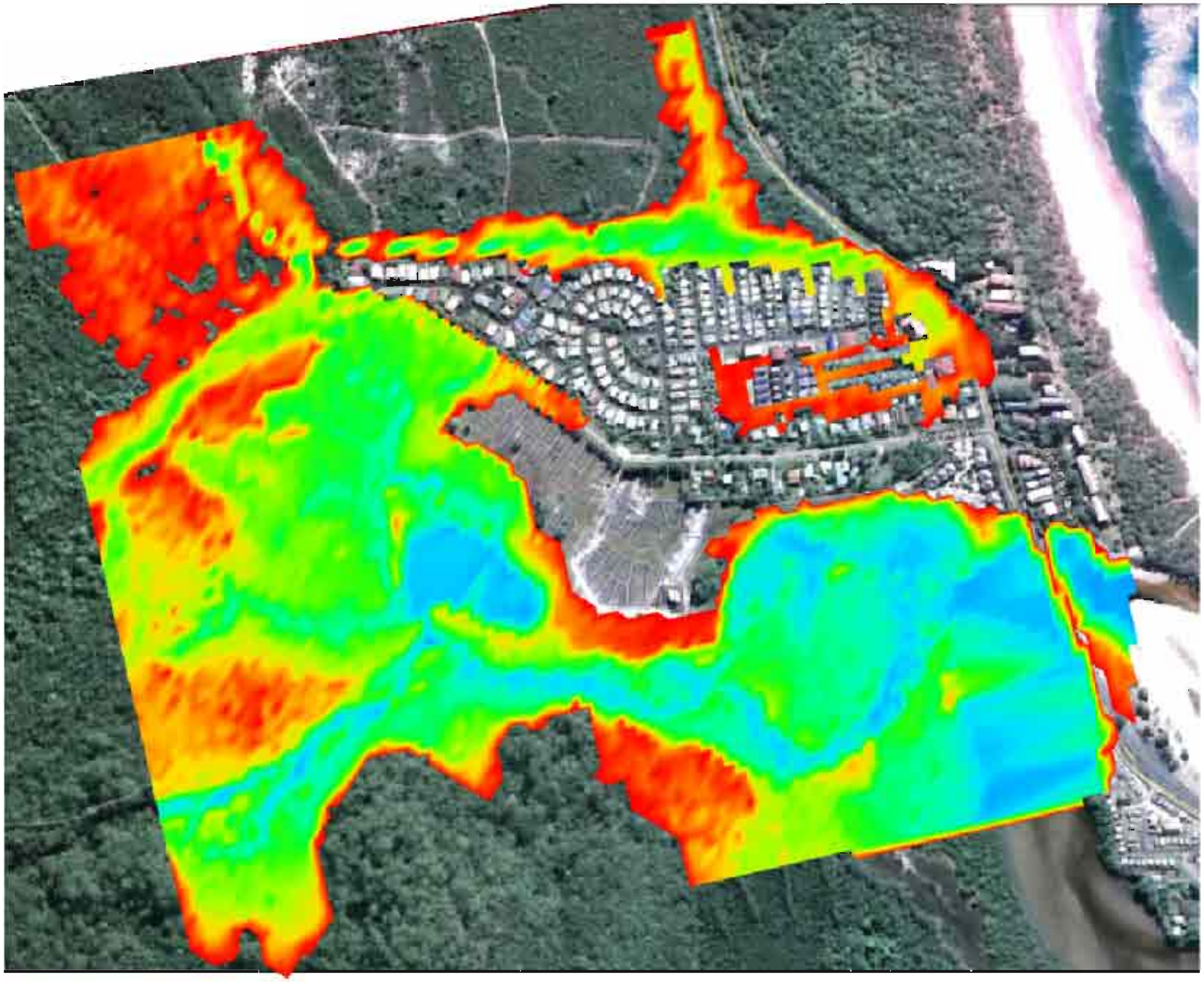
PROPOSED CASE
Q20 STORM SURGE Q100 CATCHMENT
FLOW – ELEVATION

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – DEPTH (m)

2.50
2.20
1.92
1.65
1.38
1.10
0.83
0.55
0.27
0.00

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 8.1

PROPOSED CASE
Q20 STORM SURGE Q100 CATCHMENT
FLOW – DEPTH

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone (07) 5523 1755
Facsimile. (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010

LEGEND – HAZARD (m)

HIGH	3.00
MED	0.80
LOW	0.60
	0.00

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 8.2

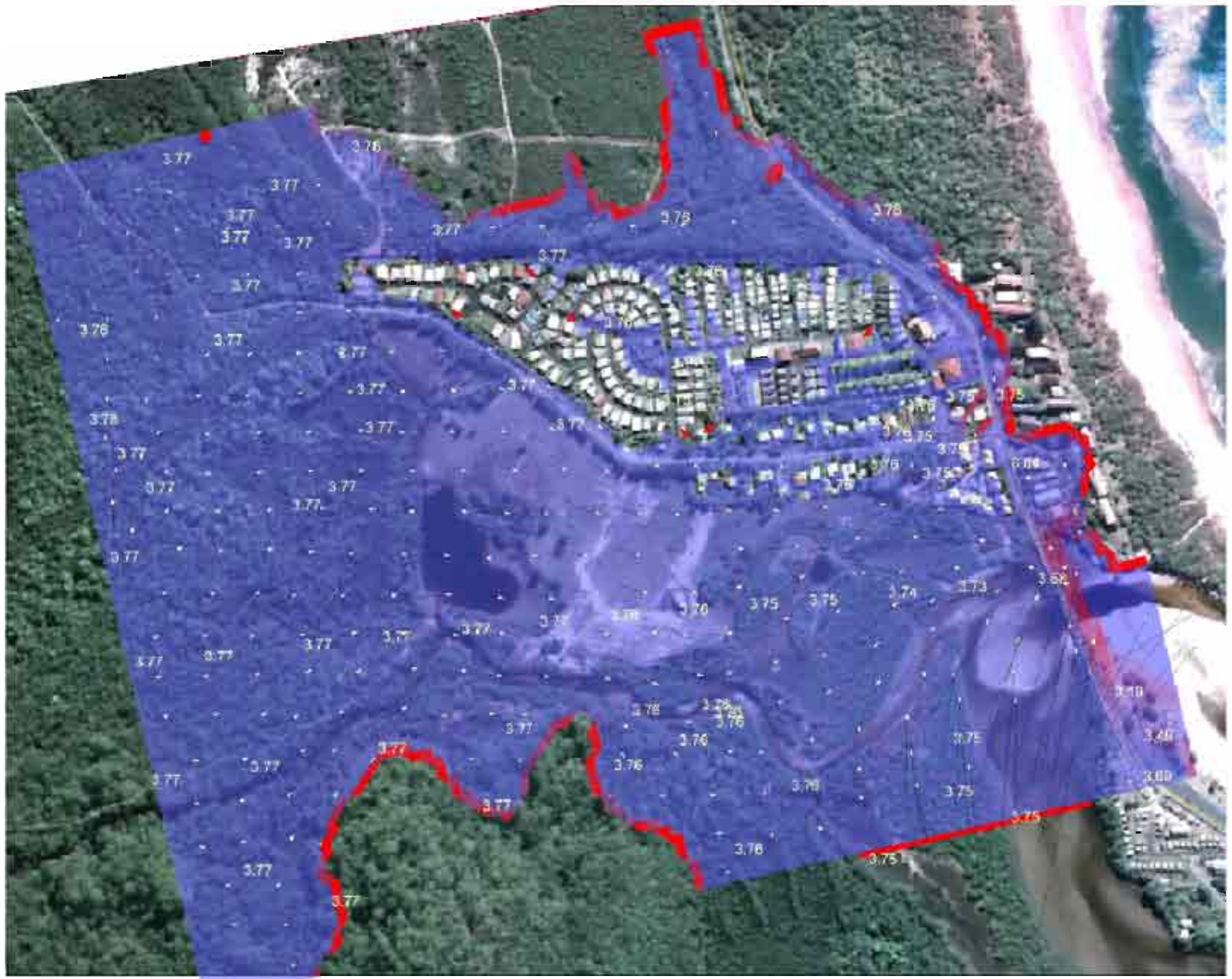
PROPOSED CASE
Q20 STORM SURGE Q100 CATCHMENT
FLOW – HAZARD

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – ELEVATION (m)

10.00
8.50
5.00
2.50
1.00
0.00

2.49 SPOT FLOOD ELEVATION (LEVEL)

FLOW DIRECTION

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 9.0

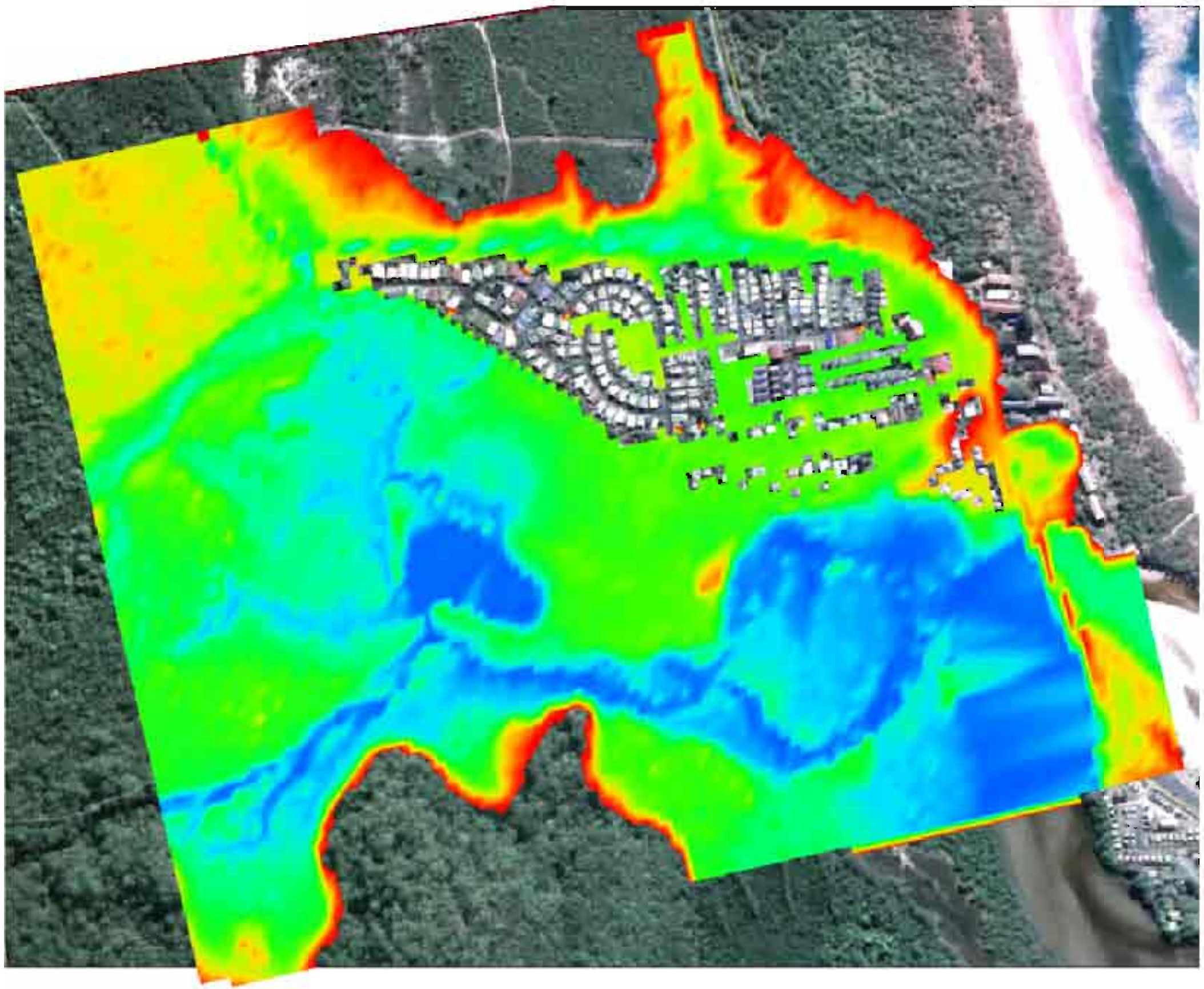
EXISTING CASE
Q100 STORM SURGE PMF FLOW–ELEVATION

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – DEPTH (m)

4.00
3.52
3.08
2.64
2.20
1.76
1.32
0.88
0.44
0.00

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 9.1

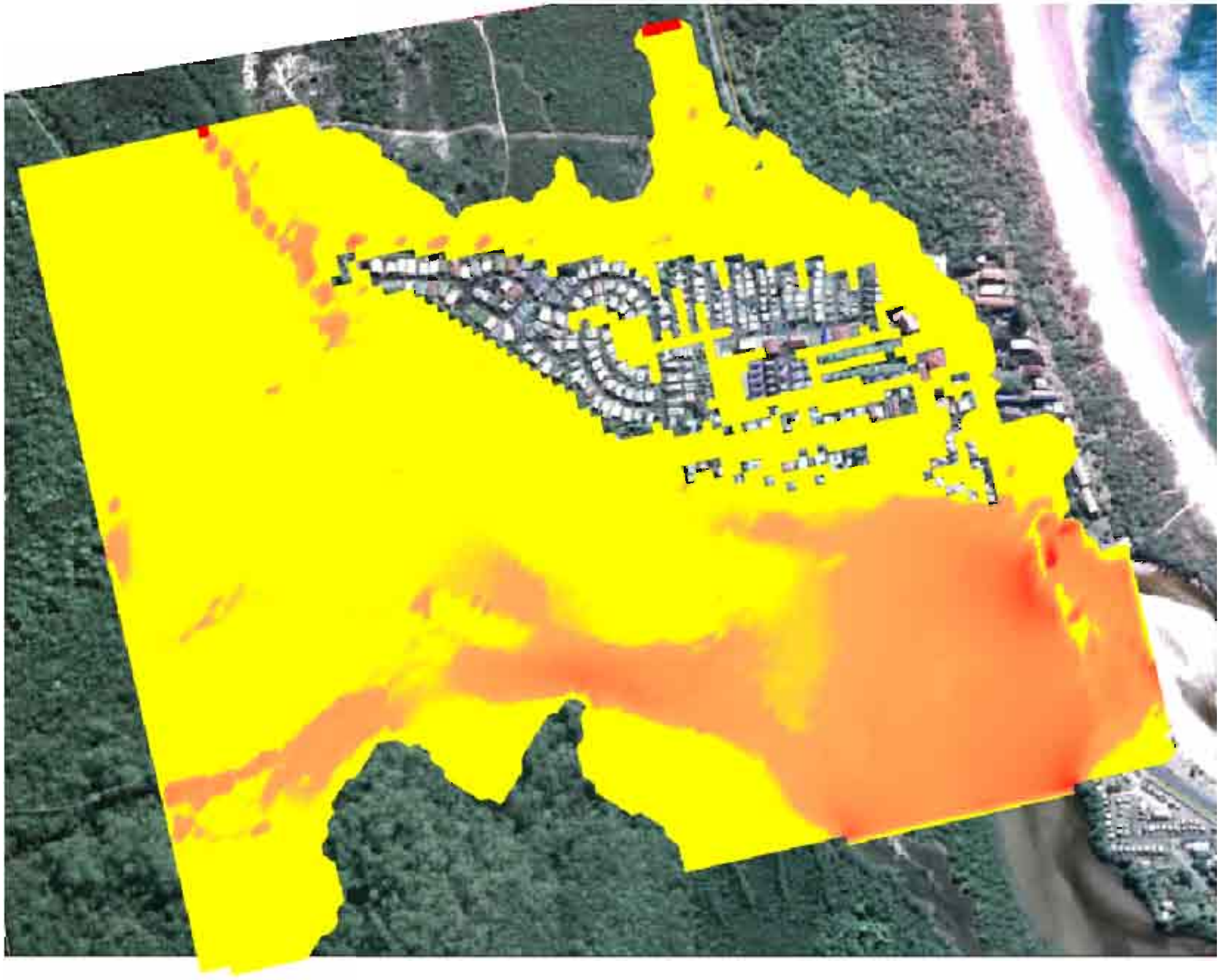
EXISTING CASE
Q100 STORM SURGE PMF FLOW–DEPTH

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile. (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – HAZARD (m)

HIGH	7.77
MED	0.80
	0.60
LOW	0.00

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 9.2

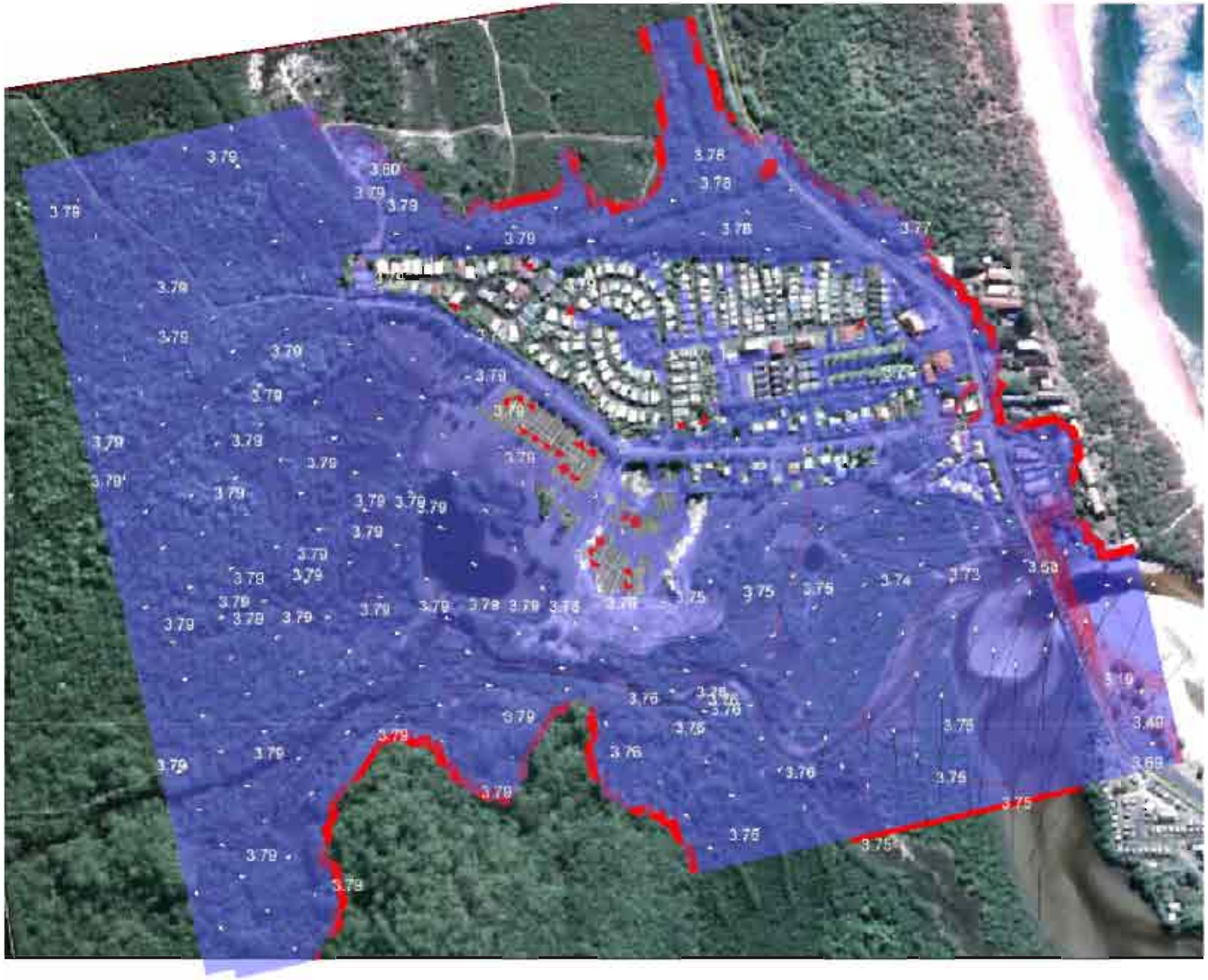
EXISTING CASE
Q100 STORM SURGE PMF FLOW–HAZARD

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – ELEVATION (m)

10.00
8.50
5.00
2.50
1.00
0.00

2.49 SPOT FLOOD ELEVATION (LEVEL)

FLOW DIRECTION

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 10.0

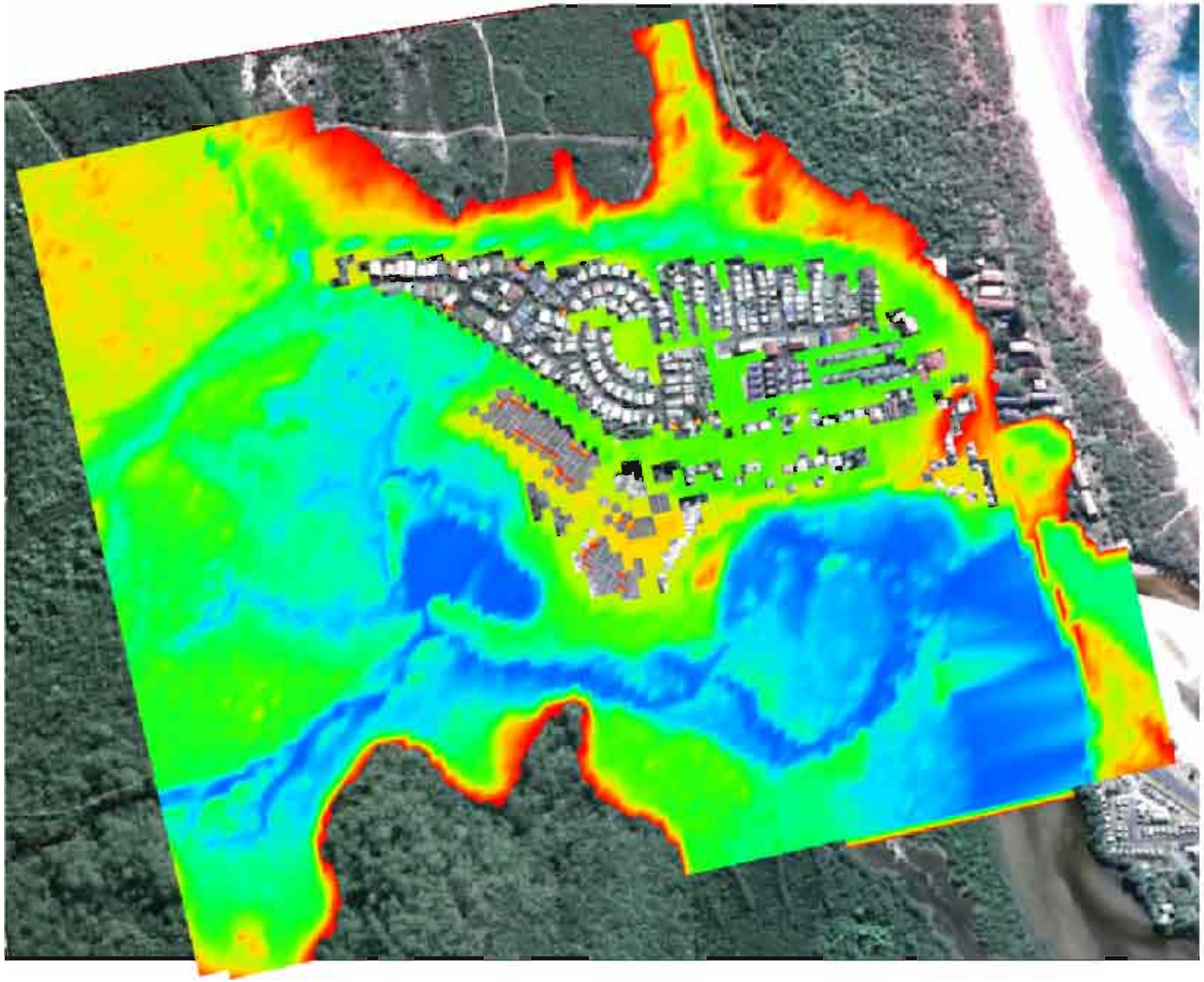
PROPOSED CASE
Q100 STORM SURGE PMF FLOW–ELEVATION

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



LEGEND – ELEVATION (m)

4.00
3.52
3.08
2.64
2.20
1.76
1.32
0.88
0.44
0.00

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 10.1

PROPOSED CASE
Q100 STORM SURGE PMF FLOW–DEPTH

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010

LEGEND – ELEVATION (m)

HIGH	3.50
MED	0.80
	0.60
LOW	0.00

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 10.2

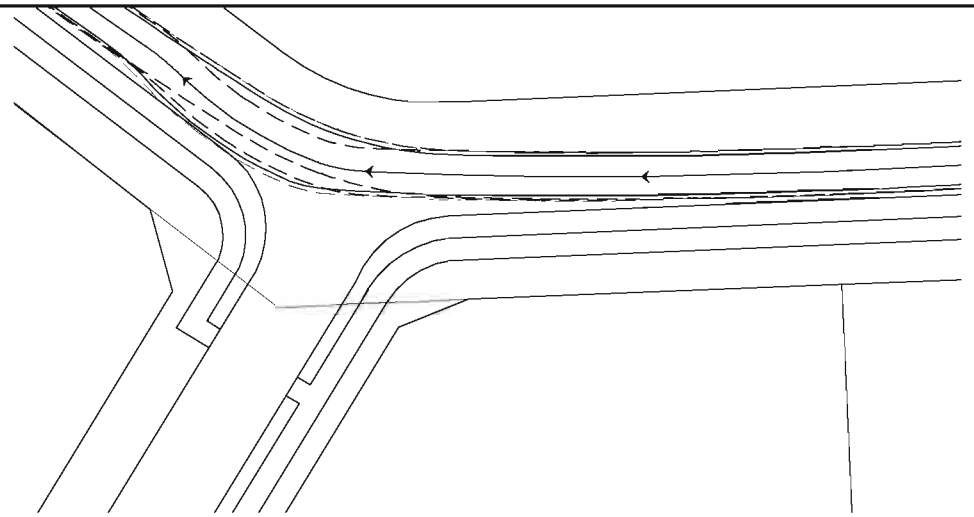
PROPOSED CASE
Q100 STORM SURGE PMF FLOW–HAZARD

OPUS QANTEC McWILLIAM

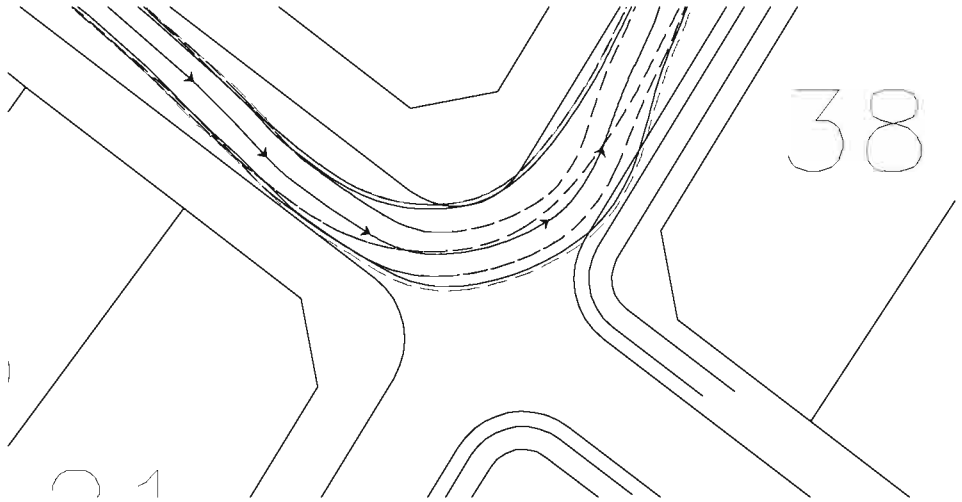
A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile. (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

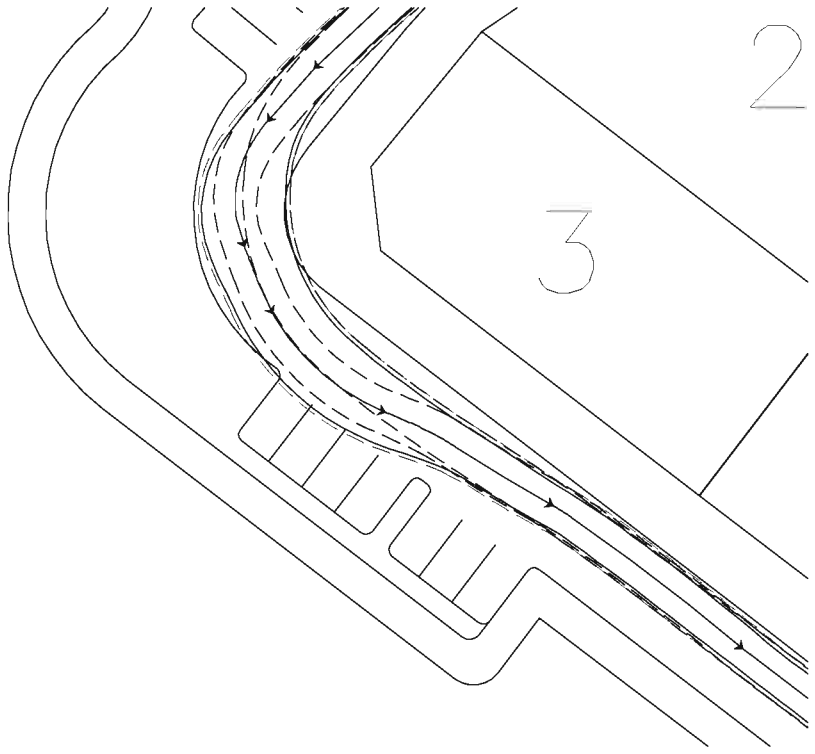
A3 206012 FEBRUARY, 2010



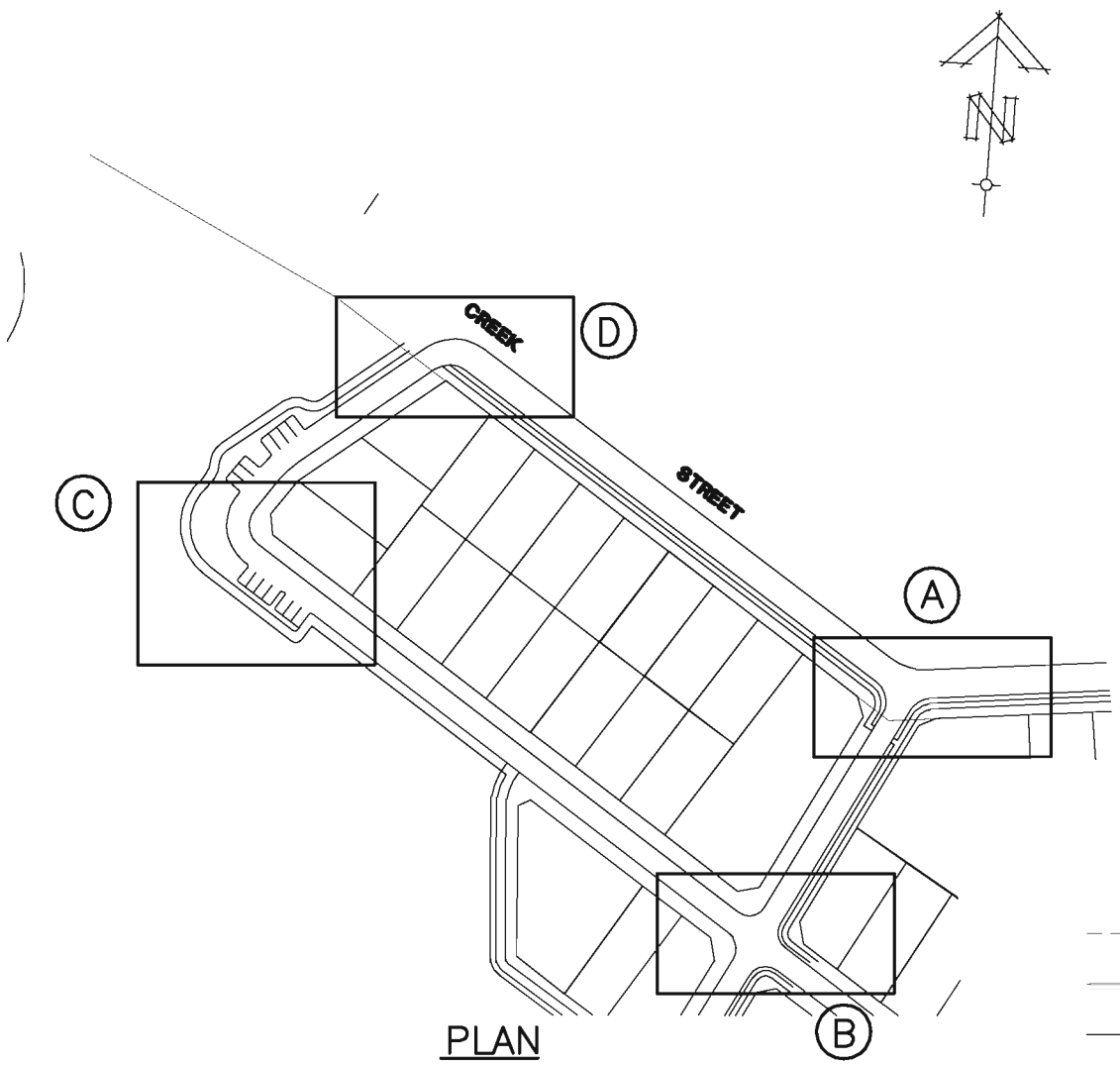
DETAIL A



DETAIL B



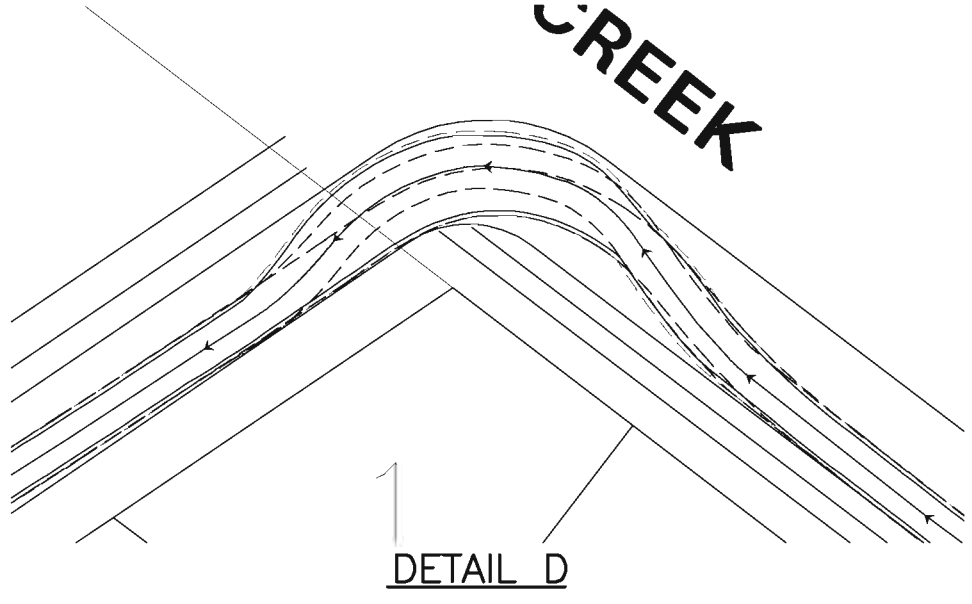
DETAIL C



PLAN

0 20 40 60 80m

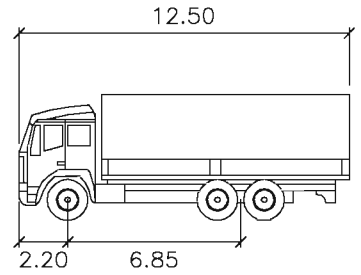
1:2,000 UNREDUCED



DETAIL D

0 5 10 15 20m

1:500 UNREDUCED



SU TRUCK meters

Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.00
Steering Angle	: 36.60

VEHICLE PROFILE

NOT TO SCALE

LEGEND

- FRONT WHEEL PATH
- BODY CLEARANCE (0.3m)
- DRIVE PATH

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 11.0

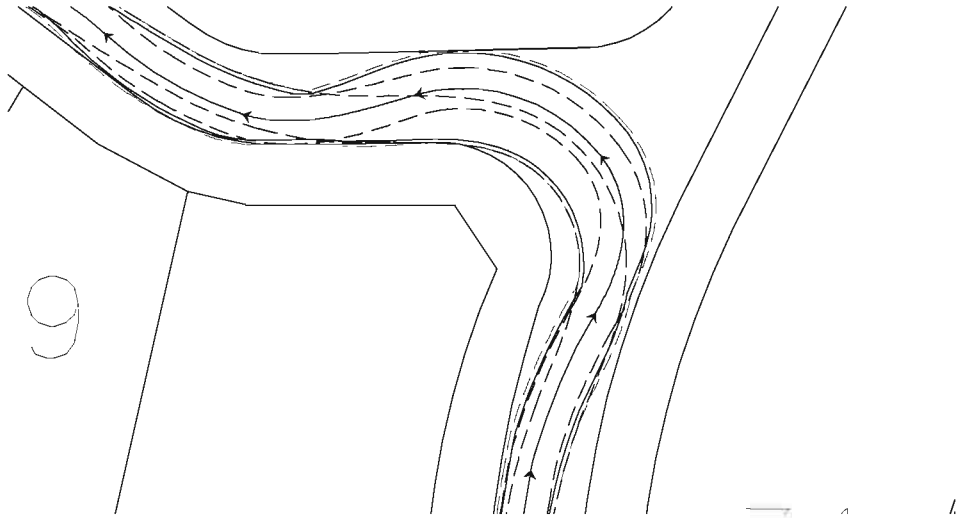
SERVICE VEHICLE CIRCULATION PLAN
1 OF 2

OPUS QANTEC McWILLIAM

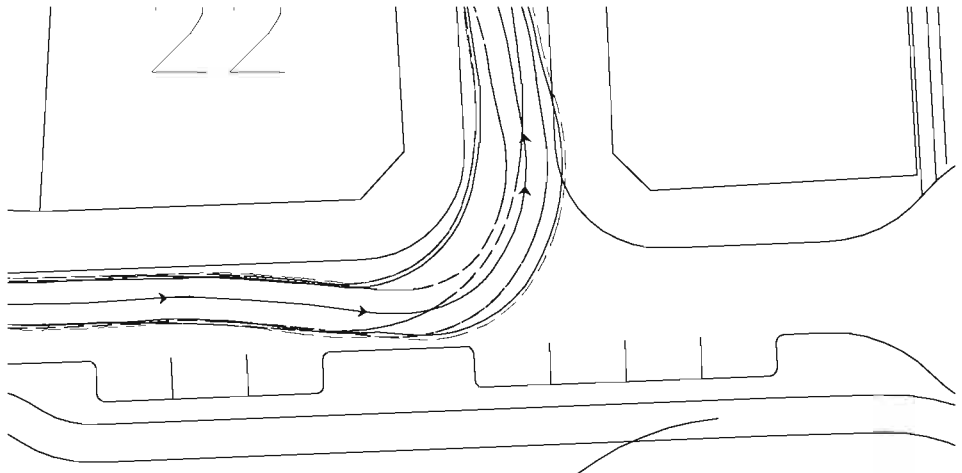
A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

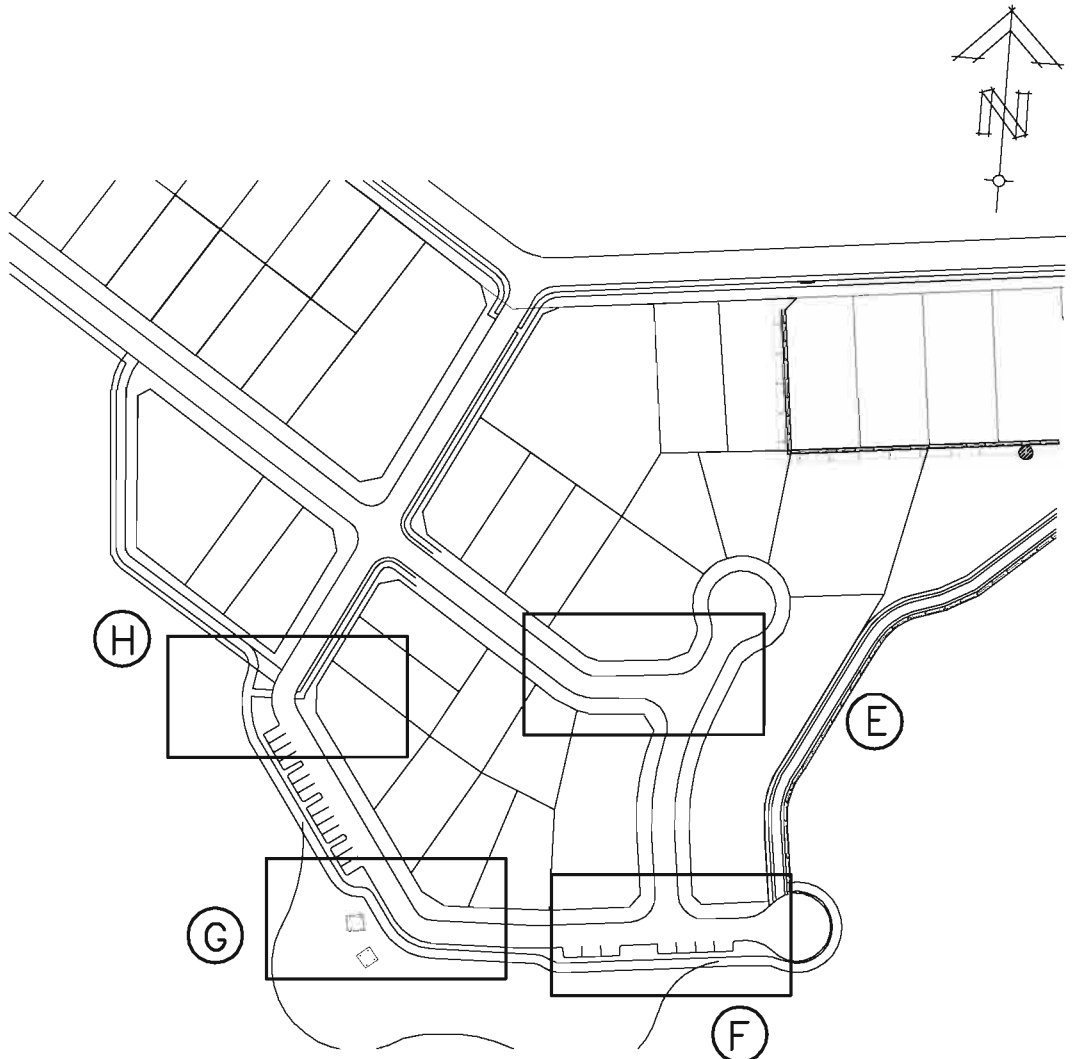
A3 206012 FEBRUARY, 2010



DETAIL E



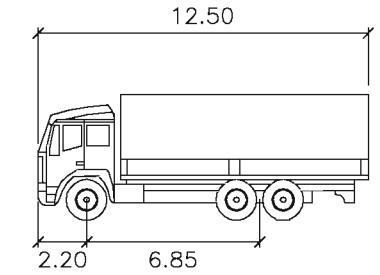
DETAIL F



PLAN

0 20 40 60 80m

1:2,000 UNREDUCED



SU TRUCK meters

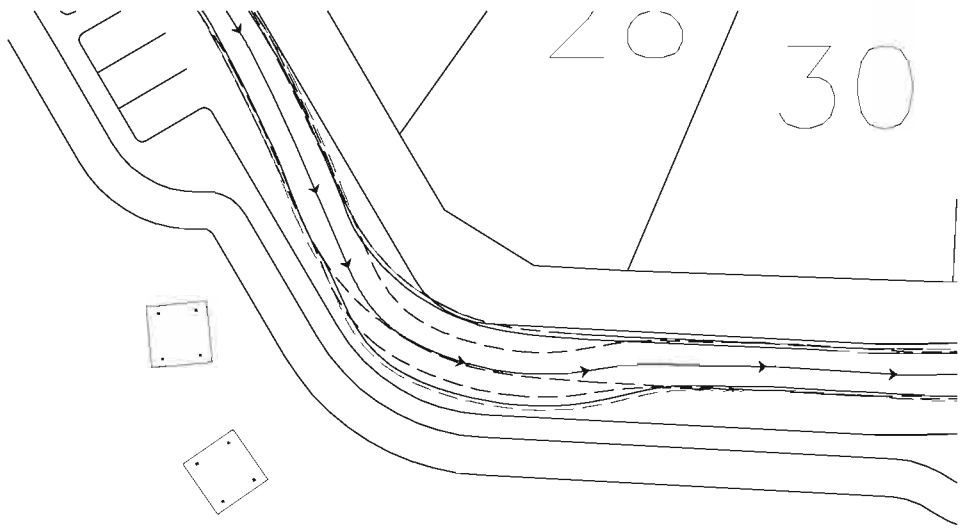
Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.00
Steering Angle	: 36.60

VEHICLE PROFILE

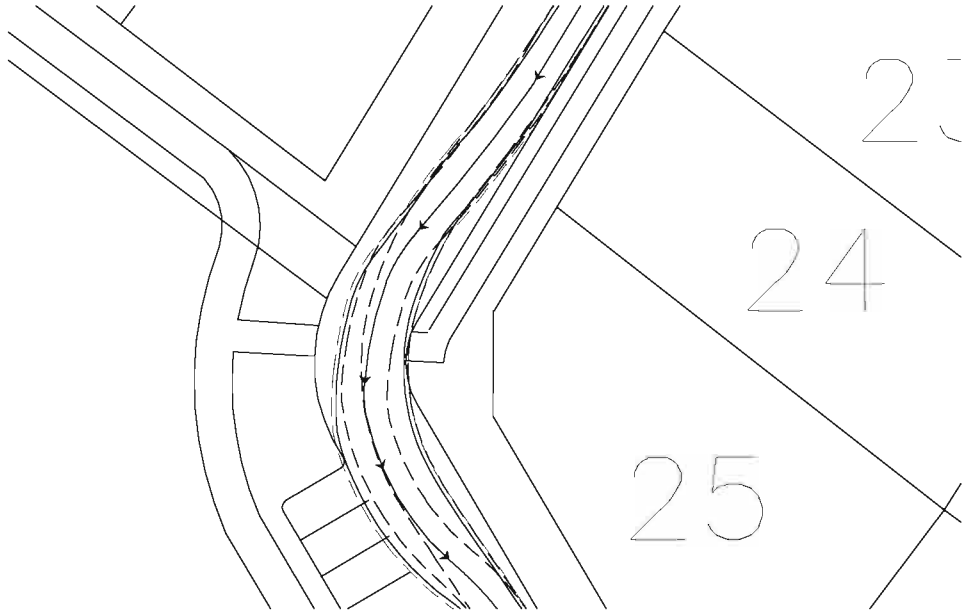
NOT TO SCALE

LEGEND

- FRONT WHEEL PATH
- BODY CLEARANCE (0.3m)
- DRIVE PATH



DETAIL G



DETAIL H

0 5 10 15 20m

1:500 UNREDUCED

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

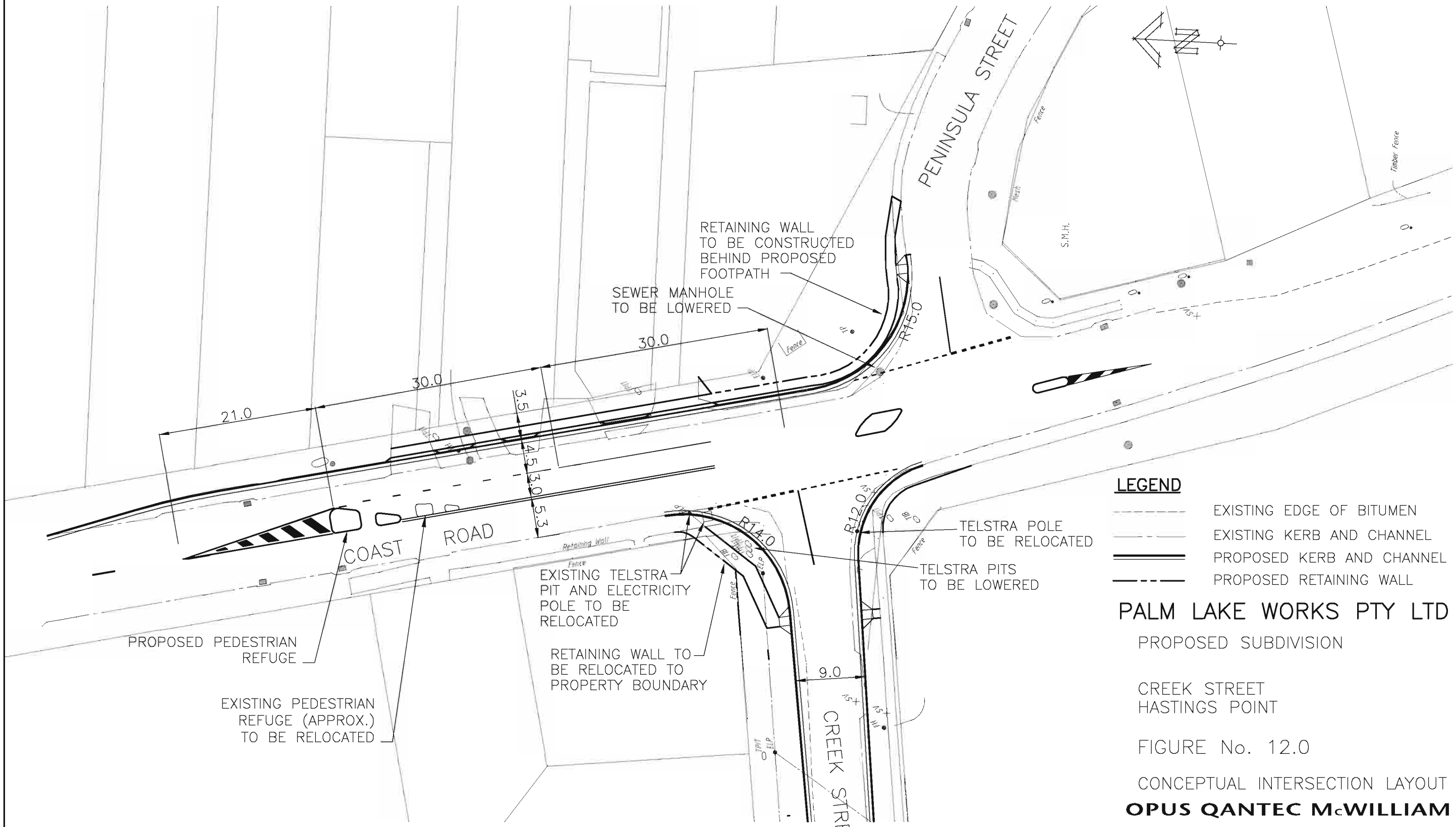
FIGURE No. 11.1

SERVICE VEHICLE CIRCULATION PLAN
2 OF 2

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au



LEGEND

- EXISTING EDGE OF BITUMEN
- EXISTING KERB AND CHANNEL
- PROPOSED KERB AND CHANNEL
- PROPOSED RETAINING WALL

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

CREEK STREET
HASTINGS POINT

FIGURE No. 12.0

CONCEPTUAL INTERSECTION LAYOUT

OPUS QANTEC McWILLIAM

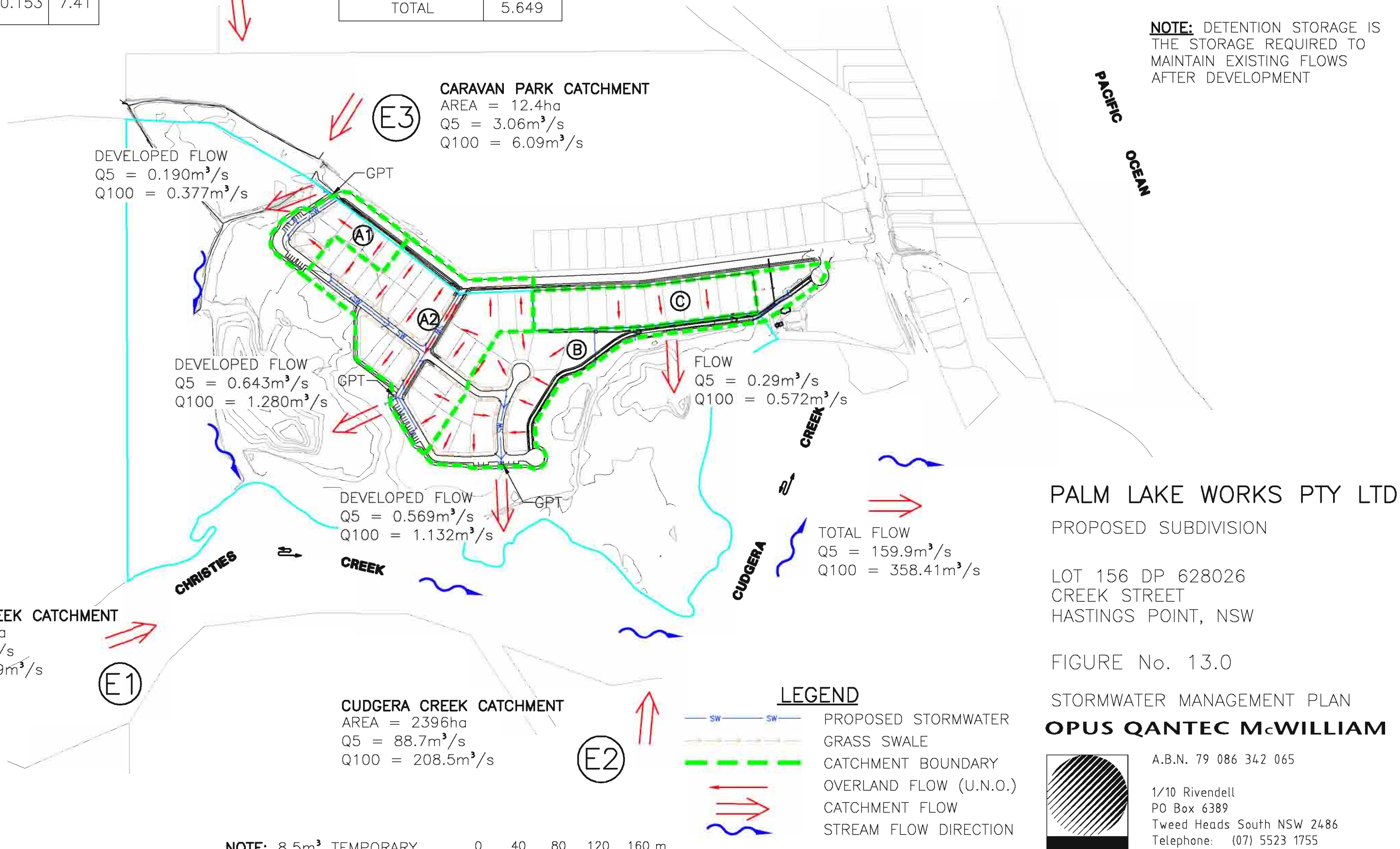
A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010

	E5	E4
AREA (ha)	77.34	23.7
Q5 (m^3/s)	14.91	3.64
Q100 (m^3/s)	30.153	7.41

SUB CATCHMENT	AREA(ha)	Q_5 (m^3/s)		Q_{100} (m^3/s)	
		EXISTING	POST DEVELOPMENT	EXISTING	POST DEVELOPMENT
A1	0.627	0.128	0.190	0.258	0.377
A2	2.329	0.434	0.643	0.875	1.280
B	1.803	0.383	0.569	0.772	1.132
C	0.890	0.290	0.290	0.572	0.572
TOTAL	5.649				



NOTE: DETENTION STORAGE IS THE STORAGE REQUIRED TO MAINTAIN EXISTING FLOWS AFTER DEVELOPMENT

LEGEND

- PROPOSED STORMWATER
- GRASS SWALE
- CATCHMENT BOUNDARY
- OVERLAND FLOW (U.N.O.)
- CATCHMENT FLOW
- STREAM FLOW DIRECTION

NOTE: $8.5m^3$ TEMPORARY DETENTION STORAGE PER RESIDENTIAL LOT

0 40 80 120 160 m
1:4,000 UNREDUCED

A3 206012 FEBRUARY, 2010

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

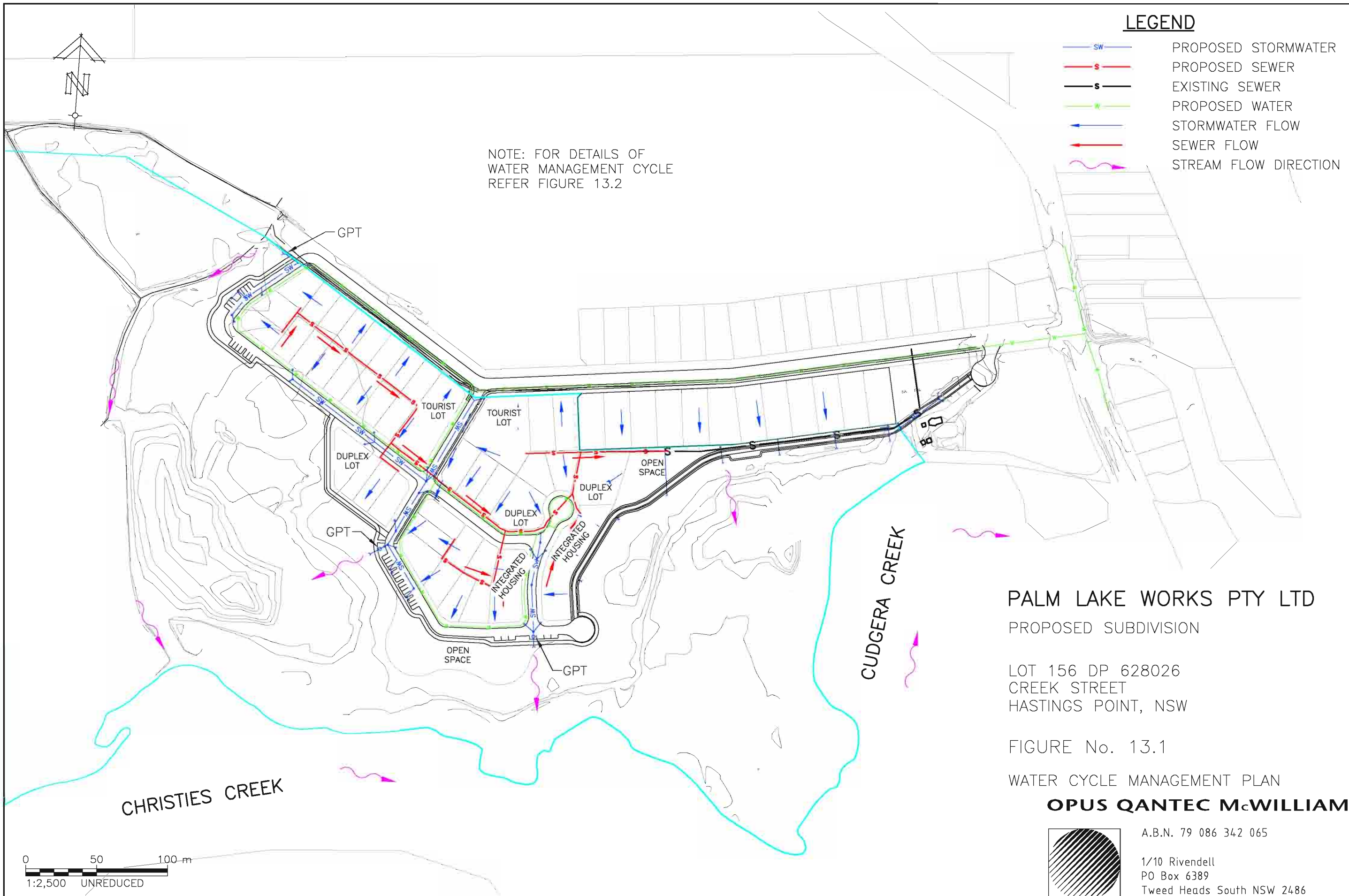
FIGURE No. 13.0

STORMWATER MANAGEMENT PLAN

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au



PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 13.1

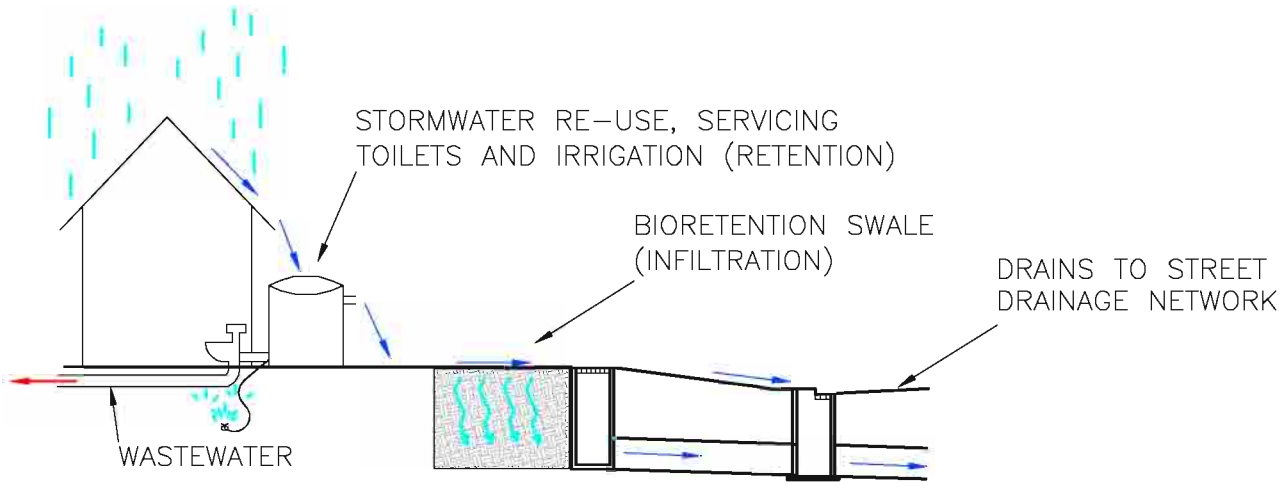
WATER CYCLE MANAGEMENT PLAN

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

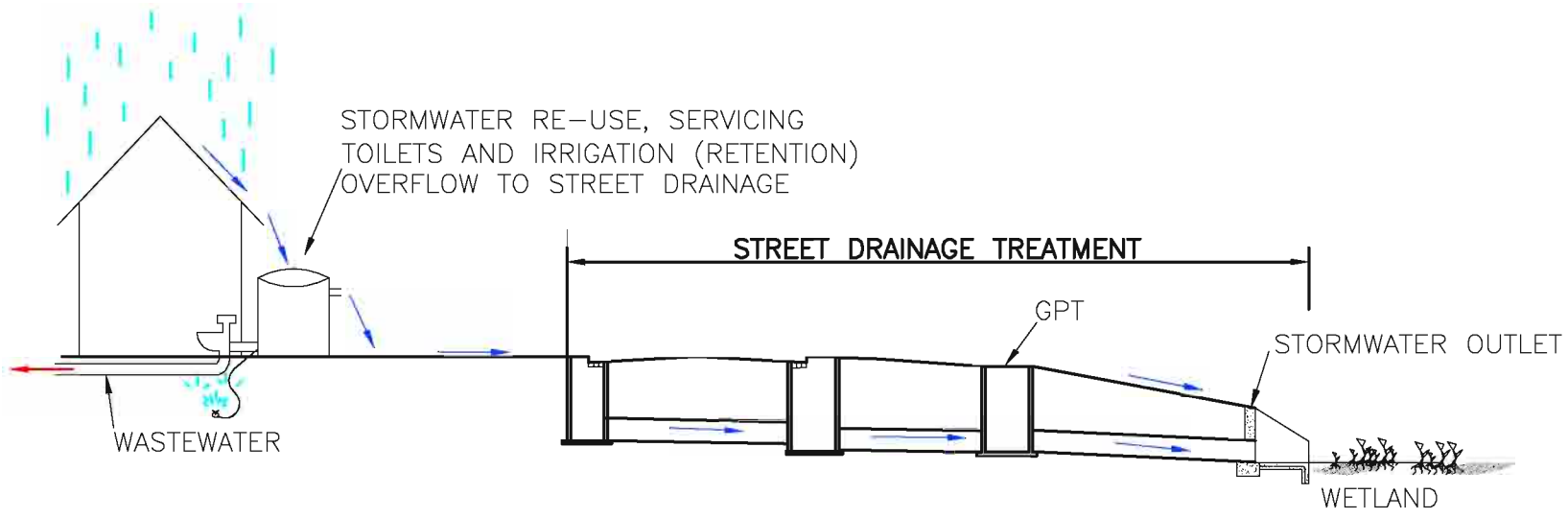
1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



PROPOSED WATER MANAGEMENT CYCLE TOURIST LOTS

NOT TO SCALE



PROPOSED WATER MANAGEMENT CYCLE
RESIDENTIAL/DUPLEX & INTEGRATED HOUSING

NOT TO SCALE

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 13.2

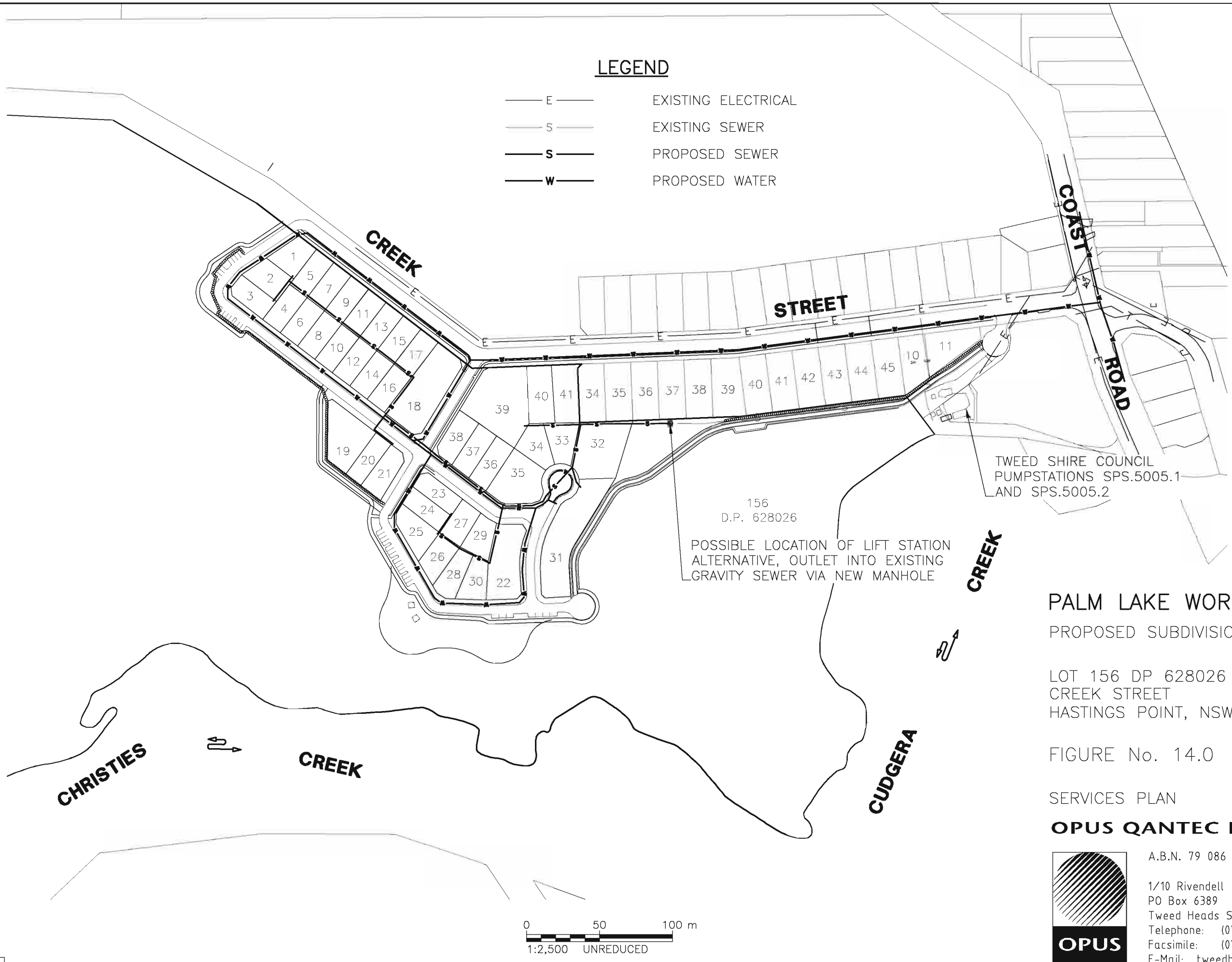
WATER CYCLE MANAGEMENT DETAIL

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 14.0

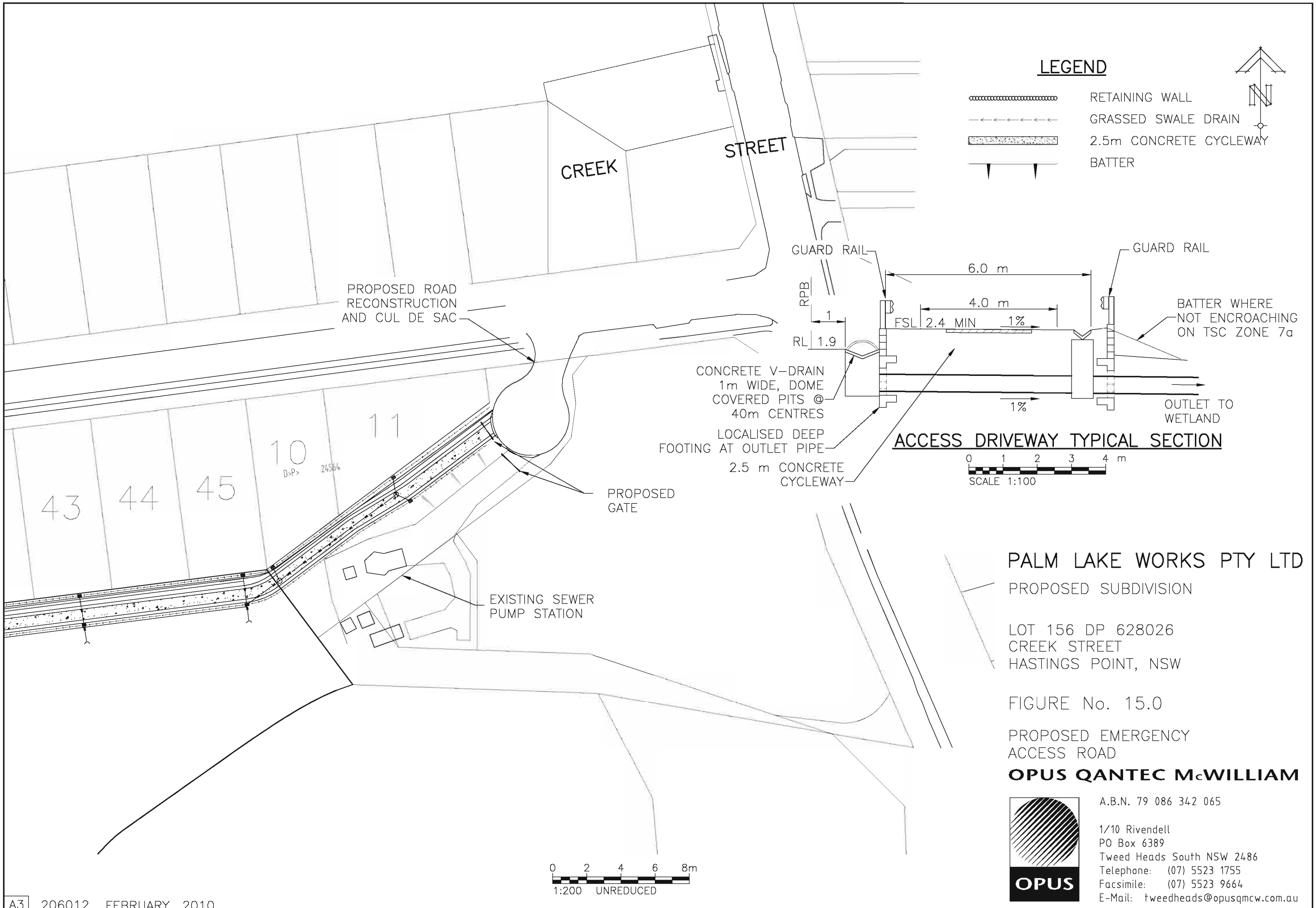
SERVICES PLAN

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010



PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 15.0

PROPOSED EMERGENCY ACCESS ROAD

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

A3 206012 FEBRUARY, 2010

CREEK STREET

40 41 34 35 36 37 38 39 40 41 42 43 44 45

34 33 32 35 31

1 2 3 4

SW

PASSING BAY

2.5m CONCRETE CYCLEWAY
0.75m GRAVEL SHOULDER

LEGEND

- RETAINING WALL
- GRASSED SWALE DRAIN
- 2.5m CONCRETE CYCLEWAY
- BATTER

0 10 20 30 40m
1:1,000 UNREDUCED

A3 206012 FEBRUARY, 2010

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

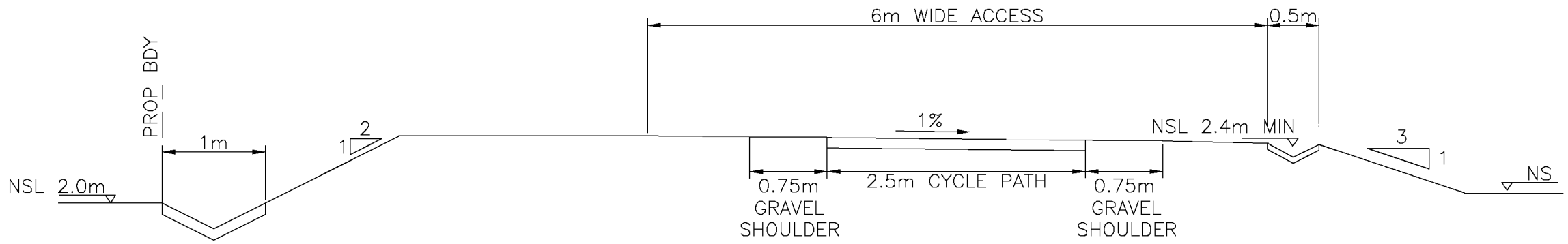
FIGURE No. 16.0

ACCESS ROAD DETAILS

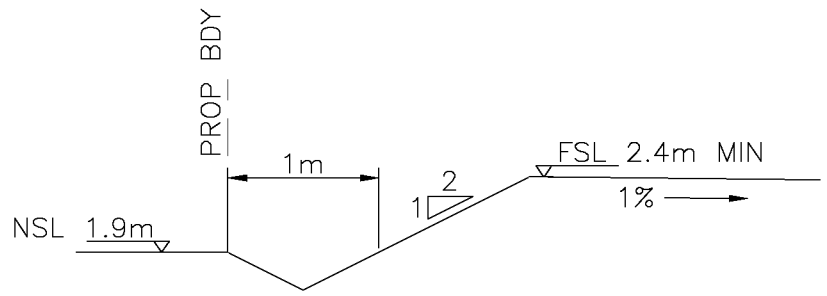
OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au



SECTION 2



SECTION 1

0 0.5 1 1.5 2m
1:50 UNREDUCED

A3 206012 FEBRUARY, 2010

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

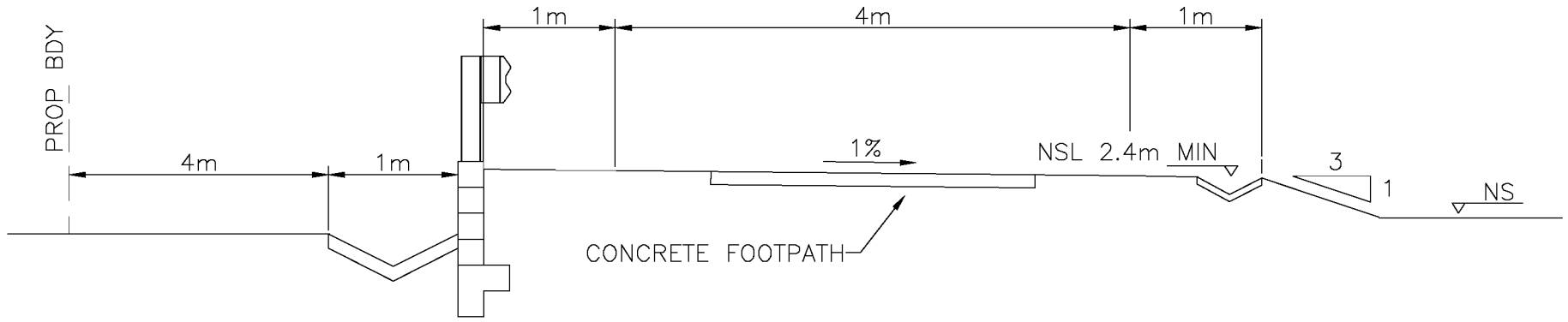
FIGURE No. 16.1

ACCESS ROAD CROSS SECTIONS

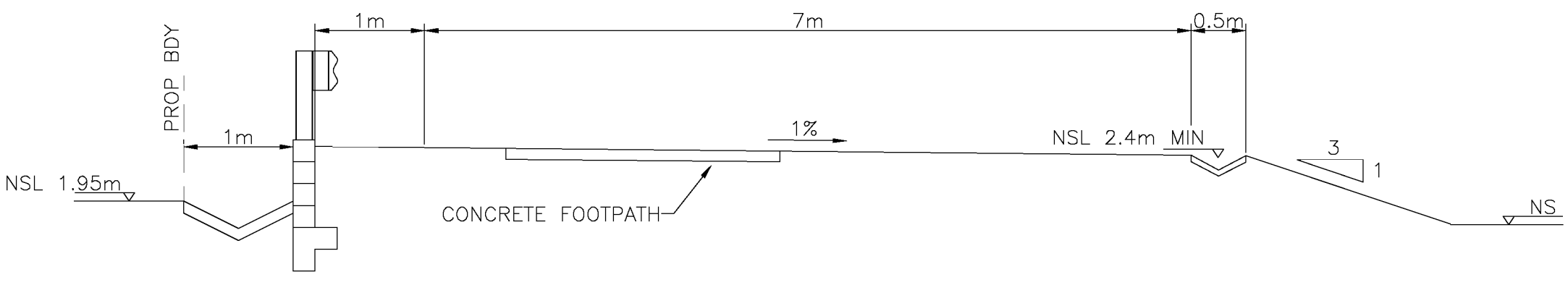
OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au



SECTION 4



SECTION 3

0 0.5 1 1.5 2m
1:50 UNREDUCED

A3 206012 FEBRUARY, 2010

PALM LAKE WORKS PTY LTD

PROPOSED SUBDIVISION

LOT 156 DP 628026
CREEK STREET
HASTINGS POINT, NSW

FIGURE No. 16.2

ACCESS ROAD CROSS SECTIONS

OPUS QANTEC McWILLIAM

A.B.N. 79 086 342 065

1/10 Rivendell
PO Box 6389
Tweed Heads South NSW 2486
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au

APPENDIX A

Preliminary Acid Sulfate Soil Management Plan

PALM LAKE WORKS PTY LTD

PRELIMINARY ACID SULFATE SOIL MANAGEMENT PLAN

PROPOSED FILLING
LOT 156 DP 628026 CREEK STREET
HASTINGS POINT NSW

OPUS QANTEC McWILLIAM

1 / 10 Rivendell, TWEED HEADS SOUTH NSW 2486
PO Box 6389, TWEED HEADS SOUTH NSW 2486

Telephone: 07 5523 1755
Facsimile: 07 5523 9664
E-mail: tweedheads@opusqmcw.com.au

MARCH 2008

DOCUMENT HISTORY PAGE

PROJECT NAME:

PROJECT NUMBER: 206012

DOCUMENT TITLE: PRELIMINARY ACID SULFATE SOIL MANAGEMENT PLAN

AUTHOR:

CLIENT: PALM LAKE WORKS PTY LTD

DESCRIPTION: FOR PROPOSED FILLING LOT 156 DP 628026 CREEK STREET HASTINGS POINT NSW

REVISION / ISSUE RECORD

DATE	DESCRIPTION	REV	AUTHOR	VERIFIED

DISTRIBUTION RECORD

	REVISION No. / Qty Issued				
RECIPIENT	**A**	**B**	**C**	**D**	**E**

TABLE OF CONTENTS

APPENDIX A

FIELD pH RESULTS

1. INTRODUCTION

This Acid Sulfate Soil Management Plan forms part of the Development Application and Statement of Environmental Effects for proposed filling in Creek Street, Hastings Point in the Shire of Tweed NSW. It shall be read in conjunction with the Engineering Impact Assessment Report.

It identifies testing frequency and procedures used to detect the presence of acid sulfate soils and the amelioration measures to mitigate potential problems.

2. DESCRIPTION OF THE SITE

The site is located on Lot 156 DP 628026 Creek Street, Hastings Point. The location is shown in Figure 1.0 of the Engineering Impact Assessment.

The approximately 50% of the site is identified in the Acid Sulfate Soil Map for Tweed Heads (9641 S4) published by Department of Land & Water Conservation 1997 as having a “High Probability of acid sulfate soils at or near the ground surface” and investigation for the presence of acid sulfate soils is recommended. The remainder of the site is identified as disturbed terrain and warrants an acid sulfate soils investigation. The existing site features are shown in Figure 2.0 of the Engineering Impact Assessment.

3. PROPOSED ACTIVITES

The current proposal is to fill the flood liable land as a precursor to residential development of the entire lot. Figure 3.0 of the Engineering Impact Assessment outlines the extent of the proposed filling works. The proposed development layout is also given in Figure 3.0. The proposed development may expose acid sulfate soils by excavation for service trenches and footings up to 2m below the existing surface. The location and depth of the trenches has not been determined. Consequently it is necessary to carry out detailed investigation for acid sulfate soil as described below prior to construction.

4. INVESTIGATION

A 0.5kg soil sample was taken at the surface and depths of 0.5m, 1.0m, 1.5m and 2.0m below the natural surface. 16 sampling locations evenly distributed over the development area were used in accordance with the ASSMAC Assessment Guidelines (1998) resulting in a total of 80 samples.

5. TESTING REGIME

All 80 samples were tested for field pH (pHF) and oxidised pH (pHFOX). 20 samples were tested in accordance with the Chromium Reducible Sulfur (Method 22B) and Acid Neutralising Capacity Methods (Method 19A2) described in the ASSMAC Assessment Guidelines (1998).

6. RESULTS

A report on the ASS Investigation was prepared by Soil Surveys Engineering Pty Ltd (July 2004) and is included in Appendix B of the Engineering Impact Assessment. A copy of the test results for field pH tests from this report are appended in Appendix A. These results indicate that Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS) are present on the subject site. Test results from the soil Surveys Report based on the Chromium Reducible Sulphur method are given in Appendix B.

7. REMEDIAL ACTION

Sandy soils have been encountered in this locality. Action thresholds for sandy soil types are listed in Table 4.4 of the Assessment Guidelines (ASSMAC 1998). The test results show an Oxidisable Sulfur percentage of 0.03% or greater and a TAA of 18 mol H^+/tonne or greater, therefore the treatment procedures described below must be implemented. Due to the irregular distribution of Acid and Sulfur trails throughout the site, we recommend adopting a single liming rate for all excavations below natural surface.

1. All trench excavation material shall be backfilled within 24 hours.
2. Stormwater runoff from trench spoil stockpiles shall be collected and retained on site. It shall only be released if the pH is greater than 6.5.
   If the pH of the water is less than 6.5 it shall be treated with agricultural lime or an approved alternative until it exceeds 6.5. Furthermore additional lime shall be applied to the soil stockpile and it shall be backfilled into the bottom of the trench immediately.
3. Excavated material shall be treated with agricultural lime at a rate of 21.3kg/tonne.

8. REPORTING

The Contractor shall report all cases to Council where the pH of collected leachate is less than 4.5.

9. CONCLUSION

The proposed excavation of service trenches and footings associated with the residential subdivision in Creek Street, Hastings Point will result in disturbance of acid sulfate soils. The application of amelioration measures described in this Management Plan will mitigate adverse impacts.

10. REFERENCE

STONE Y, AHERN CR & BLUNDEN B	(1998)	Acid Sulfate Soils Manual 1998. Acid Sulfate Management Advisory Committee, Wollongbar NSW Australia.

Report Prepared By

TRAVIS SERESHEFF

Engineer

Approved for Issue

MARTIN FINDLATER

Branch Manager

RPEQ 1969

APPENDIX A

FIELD pH RESULTS

(PRELIMINARY ACID SULFATE SOIL MANAGEMENT)

ALS Environmental

QUALITY CONTROL REPORT

Client	:	SOIL SURVEYS ENGINEERING P/L	Laboratory	:	ALS Environmental Brisbane	Page	: 1 of 16
Contact	:	PATRICK KIDD	Contact	:	Michael Heery		
Address	:	9/39 LAWRENCE DRIVE NERANG QLD AUSTRALIA 4211	Address	:	32 Shand Street Stafford QLD Australia 4053	No. of samples	: 22
Project	:	204 4808	Quote number	:	---	Date received	: 29 Jun 2004
Order number	:	B5702	Unique Report ID	:	00701	Date issued	: 12 Jul 2004
C-O-C number	:	- Not provided -					
Site	:	- Not provided -					
E-mail	:	pkidd@soilsurveys.com.au	E-mail	:	Michael.Heery@alsenviro.com	Work order	: **EB0403190**
Telephone	:	(07)5596-1528	Telephone	:	61-7-32437222		
Facsimile	:	(07)5578-3916	Facsimile	:	61-7-32437259		

This final report was issued on Monday, July 12, 2004 for the ALSE work order reference EB0403190 and supersedes any reports with this reference.
Results apply to the samples as submitted. All pages of this report have been checked and approved for release.
ND: Unable to determine the result due to sample matrix interference.
Particular samples required dilution prior to analysis due to matrix interferences. LOR values have been adjusted accordingly.

ALSE - QUALITY, SERVICE and TECHNOLOGY provided GLOBALLY

NATA Accredited Laboratory - 825

The Laboratory is accredited by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its scope of accreditation. This document shall not be reproduced except in full.

This document has been digitally signed by those names who appear on this report and are the authorised signatories. Digital signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Position	Department
Greg Greenland	Senior Organic Chemist	Inorganics - NATA 818 (Brisbane)
Greg Greenland	Senior Organic Chemist	Organics - NATA 818 (Brisbane)
Kim McCabe	Inorganics Supervisor	Inorganics - NATA 818 (Brisbane)
Shaun Crabb	Metals Team Leader	Inorganics - NATA 818 (Brisbane)

Quality Control Report - Laboratory Duplicates

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** = *Limit of Reporting,* ***RPD*** = *Relative Percent Difference.*
* Indicates failed QC.
The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:-
- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Matrix Type: SOIL

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EA055-103: Moisture Content						
EA055: Moisture Content - (QC Lot: 10246)				%	%	%
EB0403135-004	- Anonymous -	Moisture Content (dried @ 103°C)	0.1 %	43.5	46.3	6.2
EA055: Moisture Content - (QC Lot: 10246)				%	%	%
EB0403135-011	- Anonymous -	Moisture Content (dried @ 103°C)	0.1 %	82.9	74.5	10.7
EA055: Moisture Content - (QC Lot: 10247)				%	%	%
EB0403190-005	204 4808 5A	Moisture Content (dried @ 103°C)	0.1 %	5.1	4.9	5.0
EA055: Moisture Content - (QC Lot: 10247)				%	%	%
EB0403190-012	204 4808 12A	Moisture Content (dried @ 103°C)	0.1 %	4.3	5.0	16.4
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 10541)				mg/kg	mg/kg	%
EB0403128-001	- Anonymous -	Arsenic	1 mg/kg	13	12	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	1 mg/kg	12	10	15.6
		Nickel	1 mg/kg	10	7	25.8
EG005T: Total Metals by ICP-AES - (QC Lot: 10541)				mg/kg	mg/kg	%
EB0403128-011	- Anonymous -	Arsenic	1 mg/kg	52	54	5.5
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	1 mg/kg	8	8	0.0
		Copper	1 mg/kg	16	16	0.0
		Lead	1 mg/kg	14	14	0.0
		Nickel	1 mg/kg	4	4	0.0
		Zinc	1 mg/kg	27	28	5.2

ALS Environmental

Matrix Type: SOIL

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG005T: Total Metals by ICP-AES - (QC Lot: 10543)				mg/kg	mg/kg	%
EB0403190-001	204 4808 1A	Arsenic	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	1 mg/kg	<1	<1	0.0
		Copper	1 mg/kg	<1	<1	0.0
		Lead	1 mg/kg	<1	<1	0.0
		Nickel	1 mg/kg	<1	<1	0.0
		Zinc	1 mg/kg	1	1	0.0
EG005T: Total Metals by ICP-AES - (QC Lot: 10543)				mg/kg	mg/kg	%
EB0403190-011	204 4808 11A	Arsenic	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	1 mg/kg	<1	<1	0.0
		Copper	1 mg/kg	<1	<1	0.0
		Lead	1 mg/kg	2	2	0.0
		Nickel	1 mg/kg	<1	<1	0.0
		Zinc	1 mg/kg	2	2	0.0
EG035T: Total Mercury by FIMS						
EG035T: Total Mercury by FIMS - (QC Lot: 10542)				mg/kg	mg/kg	%
EB0403190-001	204 4808 1A	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
EG035T: Total Mercury by FIMS - (QC Lot: 10542)				mg/kg	mg/kg	%
EB0403190-011	204 4808 11A	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
EG035T: Total Mercury by FIMS - (QC Lot: 10544)				mg/kg	mg/kg	%
EB0403236-001	- Anonymous -	Mercury	0.1 mg/kg	<0.1	<0.1	0.0

Matrix Type: SOIL

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068: Pesticides by GCMS						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 10217)				mg/kg	mg/kg	%
EB0403155-001	- Anonymous -	alpha-BHC	0.05 mg/kg	<0.12	<0.12	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.12	<0.12	0.0
		beta-BHC	0.05 mg/kg	<0.12	<0.12	0.0
		gamma-BHC	0.05 mg/kg	<0.12	<0.12	0.0
		delta-BHC	0.05 mg/kg	<0.12	<0.12	0.0
		Heptachlor	0.05 mg/kg	<0.12	<0.12	0.0
		Aldrin	0.05 mg/kg	<0.12	<0.12	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.12	<0.12	0.0
		trans-Chlordane	0.05 mg/kg	<0.12	<0.12	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.12	<0.12	0.0
		cis-Chlordane	0.05 mg/kg	<0.12	<0.12	0.0
		Dieldrin	0.05 mg/kg	<0.12	<0.12	0.0
		4.4'-DDE	0.05 mg/kg	<0.12	<0.12	0.0
		Endrin	0.05 mg/kg	<0.12	<0.12	0.0
		beta-Endosulfan	0.05 mg/kg	<0.12	<0.12	0.0
		4.4'-DDD	0.05 mg/kg	<0.12	<0.12	0.0
		Endrin aldehyde	0.05 mg/kg	<0.12	<0.12	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.12	<0.12	0.0
		4.4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.12	<0.12	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 10217)				mg/kg	mg/kg	%
EB0403155-001	- Anonymous -	Dichlorvos	0.05 mg/kg	<0.12	<0.12	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.12	<0.12	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.12	<0.12	0.0
		Diazinon	0.05 mg/kg	<0.12	<0.12	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.12	<0.12	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.12	<0.12	0.0
		Fenthion	0.05 mg/kg	<0.12	<0.12	0.0
		Chlorpyrifos	0.05 mg/kg	<0.12	<0.12	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.12	<0.12	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.12	<0.12	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.12	<0.12	0.0
		Fenamiphos	0.05 mg/kg	<0.12	<0.12	0.0
		Prothiofos	0.05 mg/kg	<0.12	<0.12	0.0
		Ethion	0.05 mg/kg	<0.12	<0.12	0.0
		Carbophenothion	0.05 mg/kg	<0.12	<0.12	0.0
		Azinphos Methyl	0.05 mg/kg	<0.12	<0.12	0.0

Matrix Type: SOIL

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068S: Organochlorine Pesticide Surrogate - (QC Lot: 10217)				%	%	%
EB0403155-001	- Anonymous -	Dibromo-DDE	0.1 %	90.3	92.2	2.1
EP068T: Organophosphorus Pesticide Surrogate - (QC Lot: 10217)				%	%	%
EB0403155-001	- Anonymous -	DEF	0.1 %	Not determined	Not determined	0.0
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 10217)				mg/kg	mg/kg	%
EB0403190-004	204 4808 4A	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0

Matrix Type: SOIL

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 10217)				mg/kg	mg/kg	%
EB0403190-004	204 4808 4A	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Azinphos Methyl	0.05 mg/kg	<0.05	<0.05	0.0
EP068S: Organochlorine Pesticide Surrogate - (QC Lot: 10217)				%	%	%
EB0403190-004	204 4808 4A	Dibromo-DDE	0.1 %	117	117	0.3
EP068T: Organophosphorus Pesticide Surrogate - (QC Lot: 10217)				%	%	%
EB0403190-004	204 4808 4A	DEF	0.1 %	111	111	0.0

Matrix Type: SOIL

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 10310)				mg/kg	mg/kg	%
EB0403184-001	- Anonymous -	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4.4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4.4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4.4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 10310)				mg/kg	mg/kg	%
EB0403184-001	- Anonymous -	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Azinphos Methyl	0.05 mg/kg	<0.05	<0.05	0.0

Matrix Type: SOIL

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068S: Organochlorine Pesticide Surrogate - (QC Lot: 10310)				%	%	%
EB0403184-001	- Anonymous -	Dibromo-DDE	0.1 %	102	104	1.3
EP068T: Organophosphorus Pesticide Surrogate - (QC Lot: 10310)				%	%	%
EB0403184-001	- Anonymous -	DEF	0.1 %	100	100	0.3
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 10310)				mg/kg	mg/kg	%
EB0403190-022	204 4808 22A	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4.4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4.4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4.4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0

Matrix Type: SOIL

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 10310)				mg/kg	mg/kg	%
EB0403190-022	204 4808 22A	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Azinphos Methyl	0.05 mg/kg	<0.05	<0.05	0.0
EP068S: Organochlorine Pesticide Surrogate - (QC Lot: 10310)				%	%	%
EB0403190-022	204 4808 22A	Dibromo-DDE	0.1 %	97.7	98.0	0.3
EP068T: Organophosphorus Pesticide Surrogate - (QC Lot: 10310)				%	%	%
EB0403190-022	204 4808 22A	DEF	0.1 %	93.7	95.0	1.4

Quality Control Report - Method Blank and Laboratory Control Samples (LCS)

The quality control term **Method / Laboratory Blank** refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term **Laboratory Control Sample (LCS)** refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits, with the exception of surrogates, based on statistical evaluation of actual laboratory data. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Abbreviations: LOR = Limit of reporting.
* Indicates failed QC.

Matrix Type: SOIL

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 10541)		mg/kg	mg/kg	%	%	%
Arsenic	1 mg/kg	<1	13.76	94.4	70	130
Cadmium	1 mg/kg	<1	2.82	94.3	70	130
Chromium	1 mg/kg	<1	61.59	100	70	130
Copper	1 mg/kg	<1	54.68	99.8	70	130
Lead	1 mg/kg	<1	55.50	97.6	70	130
Nickel	1 mg/kg	<1	55.10	102	70	130
Zinc	1 mg/kg	<1	105.3	101	70	130
EG005T: Total Metals by ICP-AES - (QC Lot: 10543)		mg/kg	mg/kg	%	%	%
Arsenic	1 mg/kg	<1	13.76	100	70	130
Cadmium	1 mg/kg	<1	2.82	95.7	70	130
Chromium	1 mg/kg	<1	61.59	103	70	130
Copper	1 mg/kg	<1	54.68	106	70	130
Lead	1 mg/kg	<1	55.50	101	70	130
Nickel	1 mg/kg	<1	55.10	103	70	130
Zinc	1 mg/kg	<1	105.3	102	70	130
EG035T: Total Mercury by FIMS						
EG035T: Total Mercury by FIMS - (QC Lot: 10542)		mg/kg	mg/kg	%	%	%
Mercury	0.1 mg/kg	<0.1	1.34	103	70	130
EG035T: Total Mercury by FIMS - (QC Lot: 10544)		mg/kg	mg/kg	%	%	%
Mercury	0.1 mg/kg	<0.1	1.34	102	70	130

Matrix Type: SOIL

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068: Pesticides by GCMS						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 10217)		mg/kg	mg/kg	%	%	%
alpha-BHC	0.05 mg/kg	<0.05	0.25	102	54	113
Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	0.25	99.4	50	119
beta-BHC	0.05 mg/kg	<0.05	0.25	88.4	59	113
gamma-BHC	0.05 mg/kg	<0.05	0.25	89.5	59	113
delta-BHC	0.05 mg/kg	<0.05	0.25	100	62	106
Heptachlor	0.05 mg/kg	<0.05	0.25	100	50	109
Aldrin	0.05 mg/kg	<0.05	0.25	94.3	59	111
Heptachlor epoxide	0.05 mg/kg	<0.05	0.25	99.2	51	118
trans-Chlordane	0.05 mg/kg	<0.05	0.25	98.7	53	113
alpha-Endosulfan	0.05 mg/kg	<0.05	0.25	98.3	63	115
cis-Chlordane	0.05 mg/kg	<0.05	0.25	99.8	55	117
Dieldrin	0.05 mg/kg	<0.05	0.25	95.0	64	111
4.4'-DDE	0.05 mg/kg	<0.05	0.25	94.9	64	108
Endrin	0.05 mg/kg	<0.05	0.25	89.4	55	111
beta-Endosulfan	0.05 mg/kg	<0.05	0.25	92.8	61	113
4.4'-DDD	0.05 mg/kg	<0.05	0.25	90.4	57	114
Endrin aldehyde	0.05 mg/kg	<0.05	0.25	97.9	41	117
Endosulfan sulfate	0.05 mg/kg	<0.05	0.25	86.8	50	118
4.4'-DDT	0.2 mg/kg	<0.2	0.25	94.3	56	109
Endrin ketone	0.05 mg/kg	<0.05	0.25	93.9	60	113
Methoxychlor	0.2 mg/kg	<0.2	0.25	91.2	54	106
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 10217)		mg/kg	mg/kg	%	%	%
Dichlorvos	0.05 mg/kg	<0.05	0.25	90.7	43	110
Demeton-S-methyl	0.05 mg/kg	<0.05	0.25	97.4	44	114
Monocrotophos	0.2 mg/kg	<0.2	0.25	98.4	31	116
Dimethoate	0.05 mg/kg	<0.05	0.25	96.6	51	112
Diazinon	0.05 mg/kg	<0.05	0.25	93.4	58	108
Chlorpyrifos-methyl	0.05 mg/kg	<0.05	0.25	102	51	111
Parathion-methyl	0.2 mg/kg	<0.2	0.25	98.6	49	110
Malathion	0.05 mg/kg	<0.05	0.25	97.8	57	113
Fenthion	0.05 mg/kg	<0.05	0.25	98.0	48	113
Chlorpyrifos	0.05 mg/kg	<0.05	0.25	88.2	55	110
Parathion	0.2 mg/kg	<0.2	0.25	99.2	52	111
Pirimphos-ethyl	0.05 mg/kg	<0.05	0.25	97.1	49	111
Chlorfenvinphos	0.05 mg/kg	<0.05	0.25	97.2	50	112
Bromophos-ethyl	0.05 mg/kg	<0.05	0.25	97.7	53	112
Fenamiphos	0.05 mg/kg	<0.05	0.25	97.2	47	115
Prothiofos	0.05 mg/kg	<0.05	0.25	98.0	48	115
Ethion	0.05 mg/kg	<0.05	0.25	88.0	56	110
Carbophenothion	0.05 mg/kg	<0.05	0.25	98.6	49	113
Azinphos Methyl	0.05 mg/kg	<0.05	0.25	85.5	37	116

ALS Environmental

Matrix Type: SOIL

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068S: Organochlorine Pesticide Surrogate - (QC Lot: 10217)		%	mg/kg	%	%	%
Dibromo-DDE	0.1 %	105	1.25	91.2	79	127
EP068T: Organophosphorus Pesticide Surrogate - (QC Lot: 10217)		%	mg/kg	%	%	%
DEF	0.1 %	98.1	1.25	88.2	73	114

ALS Environmental

Matrix Type: SOIL

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 10310)		mg/kg	mg/kg	%	%	%
alpha-BHC	0.05 mg/kg	<0.05	0.25	97.8	54	113
Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	0.25	98.3	50	119
beta-BHC	0.05 mg/kg	<0.05	0.25	102	59	113
gamma-BHC	0.05 mg/kg	<0.05	0.25	100	59	113
delta-BHC	0.05 mg/kg	<0.05	0.25	103	62	106
Heptachlor	0.05 mg/kg	<0.05	0.25	96.9	50	109
Aldrin	0.05 mg/kg	<0.05	0.25	97.6	59	111
Heptachlor epoxide	0.05 mg/kg	<0.05	0.25	101	51	118
trans-Chlordane	0.05 mg/kg	<0.05	0.25	95.1	53	113
alpha-Endosulfan	0.05 mg/kg	<0.05	0.25	91.6	63	115
cis-Chlordane	0.05 mg/kg	<0.05	0.25	100	55	117
Dieldrin	0.05 mg/kg	<0.05	0.25	97.0	64	111
4.4'-DDE	0.05 mg/kg	<0.05	0.25	95.4	64	108
Endrin	0.05 mg/kg	<0.05	0.25	102	55	111
beta-Endosulfan	0.05 mg/kg	<0.05	0.25	98.0	61	113
4.4'-DDD	0.05 mg/kg	<0.05	0.25	98.5	57	114
Endrin aldehyde	0.05 mg/kg	<0.05	0.25	96.9	41	117
Endosulfan sulfate	0.05 mg/kg	<0.05	0.25	96.4	50	118
4.4'-DDT	0.2 mg/kg	<0.2	0.25	93.3	56	109
Endrin ketone	0.05 mg/kg	<0.05	0.25	101	60	113
Methoxychlor	0.2 mg/kg	<0.2	0.25	95.9	54	106
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 10310)		mg/kg	mg/kg	%	%	%
Dichlorvos	0.05 mg/kg	<0.05	0.25	100	43	110
Demeton-S-methyl	0.05 mg/kg	<0.05	0.25	98.8	44	114
Monocrotophos	0.2 mg/kg	<0.2	0.25	86.9	31	116
Dimethoate	0.05 mg/kg	<0.05	0.25	96.0	51	112
Diazinon	0.05 mg/kg	<0.05	0.25	98.6	58	108
Chlorpyrifos-methyl	0.05 mg/kg	<0.05	0.25	98.6	51	111
Parathion-methyl	0.2 mg/kg	<0.2	0.25	100	49	110
Malathion	0.05 mg/kg	<0.05	0.25	97.8	57	113
Fenthion	0.05 mg/kg	<0.05	0.25	98.2	48	113
Chlorpyrifos	0.05 mg/kg	<0.05	0.25	104	55	110
Parathion	0.2 mg/kg	<0.2	0.25	102	52	111
Pirimphos-ethyl	0.05 mg/kg	<0.05	0.25	100	49	111
Chlorfenvinphos	0.05 mg/kg	<0.05	0.25	93.0	50	112
Bromophos-ethyl	0.05 mg/kg	<0.05	0.25	92.7	53	112
Fenamiphos	0.05 mg/kg	<0.05	0.25	92.7	47	115
Prothiofos	0.05 mg/kg	<0.05	0.25	96.0	48	115
Ethion	0.05 mg/kg	<0.05	0.25	97.8	56	110
Carbophenothion	0.05 mg/kg	<0.05	0.25	95.4	49	113
Azinphos Methyl	0.05 mg/kg	<0.05	0.25	101	37	116
EP068S: Organochlorine Pesticide Surrogate - (QC Lot: 10310)		%	mg/kg	%	%	%
Dibromo-DDE	0.1 %	90.9	1.25	101	79	127

ALS Environmental

Matrix Type: SOIL

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068T: Organophosphorus Pesticide Surrogate - (QC Lot: 10310)		%	mg/kg	%	%	%
DEF	0.1 %	92.0	1.25	94.8	73	114

ALS Environmental

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). Surrogate DQO's based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** *= Limit of Reporting,* ***RPD*** *= Relative Percent Difference.*

* Indicates failed QC.

Matrix Type: SOIL

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	Laboratory Sample ID	Client Sample ID	LOR	Spike Concentration		MS	Low	High
EG005T: Total Metals by ICP-AES								
EG005T: Total Metals by ICP-AES - (QC Lot: 10541)				mg/kg	mg/kg	%	%	%
Arsenic	EB0403128-002	- Anonymous -	1 mg/kg	50.0	141	122	70	130
Cadmium			1 mg/kg	50.0	<1	98.9	70	130
Chromium			1 mg/kg	50.0	10	98.0	70	130
Copper			1 mg/kg	50.0	19	102	70	130
Lead			1 mg/kg	50.0	17	95.6	70	130
Nickel			1 mg/kg	50.0	4	95.6	70	130
Zinc			1 mg/kg	50.0	35	92.0	70	130
EG005T: Total Metals by ICP-AES - (QC Lot: 10543)				mg/kg	mg/kg	%	%	%
Arsenic	EB0403190-001	204 4808 1A	1 mg/kg	50.0	<1	104	70	130
Cadmium			1 mg/kg	50.0	<1	102	70	130
Chromium			1 mg/kg	50.0	<1	96.7	70	130
Copper			1 mg/kg	50.0	<1	105	70	130
Lead			1 mg/kg	50.0	<1	101	70	130
Nickel			1 mg/kg	50.0	<1	101	70	130
Zinc			1 mg/kg	50.0	1	101	70	130
EG035T: Total Mercury by FIMS								
EG035T: Total Mercury by FIMS - (QC Lot: 10542)				mg/kg	mg/kg	%	%	%
Mercury	EB0403190-001	204 4808 1A	0.1 mg/kg	10.0	<0.1	104	70	130
EG035T: Total Mercury by FIMS - (QC Lot: 10544)				mg/kg	mg/kg	%	%	%
Mercury	EB0403236-003	- Anonymous -	0.1 mg/kg	10.0	<0.1	95.8	70	130

Matrix Type: SOIL

Analyte name	Laboratory Sample ID	Client Sample ID	LOR	Spike Concentration	Actual Results: Sample Result	Actual Results: Spike Recovery MS	Recovery Limits: Static Limits Low	Recovery Limits: Static Limits High
EP068: Pesticides by GCMS								
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 10217)				mg/kg	mg/kg	%	%	%
beta-BHC	EB0403155-006	- Anonymous -	0.05 mg/kg	0.25	<0.05	85.5	70	130
gamma-BHC			0.05 mg/kg	0.25	<0.05	82.6	70	130
Heptachlor			0.05 mg/kg	0.25	<0.05	87.3	70	130
Aldrin			0.05 mg/kg	0.25	<0.05	94.2	70	130
Dieldrin			0.05 mg/kg	0.25	<0.05	85.3	70	130
Endrin			0.05 mg/kg	0.25	<0.05	87.0	70	130
4,4'-DDT			0.05 mg/kg	0.25	<0.2	77.5	70	130
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 10217)				mg/kg	mg/kg	%	%	%
Diazinon	EB0403155-006	- Anonymous -	0.05 mg/kg	0.25	<0.05	98.4	70	130
Chlorpyrifos-methyl			0.05 mg/kg	0.25	<0.05	97.8	70	130
Pirimphos-ethyl			0.05 mg/kg	0.25	<0.05	83.8	70	130
Bromophos-ethyl			0.05 mg/kg	0.25	<0.05	89.6	70	130
Prothiofos			0.05 mg/kg	0.25	<0.05	84.2	70	130
EP068S: Organochlorine Pesticide Surrogate - (QC Lot: 10217)				mg/kg	%	%	%	%
Dibromo-DDE	EB0403155-006	- Anonymous -	0.1 %	1.25	100	104	10	136
EP068T: Organophosphorus Pesticide Surrogate - (QC Lot: 10217)				mg/kg	%	%	%	%
DEF	EB0403155-006	- Anonymous -	0.1 %	1.25	93.4	Not determined	10	110
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 10310)				mg/kg	mg/kg	%	%	%
beta-BHC	EB0403186-001	- Anonymous -	0.05 mg/kg	0.25	<0.05	91.6	70	130
gamma-BHC			0.05 mg/kg	0.25	<0.05	88.1	70	130
Heptachlor			0.05 mg/kg	0.25	<0.05	98.1	70	130
Aldrin			0.05 mg/kg	0.25	<0.05	98.1	70	130
Dieldrin			0.05 mg/kg	0.25	<0.05	86.8	70	130
Endrin			0.05 mg/kg	0.25	<0.05	94.8	70	130
4,4'-DDT			0.05 mg/kg	0.25	<0.2	83.6	70	130
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 10310)				mg/kg	mg/kg	%	%	%
Diazinon	EB0403186-001	- Anonymous -	0.05 mg/kg	0.25	<0.05	87.2	70	130
Chlorpyrifos-methyl			0.05 mg/kg	0.25	<0.05	85.6	70	130
Pirimphos-ethyl			0.05 mg/kg	0.25	<0.05	81.5	70	130
Bromophos-ethyl			0.05 mg/kg	0.25	<0.05	85.3	70	130
Prothiofos			0.05 mg/kg	0.25	<0.05	89.6	70	130
EP068S: Organochlorine Pesticide Surrogate - (QC Lot: 10310)				mg/kg	%	%	%	%
Dibromo-DDE	EB0403186-001	- Anonymous -	0.1 %	1.25	103	104	10	136
EP068T: Organophosphorus Pesticide Surrogate - (QC Lot: 10310)				mg/kg	%	%	%	%
DEF	EB0403186-001	- Anonymous -	0.1 %	1.25	100	94.0	10	110

APPENDIX B

CHROMIUM REDUCIBLE SULFUR TEST RESULTS

(PRELIMINARY ACID SULFATE SOIL MANAGEMENT)

Soil & Water Laboratories P/L
19 Finchley Street, Milton, QLD. 4064
Phone: (07) 3369 6668; Fax: (07) 3503 9063

Chromium Reducible Sulphur, Titratable Actual Acidity & Acid Neutralising Capacity Test Results

(methods 2A2, 19A2, 22B, 23A & 23F)

Ref. Number: GOL-4808

Date: 01/07/2004 Location: Hastings Point

Project Number: 204-4808

Sample Number	Identification	Description	Moisture as received (85oC) (%)	Reaction to H2O2	Reaction to HCl	Init. pH (KCl)	ANC (%CaCO3 Eq.)	ANC (mol. H+/tonne)	a-ANC (eq. mol. H+/t)	TAA (mol. H+/tonne)	SCr (%S)	SCr (mol. H+/t)
1	BH01 0.0m	Silty SAND (SM), fine to medium grained, grey to black, medium ploasticity fines, moist.	4.5%	Low	None	4.5	n/a	n/a	n/a	10	0.00	0
10	BH02 2.0m	Silty SAND (SM), fine to medium grained, grey to black, medium ploasticity fines, moist.	20.5%	High	Low	4.7	n/a	n/a	n/a	10	0.04	22
13	BH03 1.0m	SAND (SP), fine to medium grained, grey to white, moist.	4.1%	Low	Low	5.4	n/a	n/a	n/a	5	0.00	0
20	BH04 2.0m	SAND (SP), fine to medium grained, light grey , trace of low plasticity fines, moist	21.9%	Low	Low	6.3	n/a	n/a	n/a	0	0.09	58
23	BH05 1.0m	Silty SAND (SM), fine to medium grained, grey to black, low plasticity fines, moist.	25.3%	Low	Low	4.9	n/a	n/a	n/a	10	0.02	9
25	BH05 2.0m	Silty SAND (SM), fine to medium grained, grey to black, low plasticity fines, moist.	21.4%	Moderate	Low	4.9	n/a	n/a	n/a	10	0.05	34
30	BH06 2.0m	Silty SAND (SM), fine to medium grained, grey to black, low plasticity fines, wet.	29.3%	Low	Low	4.5	n/a	n/a	n/a	13	0.12	75
33	BH07 1.0m	Silty SAND (SM), fine to medium grained, dark grey, low plasticity fines, wet.	30.1%	Low	Low	4.7	n/a	n/a	n/a	10	0.06	36
37	BH08 0.5m	Silty SAND (SM), fine to medium grained, dark grey, low plasticity fines, moist.	5.5%	Low	Low	5.1	n/a	n/a	n/a	5	0.01	6
41	BH09 0.0m	Silty SAND (SM), fine to medium grained, dark grey, low plasticity fines, moist.	7.9%	Low	Low	4.2	n/a	n/a	n/a	13	0.01	6
43	BH09 1.0m	Silty SAND (SM), fine to medium grained, grey mottled black, low plasticity fines, moist.	34.1%	Low	Low	4.0	n/a	n/a	n/a	58	0.44	277
50	BH10 2.0m	Silty SAND (SM), fine to medium grained, grey mottled black, low plasticity fines, moist.	21.9%	Low	Low	4.8	n/a	n/a	n/a	10	0.12	75
54	BH11 1.5m	Silty SAND (SM), fine to medium grained, brown to black, low plasticity fines, wet.	26.4%	High	Low	4.4	n/a	n/a	n/a	18	0.05	32
57	BH12 0.5m	SAND (SP), fine to medium grained, yellow to white, moist.	4.1%	Low	Low	5.5	n/a	n/a	n/a	3	0.01	6
61	BH13 0.0m	Silty SAND (SM), fine to medium grained, low plasticity fines, just moist.	5.8%	High	Low	4.6	n/a	n/a	n/a	5	0.01	6
65	BH13 2.0m	Silty SAND (SM), fine to medium grained, brown to black, low plasticity fines, wet.	24.7%	Low	Low	4.2	n/a	n/a	n/a	25	0.15	95
70	BH14 2.0m	Silty SAND (SM), fine to medium grained, brown to black, low plasticity fines, wet.	24.4%	Low	Low	4.5	n/a	n/a	n/a	23	0.09	58
71	BH15 0.0m	Silty SAND (SM), fine to medium grained, grey to black, low plasticity fines, just moist.	7.4%	Low	Low	5.0	n/a	n/a	n/a	5	0.02	15
75	BH15 2.0m	Silty SAND (SM), fine to medium grained, grey to black, low plasticity fines, moist.	21.2%	Moderate	Low	4.8	n/a	n/a	n/a	10	0.04	22
80	BH16 2.0m	Silty SAND (SM), fine to medium grained, grey to black, low plasticity fines, moist.	22.5%	High	Low	4.8	n/a	n/a	n/a	15	0.10	62

Determinations have been derived by the adoption of published test methods recommended by National Committee for Acid Sulphate Soils (NatCASS); Queensland Acid Sulphate Soils Management Advisory Committee (QASSMAC); Queensland Acid Sulphate Soils Investigation Team (QASSIT) & Queensland Department of Natural Resources, Mines and Energy; as described in the 'Acid Sulphate Soils Laboratory Methods Guidelines 2004'.