Tonkin+Taylor

Job No: 1008135
03 July 2020

Brookside Developments - Featherston Ltd
26 Blick Terrace
Nelson 7010

Attention: Ian McComb

Dear Ian

Additional information on flood hazard modelling for new development at Harrison Street East, Featherston

In accordance with our Variation 1 (signed 15 June 2020), this letter details the assumptions used in the revised flood hazard modelling in relation to Stages 2 and 3 of the proposed subdivision. This additional work has been undertaken in accordance with the conditions of our engagement (letter T+T ref: 1008135, dated 24 August 2018).

1 Background

In 2018 Tonkin & Taylor Ltd (T+T) undertook flood modelling of a future 1% annual exceedance probability (AEP) event through the site (allowing for 2°C increase in temperatures over present day values), to help inform development decisions (refer to letter T+T ref: 1008135, dated 7 December 2018). The previous modelling identified two main overland flowpaths through the site. The majority of this flooding results from overtopping and overflow from the Donald's Creek flood detention pond upstream of the site during extreme rainfall events. The detention pond was constructed in 1999, and was sized for the 2% AEP event[1].

In February-March 2020 T+T revised the model to incorporate the proposed swales through the site (refer to letter T+T ref:1008135, dated 10 March 2020). This modelling indicated that with some filling of existing low points, the proposed swales and road carriageway could accommodate the future 1% AEP flow through the site such that the proposed subdivision lots would not be affected by the 1% AEP flood hazard caused by overflow from the detention pond.

The purpose of this letter is to assess the effects of proposed subdivision and development of Lots 31-36, 300-309, and 400-401 on flooding affecting adjacent properties. The extent of the development considered in this study is shown on Tomlinson & Carruthers Surveyors Ltd drawing: T18/051 S 4A attached in Appendix B.

2 Catchment hydrology

Three peak flow estimation methods were considered to identify an appropriate design peak flow rate. These were:

[1] Information sourced from the Greater Wellington Regional Council information sign at the detention pond.

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- NIWA's NZ Flood Frequency Tool[2] (regional method);
- Rational method (as developed using NIWA's NZ Flood Frequency Tool);
- SCS method using a HEC-HMS hydrological model.

A HEC-HMS model (version 3.5) was developed using the SCS loss method and HIRDS v4 rainfall data and storm profiles. For the purposes of comparison with the NZ Flood Statistics tool (that reports present day flows), the HEC-HMS model was run with present day rainfall.

Using available land cover and soil databases and the curve number values given in the Wellington Water Reference Guide for Design Hydrology[3], a CN value of 50 was derived. However, this yielded a peak runoff value that was much lower than other estimates and considered too low. For the purpose of this study, a CN of 57 was considered more appropriate (i.e. a better match with the other estimates), and in the absence of any site-specific rainfall and flow gauge data, has been adopted for design.

GWRC requires consideration of flooding in up to the 2100 RCP6.0 1% AEP flood hazard for subdivision development.

Table 2-1 summarises the parameters and assumptions used in the HEC-HMS model.

Table 2-1. Summary of HEC-HMS model parameters

Parameter	Value
Detention pond catchment area	12.4 km^2
Detention pond catchment SCS curve number (CN)	57
Initial abstraction	19 mm (Taken as 0.1S as per the Wellington Water guidelines). Storage depth (S) is a function of the curve number.
Time of concentration (SCS method)	51 minutes
SCS lag (2/3 of the time of concentration)	31 minutes – USSCS/Ramser Kirpich Method
Rainfall inputs	Rainfall depths were generated using NIWA's High Intensity Rainfall Design System (HIRDS) v4. This data was used to create HIRDS v4 rainfall profile storms (East the North Island rainfall pattern).
Climate change scenario	Applied rainfall uses HIRDS v4 RCP6.0 scenario estimates for the year 2100.

Table 2-2 presents a summary of the various flow estimation methods that were compared to arrive at a design peak flow rate into the detention pond immediately upstream of the development site.

Table 2-2. Summary of present day 1% AEP peak flow estimates

Method	Estimated Peak Present Day 1% AEP flow (m^3/s)
NIWA's NZ River Flood Statistics Tool - regional method	24.5
NIWA's NZ River Flood Statistics Tool - Rational Method, C = 0.2-0.4	23 - 45
SCS method, CN = 50	23
SCS method, CN 57 (adopted for design)	30

[2] https://niwa.co.nz/natural-hazards/hazards/floods
[3] Cardno, Reference Guide for Design Storm Hydrology - Storm Parameters for Hydrological Modelling, 9 April 2019, Prepared for Wellington Water Ltd

Once the catchment parameters were confirmed, the model was used to assess the 2100 RCP6.0 1% AEP flow rate and hydrographs, and to estimate what proportion of flows would be expected to pass through the pond's primary outlet, and what proportion would be expected to spill from the pond and affect the application site. Overflows from the pond were modelled as weirs based on low points along the eastern length of the detention pond bund.

A range of storm durations was assessed to determine the critical duration of the detention pond. The resulting pond inflow and outflow hydrographs are presented in Figure 2-1 to Figure 2-4.

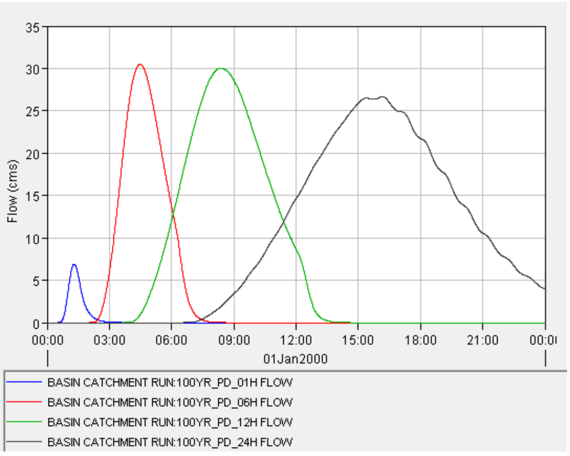


Figure 2-1. HEC-HMS present day pond inflow hydrographs

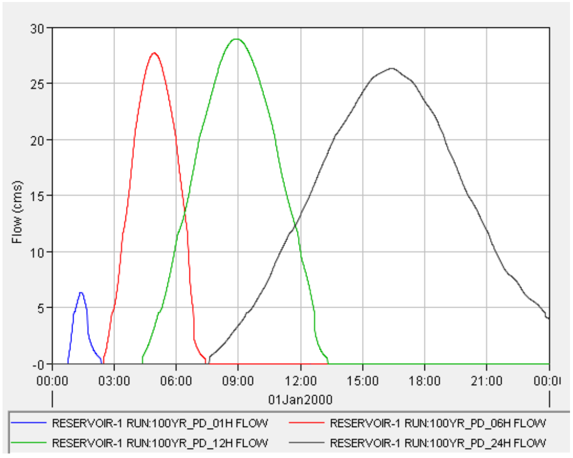


Figure 2-2. HEC_HMS present day pond outflow hydrographs

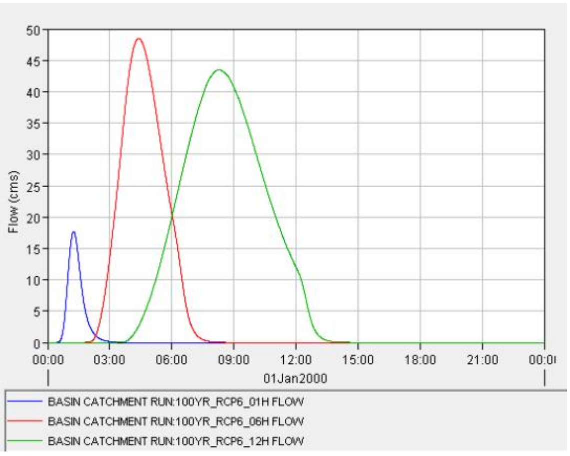


Figure 2-3. HEC-HMS RCP6.0 pond inflow hydrographs

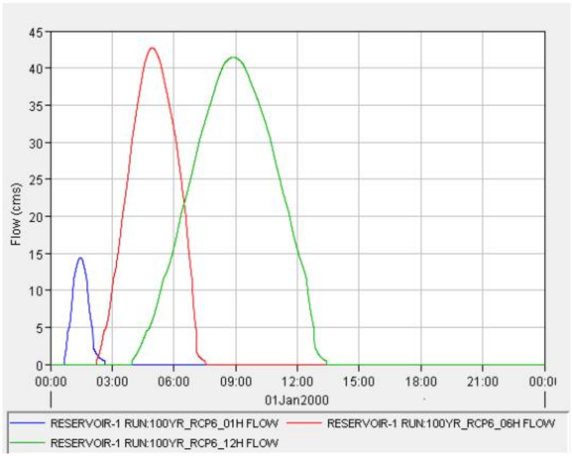


Figure 2-4. HEC-HMS RCP6.0 pond outflow hydrographs

In the present-day scenario, the 6-hour storm is the most critical for inflows to the pond, however, the 12-hour storm is most critical for peak outflow of the pond. In the 2100 RCP6.0 1% AEP flow the 6-hour storm was most critical for both pond inflow and outflow, hence this is the scenario that was used as the design inflow in the TUFLOW model.

3 Hydraulic modelling

A 2D TUFLOW model (engine version 2020-01-AB) was used to assess flooding affecting the site and adjacent property. The resulting hydrograph for the 2100 RCP6.0 1% AEP detention pond inflows were introduced to the model immediately upstream of the existing detention pond. The model was then run to determine how much of the flow in this event would stay within the main flow conveyance system, and how much might be expected to spill from the pond and flow through the application site. Table 3-1 summarises the updated parameters and assumptions used in the TUFLOW model.

Table 3-1. Summary of TUFLOW model parameters

Parameter	Value
Rainfall inputs	Rainfall depths were generated using NIWA's High Intensity Rainfall Design System (HIRDS) v4. This data was used to create HIRDS v4 rainfall profile storms.
Climate change scenario	Applied rainfall uses HIRDS v4 2100 RCP6.0 1% AEP data.
Model domain area	11 km^2 encompassing the detention pond and extending downstream past the proposed development to Revans St.
Ground surface	1 m 2013 LIDAR data sourced from the LINZ data service website. The post-development surface incorporates Stage 2 and 3 earthworks encompassing filling of lots, proposed swales, ROW's, and roads.
Model cell size	1 m by 1 m (1 m^2 cells)
Sub-Grid sampling size	0.2 m
Timestep	The TUFLOW GPU model utilises an adaptive timestep based on a maximum Courant number of 1.
Viscosity	The default viscosity approach in TUFLOW GPU uses the Smagorinsky method. The default coefficient of 0.20 has been adopted.
Landuse (surface roughness)	Roughness values based on land use in Landcare Research's Land Cover Database version 4.1 (LCDB4), released July 2015. The corresponding Manning's n values are shown in Table 2.2. Post-Development scenario assumes a 50% impervious surface over the development site.
Infiltration losses	The Horton loss model was used. The soil classes were taken from the Landcare Research's S-map updated September 2016. Mapping of S-map soil classes to infiltration rates was as per calibrated values from the Canterbury Earthquake Recovery Agency (CERA) Increased Flood Vulnerability (IFV) flood modelling project.
Modelled peak 2100 1% AEP RCP6.0 flood flow in Donald's Creek (downstream of Harrison Street East).	Approx. 35 m^3/s for 6hr storm duration (critical duration).

Table 3-2. Summary of Manning's n values used in the model

Land cover type	Manning’s n
Exotic forest	0.150
Gorse	0.125
Exotic grassland	0.050
Indigenous forest	0.150
Orchard/Vineyard	0.05

The post development modelling includes changing the development area to 50% impervious as well as the following changes to the pre-development LiDAR ground surface:

- Proposed lots have been filled to a smooth surface to remove existing flow paths.
- The swales, road and ROW have been added to the modelled surface as per Davis Cartwright Consulting Drawings FST-050 and FST-051 (draft) attached in Appendix B.

3.1 Model validation

There are no flow gauges within the modelled area against which to calibrate or validate the model. However, flooding in December 2018 provides some anecdotal validation of the findings of the modelling.

Overflow from the detention basin flowed across Harrison Street East into the site of the proposed development (See Photograph 3-1). This confirms the overflow point identified in the modelling.

Photograph 3-1. December 2018 photograph showing flow crossing Harrison Street East.

Further, you have advised us that the floor level of the main dwelling at 25 Brown Street is elevated approximately 500 mm above surrounding ground levels, and that the floor level of the sleepout is less than this. Modelling indicates that the 2100 RCP6.0 1% AEP flood depth around the house and sleepout is in the order of 200-300 mm. You have advised us that the main dwelling did not experience flooded floors in the December 2018 event, however the small sleepout at a lower level did. These observations are consistent with the modelling results. We note that the flood level in this area is controlled to a large degree by the downstream road level that acts as a large capacity weir, and hence it would take considerably greater flows to change the situation at 25 Brown Street and surrounding areas.

These two comparisons with anecdotal evidence do not comprise a model validation, but do support the modelled depths and flowpaths at two locations, and provide a degree of confidence in the modelling results.

4 Flood assessment results

Pre and post development scenarios were run. The difference between the models was the change in land use and change in ground surface of the development area. Modelled post development flood depths and selected flow values are shown on T+T Figure 1008135-F1 in Appendix A.

T+T Figure 1008135-F2 in Appendix A shows the depth differences between the two model runs. Differences of less than 10 mm are not shown, as these are considered to be within the tolerance/uncertainty limits of the model. The extent of these changes in modelled flood depth are confined to within the site boundary, except for a small area of decreased flood depth shown at 144-146 Fitzherbert Street.

The revised modelling indicates that the proposed swales and road corridors will capture and convey the 2100 RCP6.0 1% AEP flow that arrives at the site. Therefore, as previously reported, the proposed flood mitigation measures are expected to eliminate flood hazard from upstream flows on the proposed lots.

5 Conclusions

- The estimated 2100 RCP6.0 1% AEP peak flow into the detention pond is 30 m^3/s;
- The detention pond is expected to overtop in the 2100 RCP6.0 1% AEP event, with overflows flowing over Harrison Street East and across the application site;
- Proposed development includes flood mitigation measures (raised ground levels, interception swales and new flowpaths incorporated into subdivision design). Our revised modelling indicates that the proposed flood mitigation measures are expected to eliminate flood hazard for proposed lots 31-36, 300-309, and 400-401;
- The effect of the proposed development, including the effect of increased impervious areas (increased runoff rates/volumes), is to locally raise flood depths. However, the extent of any increases in flood depths greater than 10 mm is confined to the site boundary. There is one small area of decreased flood depth at 144-146 Fitzherbert Street.

6 Applicability

This report has been prepared for the exclusive use of our client Brookside Developments - Featherston Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be used by South Wairarapa District Council in undertaking its regulatory functions in connection with the proposed development.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
....	....
Alex Evans Natural Resources Engineer	Maurice Mills Project Director

Reviewed by Damian Velluppillai, Senior Water Resources Engineer

AAJE
p:\1008135\issueddocuments\20200702.aaje.stage2-3floodassessment.docx

Appendix A: T+T Figures

- 1008135-F1 – Post Development Flood Depth
- 1008135-F2 – Difference in Modelled Flood Depth

LEGEND

Development Area

Flow direction

Post-Development Modelled Flood Depth (m)

- < 0.05
- 0.05 - 0.10
- 0.10 - 0.20
- 0.20 - 0.30
- 0.30 - 0.50
- 0.50 - 0.75
- > 0.75

A3 SCALE: 1:1,750

0 10 20 30 40 50 Meters

Location Plan

Featherston

Land Information New Zealand,

Notes:
Property boundaries sourced from GWRC WebGIS
Lot layout as per Tomlinson & Carrruthers Surveyors Ltd
Drawing: T18/051 S 4A

DRAWN	AAJE	Jul.20
CHECKED	DNV	Jul.20
APPROVED	DNV	Jul.20

ARCFILE 1008135-F1.mxd

SCALE (AT A3 SIZE) 1:1,750

PROJECT No. 1008135

Tonkin+Taylor
Lucas House, 51 Halifax Street, Nelson
www.tonkintaylor.co.nz

BROOKSIDE DEVELOPMENTS - FEATHERSTON LTD
DONALD STREAM, FEATHERSTON
POST DEVELOPMENT
MODELLED FLOOD DEPTH

1008135-F1

LEGEND

Development Area

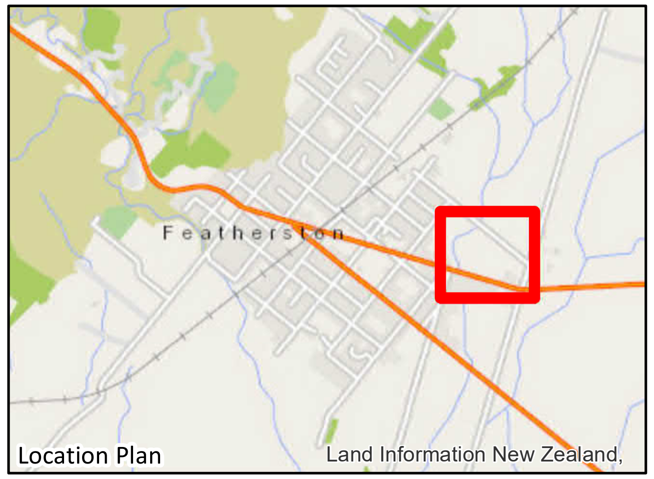
Difference in Modelled Flood Depth (mm)

- < -100
- -100 - -10
- 10 - 100
- > 100

A3 SCALE: 1:1,750

0 10 20 30 40 50 Meters

N



Notes:

Property boundaries sourced from GWRC WebGIS

Lot layout as per Tomlinson & Carrruthers Surveyors Ltd

Drawing: T18/051 S 4A

DRAWN	AAJE	Jul.20
CHECKED	DNV	Jul.20
APPROVED	DNV	Jul.20
ARCFILE 1008135-F2.mxd		
SCALE (AT A3 SIZE) 1:1,750		
PROJECT No. 1008135		

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BROOKSIDE DEVELOPMENTS - FEATHERSTON LTD

DONALD STREAM, FEATHERSTON

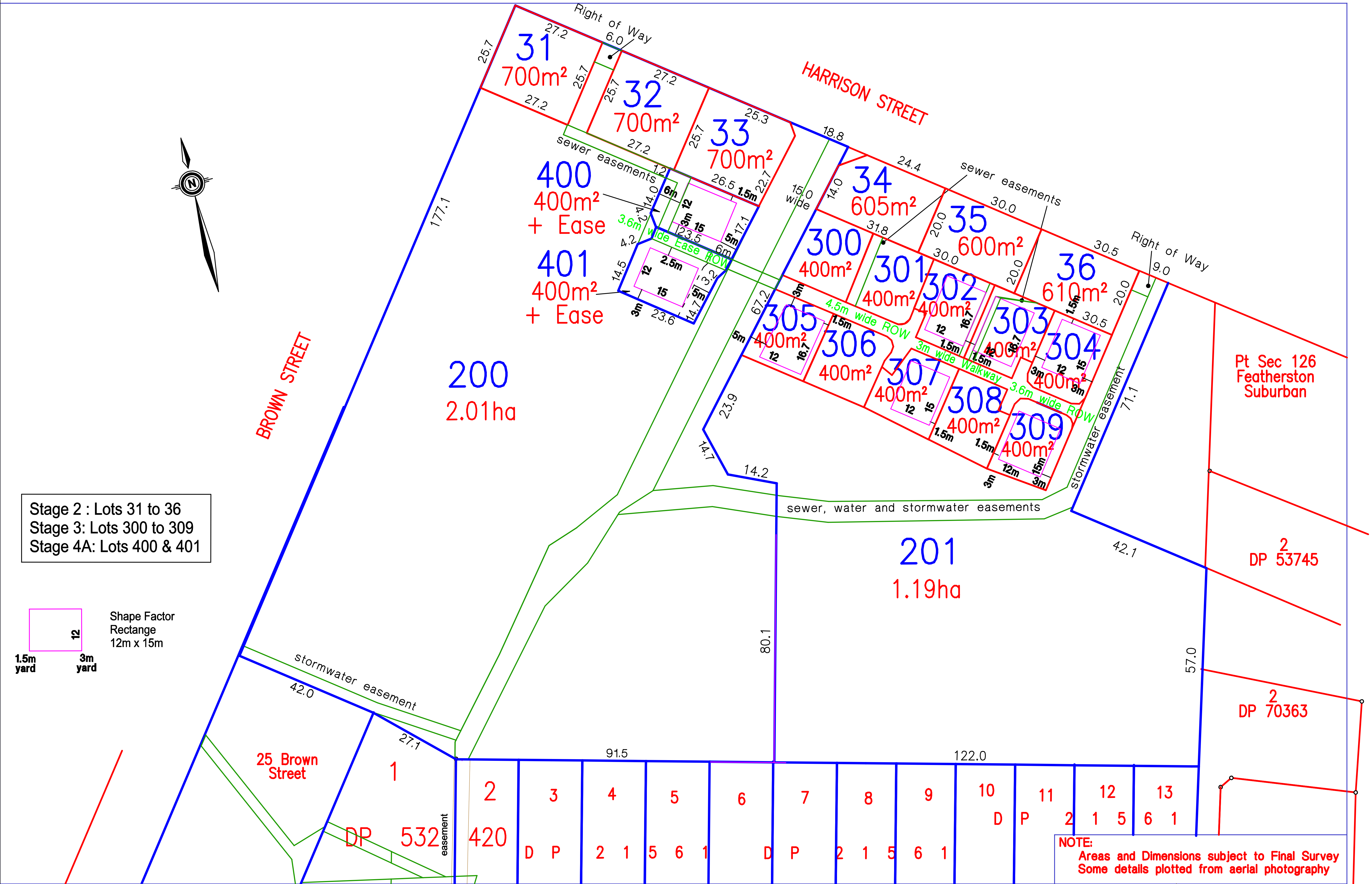
DIFFERENCE IN

MODELLED FLOOD DEPTH

1008135-F2

Appendix B: Proposed development drawings

- T18/051 S 4A – Tomlinson & Carruthers Surveyors Ltd
- FST-050 – Harrison St – Stages 2 & 3 East Swale and Elevations
- FST-051 – Harrison St – Stages 2 & 3 Road 1 Construction

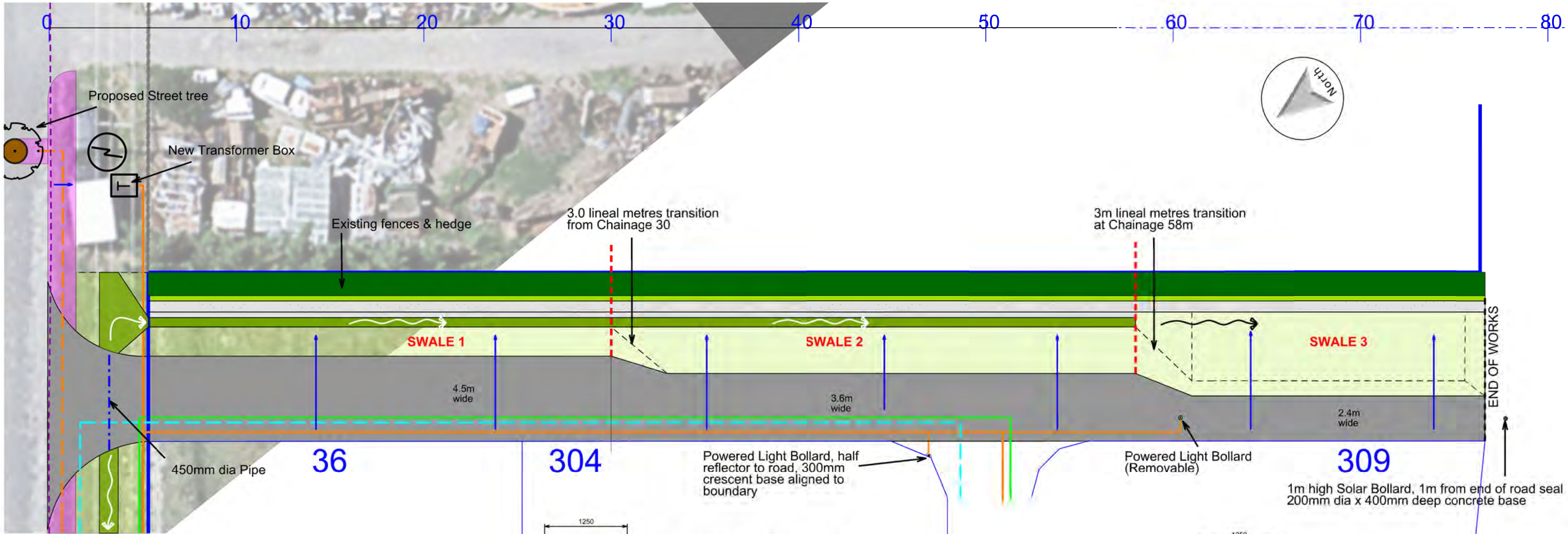


Tomlinson & Carruthers Surveyors Ltd

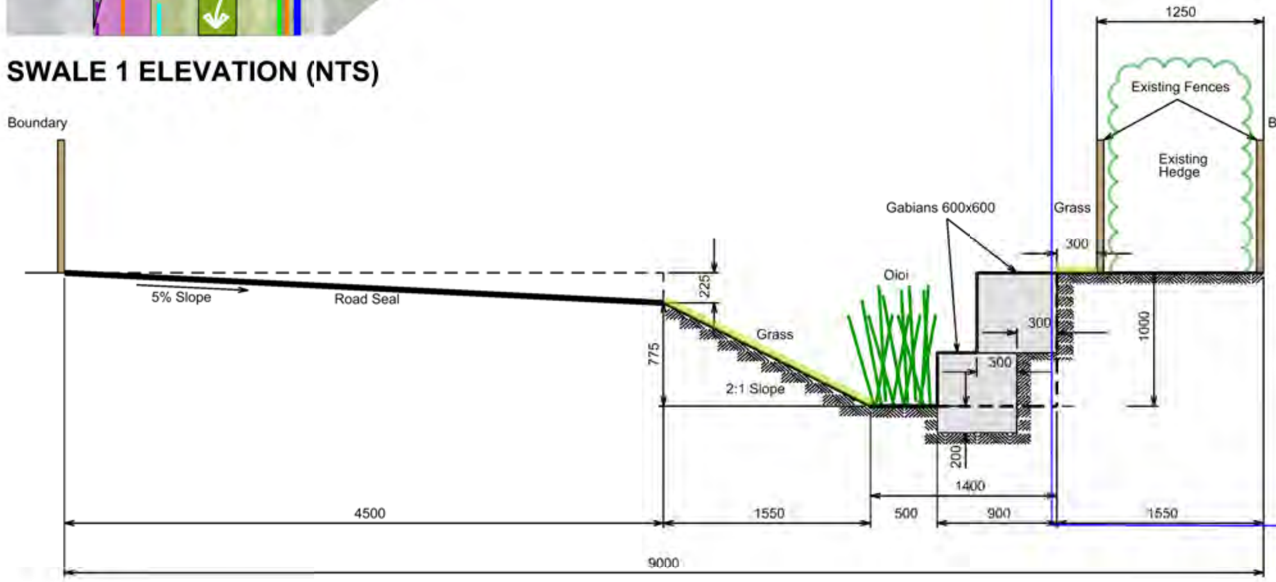
16 Perry Street, P.O. Box 246, Masterton
Ph (06) 370-0800 Email: eric@tcsurvey.co.nz

STAGES 2, 3 & 4A PROPOSED SCHEME
LOT 3 DP 532420
HARRISON STREET, FEATHERSTON

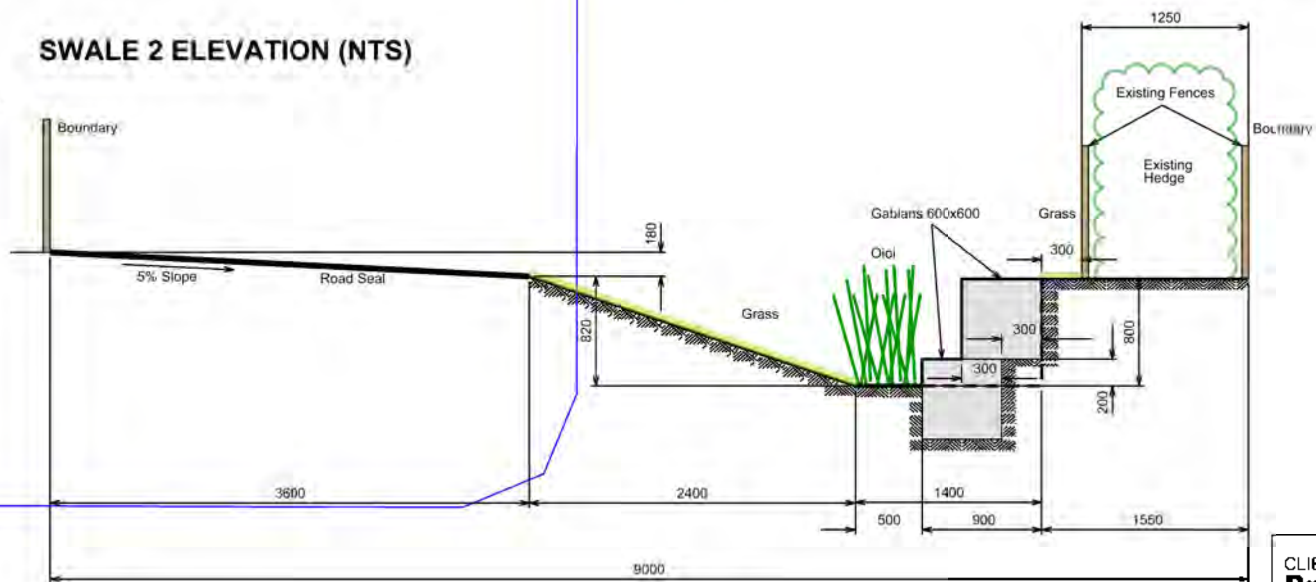
Prepared for:	Brookside Developments
Drawn Date:	29 June 2020 w Shapes
Compiled in:	RT 871419
Territorial Authority:	South Wairarapa District
Scale: 1:1000 @ A3	Ref #: T18/051 S 4A



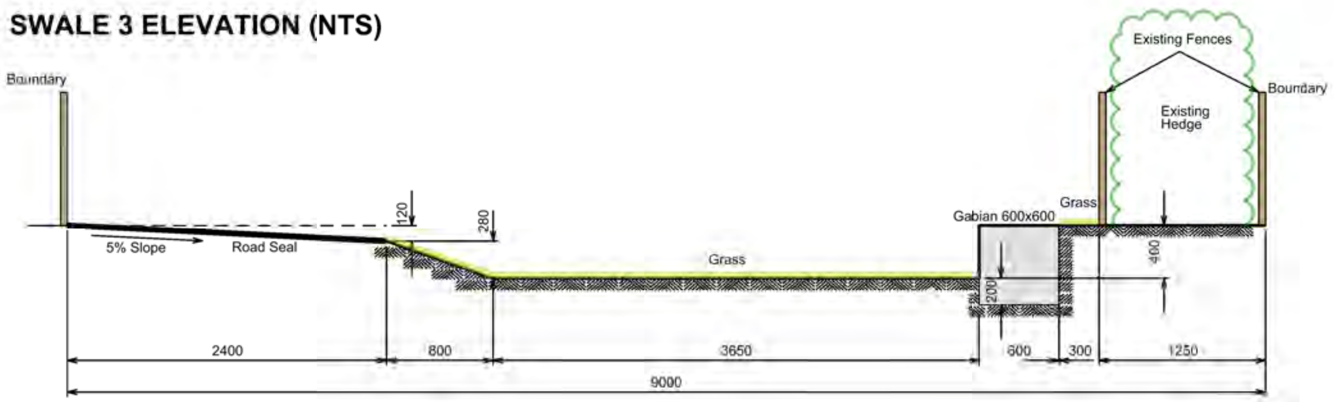
SWALE 1 ELEVATION (NTS)



SWALE 2 ELEVATION (NTS)



SWALE 3 ELEVATION (NTS)



KEY

Water (Existing)	Power Pole
Water (New) - refer to Water Plan	Lot Boundary & Number (New)
Stormwater Stormwater crossfall direction	Property Boundary (Existing)
Power (Proposed, East of bridge)	Light Bollards (Black, Powered, Yellow, Solar)
Power (Proposed, Bollard Circuit)	Chainage
Chorus Duct (New)	Vegetation
Edge of Road Seal (Existing)	Planted Swale Base + Flow Direction
Bitumen	Grass
Porous Concrete	Swale Berm & Slope
Gabion	

CLIENT
Brookside Developments (Featherston) Ltd

PROJECT
Brookside Subdivision

TITLE
Harrison St - Stages 2 & 3
East Swale & Elevations

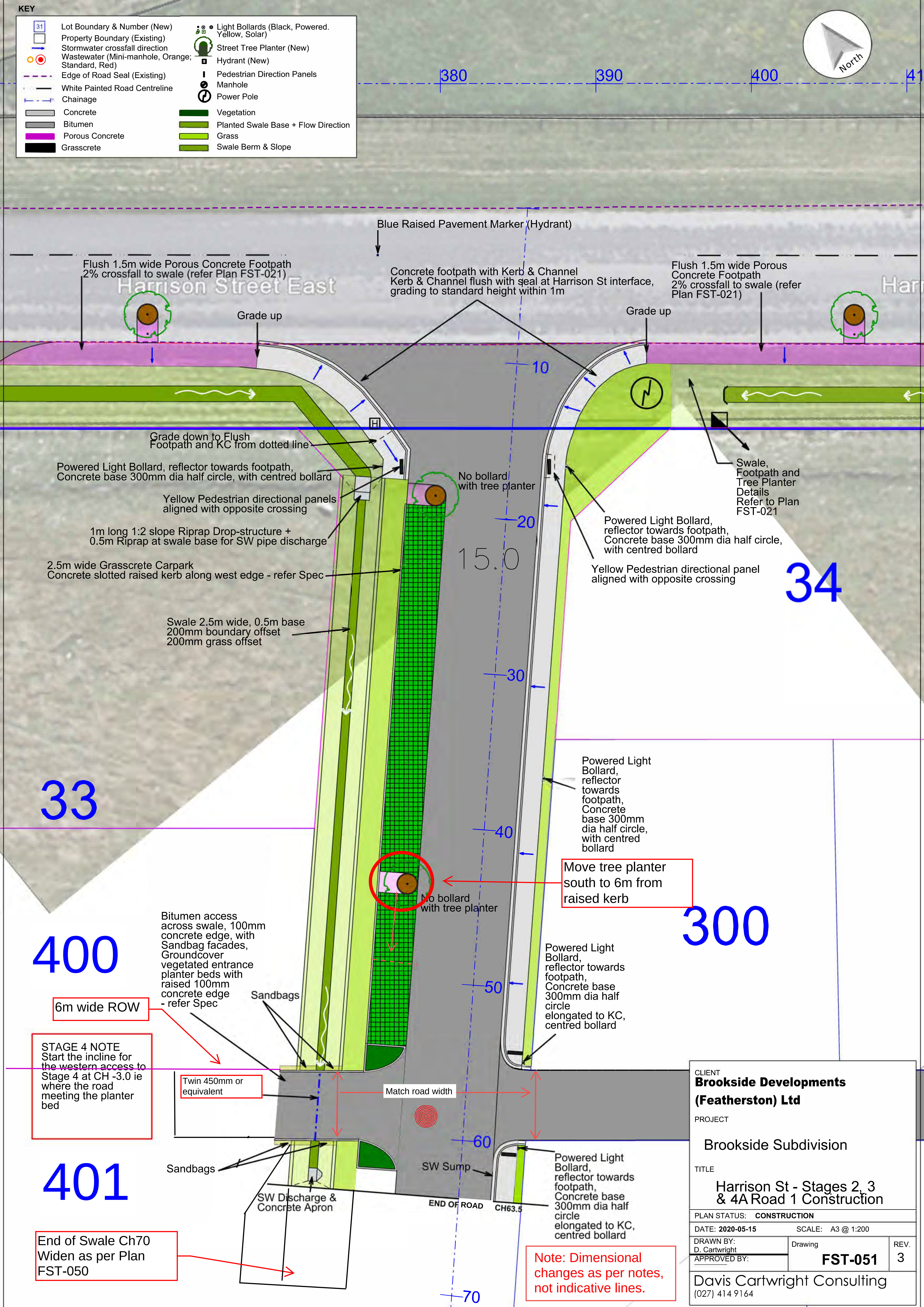
PLAN STATUS: DRAFT

DATE: 2020-03-11 SCALE: A3 @ 1:200

DRAWN BY: D. Cartwright
APPROVED BY:

Drawing **FST-050** REV. **(0)**

Davis Cartwright Consulting
(027) 414 9164


KEY
Lot Boundary & Number (New)
Property Boundary (Existing)
Stormwater crossfall direction
Wastewater (Mini-manhole, Orange; Standard, Red)
Edge of Road Seal (Existing)
White Painted Road Centreline
Chainage
Concrete
Bitumen
Porous Concrete
Grasscrete
Light Bollards (Black, Powered. Yellow, Solar)
Street Tree Planter (New)
Hydrant (New)
Pedestrian Direction Panels
Manhole
Power Pole
Vegetation
Planted Swale Base + Flow Direction
Grass
Swale Berm & Slope
North
380
390
400
41
Blue Raised Pavement Marker (Hydrant)
Flush 1.5m wide Porous Concrete Footpath
2% crossfall to swale (refer Plan FST-021)
Harrison Street East
Concrete footpath with Kerb & Channel
Kerb & Channel flush with seal at Harrison St interface, grading to standard height within 1m
Flush 1.5m wide Porous Concrete Footpath
2% crossfall to swale (refer Plan FST-021)
Grade up
Grade up
10
Grade down to Flush Footpath and KC from dotted line
Powered Light Bollard, reflector towards footpath, Concrete base 300mm dia half circle, with centred bollard
Yellow Pedestrian directional panels aligned with opposite crossing
1m long 1:2 slope Riprap Drop-structure + 0.5m Riprap at swale base for SW pipe discharge
2.5m wide Grasscrete Carpark
Concrete slotted raised kerb along west edge - refer Spec
Swale 2.5m wide, 0.5m base
200mm boundary offset
200mm grass offset
No bollard with tree planter
20
15.0
Swale, Footpath and Tree Planter Details
Refer to Plan FST-021
Powered Light Bollard, reflector towards footpath, Concrete base 300mm dia half circle, with centred bollard
Yellow Pedestrian directional panel aligned with opposite crossing
34
30
33
Powered Light Bollard, reflector towards footpath, Concrete base 300mm dia half circle, with centred bollard
40
Move tree planter south to 6m from raised kerb
No bollard with tree planter
300
400
Bitumen access across swale, 100mm concrete edge, with Sandbag facades, Groundcover vegetated entrance planter beds with raised 100mm concrete edge - refer Spec
Sandbags
6m wide ROW
Powered Light Bollard, reflector towards footpath, Concrete base 300mm dia half circle elongated to KC, centred bollard
50
STAGE 4 NOTE
Start the incline for the western access to Stage 4 at CH -3.0 ie where the road meeting the planter bed
Twin 450mm or equivalent
Match road width
60
401
Sandbags
SW Sump
SW Discharge & Concrete Apron
END OF ROAD
CH63.5
Powered Light Bollard, reflector towards footpath, Concrete base 300mm dia half circle elongated to KC, centred bollard
End of Swale Ch70
Widen as per Plan FST-050
Note: Dimensional changes as per notes, not indicative lines.
70
CLIENT
Brookside Developments (Featherston) Ltd
PROJECT
Brookside Subdivision
TITLE
Harrison St - Stages 2, 3 & 4A Road 1 Construction
PLAN STATUS: CONSTRUCTION
DATE: 2020-05-15
SCALE: A3 @ 1:200
DRAWN BY: D. Cartwright
APPROVED BY:
Drawing
FST-051
REV. 3
Davis Cartwright Consulting
(027) 414 9164