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Memo Rev01

To **Xavier Devereaux**

From **Hamish Peacock**

Date **15/10/2021**

RE: **Sideling Stage 1** **Subject: Preliminary Drainage Assessment**

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1. Background & Specifications

A section of the Tasman Highway near the Sideling is to be upgraded by widening the road, improving drainage infrastructure and general road safety. An assessment of the existing stormwater infrastructure is required to confirm the capacity and determine any deficiencies.

Newly aligned stormwater drainage infrastructure is necessary to allow for appropriate changes to the road geometry. New stormwater drainage infrastructure is generally required to meet the following Department of State Growth criteria for a Category 4 road some of these criteria include which are particularly relevant for this section of highway include:

- Flood immunity for a 20-year ARI flood (5% AEP) event
- Flow depth for the 5-minute, 50% AEP event to be below aquaplaning depth
- Minimum 0.5% longitudinal grade on open drains and culverts
- Maximum pipe grades to limit pipe and outlet velocities to acceptable levels
- Minimum road culvert size 375mm
- Minimum access culvert size 300mm
- Allowable flow widths as per AGRD Part 5.

Initial assessment has shown multiple culverts to be significantly deficient and sections of road and drain geometry are inadequate for safe conveyance of stormwater. Inspections undertaken by pitt&sherry in conjunction with survey showed many culverts were completely blocked with sediment and debris.

Given the high debris load and propensity for blockage it is recommended that a larger than typical minimum pipe diameter and additional inlet works are undertaken to reduce the likelihood of blockage. Where stormwater infrastructure is required/recommended to be removed and replaced it will be upgraded to the design specification standard for a DSG Category 4 road.

A flooding assessment was undertaken to assess a possible change in flood behavior at 36514 Tasman Highway where buildings have been identified.

A desktop study of the local topography was undertaken to ascertain stormwater catchment data. Details of the catchment areas are outlined in Figure 1 and Figure 2.

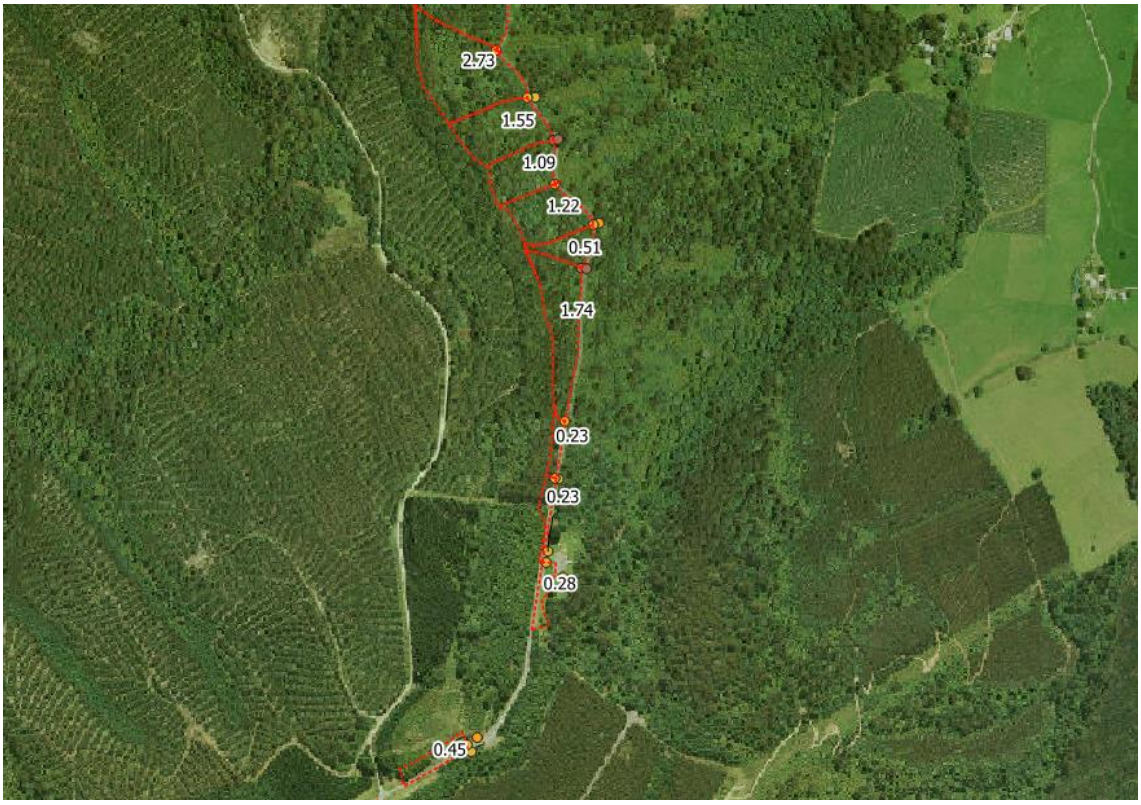

Figure 1: Catchment Extents Chainages 2780-4300

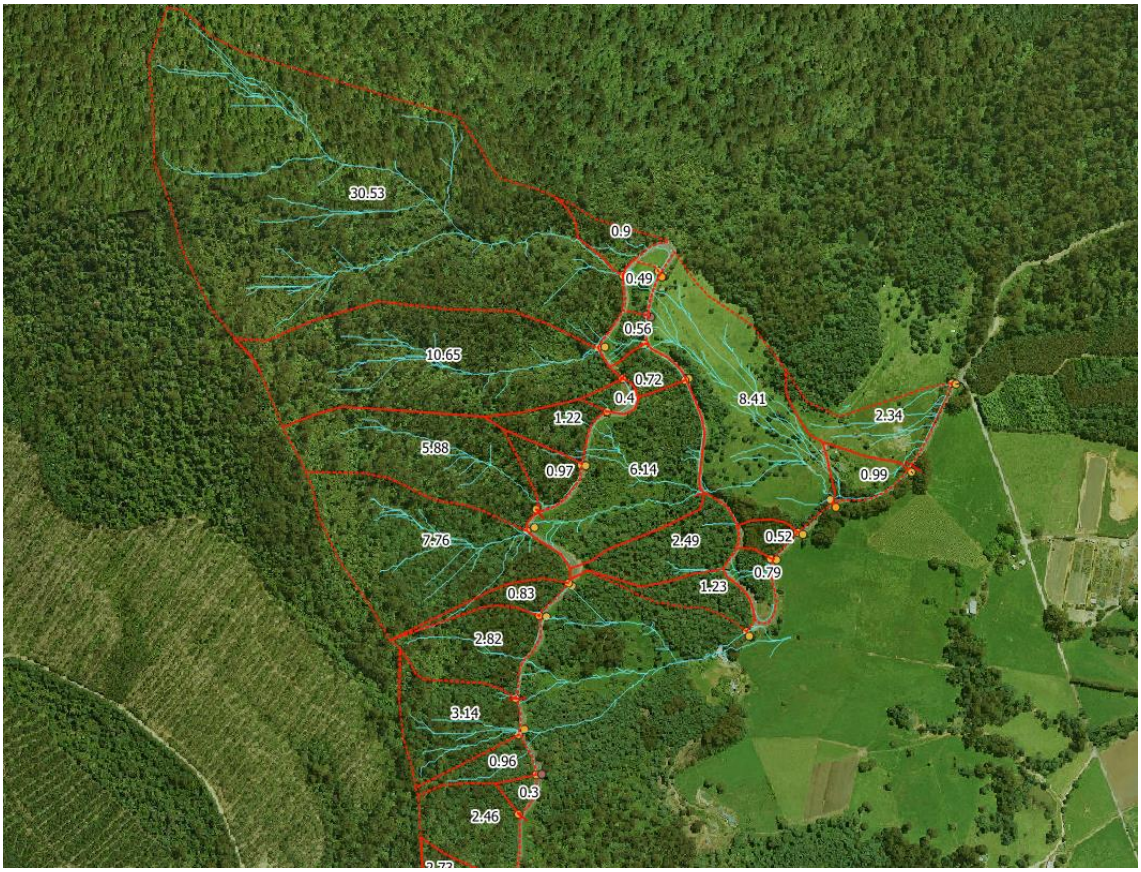

Figure 2: Catchment Extents (Hectares) Chainages 0-2780m

2. Existing Catchments and Infrastructure

There are approximately 35 transverse (cross) culverts along this section with the catchments varying from under 1-hectare to 72-hectares.

- The existing catchments are combination of dense forest / bushland, paddocks, and road surface. Steep to very steep terrain (above 30% in many areas) in catchments will likely create rapid runoff and relatively short concentration times at the highway culverts
- Hydraulic modelling suggests that a number of existing culverts are significantly undersized for the desired 5% AEP flood immunity criteria
- The highway along these sections is serviced by transverse pipe culverts from 225mm to 450mm diameter. The majority are 300mm which is less than the minimum DSG pipe size for new culverts
- Open drains exist along the length of the sections with some narrow and shallow drains present along the base of some cuttings. These very narrow drains contain debris which make aquaplaning a current risk in heavy rainfall, particularly where the crossfall of the road transitions to falling away from the cuttings
- Many pipes are laid on very steep grades (exceeding 20% in some locations) well above recommended limits for concrete pipes
- There are a number of “on-grade” culverts where excess flow not entering the pipe will continue along the open drain on the same side of the road, it is likely that during major storms, the flows cascade down past the blocked culverts before overtopping the road where the crossfall transitions allowing spill across the road and down the fill batters
- There do not appear to be any catch drains at the top of cut batters.

3. Hydrology

Hydrologic and hydraulic analysis was undertaken in accordance with the procedures recommended by Australian Rainfall and Runoff 2019 and Austroads Part 5 - Drainage Design. Rainfall data was obtained from the Bureau of Meteorology website. Terrain data was obtained from detailed survey and existing Tasmanian 1m DEM lidar freely available from Geoscience Australia. QGIS was utilised to delineate catchments.

To the culvert assessment, a DRAINS model was created to assess both the existing hydrology and hydraulics. The catchments are ungauged with no calibration or validation undertaken. An Initial Loss, Continuing Loss (IL-CL) hydrological model was used to assess the hydrology.

To the flood assessment, a Tuflow model was created to assess both the existing hydrology and hydraulics. A grided rainfall was applied to the model with no area reduction factor applied.

The following assumptions were made in the model:

- Pervious Area Initial Loss value of 21mm from the ARR DatahubPervious Area Continuing Loss Value of 1.76mm/hr from the ARR Datahub applying 0.4 factor to 4.4mm/hr
- Impervious area (roofs and pavement) initial loss 1mm and continuing loss 0mm/hr
- Median pre-burst rainfall depths obtained from the ARR Data hub
- Rainfall Temporal Patterns and Intensity Duration Frequency (IFD) Obtained from ARR datahub.

4. Hydraulics

Hydraulic modelling was undertaken to determine the existing capacity of the drainage system.

The following general assumptions were made to the DRAINS and Tuflow models:

- Culverts were assumed to be unblocked (clearly not the case currently)
- Culvert inlet head loss coefficient of 0.5
- RCP Manning's n of 0.013
- Open drain Manning's' n of 0.06
- Overflow paths either across highway or along adjacent table drains

The following general assumptions were added to the Tuflow model:

- Bushland areas were modelled with depth varied manning's 'n', 0.20 up to 100mm and 0.12 above 300mm, with values interpolated between the two depths
- Grass areas were modelled with depth varied manning's 'n', 0.15 up to 100mm and 0.06 above 300mm, with values interpolated between the two depths
- Road and pavement surface Manning's 'n' of 0.020

5. Results and Recommendations

Existing stormwater culverts where reviewed, assessed and recommendations made below. Note these recommendations are based on hydraulic capacity including blockage potential.

5.1 Transverse Culverts

Table 1: Transverse Culvert Capacity Checks

Transverse Culvert Chainage (m)	Catchment (ha)	Existing Pipe Culvert Size (mm)	5% AEP Peak Flow (m^3/s)	5% AEP Capacity	Overtopping of Highway (2% AEP)	Hydraulic Notes & Recommendations
40	2.34	300	0.183	NO	NO	Culvert is not majorly deficient for its immediate catchment but is less than minimum culvert size. **RECCOMMENDATION: UPGRADE TO DN450**
220	0.99	300	0.97	YES	NO	This culvert is hydraulically adequate but is less than minimum size. **RECCOMMENDATION: UPGRADE TO DN450**
380	73	375	4.4	NO	YES	This culvert is significantly deficient for its intended catchment. It is assumed this culvert overtops regularly; however deficient upstream culverts may divert flow away from this location. **RECOMMENDATION: UPGRADE TO TWIN 900 OR SINGLE 1350. LOCAL EARTHWORKS MAY BE REQUIRED TO DIRECT FLOWS TO CULVERT INCLUDING POTENTIAL RESHAPING OF DRIVEWAY. FLOODWATER MAY BE COMING DOWN THE PROPERTY DRIVEWAY**
460	0.52	300	0.05	YES	NO	This culvert is hydraulically adequate but is less than minimum size. **RECCOMMENDATION: UPGRADE TO DN450**

Transverse Culvert Chainage (m)	Catchment (ha)	Existing Pipe Culvert Size (mm)	5% AEP Peak Flow (m^3/s)	5% AEP Capacity	Overtopping of Highway (2% AEP)	Hydraulic Notes & Recommendations
530	3.28	300	0.32	NO	MAYBE	This culvert is deficient. **RECOMMENDATION: UPGRADE TO DN450**
790	2.49	300	0.22	NO	MAYBE	This culvert deficient but not substantially. **RECOMMENDATION: UPGRADE TO DN450**
980	22.5	300	1.60	NO	YES	Culvert is significantly deficient for the intended catchment. It is assumed this location overtops regularly. **RECOMMENDATION: UPGRADE TO DN750**
1190	1.12	300	0.13	YES	NO	This culvert is hydraulically adequate but is less than minimum size. **RECCOMMENDATION: UPGRADE TO DN450**
1290	11.21	300	0.90	NO	YES	This culvert is significantly deficient for the immediate catchment. **RECOMMENDATION: UPGRADE TO DN750**
1340	0.49	225	0.06	NO	YES	This culvert is much smaller than minimum size. **RECOMMENDATION: UPGRADE TO DN450 OR REMOVE AND ALLOW FLOW TO CONTINUE TO CH1290**
1420	31.0	300	2.17	NO	YES	A drain takes flow from CH1570 culvert to CH1420. Much of this flow would likely spill from the drain and end up at CH1340 Culvert. The culvert is significantly deficient for its intended catchment. **RECOMMENDATION: UPGRADE THE DRAIN THROUGH CROWN**

Transverse Culvert Chainage (m)	Catchment (ha)	Existing Pipe Culvert Size (mm)	5% AEP Peak Flow (m^3/s)	5% AEP Capacity	Overtopping of Highway (2% AEP)	Hydraulic Notes & Recommendations
						LAND BETWEEN CH1570 AND CH1420. DRAIN TO BE ROCK LINED WITH 1M BASE WIDTH 3:1 BATTERS AND MIN 600MM DEEP. REALIGN AND UPGRADE TO DN900 WITH 2M TO INVERT OR DN1050 AT MIN COVER. RETAIN OUTLET HEADWALL LOCATION
1570	30.5	375	2.10	NO	YES	Culvert is significantly deficient for its intended catchment. **RECOMMENDATION: UPGRADE TO DN900 WITH 2M TO INVERT OR DN1050 MIN COVER. REALIGN SO CULVERT OUTLET IS IN LINE WITH NEW DOWNSTREAM DRAIN**
1710	10.6	300	0.84	NO	YES	Culvert significantly deficient for intended catchment. **RECOMMENDATION: UPGRADE TO DN600**
1770	0.40	300	0.046	YES	NO	This culvert is hydraulically adequate but is less than minimum size. **RECOMMENDATION: UPGRADE TO DN450**
1890	1.22	375	0.11	YES	NO	**RECOMMENDATION: RETAIN**
2000	0.97	300	0.17	NO	NO	The culvert is deficient for its intended catchment but not significantly. **RECCOMMENDATION: UPGRADE TO DN450**
2130	5.88	300	0.53	NO	YES	This culvert is significantly deficient for its intended catchment. **RECOMMENDATION: UPGRADE TO DN525**
2170	7.76	300	0.715	NO	YES	This culvert is significantly deficient for its intended

Transverse Culvert Chainage (m)	Catchment (ha)	Existing Pipe Culvert Size (mm)	5% AEP Peak Flow (m^3/s)	5% AEP Capacity	Overtopping of Highway (2% AEP)	Hydraulic Notes & Recommendations
						catchment. **RECOMMENDATION: UPGRADE TO DN600**
2310	0.83	300	0.093	YES	NO	This culvert is hydraulically adequate but is less than minimum size. **RECCOMMENDATION: UPGRADE TO DN450**
2380	2.82	375	0.26	YES	NO	There may be a culvert between 2380 and 2540 that hasn't been picked up in survey. **RECOMMENDATION: RETAIN AND CONFIRM IF CULVERT EXISTS BETWEEN 2380 AND 2540**
2540	1.16	300	0.11	YES	NO	This culvert is hydraulically adequate but is less than minimum size. **RECCOMMENDATION: UPGRADE TO DN450**
2600	2.95	375	0.27	YES	NO	**RECOMMENDATION: RETAIN**
2690	0.3	225	0.03	YES	NO	Hydraulically adequate but well below minimum pipe size. **RECOMMENDATION: UPGRADE TO DN450 OR REMOVE CULVERT ALLOW FLOW TO CONTINUE TO 2600**
2780	2.46	300	0.23	NO	NO	Culvert is deficient for intended catchment but not significantly. **RECOMMENDATION: UPGRADE TO DN450**
2910	2.73	375	0.25	YES	NO	**RECOMMENDATION: RETAIN**
3020	1.55	300	0.14	YES	NO	Hydraulically adequate but below minimum pipe size and pipe grade 24% well above acceptable minimum.

Transverse Culvert Chainage (m)	Catchment (ha)	Existing Pipe Culvert Size (mm)	5% AEP Peak Flow (m^3/s)	5% AEP Capacity	Overtopping of Highway (2% AEP)	Hydraulic Notes & Recommendations
						RECOMMENDATION: UPGRADE TO DN450
3120	1.09	300	0.09	YES	NO	Hydraulically adequate but below minimum pipe size. **RECCOMMENDATION: UPGRADE TO DN450**
3210	1.22	300	0.11	YES	NO	Hydraulically adequate but below minimum pipe size. **RECCOMMENDATION: UPGRADE TO DN450**
3310	0.51	300	0.05	YES	NO	Hydraulically adequate but below minimum pipe size. **RECCOMMENDATION: UPGRADE TO DN450**
3410	1.74	450	0.19	YES	NO	**RECOMMENDATION: RETAIN**
3700	0.23	375	0.03	YES	NO	**RECOMMENDATION: RETAIN**
3810	0.23	300	0.02	YES	NO	Hydraulically adequate but below minimum pipe size. **RECCOMMENDATION: UPGRADE TO DN450**

5.2 Access Road Culverts

All new access road culverts should be:

- Access culverts should be minimum 300mm diameter and where possible overflow should be across the access and not across the highway, access culverts have not been sized at this stage
- Some access culverts may need to be greater than 300mm if hillside catchments are relatively large. These will need to be confirmed as the design progresses.

5.3 “On-Grade” culverts

At the location of “on-grade” culvert inlets (i.e. culverts where spill will continue along table drains), the following is recommended:

- The downstream face is required to be generally elevated above the culvert so that water can build up at the culvert inlet
- The spill level should be located appropriately to allow overflow to continue along the road drain where appropriate

5.4 Culvert Outlet and Drain Scour Protection

Scour protection is recommended at the following locations:

- All new or stripped culvert outlets, larger than nominal diameter rock (e.g. Greater than D_{50} = 200-300mm) will be required at some of the larger pipes or where outlet velocities are very high
- Outlet protection will be dependent on adopted culvert grades, sizes and outlet velocities
- There are some culvert outlets on very steep grades which will present a challenge to suitably protect the outlets. Batter channels with additional shaped grouted rock armoring may be necessary in some locations to keep culvert grades to acceptable levels and protect the fill batters and culvert endwalls
- Steep culverts will require anchor blocks
- In steep open and catch drains rock lining will be necessary
- Batter chutes will likely be necessary to convey flow from bench drains, some of these may require additional grouted rock protection around the channels
- At significant open drain transitions particularly where catch drains discharge through batter breakouts.

5.5 Culvert Inlets

Complete blockage of culverts was observed extensively during site investigations. Creation of local depressions at culvert inlets will be necessary to achieve acceptable pipe grades. Additional batter channels, rock armoring, shotcreting and grouted rock pitching may be necessary, subject to geotechnical input.

- It is recommended that minimum pipe diameter adopted is 450mm to provide a balance between limiting blockage and not overly constraining the road design in particular depth of drains and requirement for guard rail,
- It is recommended that shotcreting (or similar) is incorporated around the culvert inlets in order to funnel flows and small debris into and through the culverts,
- Additional rock stabilisation of cuts around culvert inlets may be necessary,
- In some locations where gullies approach culvert inlets, debris traps in the form of posts upstream of the culverts may be suitable to provide protection from larger debris such as large bark and sticks that would catch on culvert inlets

5.6 Top of Batter Catch Drains

Numerous roadside cuttings are proposed to achieve acceptable road geometry and line of sight. There may be considerable lengths of catch drains at the top of these cuttings, or on cutting benches which will act to convey hillside flows down to culverts. These will present a maintenance issue and the geotechnical aspects need to be considered with some areas potentially being suitable to allow hillside sheet flow directly across the batter faces. In these locations the roadside drains may need to be larger.

5.7 Roadside Drains

Roadside drain sizing and depth will be dictated in part by the inclusion of the batter catch drains. Where the pavement design allows, the roadside drains in some areas could be shallow spoon drains to intercept batter and road flows only. Areas where road drains would spill across the road if they overflow (i.e. road crossfall away from the cutting), are recommended to incorporate freeboard to allow for accumulation of debris and protect from aquaplaning.

6. Changes in Flood Behavior

The significant improvement in drainage may create a situation where, in flood conditions, flows will now be re-directed to locations where they would have naturally flowed prior to the road's construction (as opposed to very likely current situation of cascading spill from culverts down road drains and across roads sporadically). There appears to be a single dwelling at 36514 Tasman Highway where flood impact was assessed to verify whether the changes in flood behavior would affect either dwellings or outbuildings. The flood modelling intended to clarify the impact and risk given the road drainage upgrade (if any).

The *Figure 3* and

*Figure **4*** below shows the location of what is believed to be a dwelling and outbuildings. The *Figure 5* shows the 5% AEP event overflow path in this region.

Figure 3: Cadastral Parcels (ListMap), dwelling and outbuildings

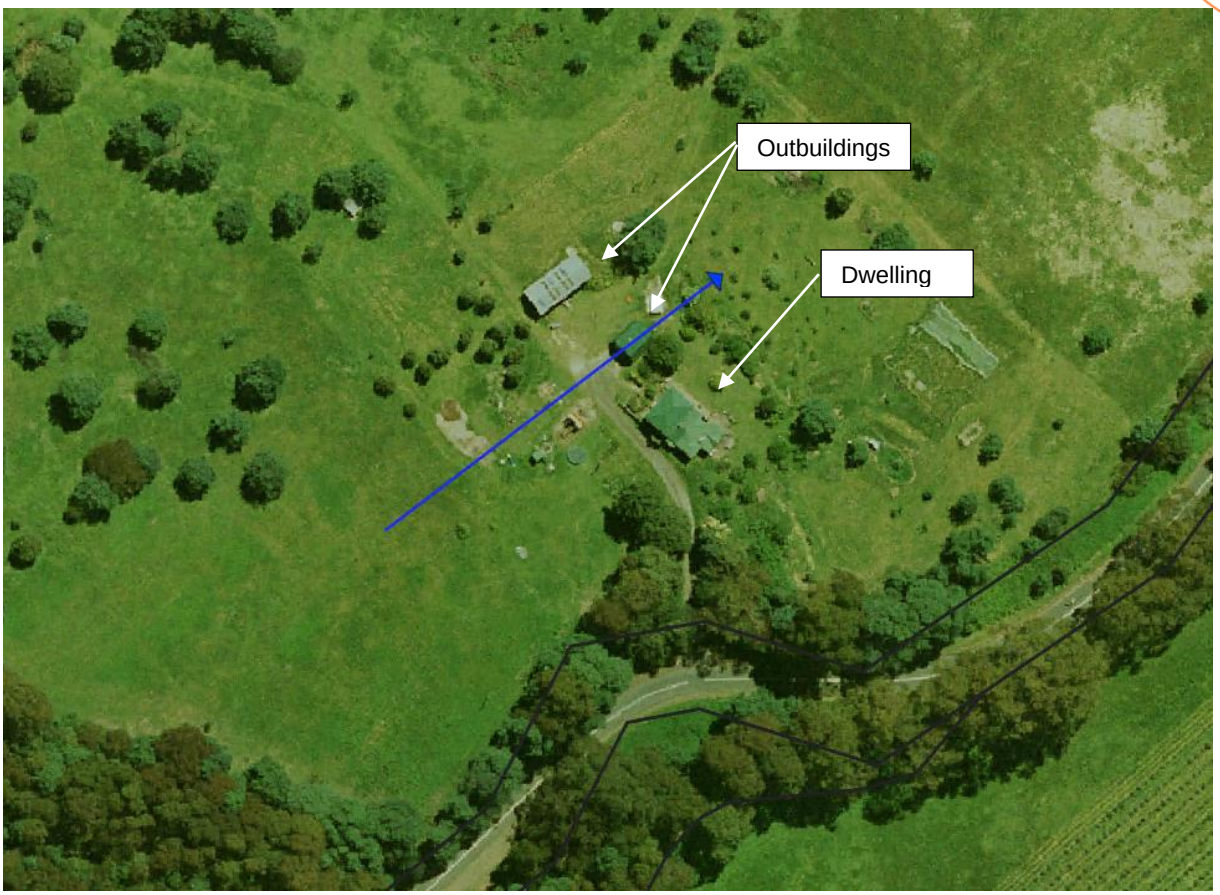

Figure 4: Dwelling and outbuildings, time series section (blue arrow)

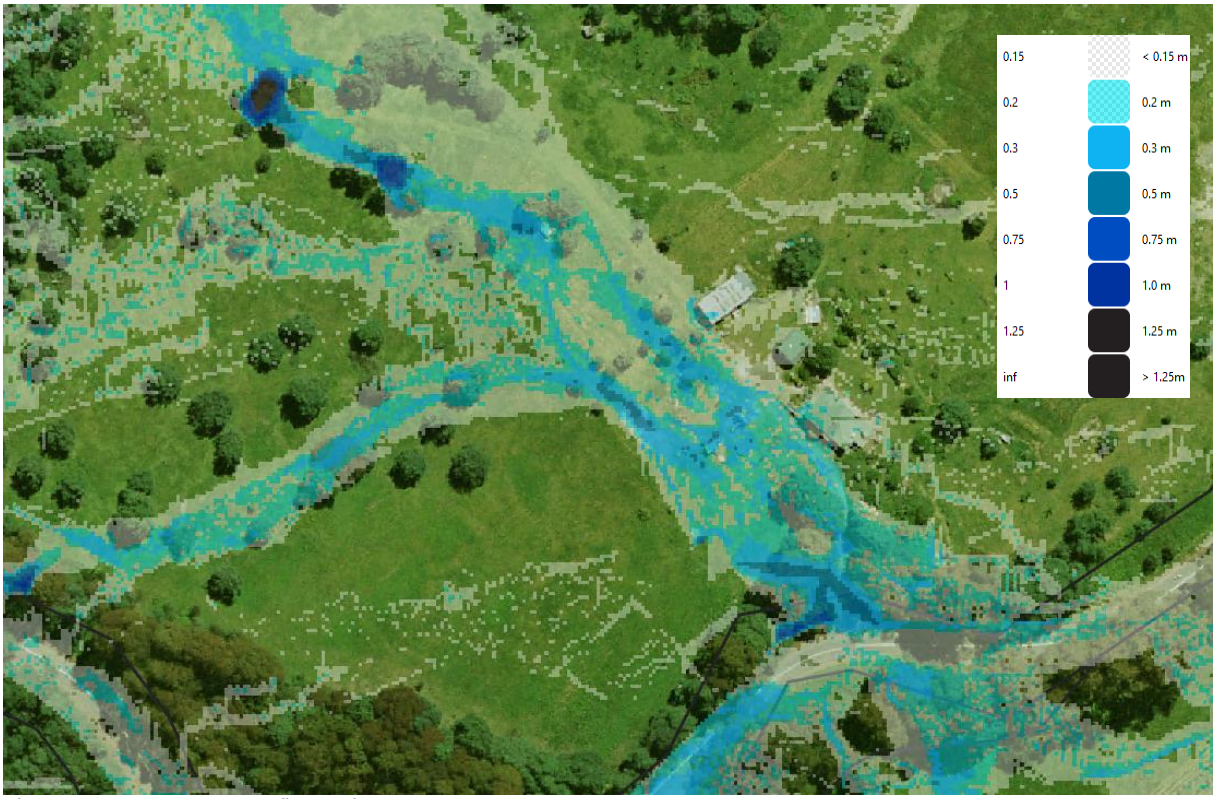

Figure 5: 5% AEP event overflow path

6.1 Flood Assessment Results

The time series results have shown that the 5% AEP peak flow (cu.m/s) through the section presented in

*Figure **4*** have not changed after drainage infrastructure upgrade. For the existing case, the peak flow is 4.170cu.m/s and for the developed case is 4.168cu.m/s. In addition, it is not clear whether the dwelling and outbuildings would be adversely affected by runoff as the floor levels are not known and Lidar data was used to assess the flooding event.

7. Summary

- Assessment of the existing drainage infrastructure has been made to ascertain any deficiencies
- Infrastructure has found to be deficient in many areas and recommendations for improvement during the design process have been made
- Design catchments are likely to be different to existing catchments with the inclusion of batter catch drains that may redirect portions of flow to different culverts
- The following have been identified as some of the key drainage constraints will need to be addressed:
    - Providing adequate road drains to protect against spill, debris accumulation and aquaplaning
    - Achieving acceptable pipe grades and culvert flow velocities in steep areas
    - Protecting culvert outfall areas from scour and subsequent risk of embankment and culvert headwall undermining
    - Construction of batter catch drains and their suitability from maintenance and geotechnical perspective
    - Transition of batter catch drains down to culvert inlets to protect from erosion, scour and blockage

- Protection of cut batter faces from erosion
- Check there are no adverse flood impacts owing to drainage improvements and re-direction of flood flows

- Flood assessment at 36514 Tasman Highway was undertaken and results has shown that changes in flood behavior would not affect adversely the buildings