North West Treatment Hub Review of Environmental Factors

Hydrology and Geomorphology Impact Assessment – Rouse Hill & Castle Hill WRP Upgrades and proposed new sludge transfer pipelines

13/07/2022

Revision: Final for exhibition v2

Job title	North West Treatment Hub Review of Environmental Factors	**Job number** 505018	
Document title	Hydrology and Geomorphology Impact Assessment – Rouse Hill & Castle Hill WRP Upgrades and proposed new sludge transfer pipelines	**File reference:** as above	
Document ref			

Revision	**Date**	**Filename**	Https://aurecongroup.sharepoint.com/sites/Waterresourcesteam-Sydney/Shared Documents/General/505018 - NWTH/5 Working Files/Reporting/505018_NWTH_RouseH_HydroGeomorph_REF_Draft.docx		
0	2022-02-14	**Description**	DRAFT		
			Prepared by	**Checked by**	**Approved by**
		Name	A Basson, S Jelly	P Gillam	
		Signature			
1	2022-04-12	**Filename**	https://aurecongroup.sharepoint.com/sites/Waterresourcesteam-Sydney/Shared Documents/General/505018 - NWTH/5 Working Files/Reporting/Final/505018_NWTH_RouseH_HydroGeomorph_REF_Final_PP.docx		
		Description	Final Draft		
			Prepared by	**Checked by**	**Approved by**
		Name	S Jelly, J Bone	A Basson, P Gillam	P Gillam
		Signature			
2	2022-07-13	**Filename**	https://aurecongroup.sharepoint.com/sites/Waterresourcesteam-Sydney/Shared Documents/General/505018 - NWTH/5 Working Files/Reporting/Final Issued/505018_NWTH_Riverstone_HydroGeomorph_REF_Final.docx		
		Description	Final for exhibition		
			Prepared by	**Checked by**	**Approved by**
		Name	S Jelly, J Bone	P Gillam	P Gillam
		Signature			

Issue Document Verification with Document ☐

Abbreviations

Term	Abbreviation
Australian Height Datum	AHD
Downstream	d/s
Litres per hectare	L/ha
Manning's roughness coefficient	n
Meters per second	m/s
Mean Annual Precipitation	MAP
Mean Annual Runoff Volume	MARV
Megalitres per day	ML/d
North West Treatment Hub	NWTH
Upstream	u/s
Urban Streamflow Impact Assessment	USIA
Wastewater Treatment Plant	WWTP
Water Recycling Plant	WRP
Standard Deviation	SD

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1 Introduction

1.1 Project description

The North West Treatment Hub (NWTH) program of works involves the upgrades of two water recycling plants (WRP) at Castle Hill and Rouse Hill, upgrades at Riverstone wastewater treatment plant (WWTP) and the installation of a new sludge pipeline between the plants to transfer sludge to Riverstone WWTP.

Overall project objectives for the NWTH program include:

- Service immediate growth and enable future growth servicing to 2050
- Ensure servicing meets current and future compliance requirements
- Maintain environment and community values.

The location of the water treatment facilities and the proposed sludge transfer lines are shown in Figure 1-1. Also indicated are the three discharge locations:

- Castle Hill WRP: Cattai Creek (tributary to Hawkesbury River)
- Rouse Hill WRP: Seconds Ponds Creek (tributary to Cattai Creek)
- Riverstone WWTP: Eastern Creek (tributary to Wianamatta-South Creek)

1.2 Report objectives

This report documents a hydraulic and erosion risk assessment for a reach of the Second Ponds Creek downstream of the Rouse Hill WRP.

The assessment considers the potential change in baseline hydraulic conditions under the project components listed in Table 1-1.

Table 1-1 Activities assessed

Location	Proposed activity	Assessment methodology
Rouse Hill WRP	Increase treatment capacity from 26 ML/d to 40 ML/d	**Quantitative:** Two sets of criteria have been considered: Relevant eco-hydraulic thresholds
Castle Hill WRP (Cattai Creek)	Increase average discharge rate from 6.9 ML/d to 7 ML/d	**Qualitative:** Given the minor deviation from the current conditions
Pipeline corridors: refer to general study area	Construction and operation of Sludge pipelines and associated infrastructure: ■ Sludge pump stations at Castle Hill and Rouse Hill WRPs ■ Sludge transfer pipelines between Castle Hill and	**Qualitative:** Any potential significant impacts are likely to occur during the construction phase, and these have been identified along with proposed mitigation measures

		Rouse Hill; and Rouse Hill and Riverstone ▪ Several ancillary infrastructure items such as pigging and flushing stations, barometric loops and chemical dosing units	

The study assessing the hydrological and geomorphological impacts associated with the proposed increase in discharge from Riverstone WWTP has been covered in a separate report (Aurecon, 2022).

A new sludge transfer pipeline will transfer sludge from Castle Hill to Rouse Hill WRP (10.2 km) and then from Rouse Hill WRP to Riverstone WWTP (6.3 km). Pumping stations will be required at Castle Hill (19 L/s) and at Rouse Hill (55 L/s). Construction is anticipated to start in late 2022 and be completed in late 2026.

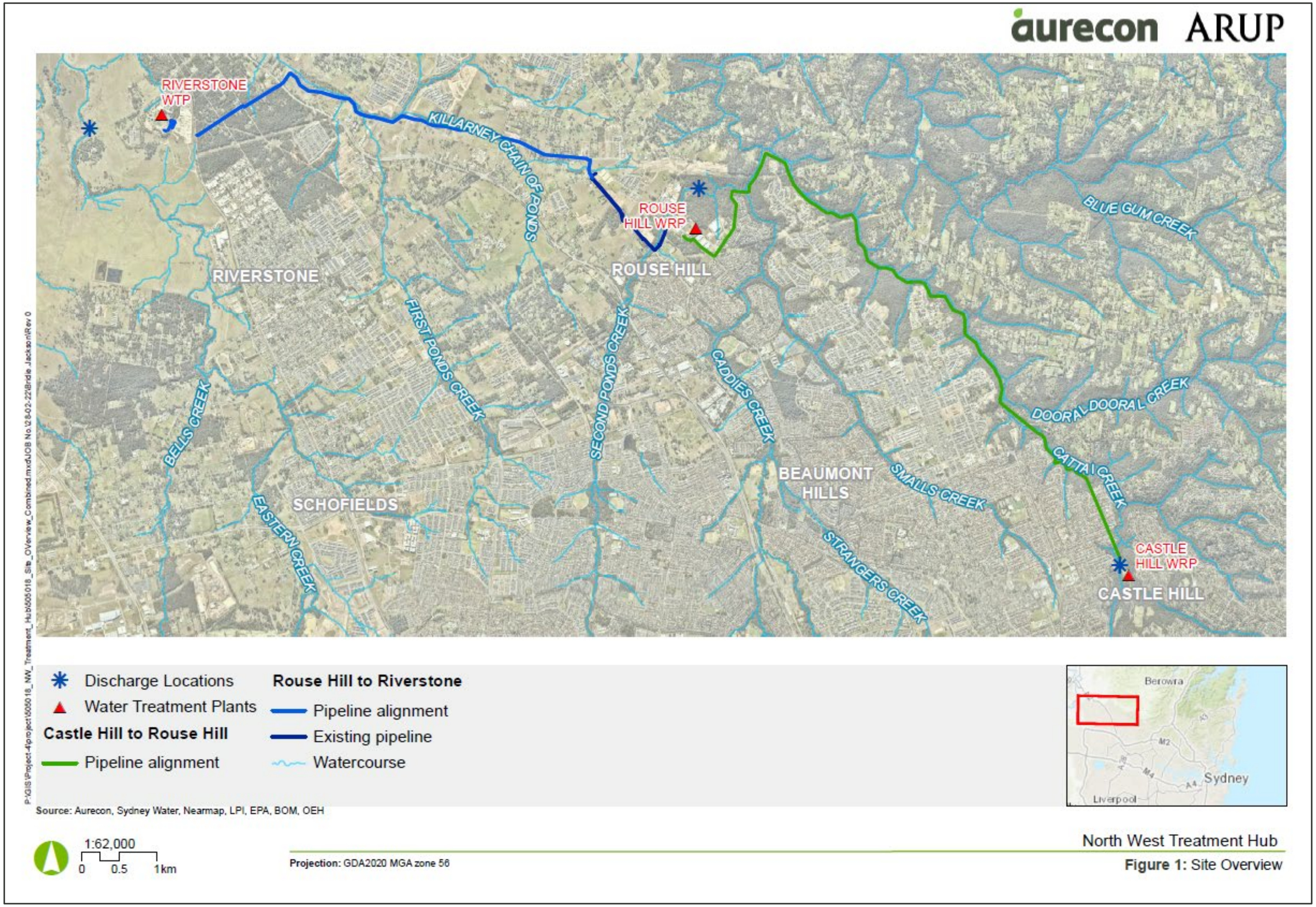

Figure 1-1 Project study area

2 Assessment methodology

A risk-based assessment has been conducted, examining the potential for increased erosion or habitat loss due to increased wastewater discharge from Rouse Hill WRP to Second Ponds Creek.

2.1 Second Ponds Creek assessment

Three sets of criteria were considered to inform the assessment:

- Hydrologic metrics relevant to urban settings as recommended in the Stormwater and Outflow Planning Controls for Waterway Health: Applying the Urban Streamflow Impact Assessment (USIA) (Streamology et al., 2019) (methodology detailed in Section **Error! Reference source not found.**), show whether the hydrologic indices indicate hydrologic condition the waterway reach and its likely trajectory
- Ecological hydraulic thresholds (methodology detailed in Section 2.1.2) indicate the risk of the waterway becoming impassable to fish types or risk of habitat being washed out by additional discharge from the WRP
- Erosion risk to channel bed and banks due to increased shear-stresses resulting from increased discharge (methodology detailed in Section 2.1.3) that may cause alteration of channel geometry or increase the rate of downstream erosion and deposition processes.

As the methodology is a risk-based assessment, it is not intended to be a detailed geomorphic investigation of the entire downstream creek system but is intended to indicate where further investigations would be required to quantify the extent and nature of potential downstream impacts.

2.1.1 Hydrologic changes

To establish the context of hydrologic change, a range of environmental flow metrics were assessed for change resulting from additional discharge at the Rouse Hill WRP.

In the absence of specific Water Quality and Flow Objectives being set for the waterway, a range of flow metrics have been compiled in previous work undertaken by Sydney Water to characterise the hydrologic aspects of waterways and are referred to as the *Stormwater and Outflow Planning Controls for Waterway Health: Applying the Urban Streamflow Impact Assessment* (USIA) (Sydney Water, 2019): These metrics are listed below and illustrated in Figure 2-1:

- Mean annual runoff volume (MARV)
- Mean duration of zero flow periods (average over all zero flow events) *
- Total duration of zero flow periods (as a portion of the total flow period assessed) *
- Baseflow index (ratio of baseflow to total flow volume) (flows < top 20th percentile) **
- Frequency of freshes (flows > 3 times median flow)
- Total duration of freshes (flows > 3 times median flow)

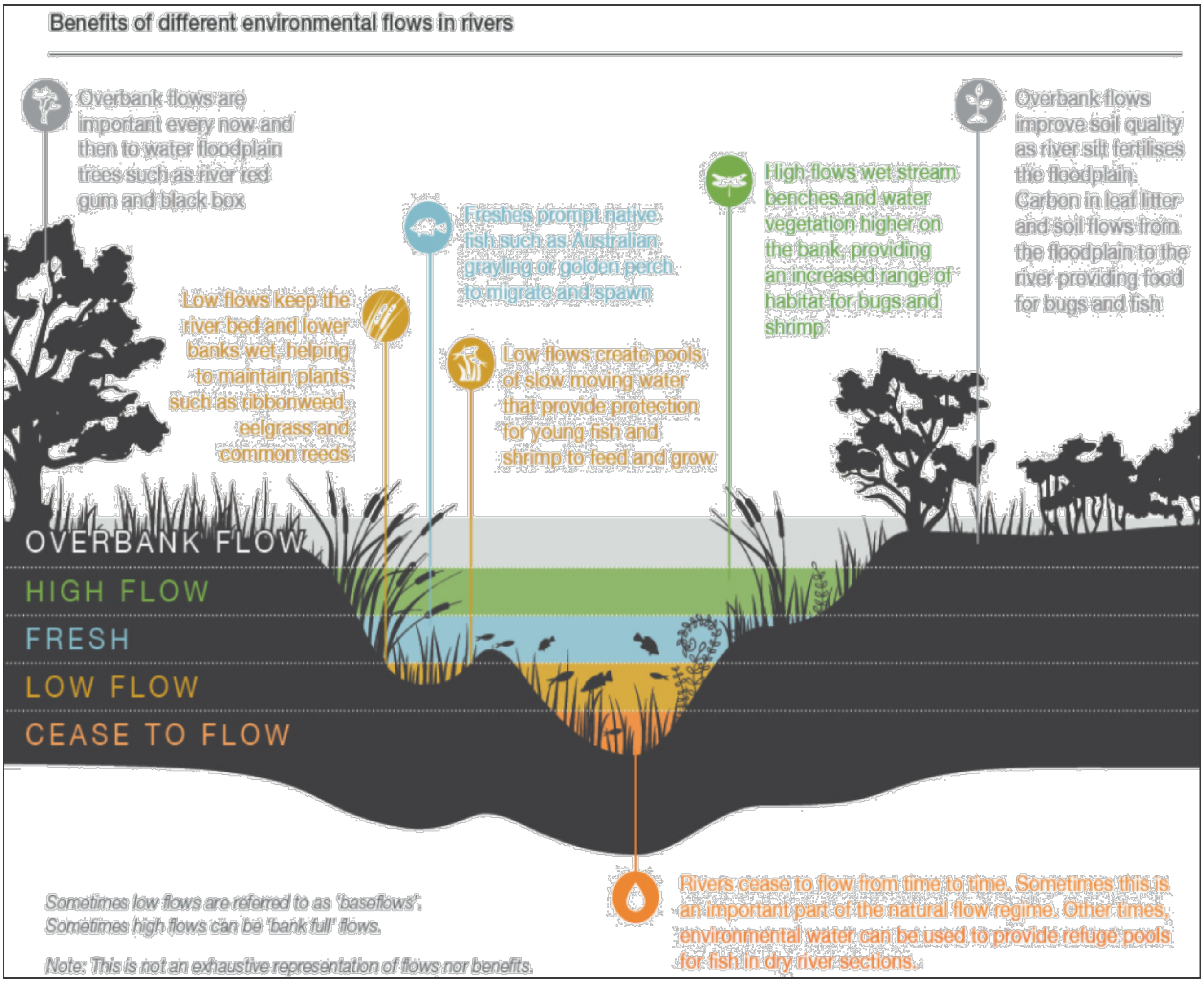

Figure 2-1 The function of flow metrics and their respective importance in rivers (VEHW, 2020)

The framework expresses the proportional change in a metric. The following generic impact classes have been defined based on the percentage of change from the current condition and corresponding risk of degrading or losing creek value:

- Low risk: <20% change
- Moderate risk: 20-50% change
- High risk: >50% change

2.1.2 Eco-hydraulic thresholds

An assessment of current (base case) and proposed case waterflow velocities was conducted to identify potential impact from variations to flow within Second Ponds Creek. As Second Ponds Creek feeds into the larger Caddies Creek/Cattai Creek confluence, the assessment was limited to the confluence of Second Ponds Creek and Caddies Creek.

The ecological hydraulic threshold assessment was conducted in order to quantify potential impacts to obligate-aquatic fauna that may occur within Second Ponds Creek and use the various zones of the waterway as habitat. Aquatic organisms may utilise a variety of hydraulic zones within a watercourse, including high flow (e.g. runs) and lower flow velocity (e.g. edgewaters) zones.

The use of published velocity thresholds indicates the potential for impassable flow conditions to form where specific velocity thresholds are exceeded.

Where velocity thresholds for invertebrates and macrophytes were not available, scour thresholds were used to qualify the potential impact on habitat becoming unusable. The scour thresholds thus act as a proxy indication of impact on all aquatic biota. In this manner, while individuals might not be predicted to be present within Second Ponds Creek, assessment of indirect impacts on species such as Platypus, through prey item impacts (on potentially scoured substrates), could be made.

The key thresholds are those considered to reduce ecological stability by either:

1. indirect impacts e.g. increase in shear stress causing habitat scour or
2. direct impacts e.g. exceedance of velocity threshold for biota favourable condition impacts.

The assessment was informed by the aquatic physical habitat values that were identified from the North West Treatment Hub – Sensitive Aquatic Habitat Summary (ELA, 2021). It compared the outcomes of the local hydraulic modelling to the identified ecologically driven threshold values for fish swimming performance and substrate erosion resistance (Watson et al, 2019 and Austroads, 2018, respectively) to predict the change in impact to the waterway ecological values for the proposed future scenarios.

Direct flow velocities were derived from experimental data informed by the swimming performance of a selection of native Australian fish species (in relation to instream asset structures (Watson et. al 2019). These experimental data were identified as a conservative proxy for appropriation for wild fish and are utilised as a threshold for likely effect on species likely to occur downstream of the discharge. Due to the potential for a variety of fish species to utilise Second Ponds Creek, a selection of potential fish species across various body shape morphologies were selected for swimming performance (refer Table 2-1). The selection of this was based on physical habitat assessment and potential species (ELA 2021) and an assumption of unknown species utilising the habitat (due to no targeted fish community assessment). As such, a variety of likely species (in terms of both species and general body shapes) were selected to reduce risk of impact to a species which may utilise Second Ponds Creek (i.e. gudgeon as a proxy for other limited swimming capacity Compressiform-bodied fish).

The conservative nature of experimental testing was identified due to the non-natural setting and laminar nature of the experimental plume (i.e. not simulating natural turbulence zoning) and the focus on small class sizes of the fish species used in the experiment. The specific velocities of concern as predictive prolonged swimming performance speed (*Ucrit 25th percentile* (m/s)), related specifically to fish-swimming performance in a 12 metre flume are presented in Table 2-1. The *Ucrit* performance metric was selected (rather than burst speeds) as the best indicator for identifying prolonged swimming performance due to it being a combination of both sustained and burst swimming performance. As swimming performance is positively geared to body size, relative to capacity to overcome higher velocity (Watson et al. 2019), size of assessed fish are identified in Table 2-1. As such, the assessment then identifies various potential body lengths but also the most vulnerable size classes of fish within Second Ponds Creek. Larger fish are expected to have higher *Ucrit* capacity than those reported, and used, for the eco-hydraulic thresholds. While prolonged swimming performance for eels is within the *Ucrit* (up to 0.64 m/s; Langdon and Collins 2010), they were not included in this assessment due to capacity to overcome any sustained increases to water velocity through overland travel behavioural responses.

Table 2-1 Second Ponds Creek potential fish species Ucrit swimming performance data (modified from Watson et al. 2019)

Scientific name	Common name	*Body Shape*	*U*crit size (cm) (Mean ± SD [range])	*U*crit 25th percentile (m/s)
Macquaria novemaculeata	Australian Bass	Compressiform	6.0 ± 0.7 [4.3 - 7.3]	0.53
Trachystoma petardi	Freshwater mullet	Fusiform	7.3 ± 1.0 [5.9 - 8.8]	0.80
Hypseleotris galii	Firetail gudgeon	Compressiform	3.8 ± 0.8 [2.4 - 5.4]	0.34
Retropinna semoni	Australian Smelt	Fusiform	4.5 ± 0.7 [2.5 - 6.0]	0.62

Table note:

*U*crit refers to critical velocity threshold where 75 percent of fish are able to maintain prolonged swimming speeds for a defined distance

Hydraulic modelling was undertaken for a portion of Second Ponds Creek downstream of the WRP discharge point to assess the impact that increased flow regimes may have on the aquatic fauna in the downstream Second Ponds Creek environment. The model set up and the identification of critical assessment locations is further detailed in Section 2.1.4. The critical locations are representative of potential key risks that increased flows due to the WRP discharge may have on the local environmental receptors. The output from the hydraulic modelling was used to assess the risk of impacting habitat suitability and fish passage, by considering the expected change to the amount of time the relevant thresholds are exceeded (refer Section 4.14).

2.1.3 Erosion and shear stress risk

An assessment of baseline and proposed shear stress was conducted over the study reach to identify the risk for habitat loss due to vegetation and channel scour.

Critical tractive force (shear stress) thresholds for various particle sizes and aquatic vegetation were adopted from published values in the Technical Guidelines for Waterway Management, Part 6 (DSE, 2007).

A relationship between shear stress and flow at the critical assessment locations along the study reach (refer Section 2.1.4) were derived from the hydraulic modelling results. These relationships were used to determine how often these critical shear stress thresholds are predicted to be exceeded in current and future flow conditions. The impact assessment for Second Ponds Creek is presented in Section 4.1.4.

Sediment

A range of particle thresholds were considered using the data presented in Figure 2-2, with regard to local sediment samples and observations of the waterway (Section 3).

In adopting shear stress thresholds for various particle sizes, the lower end of the range has been selected for each class i.e. fine sand spans from 0.125 to 0.250 mm, and the threshold has been set based on a size of 0.125 mm. This results in a conservative estimate when presenting the exceedance of these thresholds in Section 4.1.3.

By definition, where flows increase erosion it is also implied that there is a deposition risk in downstream waters. Sediment may either drop out locally or be conveyed downstream until the transport capacity it too low and lead to deposition at some point down the system. Our modelling results indicated whether deposition would occur only within the study area and does not include deposition risk in the downstream creek system.

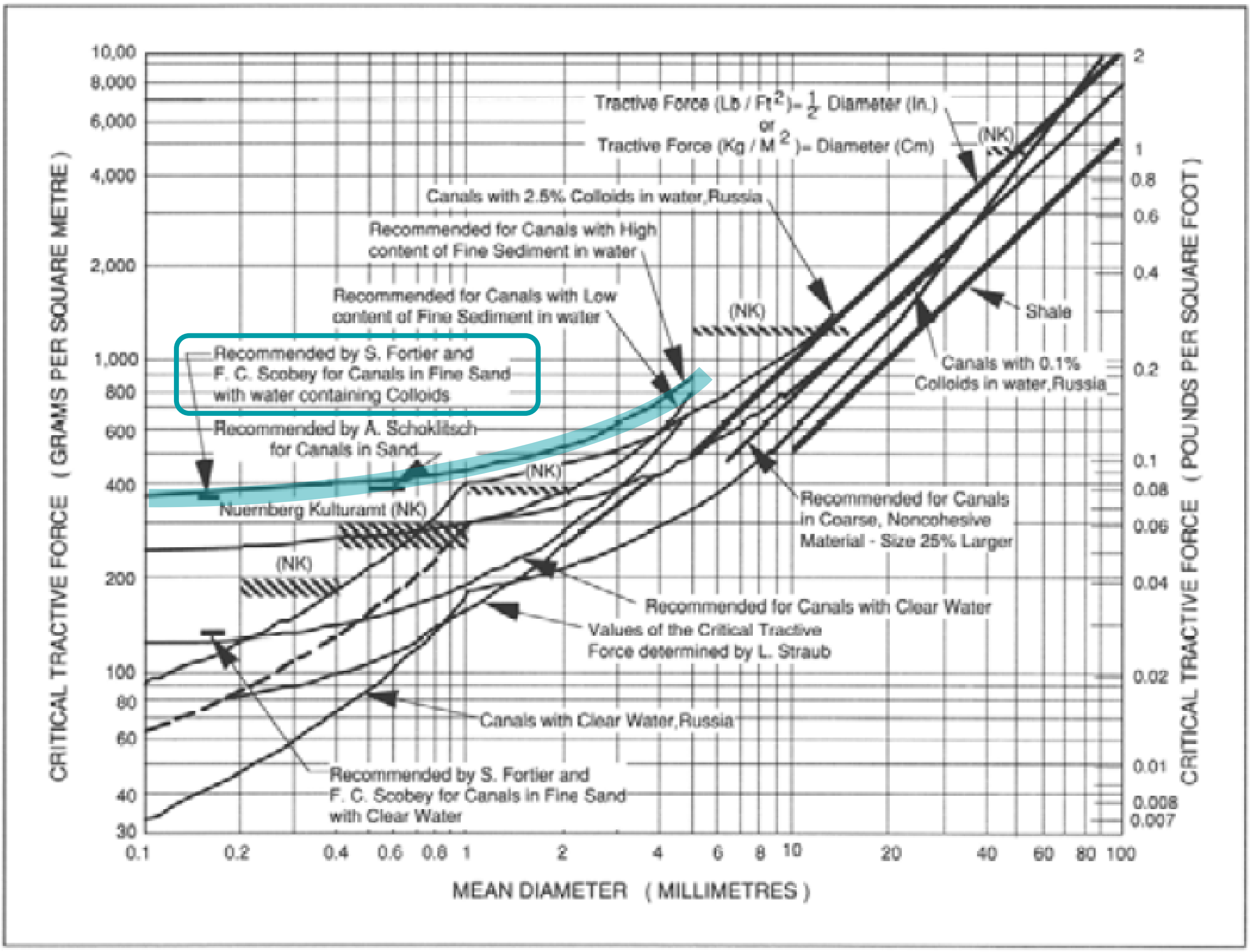

Figure 2-2 Relationships between the tractive forces on the stream bed and size of bed material that will erode (DSE, 2007)

Note: The Canals in Fine Sand with water containing Colloids curve is clouded above and was used for the assessment

Vegetation

Thresholds were also adopted for aquatic vegetation and standing macrophytes (tussock and sedge) (DSE, 2007). These thresholds reflect the point of incipient motion of the bank / bed sediment or aquatic vegetation (i.e. the transition from a stationary state to a state of initial motion in response to an increase in the hydrodynamic forces acting on the sediment / macrophytes).

2.1.4 Input data preparation and modelling

Hydrologic modelling

A hydrological model of the Cattai Creek system was developed by Sydney Water using the eWater Source platform. This model includes allowance for discharges from the water treatment plants in the catchment to the waterways. The current and future flows simulated upstream and downstream of the Rouse Hill WRP discharge were extracted from this model adopting the same climatic conditions from January 2012 to December 2018.

Current day and future urban development, catchment conditions have been adopted to consider the changes in flow brought about by shifting from the existing to the future land use within the Second Ponds Creek catchment. These are scenarios are summarised in Table 2-2.

Table 2-2 Flow scenarios modelled

ID	Catchment Development	Treatment capacity* (ML/d)	Average discharge (total) (ML/d)	Location assessed	Representative of
1A	2017 Landuse data	26	0	Upstream of discharge	Current day catchment conditions without WRP discharge
1B	2017 Landuse data	26	16	Downstream of discharge	Current day catchment conditions **with** WRP discharge
2A	2036 Landuse data	40	0	Upstream of discharge	Future catchment conditions without WRP discharge
2B	2036 Landuse data	40	31	Downstream of discharge	Future catchment conditions **with** WRP discharge

* Average Dry Weather Flow capacity

Continuous hydrographs of average daily flow for each of the four scenarios were extracted and flow duration curves were developed.

Critical points of the flow duration curves were then used to develop boundary conditions for hydraulic modelling.

Hydraulic modelling

Hydraulic modelling was undertaken using a TUFLOW model of the flow scenarios over a typical reach of the waterway in Second Ponds Creek shown in Figure 2-3. TUFLOW model parameters are summarise below and modelling results are presented in Section 4.1.2 and 4.1.3.

Data

Bathymetry and topographic surveys were completed by Marine & Earth Sciences, with cross sections taken every 5m longitudinally along Second Ponds Creek. Each cross section extended to 10m either side of the creek. More detail was captured for features that may constrict water flow (MES, 2021). The details of the supplied topographic data set used in the hydraulic modelled is shown in Table 2-3. The elevation data was reduced to Australian Height Datum (AHD) using the Ausgeoid 2020 model.

Table 2-3 Topographic data

Data Set	Supplier	Data Type	Indicative Accuracy
SecondPonds-DTM_xyz-AHD.dat	Marine & Earth Sciences	Bathymetry	+/-2cm vertical and +/-1cm horizontal.
		Topographic survey	+/-2cm vertical and +/-1cm horizontal.

Model parameters

The parameters used to build the TUFLOW model are summarised in Table 2-4. The model setup is shown in Figure 2-3.

Table 2-4 TUFLOW model parameters

Parameter	Second Ponds Creek TUFLOW Model
Completion date	December 2021
Hydrologic modelling	Source model – refer Table 2-2
Percentile exceedance flow rates modelled	Minimum flow, 95%, 90%, 75%, 50%, 25%, 10%

Parameter	Second Ponds Creek TUFLOW Model
Hydraulic model software	TUFLOW quadtree module with version 2020-10-AB-iSP-w64
Grid size	Base: 2 metres Main body of creek: 0.5 metres
DEM	SecondPonds-DTM_xyz-AHD.asc
Roughness	0.03 – Creek bed 0.1 – Floodplain with woody debris
Model boundaries	Upstream – Modelled inflows applied at QT (flow-time) 2D boundary condition for the upstream catchment and QT 2D source area for the discharge location. Downstream – Generated HQ (stage-flow) 2D boundary condition.
Initial water level	An IWL grid was simulated and read in to represent the pools being full at the beginning of simulation.

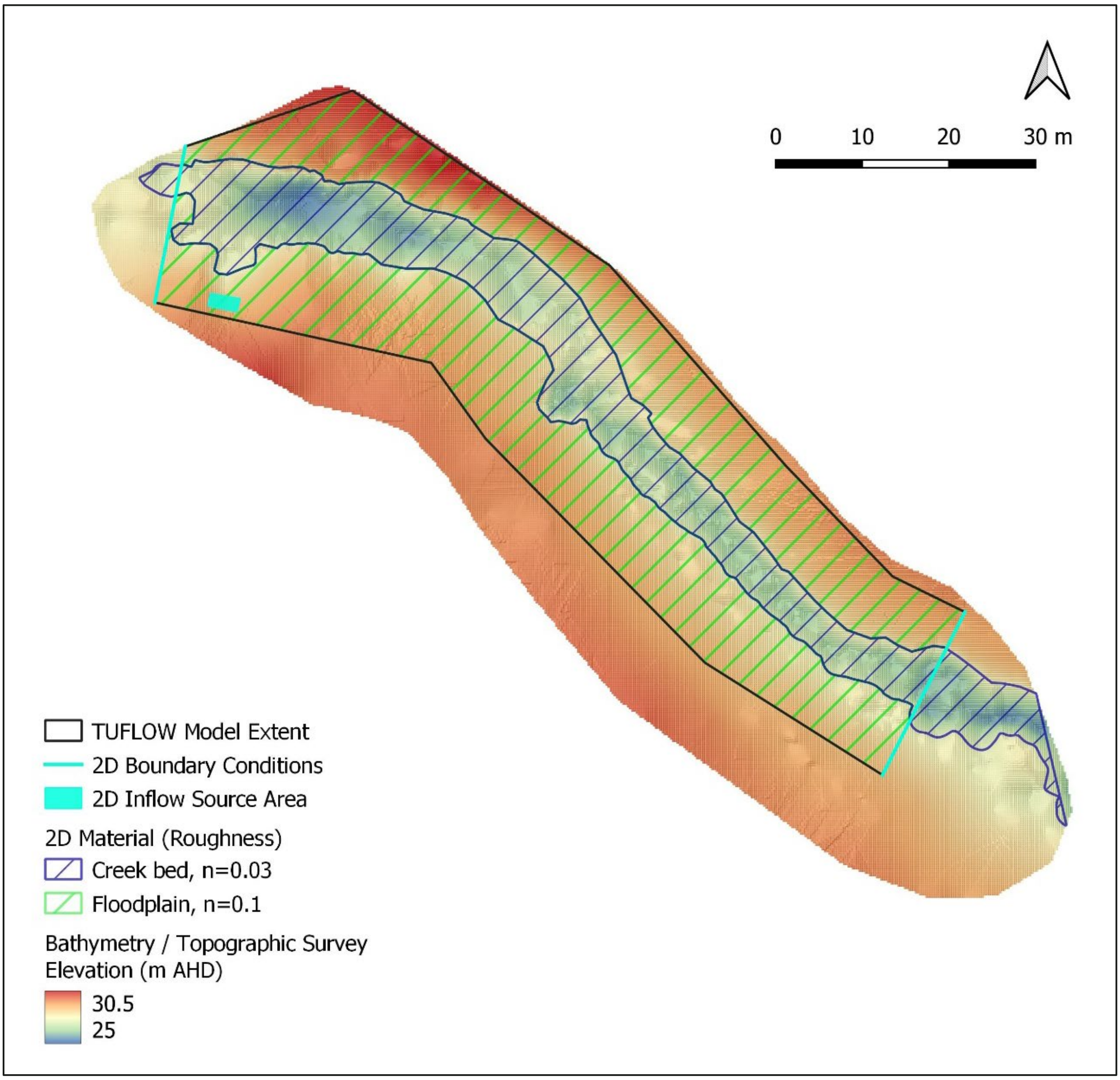

Figure 2-3 TUFLOW Model Setup

Eco-hydraulic and geomorphology assessment locations

Three discrete locations downstream of the WRP discharge point in Second Ponds Creek reach were analysed in detail due to their representation of potential habitat risks that increased flows pose and these are shown in Figure 2-4. The study reach was field-verified by ecologists (refer ELA 2021) and potential aquatic environmental receptors were identified. These specific assessment locations were chosen based on the following observations:

- Location A: Representative of key risk #1 **dislodgement of existing aquatic macrophytes** that are growing in the pond. There is significant growth of these native submerged aquatic macrophytes directly at the treatment plant discharge point to the creek.
- Location B: Representative of key risk #2 **bank erosion**; constriction point is predominantly rock and so downstream substrates will be at risk of erosion under increased flows. Flow through this constriction may increase velocities leading to **impeded flow and fish passage**.
- Location C: Representative of key risk #3 potential impact to **fish passage**.

A relationship between flow,-velocity and flow-shear stress was determined using the hydraulic modelling results at each location. This approach uses a combination of the following model results to generate the site specific flow, velocity and shear stress relationships.

- Cross-sectional averaged velocity; and
- Point water level and velocity timeseries to calculate shear stress.

Once these relationships are established, the changes in the frequency of velocity and shear stress can be determined for each flow scenario, providing a indication of where ecological thresholds are likely to be exceeded under the WRP discharge scenarios.

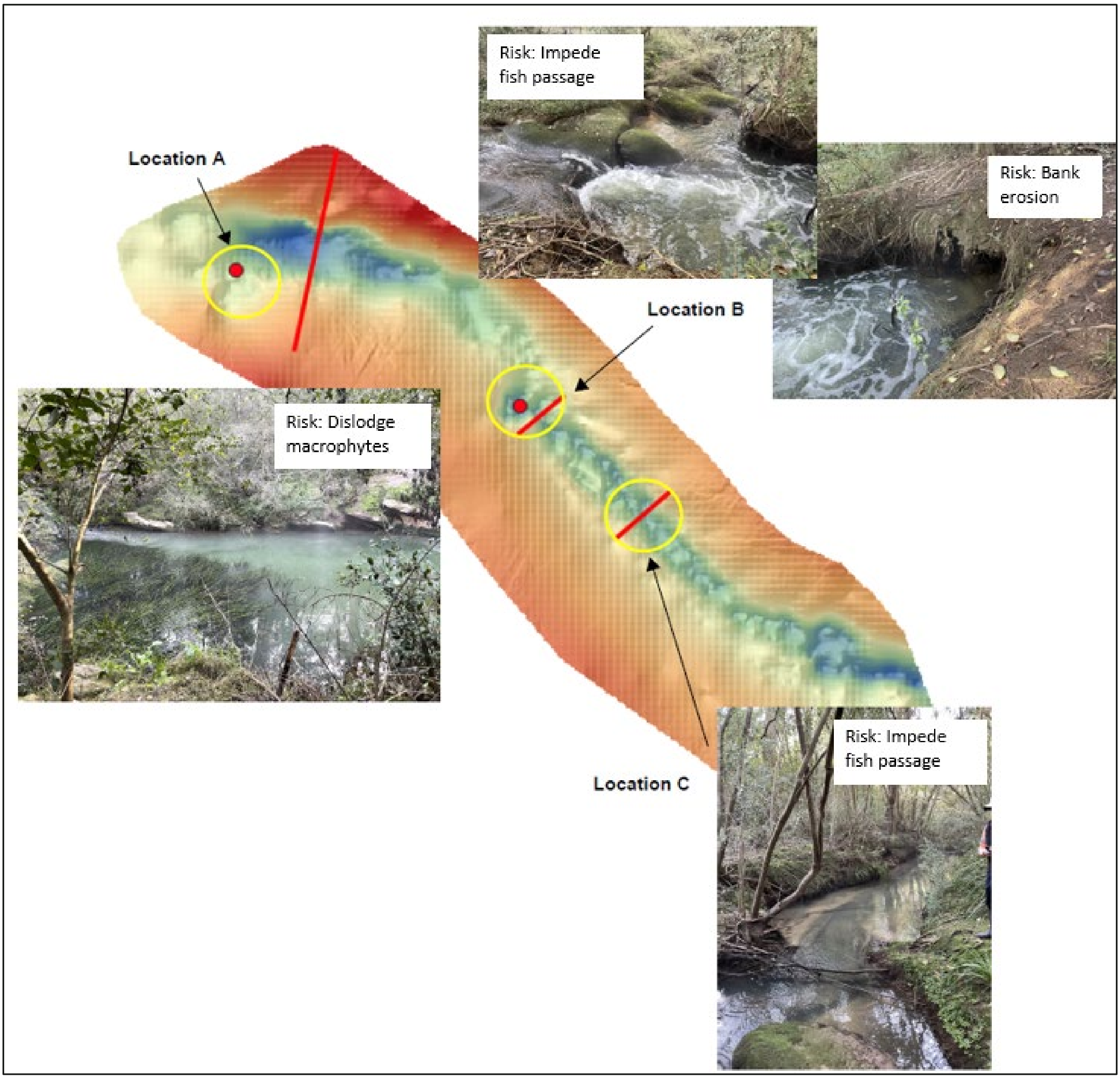

Figure 2-4 Locations modelled for at-risk environmental receptors (Second Ponds Creek)

2.2 Cattai Creek and sludge pipelines assessment

The general hydrology and geomorphology assessment for potential impacts deriving from the marginal increase in discharge to Cattai Creek as well as the pipeline construction and operations, uses a severity-based impact assessment framework to identify and assess proposal related impacts in relation to receiving environment receptors.

Due to limited current definition of the construction methodology, the pipeline was considered to be constructed using conventional trenching techniques for crossing or trenching 1st and 2nd order waterways. At these locations general direction drilling was considered as the standard practice for construction. Trenchless construction methods would be adopted for major road, rail and creek crossings (≥ 3rd order).

For the purposes of the assessment, a significant impact depends upon sensitivity to impact and the intensity, duration, magnitude and potential spatial extent of the potential impacts. The following sections discuss and define impact magnitudes, receptor sensitivity and impact severity.

2.3 Impact classification

The significance of any potential project impact on the local habitat has been determined by considering the sensitivity of the environment related to the assessed criteria as well as the magnitude of the expected change. The resultant matrix of significance is shown in Table 2-5.

Table 2-5 Impact significance assessment matrix

Magnitude of potential impact	Sensitivity of receiving environment		
	Low	Medium	High
Low	Negligible	Low	Moderate
Medium	Low	Moderate	High
High	Moderate	High	Major

The *Sensitivity of Environmental Values* evaluation is influenced by the following criteria:

- Condition of the environmental value, i.e. how far is it understood to have already been changed from its original natural form or state?
- How unique or rare is the condition or value or it's dependant ecological receptors?
- How sensitive are the dependant receptors to changes?

The *Magnitude of Impact* evaluation is influence by the following criteria:

- If a qualitative assessment has been conducted, how do the results compare to the relevant waterway objectives
- For quantitative assessments the following is considered
- Expected duration of impact: Temporary vs. long-lasting/permanent
- Expected extent of impact: Local vs. regional/widespread
- Estimated degree of change from pre-development conditions

3 Existing environment

3.1 Catchment description

Second Ponds Creek is located within the Hawkesbury-Nepean basin, which encompasses 21,400 square kilometres (km^2). The Second Ponds Creek catchment (11 km^2), indicated in Figure 3-1, is comprised of primarily urban and pockets of peri-urban land zones. A minor amount of development within the catchment is expected within the near future. The catchment falls within the National climatic zone 6 indicating the general climate is considered temperate with no defined dry seasons and warm to hot summers (BoM 2021).

Second Ponds Creek discharges into Caddies Creek approximately 800m downstream of the discharge location. Caddies Creek subsequently discharges to Cattai Creek 600m further downstream, which flows towards the Hawkesbury River. A constructed wetland is located upstream of the discharge location, which was previously used as a final polishing step in the treatment process. Because the quality of the water entering the wetland (i.e. impacted stormwater) resulted in resulted in an increase in TSS, TP and Faecals compared with the effluent entering the wetlands a decision was made to adjust the discharge to downstream of the wetlands to enable Sydney Water to better monitor and control it's effluent quality.

The Strahler stream order for Second Ponds Creek at the assessed discharge location was determined using the available NSW Hydro Line spatial data (NSW DPI, 2018b). Second Ponds Creek is defined as a Strahler stream order of three (3) indicating inflow from a number of headwater streams.

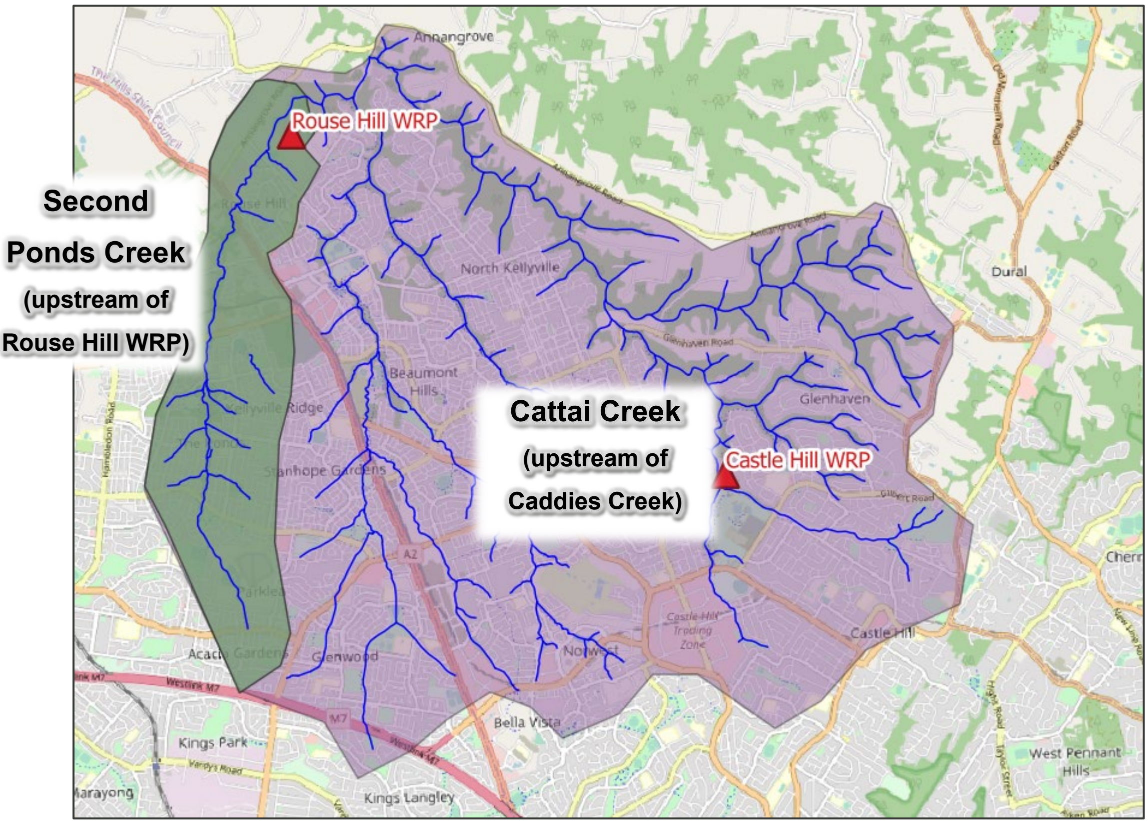

Figure 3-1 Second Ponds Creek catchment

The Cattai Creek Catchment, partially shown in Figure 3-1, discharges into the Hawkesbury Nepean River. The catchment has faced significant degradation from a history of agricultural land uses and urban encroachment. The catchment land use is a mix of residential and industrial sites, limited development of currently undeveloped areas is expected within the near future.

3.2 Aquatic habitat

Second Ponds Creek aquatic physical habitat values were identified from the North West Treatment Hub – Sensitive Aquatic Habitat Summary (ELA, 2021) (refer Table 3-1).

The assessment identified that the assessed section, downstream of the discharge, was dominated by boulders and bedrock stream substrate indicating the potential for resistance to scour from higher flows. Bank substrate was dominated by fines and sand and likely to have minimal resistance to erosion. Evidence of bank erosion are already present within the channel and the assessment identified that the channel is suitable for small fish and amphibians, in moderate condition but unlikely to provide habitat for threatened aquatic fauna.

While no listed species under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) *Fisheries Management Act 1994* (NSW), Second Ponds Creek is identified as containing NSW DPI ‘key fish habitat’ with respect to the application of the FM Act, FM regulations and the policies and guidelines provided (NSW DPI 2013). As such, potential changes to current ecological zones were selected to qualify the risk of impact from changes to hydrology and geomorphology, due to Rouse Hill WRP discharge changes within Second Ponds Creek.

Table 3-1 Key aquatic features of Second Ponds Creek downstream from discharge (ELA 2021)

Reach	Hydrology	Physical form	Instream habitat	Streamside vegetation	Overall condition
Second Ponds Creek Downstream of WWTP discharge point and constructed wetlands	3rd order stream. Partially developed catchment Semi permanent / base flows. Some evidence of high flows with flood debris evident in trees No impoundments or significant barriers to flow. Some instream woody debris providing habitat.	Channel typically 2-3 m wide Banks <1 m high, mostly <30° slope. Channel has low grade and low sinuosity and is well defined through tree-lined riparian corridor. Small pockets of localised erosion and one area of substantial bank erosion. No obvious explanation for bank erosion. Substrate dominated by boulders and bedrock	Key fish habitat – Type 1 highly sensitive key fish habitat due to native macrophytes and Type 2 Moderately sensitive key fish habitat due to lack of aquatic plants. Flowing at time of survey, typically <10 cm deep. 50% pool, 50% riffle/run sequence. Minor large woody debris contributing to habitat. Channel suited to amphibians and small fish although none were observed. Unlikely to provide habitat for threatened aquatic fauna. One large area of native submerged macrophytes (Vallisneria sp.) near discharge point (Photo point 3). Otherwise very little instream vegetation. Water slightly turbid in pools with blue-grey tint, otherwise clear.	Good riparian extent and continuity, however vegetation is primarily exotic, dominated by Ligustrum sinense (Small Leaf Privet) Little evidence of natural recruitment of woody natives 70% tree cover 5% shrub cover 30% grass/ground cover.	Moderate condition, stabilised by bedrock in some areas.

Source: ELA (2021)

1.1 Sediments

A representative sample of the over-bank material (Figure 3-2) was collected downstream of the proposed discharge location and the particle sizes analysed (Figure 3-3). The results indicate the sample comprised of

- 50% of particles smaller than fine sands (<0.125mm) and
- 50% greater than fine sands (0.038 – 2.000 mm).

It is noted that this sample is not representative of material in the bed or lower banks. It is expected that material collected in the location represents highly mobilised sediments while heavier and larger particles would comprise bed material, For this reason, a range of particle sizes have been considered in the assessment.

Figure 3-2 Photo of bank material where soil sample SD01 was taken

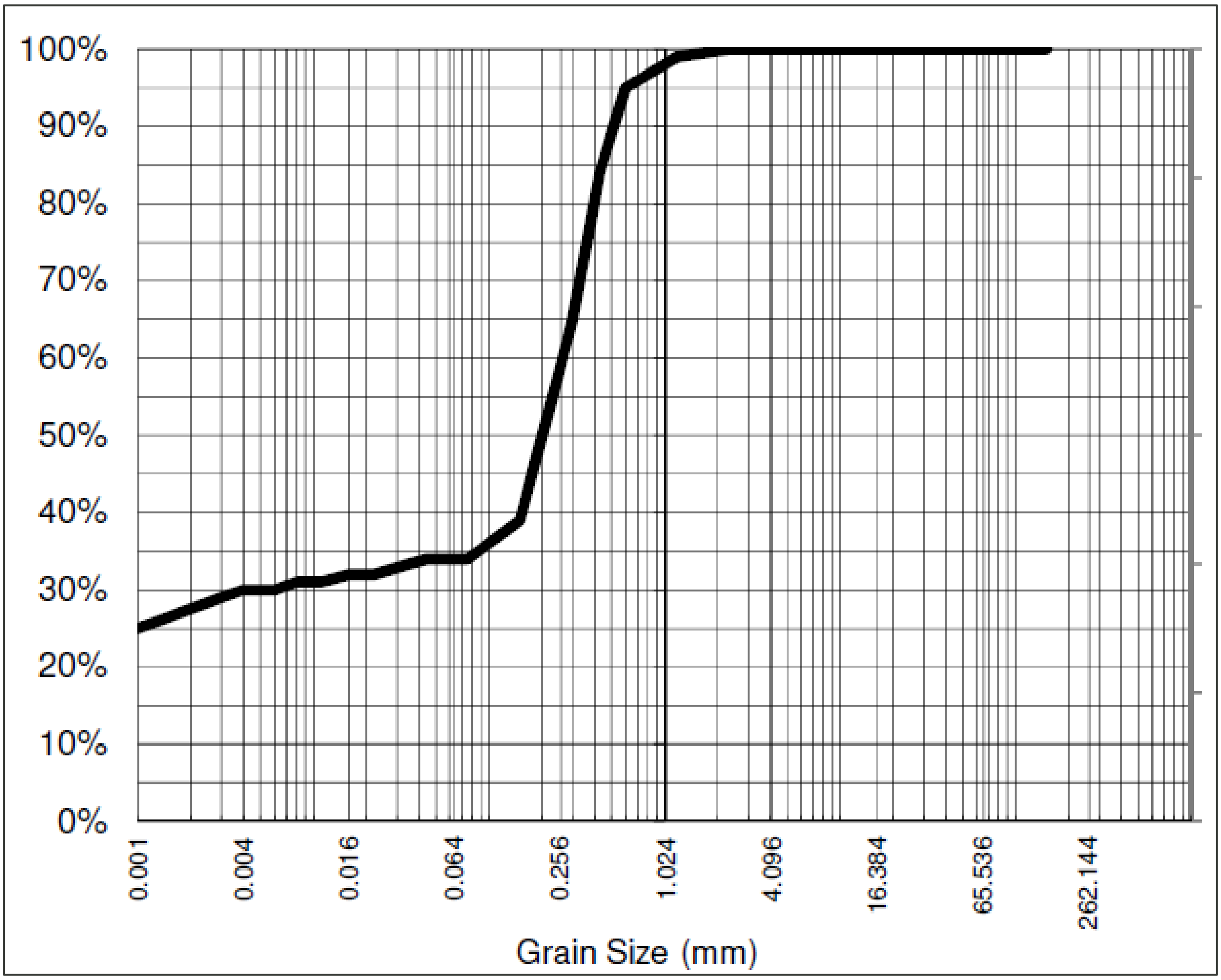

Figure 3-3 Particle size distribution of bank material adjacent to discharge location (Second Ponds Creek, sample SD01 – Latitude -33.664529, Longitude 150.923962)

3.3 Flow monitoring data

A streamflow gauge is located downstream of the discharge points, on Cattai Creek, directly after the confluence with Caddies Creek. The gauge was installed in February 2011, however continuous data is only available from February 2013. The metadata associated with this stream gauge is indicated in Table 3-2.

Table 3-2 Stream flow gauge related to Cattai Creek gauge at Murphy Bridge

Station name	Station number	Catchment Area	Data owner	Number of records (years)	Record commenced
Cattai at Murphy Bridge	212059	75 km^2	WaterNSW	9	February 2011

The gauged flow regime in Cattai Creek is presented in Figure 3-4 along with comparisons to the modelled flows from the Sydney Water hydrologic models for the following scenarios:

- Cattai Creek Gauge at Murphy Bridge (2013 – 2022): The full record of flow data available at the gauge located downstream of the discharge locations on Cattai Creek
- Scenario 1A - SPC: No discharge (2012 – 2018): The simulated flows at the Rouse Hill discharge location on Second Ponds Creek, excluding any discharge the Castle Hill plant
- Scenario 1B – SPC: With discharge (2012 – 2018): The simulated flows at the Rouse Hill discharge location on Second Ponds Creek, including discharge from the Castle Hill plant
- Gauge (2013 - 2018): Available gauge data for the period corresponding to the available simulated synthetic records

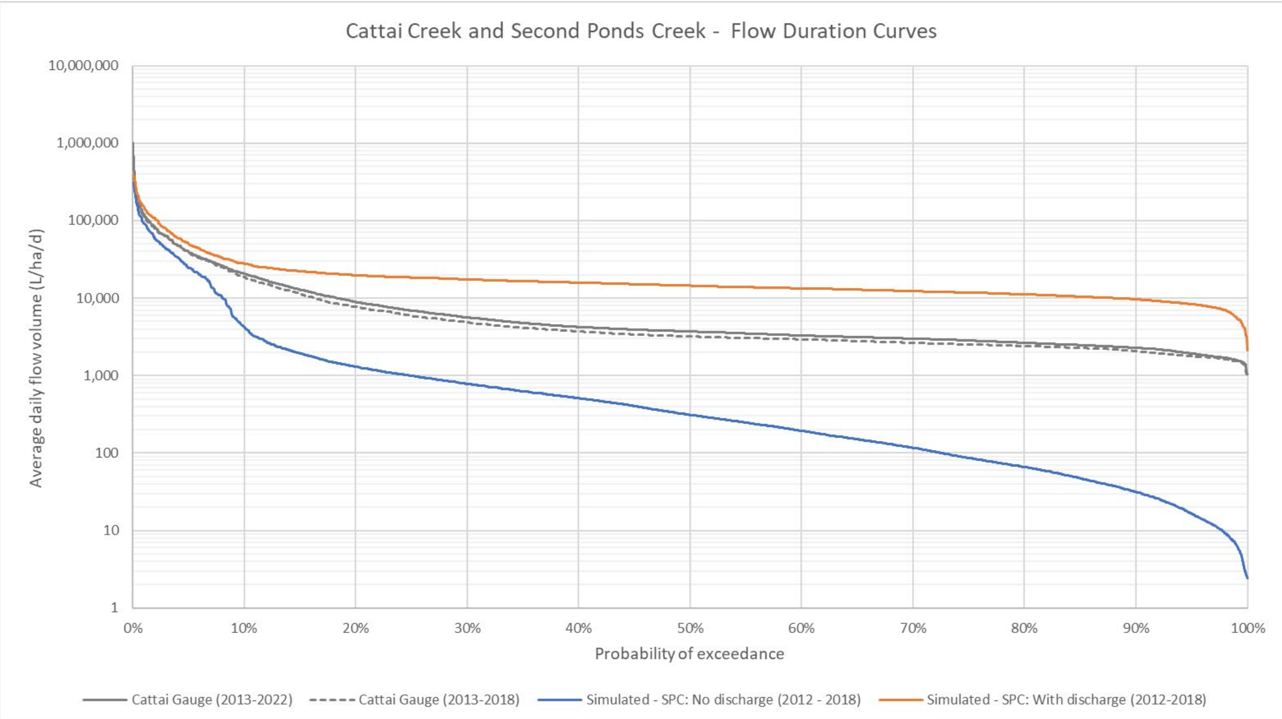

Figure 3-4 Flow duration curves – Measured vs simulated flow data

The modelling shows that discharge from the treatment plants has altered the natural daily flow rates by several orders of magnitude with a persistent and consistent base flow provided by the treatment plant discharges. Key flow metrics for the simulated Second Ponds Creek are presented in Table 3-3.

Table 3-3 Summary statistics for Second Ponds Creek flow duration curves

Dataset	Percentile exceedance flow rate (ML/d)					Average flow (ML/d)
	20th	25th	Med	75th	90th	
Simulated: No discharge (2012-2018) Scenario 1A	0.07	0.09	0.32	1.0	4.4	4.8
Simulated: With Discharge (2012-2018) Scenario 1B	11.5	12.2	14.9	19.0	28.8	21.1

3.4 Fluvial geomorphology

The River Styles framework is used to characterise geomorphic river conditions of rivers and identifies the sensitivity to change (fragility) and likelihood of recovery. The framework provides for a high-level, qualitative assessment of the general geomorphic condition. The river styles characteristics for Second Ponds Creek are identified in Table 3-4.

Upstream of the discharge location has been modified and doesn't reflect the natural condition of the waterway.

Below the discharge location, the watercourse is generally in good condition. Sections of the creek are confined by bedrock, while other areas are exhibiting erosion which is being controlled by tree roots.

Table 3-4 Second Ponds Creek River Styles characteristics (after Brierley and Fryirs 2005)

Watercourse	River style	Stream condition	Recovery potential	Fragility
Second Ponds Creek immediately d/s of discharge point	Confined, bedrock margin-controlled, gorge, bedrock	Good	Conservation	Low
Second Ponds Creek d/s of discharge point (after confluence with Caddies Creek)	Planform controlled, low sinuosity, fine grained	Moderate	Moderate	Moderate
Second Ponds Creek immediately u/s of discharge point	Anthropogenic (water storage)	None	None	Low
Second Ponds Creek u/s of discharge point (Withers Road intersection)	Planform controlled, low sinuosity, fine grained	Moderate	Moderate	Moderate

Limited observations can be made from available historic aerial imagery with regards to watercourse movement over time, see Figure 3-5. Field observation indicate several location with bank undercutting taking place (Figure 3-6) and stretches where sandy material has settled out on the creek bed and been deposited along the banks during high flows.

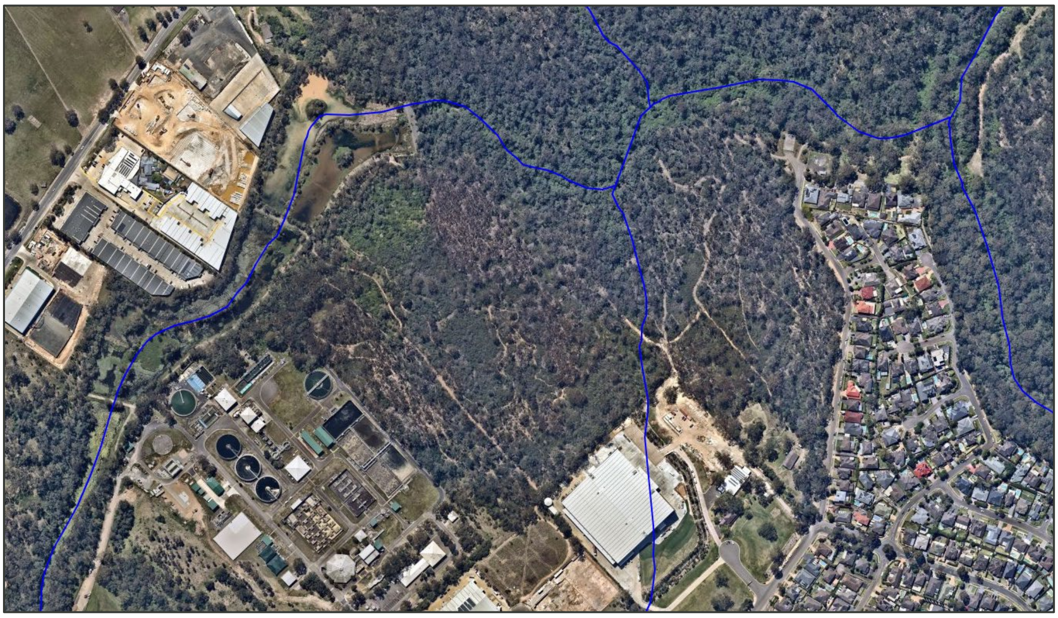

Figure 3-5 Aerial imagery of Second Ponds Creek – 6 October 2021 (Nearmap, 2022)

Figure 3-6 Evidence of bank undercutting in silty material within the Second Ponds Creek –

1.1.1 Long Section

A long section of the existing bathymetry surveyed in 2021 (described in Table 2-3) is shown in Figure 3-7. The extent of the bathymetry shown is for the length of the hydraulic model (upstream boundary at chainage 0m, downstream boundary at ~115m). This long section shows the pond (approximately chainage 4m to 55m) where the discharge enters the creek in the upstream section of the model.

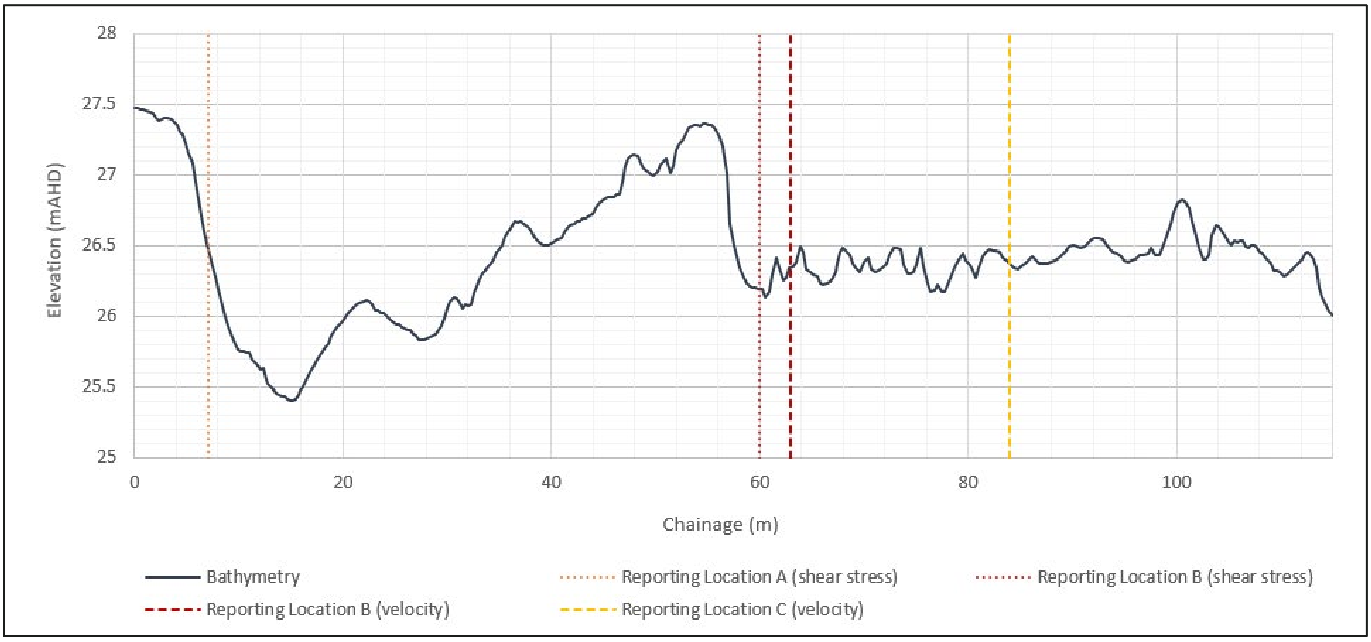

Figure 3-7 Bathymetry along creek thalweg

The waterway is generally in good condition, but evidence of deposition and erosion shows that the waterway is actively responding to altered catchment conditions and existing discharges from treatment plants.

The long section shows a mix of pools and chutes. Based on the fragility characteristic, the waterway has some resilience to changes but may also be at risk of changing shape, location or condition under additional hydrologic discharge.

4 Impact assessment

4.1 Second Ponds Creek

4.1.1 Hydrologic change

The flow duration curves for all four simulated scenarios are provided in Figure 4-1 and the key percentile values in Table 4-1. The data indicated an almost negligible shift in flow regime between the 2017 catchment conditions and 2036 catchment conditions with no discharge from the WRP. This is due to very limited further development of the catchment expected.

The 2017 discharge scenario indicates a major shift in flow regimes with median flow rates increasing from 0.3 ML/d to 15 ML/d due to the discharge from the WRP. This divergence is expected to increase when considering the 2036 discharge scenario data, though the relative additional change would be less severe than the current conditions, increasing to a median flowrate of 29 ML/d. The flow duration curve data indicates a shift throughout all flows with low median and high flows all increasing.

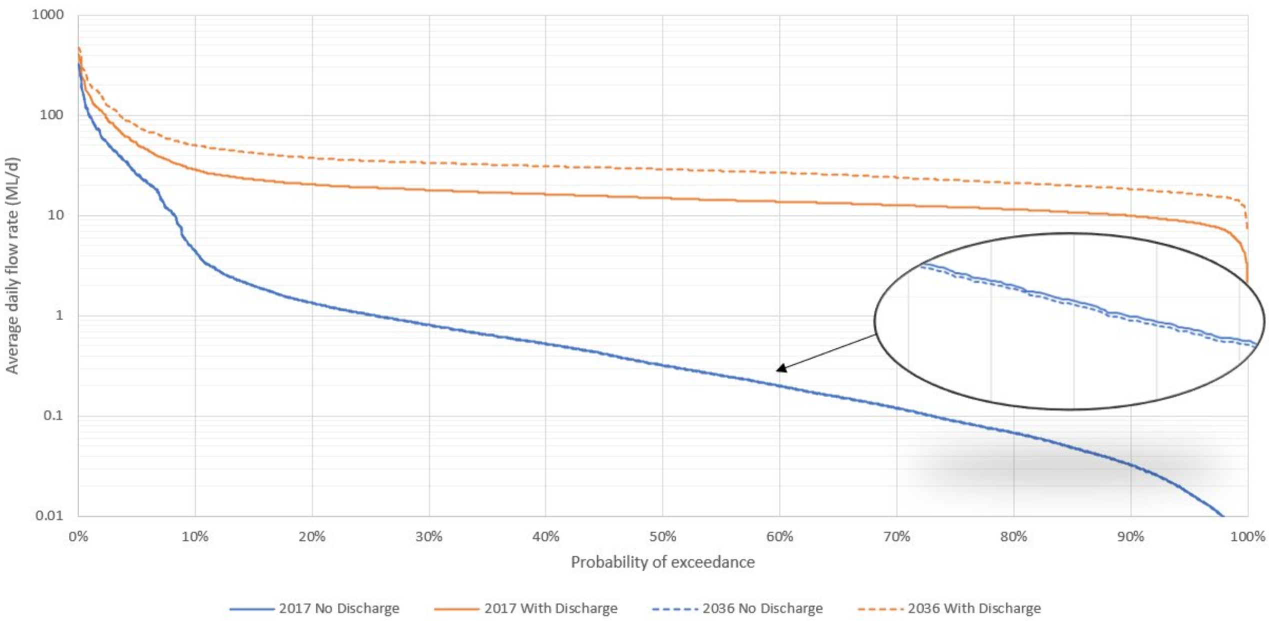

Figure 4-1 Second Ponds Creek flow duration curves under each respective scenario

Table 4-1 Percentile exceedance flow rates for Second Ponds Creek under each respective scenario (ML/day)

Percentile Flow Event	2017 No Discharge	2036 No Discharge	2017 With Discharge	2036 With Discharge
100th	~0	~0	2	7
95th	0.02	0.02	9	17
90th	0.03	0.03	10	18
75th	0.09	0.09	12	23
50th	0.3	0.3	15	29
25th	1	1	19	35
10th	4	4	29	50
5th	25	26	52	78

The tabulated flows for the 2036 WRP upgrade show flow rates will be at least 50% greater, suggesting a high risk of hydrologic impact according to the adopted USIA framework outlined in Section 2.1.1.

Other USIA flow metrics are presented in Table 4-2 for all four scenarios. As was evident in the flow duration curve datasets, all flow metrics associated with WRP discharge are impacted when compared to flows upstream of the WRP demonstrating that the natural flow conditions of the waterway have been altered significantly downstream of the WRP discharge point. The relative change from 2017 WRP discharges to 2036 WRP discharges represents a further change, but incrementally, this change is a much smaller step change than has been experienced already by the waterway under existing WRP discharges.

The only metrics which are not impacted by the discharge from the WRP are the zero-flow metrics, as the simulated data between 2012 and 2018 indicated no cease to flow conditions in the no discharge scenarios.

Table 4-2 USIA Metrics Comparison – Second Ponds Creek

Parameter	Units	Scenarios			
		2017 No Discharge	2017 with WRP Discharge	2036 No Discharge	2036 with WRP Discharge
Mean Annual Flow Volume	ML/yr	1,763	7,709	1,794	13,238
Mean duration of zero flow periods (<0.001 ML/d)	ML/d	n/a	n/a	n/a	n/a
Percent duration of zero flow periods	days	n/a	n/a	n/a	n/a
Baseflow index (ratio of baseflow to total flow)	%	5	46	4	52
3 x median flow (freshes threshold)	*ML/d*	*0.96 (based on the 2017 U/S threshold)*			
Frequency of freshes (flows > 3 times median)	events/yr	22	constant	22	constant
Total duration of freshes (Percentage of time > 3 x median)	%	26.5	100%	26.1	100%
Low risk of degrading or losing creek value compared to the current conditions (2017 With Discharge)					
Moderate risk of degrading or losing creek value compared to the current conditions (2017 With Discharge)					
High risk of degrading or losing creek value compared to the current conditions (2017 With Discharge)					

As the deviations from the No discharge USIA metrics are large and will subsequently increase under the proposed future conditions, additional modelling considering local bed and bank shear stresses was conducted to study the risk associated with erosion and potential geomorphological changes (Section 4.1.3).

4.1.2 Eco-hydraulic thresholds

As described in Table 2-4, a range of flow rates were run through the hydraulic model representing the full range of future discharges. Resulting velocity, depth and water levels corresponding to each of these flow rates are compared for each of the three critical assessment locations described in Section 2.1.4.

For the eco-hydraulic velocity thresholds, Location B and Location C were identified as the critical locations for assessment, where there was risk of impeding fish passage.

A relationship between velocity and flow (i.e. a velocity rating curve) was established at Location B and Location C in order to determine the portion of the time these thresholds would be exceeded for each hydrologic scenario. The velocity exceedance curves and tabulated results for the locations at risk of fish passage impacts are presented below.

Resulting velocities have been compared to ecological velocity thresholds for key fish identified in Section 2.1.2 to identify when flow conditions may impact certain fish species.

This analysis has assumed that fish use the edges of the channel for refuge habitat whilst fish passage would be sought on an opportunistic basis wherever there was space and suitable flow velocities to enable swimming upstream. This is shown in Figure 4-2 and Figure 4-3 indicating discrete areas within the creek which exceed the eco-hydraulic thresholds (i.e. prolonged swimming performance) for the 50^{th} percentile flowrates.

Along the creek there is typically areas along the edgewaters where fish may be able to find passage, but within this reach there are a few choke points that result in high velocities along the entire section. Where these thresholds are being exceeded at the 50^{th} percentile flow across the entire section, it is noted that the thresholds for fish that are stronger swimmers (i.e. Freshwater Mullet) are exceeded in both 2017 and 2036 discharge conditions.

The same is shown at the 75^{th} percentile flow in Figure 4-4 and Figure 4-5, and at the 90^{th} percentile flow in Figure 4-6 and Figure 4-7. This indicates that these stronger swimming species cannot pass through these sections of the creek at the 50^{th}, 75^{th} and 90^{th} percentile flow in existing conditions, and although the spatial extent of these thresholds increase under 2036 discharge conditions, it does not change the outcome of their ability to pass through these constrictions.

Comparison maps between velocity results under 2017 and 2036 WRP discharge conditions are presented in Figure 4-8 through Figure 4-10 to show the velocity thresholds along the creek under the 50^{th}, 75^{th} and 90^{th} percentile flowrates respectively. Comparison of the velocity mapping indicates the potential change in velocities and extent of habitat change.

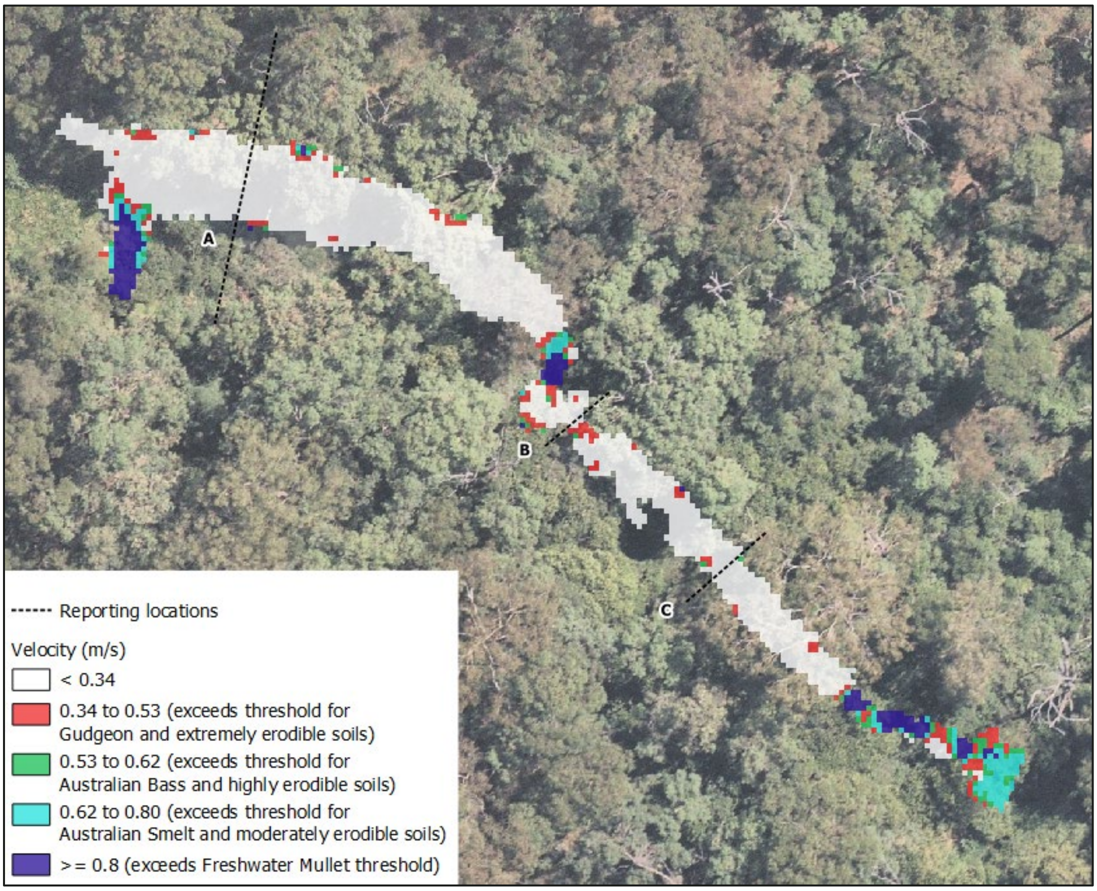

Figure 4-2 **2017 Discharge scenario velocity at 50th percentile flow**

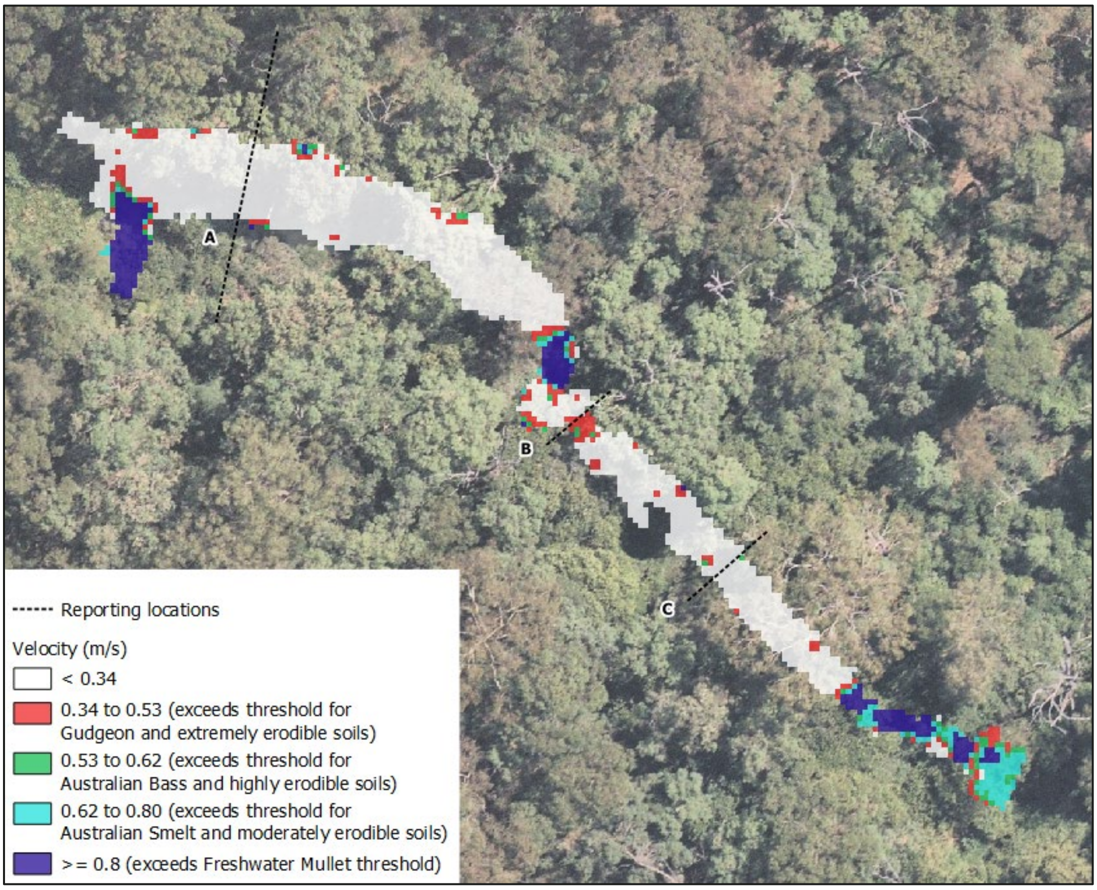

Figure 4-3 **2036 Discharge scenario velocity at 50th percentile flow**

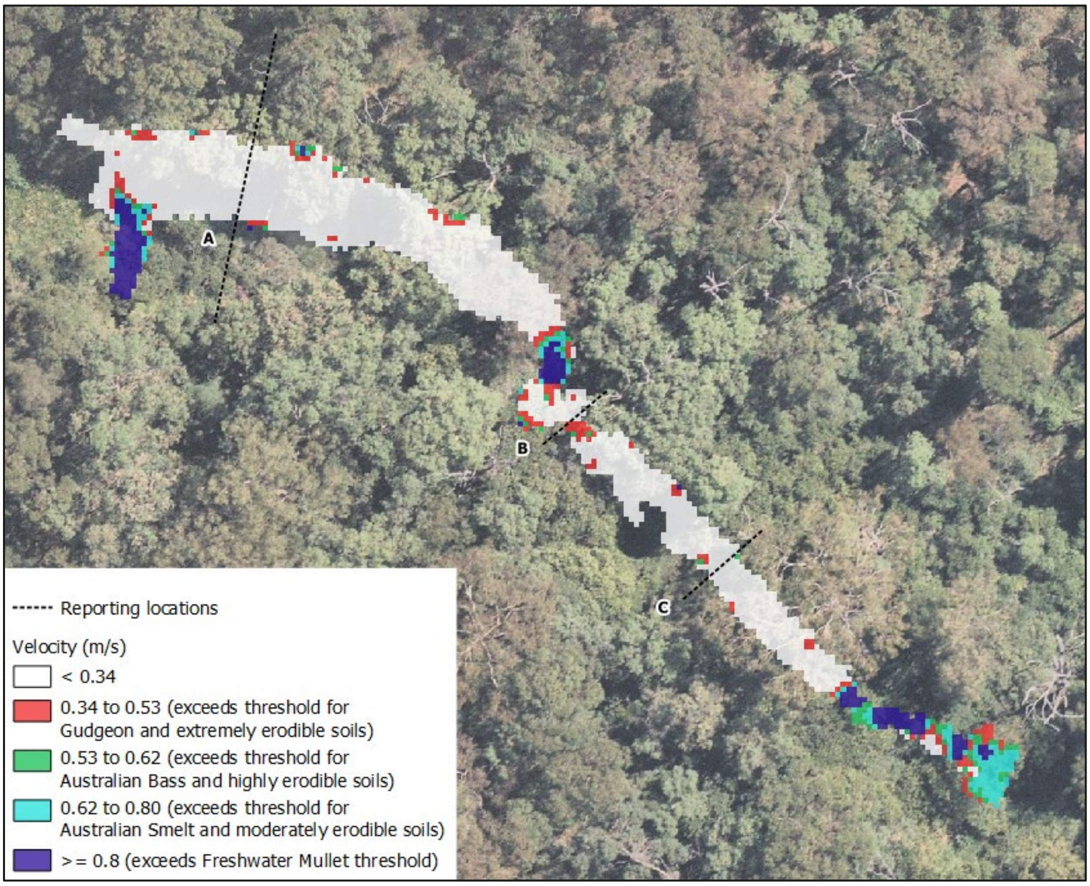

Figure 4-4 2017 Discharge scenario velocity at 75th percentile flow

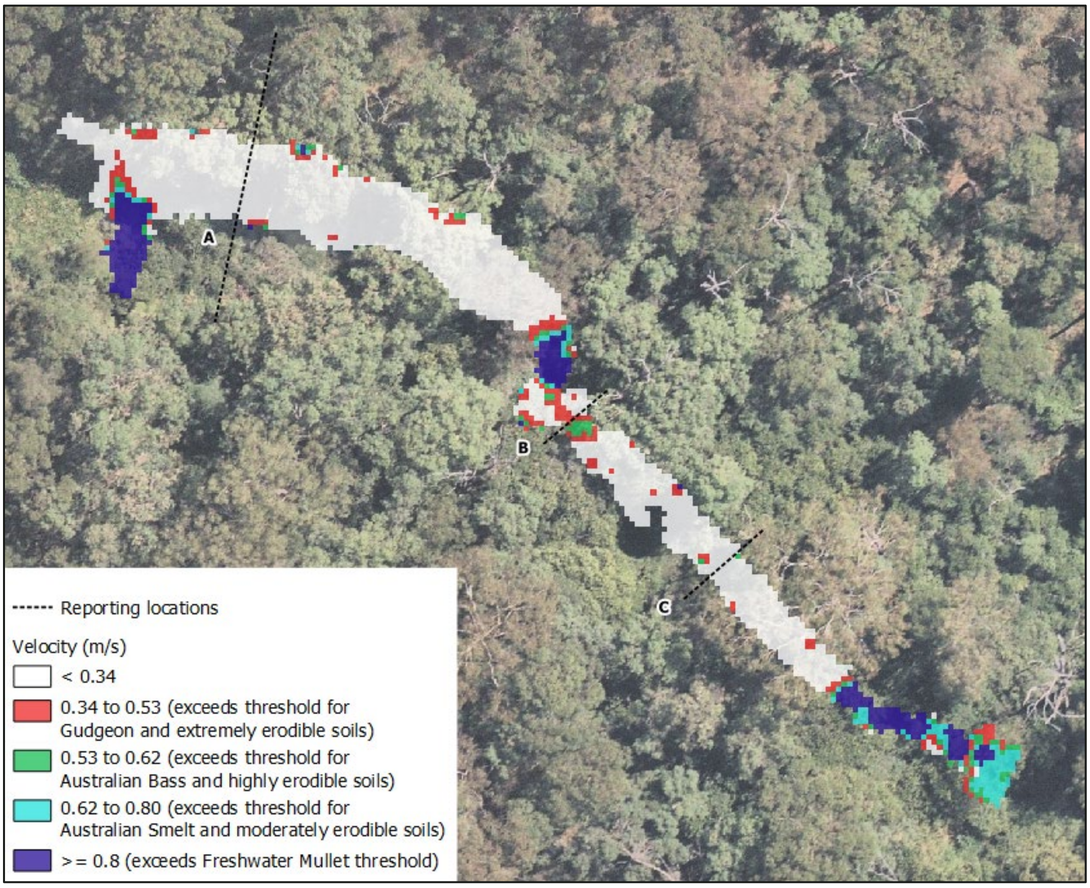

Figure 4-5 2036 Discharge scenario velocity at 75th percentile flow

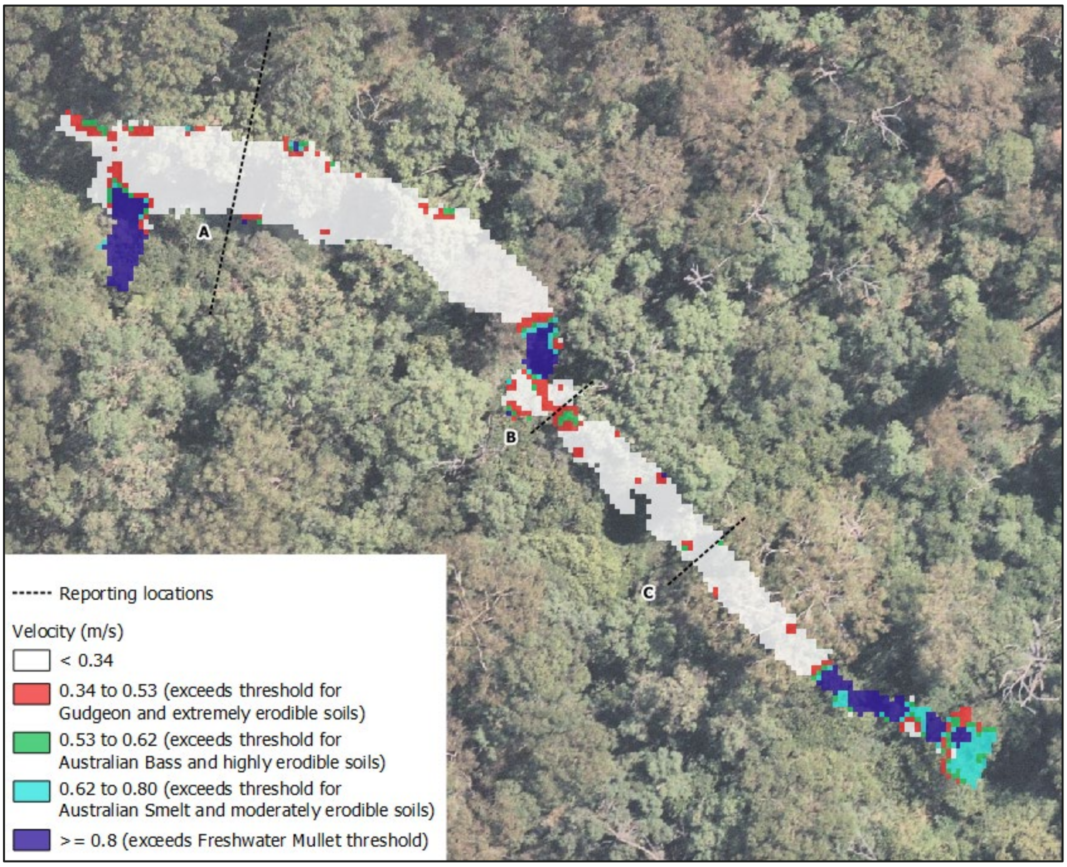

Figure 4-6 **2017 Discharge scenario velocity at 90th percentile flow**

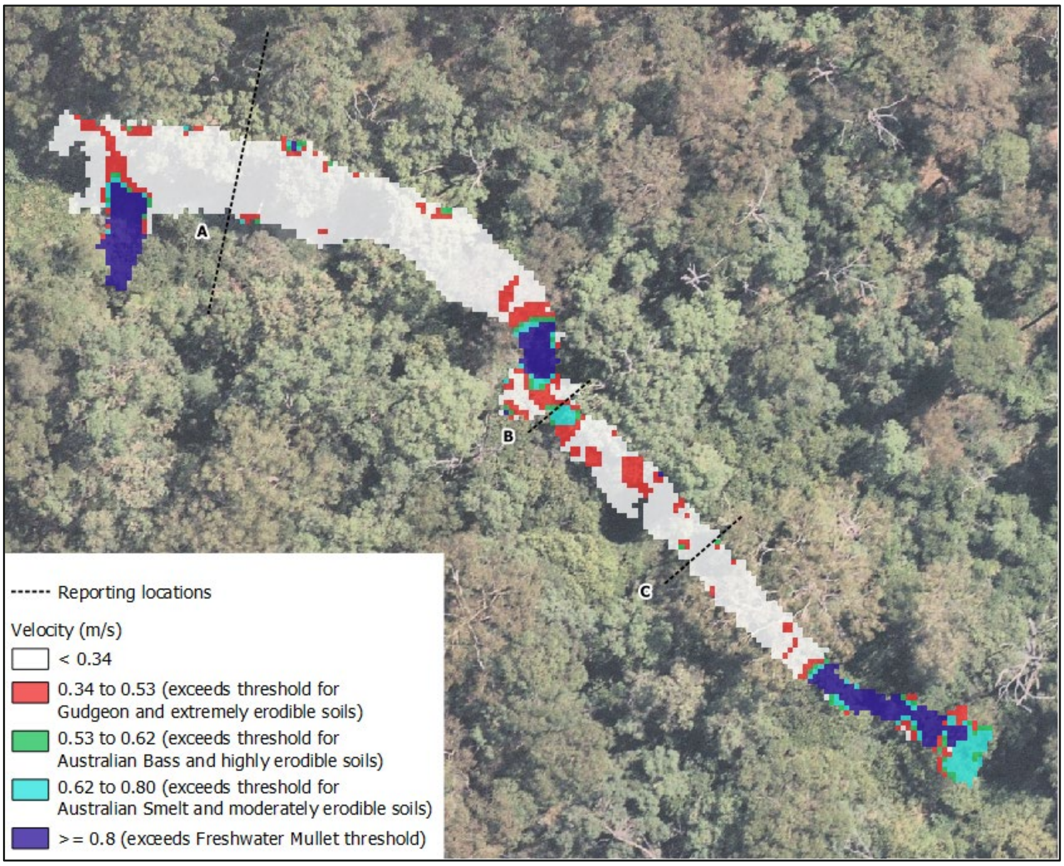

Figure 4-7 **2036 Discharge scenario velocity at 90th percentile flow**

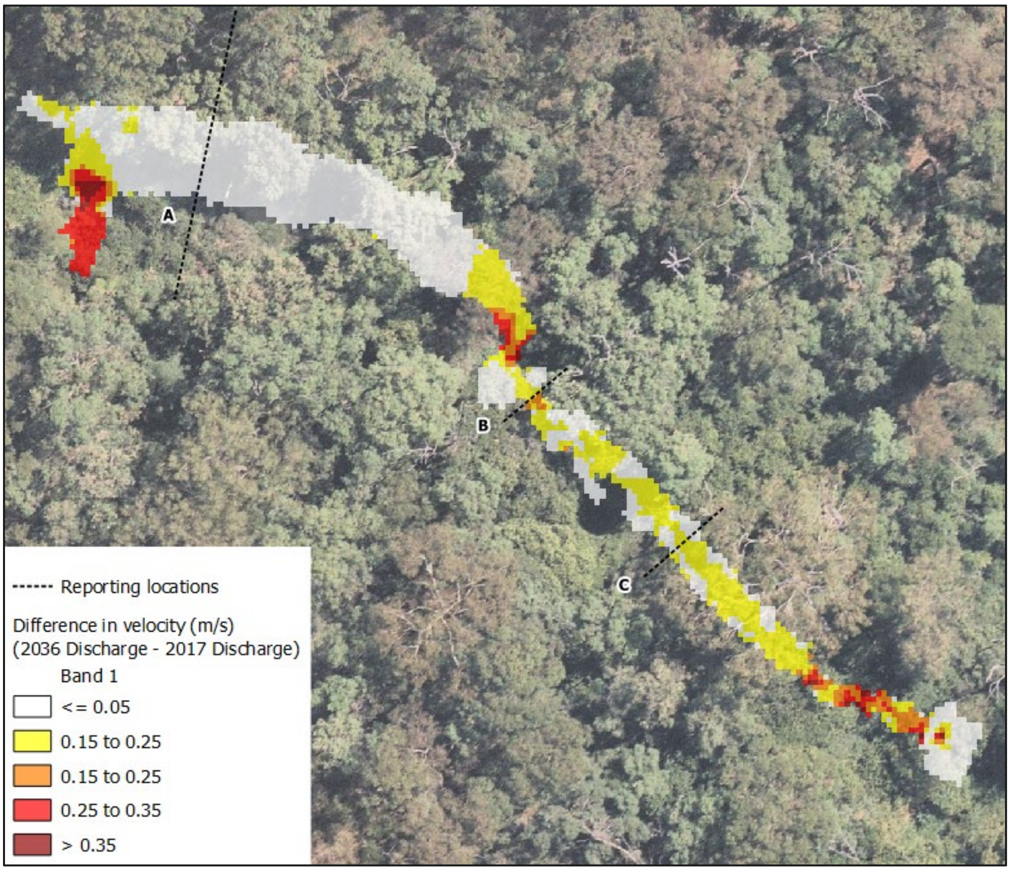

Figure 4-8 Velocity difference map at the 50th percentile flow (2017 vs 2036)

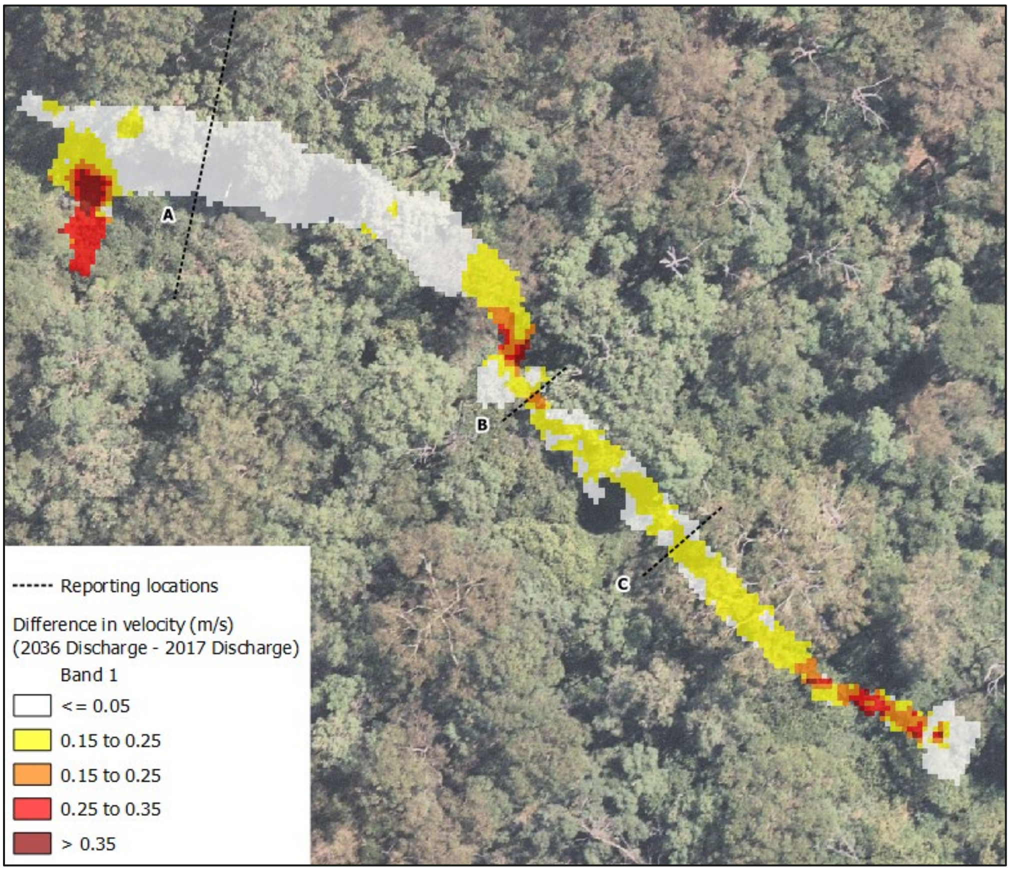

Figure 4-9 Velocity difference map at the 75th percentile flow (2017 vs 2036)

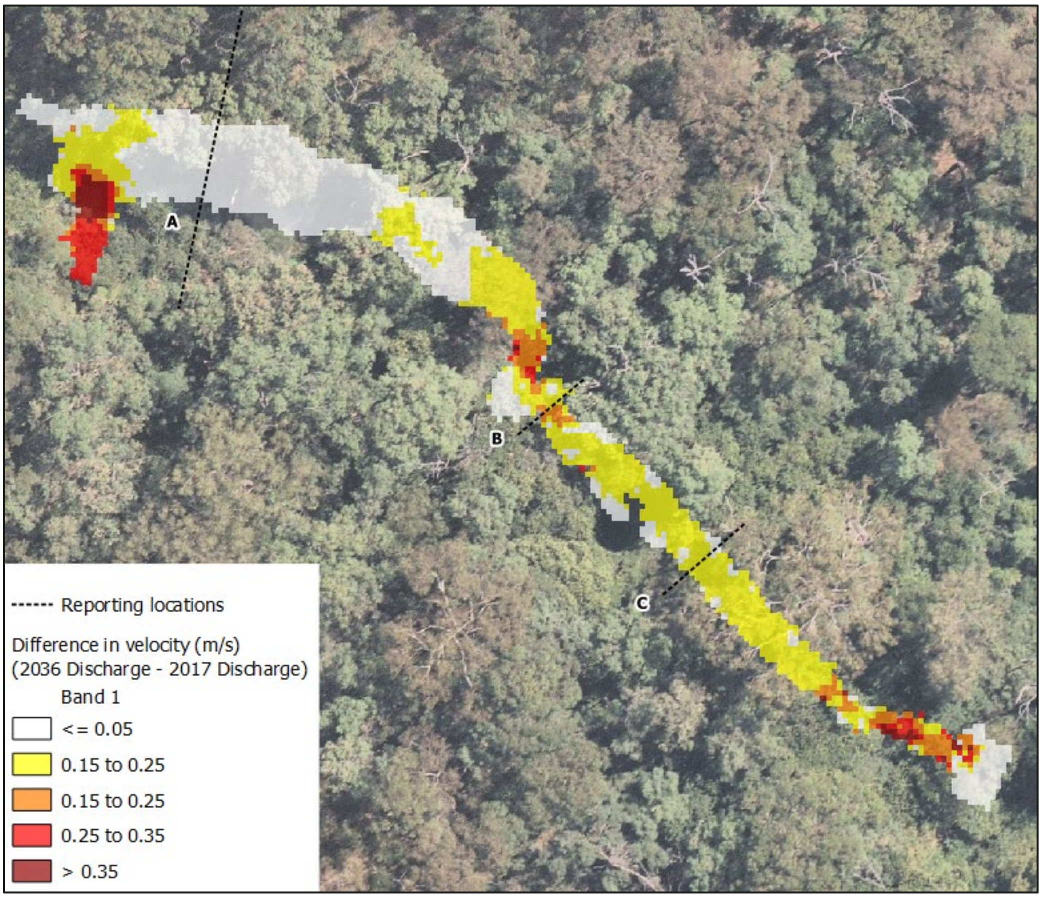

Figure 4-10 Velocity difference map at the 90th percentile flow (2017 vs 2036)

Location B (Fish passage impact risk)

Modelling at location B indicates that the creek only has a potential impact to select fish species that prefer slower moving waters (i.e. Firetail Gudgeon).

In the 2017 scenario the velocities do exceed the threshold for this species 13% of the time when there is discharge from the treatment plant, and this increases up to 65% of the time in the 2036 discharge scenario (refer Table 4-3). This is considered a significant change from existing conditions and may have adverse impacts for the passage of the Firetail Gudgeon fish species. Velocities are not expected to exceed the thresholds for other species as velocities typically remain below 0.5 m/s under all scenarios as shown in Figure 4-11.

Table 4-3 Portion of time average velocity exceeding aquatic ecology zone thresholds (Location B)

Impact receptor / Risk	Velocity required for impact (m/s)	% of time that velocity is exceeded			
		2017 No Discharge	2017 With Discharge	2036 No Discharge	2036 With Discharge
Australian Bass	0.53	0%	0%	0%	0%
Freshwater Mullet	0.80	0%	0%	0%	0%
Firetail Gudgeon	0.34	0%	13%	0%	68%
Australian Smelt	0.62	0%	0%	0%	0%

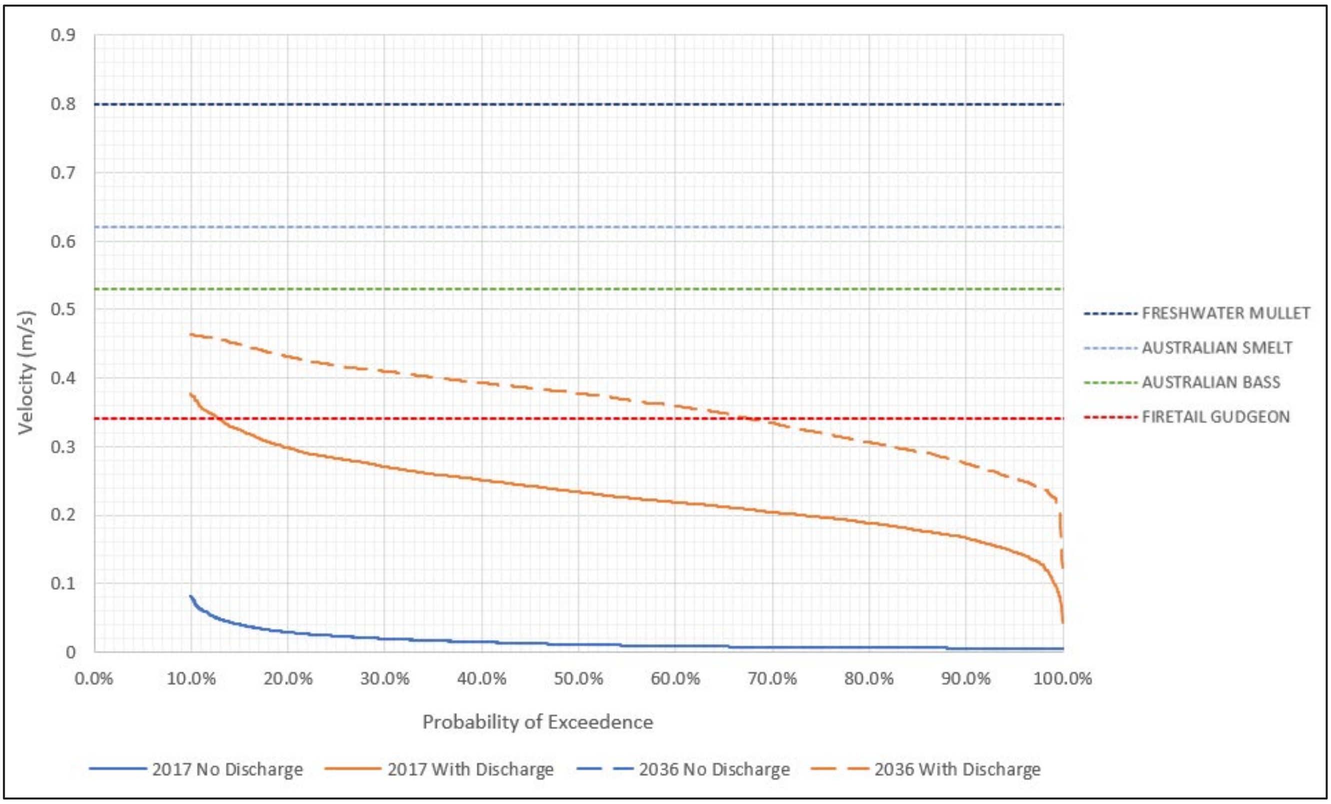

Figure 4-11 Location B velocity exceedance curve

Note: 2017 No Discharge and 2036 No Discharge curves are effectively equal

Location C (Fish passage impact risk)

Modelling of Location C indicates this section is not at risk of impacting fish passage. The flow profile from all scenarios remains under the critical thresholds for the fish species analysed in 4-4 and typically remains below 0.2 m/s as shown in Figure 4-12.

The low velocities through this section are likely due to the shallow grades along this length of the creek as observed in bathymetry (refer Figure 3-7).

Table 4-4 Portion of time average velocity exceeding indirect and direct aquatic ecology zone thresholds (Location C)

Impact receptor / Risk	Velocity required for impact (m/s)	% of time that velocity is exceeded			
		2017 No Discharge	2017 With Discharge	2036 No Discharge	2036 With Discharge
Australian Bass	0.53	0%	0%	0%	0%
Freshwater Mullet	0.80	0%	0%	0%	0%
Firetail Gudgeon	0.34	0%	0%	0%	0%
Australian Smelt	0.62	0%	0%	0%	0%

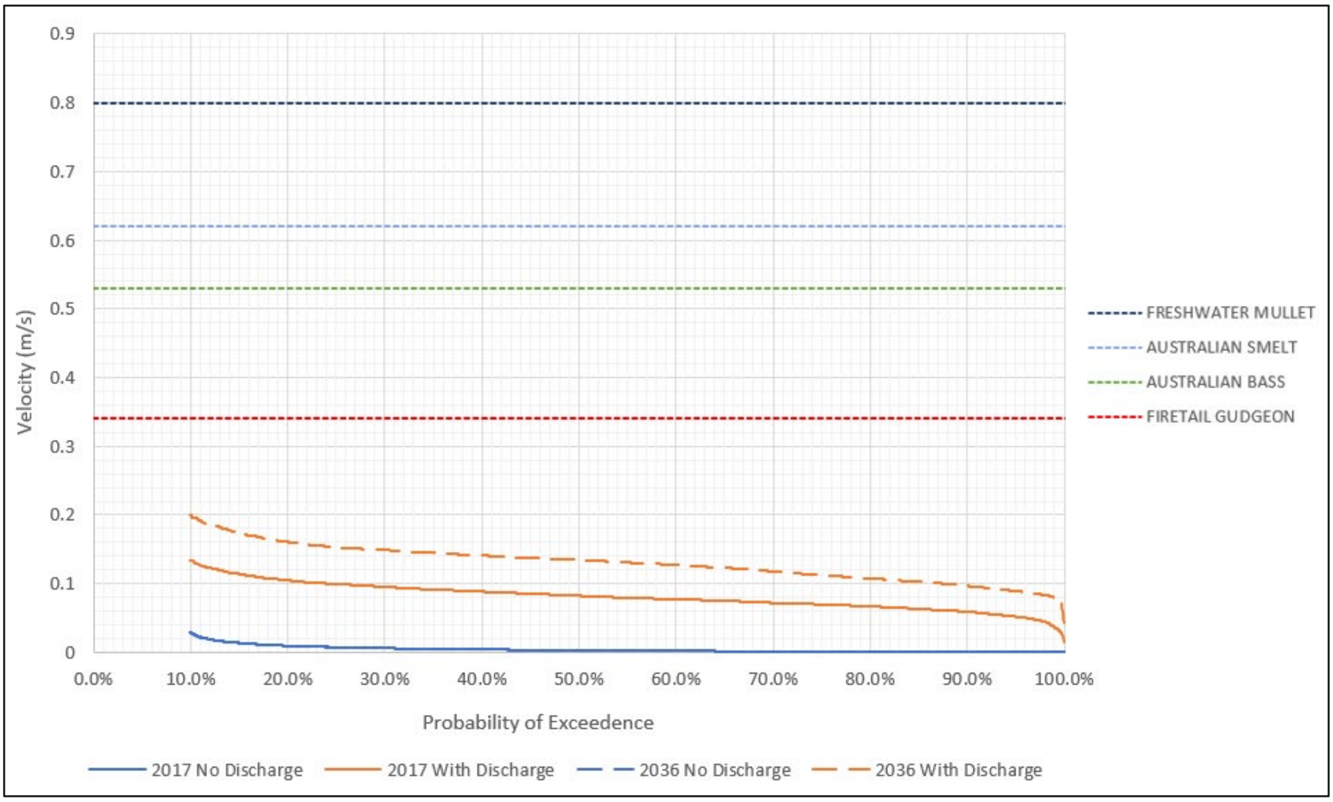

Figure 4-12 Location C velocity exceedance curve

Note: 2017 No Discharge and 2036 No Discharge curves are effectively equal

4.1.3 Fluvial geomorphology: Erosion risk based on shear-stress

Locations A and B (refer Section 2.1.4) were used to determine potential risk of increase bank erosion and macrophyte loss under 2036 WRP discharge. Bank erosion was predominantly discussed with respect the creek geomorphology, but also has indirect implications to ecological stability and may cause deterioration of water quality where erosion processes are accelerated.

The velocity and flow depths were extracted at single points on the cross-section and converted to bed shear stress using Equation 4-1. Point results were used rather than cross-sectional averages, as Equation 4-1 yields answers sensitive to the adopted flow depth. As such, points were placed at appropriate locations of concern to produce relevant results for the environmental receptor of interest.

$$\tau_{bed} = \frac{\rho g V^2 n^2}{y^{\frac{1}{3}}}$$

$\rho = density\ \left(\frac{kg}{m^3}\right)$ $V = velocity\ \left(\frac{m}{s}\right)$ $y = depth\ (m)$

$g = gravity\ (\frac{m}{s^2})$ $n = Manning's\ coefficient$

Equation 4-1 Bed shear stress calculation in TUFLOW hydraulic model (BMT, 2018)

Figure 4-13 and Figure 4-14 present how bed shear stress results vary across the study area for the 2017 and 2036 discharge scenarios under the 50th percentile flow. A comparison map between bed shear stress results under 2017 and 2036 discharge conditions under the 50th percentile flow has been presented in Figure 4-15 to show the overall bed shear stress impact along the creek.

The shear stress exceedance curves and tabulated results for the locations at risk of erosion impacts are presented below.

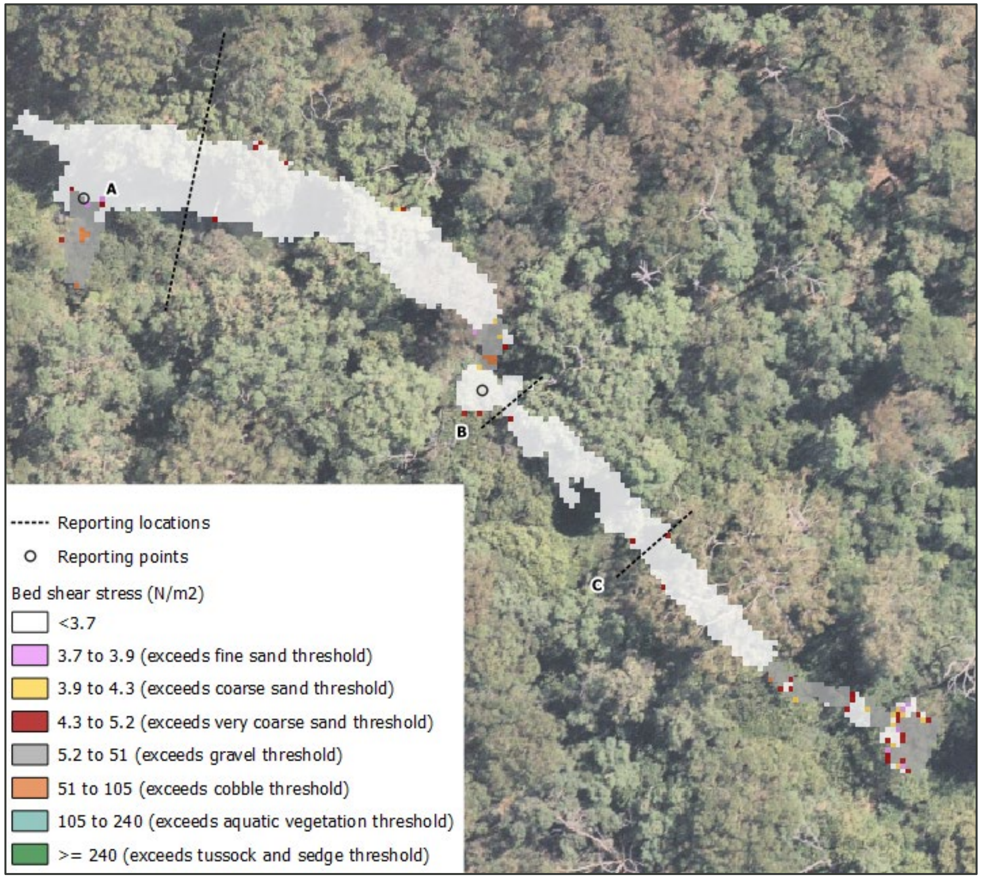

Figure 4-13 2017 Discharge scenario bed shear stress at 50th percentile flow

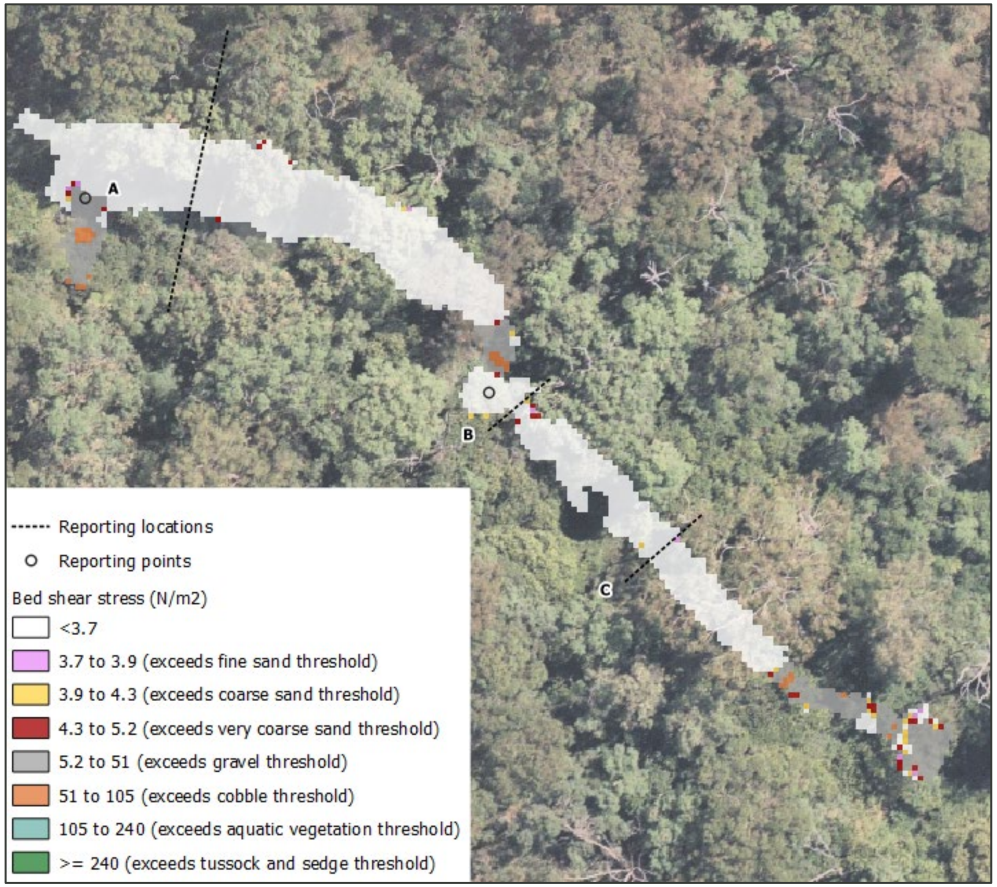

Figure 4-14 2036 Discharge scenario bed shear stress at 50th percentile flow

The extents of shear stress causing mobilisation of gravel in a 50%ile event are relatively similar. This indicates that the average discharge rates from the WRP upgrade will not increase erosion rates under normal, ambient conditions.

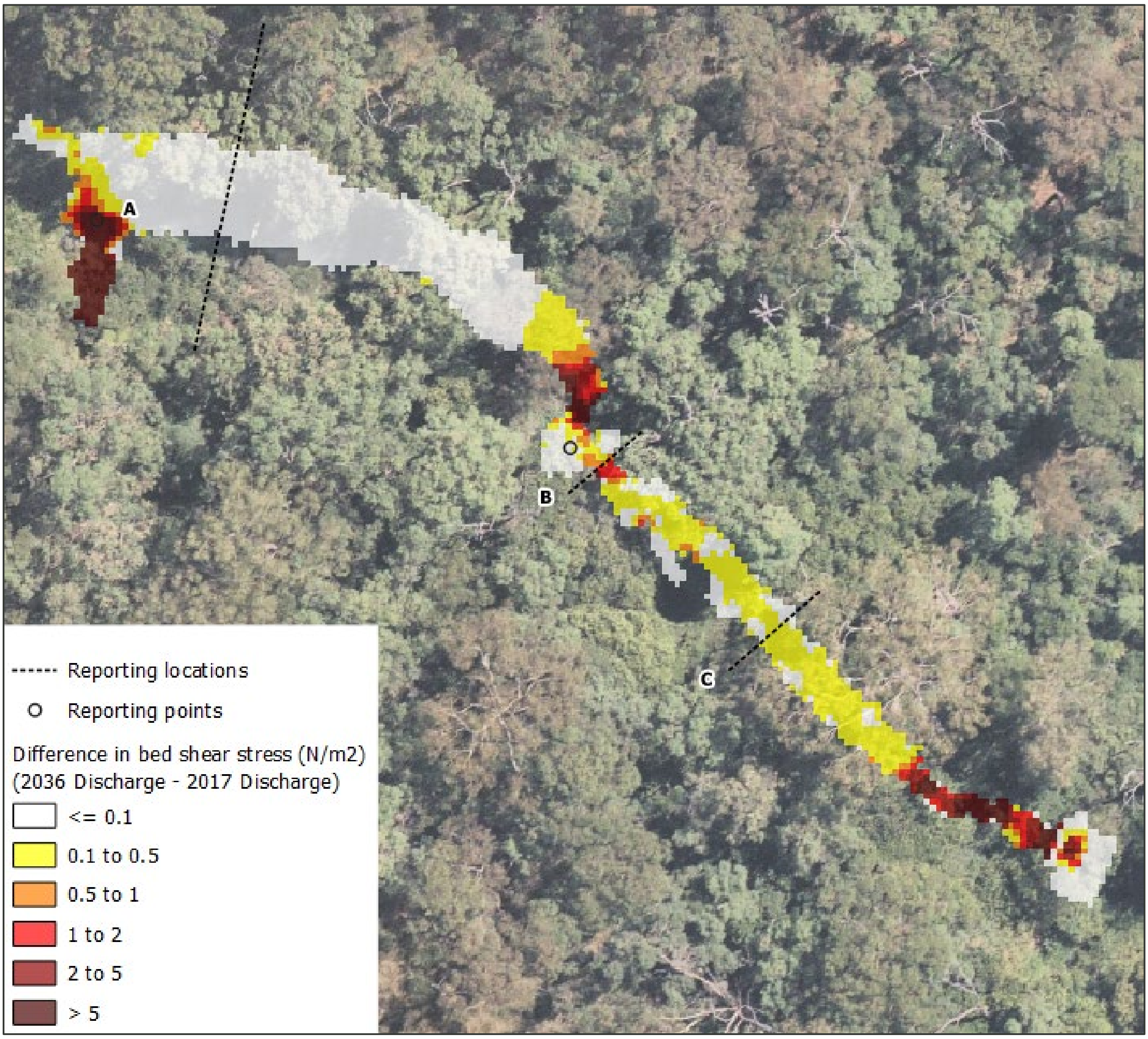

Figure 4-15 Bed shear stress difference map between 2036 and 2017 discharge scenarios at the 50th percentile flow

Location A (Macrophyte dislodgement risk)

Modelling indicates that at location A under the 2017 conditions, the creek does not exceed the shear thresholds for erosion or impact to vegetation. This only changes under 2036 discharge conditions where the thresholds are exceeded for particle sizes between fine sand and gravel. While this does predict an impact for these particle sizes in the 2036 ultimate conditions, the thresholds are exceeded 34% of the time for fine sand to 15% of the time for gravel as shown in Table 4-5. The primary threshold of concern for this location was for submerged aquatic macrophytes due to the existing growth within the pond. The results indicate that there will be no impact to these macrophytes in this location.

Existing bathymetry of the area shows that Location A is within a large pool (refer Figure 3-7). The hydraulic modelling indicated this pool is a relatively dynamic zone where inflows typically circle the pond before flowing downstream. The hydraulics within the pond may account for the low shear stresses observed at Location A, and the depth of the pool here may inhibit the incoming velocities from the treatment plant discharge location.

Table 4-5 Portion of time bed shear stress exceeds geomorphology thresholds (Location A)

Impact receptor / Risk	Critical Tractive Force (N/m²)	% of Time That Critical Tractive Force is Exceeded			
		2017 No Discharge	2017 With Discharge	2036 No Discharge	2036 With Discharge
Fine sand (0.125mm)	3.7	0%	0%	0%	34%
Coarse sand (0.5mm)	3.9	0%	0%	0%	30%
Very coarse sand (1mm)	4.3	0%	0%	0%	23%
Gravel (2mm)	5.2	0%	0%	0%	15%
Cobble (64mm)	51	0%	0%	0%	0%
Aquatic vegetation	105	0%	0%	0%	0%
Tussock and sedge	240	0%	0%	0%	0%

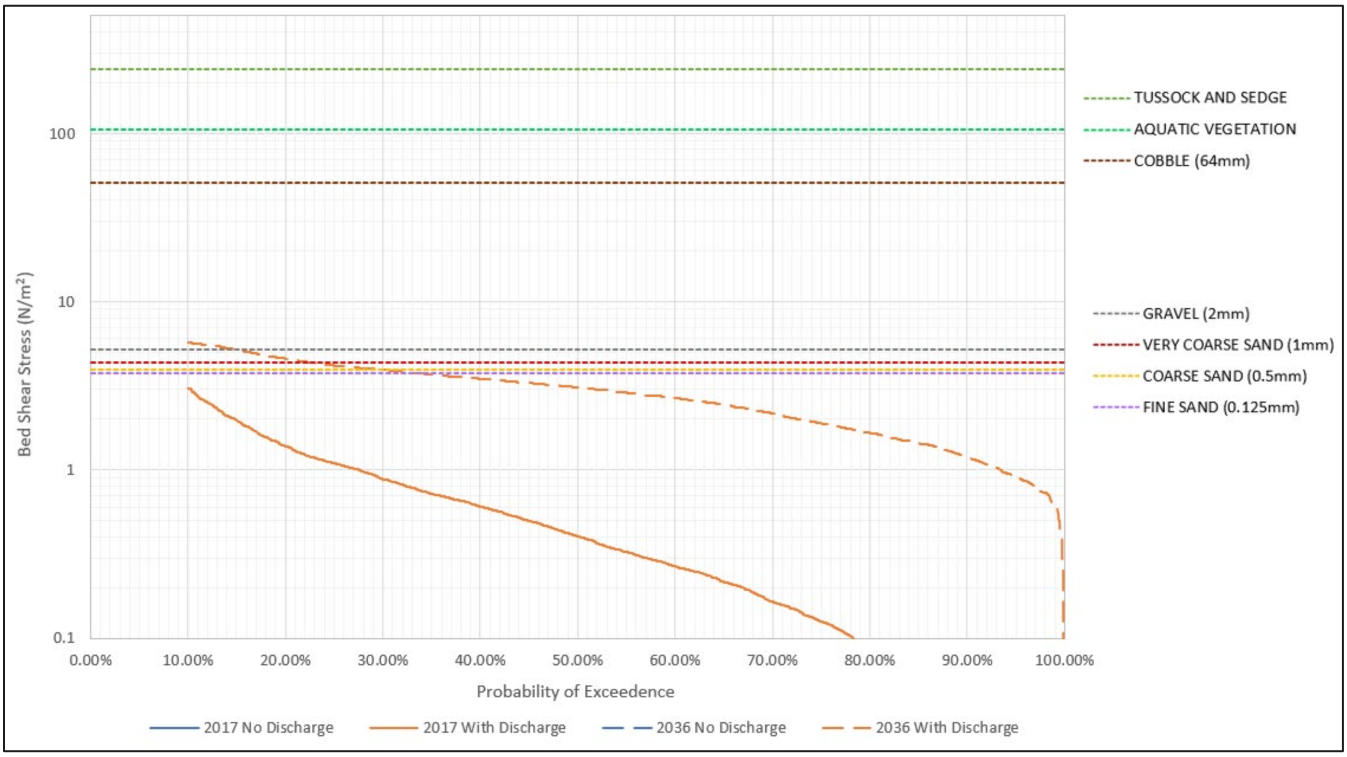

Figure 4-16 Location A shear stress exceedance curve

Note: 2017 No Discharge and 2036 No Discharge curves are below 0.1 N/m²

Location B (Erosion and fish passage impact risk)

Modelling at Location B under all scenarios indicates that erosion thresholds and vegetation thresholds are not exceeded for all flow rates (refer Table 4-6 and Figure 4-17). Field inspections recorded bank erosion in this area which is not detected in model calculations.

Table 4-6 **Portion of time bed shear stress exceeds geomorphology thresholds (Location B)**

Impact receptor / Risk	Critical Tractive Force (N/m^2)	% of Time That Critical Tractive Force is Exceeded			
		2017 No Discharge	2017 With Discharge	2036 No Discharge	2036 With Discharge
Fine sand (0.125mm)	3.7	0%	0%	0%	0%
Coarse sand (0.5mm)	3.9	0%	0%	0%	0%
Very coarse sand (1mm)	4.3	0%	0%	0%	0%
Gravel (2mm)	5.2	0%	0%	0%	0%
Cobble (64mm)	51	0%	0%	0%	0%
Aquatic vegetation	105	0%	0%	0%	0%
Tussock and sedge	240	0%	0%	0%	0%

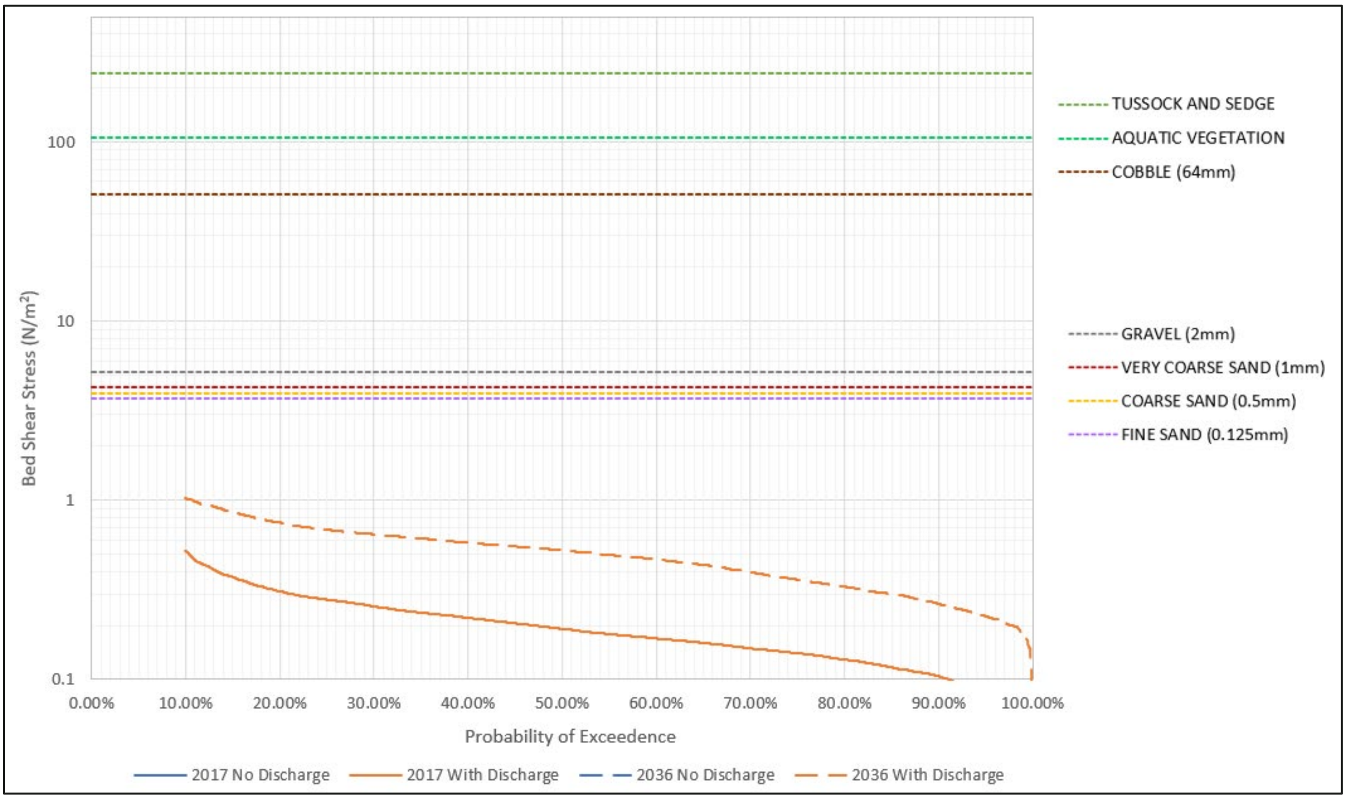

Figure 4-17 **Location B shear stress exceedance curve**

Note: 2017 No Discharge and 2036 No Discharge curves are below 0.1 N/m^2

4.1.4 Impact Assessment Outcomes

1.1.1.1 Cumulative impact assessment

The Cattai Creek catchment upstream of the discharge location is expected to undergo limited urbanisation within the coming years which could potentially further impact the flow regime in Cattai Creek however only to a limited extent.

To account for these changes, the land-use data within the catchment was adjusted in the Source model (see Table 2-2), and thus the simulated no discharge flows for the 2017 and the 2036 scenarios differ. The assessed 2036 discharge scenario thus accounts for both the proposed project changes as well as the expected catchment changes. It is possible to apportion the predicted impacts to either the proposed project or the external changes, by considering the no discharge 2017 versus 2036 results as well. In general, the impacts resulting from the proposed projects changes are much larger than those expected as a result of upstream catchment changes.

1.1.1.2 Summary of potential impacts, proposed mitigation measures and management

The average discharge rate at the Rouse Hill WRP is projected to increase from 16 to 31 ML/day. This is a considerable increase in daily flow; however the waterway has already undergone a significant change in flow conditions at the introduction of wastewater discharge from the 16 ML/day discharge from the existing treatment plant.

The hydraulic modelling undertaken shows that the under existing velocity conditions prevent fish passage at times. This is likely where the channel is constrained by bedrock which forms natural rock chutes and riffles. Modelling also shows that the proposed increase in discharge from the WRP upgrade from 16 to 31 ML/day will not significantly increase the extent of these zones and will not further reduce the extent of fish habitat during times when those chutes become impassable to fish.

Predictive erosion modelling shows that shear stresses will increase along certain zones such as Location A and Location B. The study reach showed that Location A is predicted to experience increased erosive forces where it currently would not experience erosive forces.

Location B, which would also experience an increase in shear stress, however erosion forces would not reach levels that cause the mobilisation of sediment and erosion. This increase in erosive forces may cause localised channel widening and increased erosion and sediment transport processes in some zones. Given than some reaches are exhibiting erosion, this is likely to occur where the banks comprise silts and fine materials sands.

The potential impacts to geomorphology and hydrology from the increased treatment plant discharge and future land use were assessed to include:

- Increased erosion risk of the creek banks and bed due to more frequent higher flows and velocities
- Continued periods where fish passage is impeded due to high velocities, but not significantly more or larger areas of high velocities
- Occasional dislodgement or redistribution of macrophytes, which create habitat for the local ecology.

A summary of the key outcomes is provided in Table 4-7.

Table 4-7 Summary of potential impacts, proposed mitigation measures and management (Rouse Hill WRP)

<table>
<tr><th rowspan="2">Assessment location</th><th rowspan="2">Potential impact</th><th rowspan="2">Analysis</th><th colspan="3">Impact significance</th><th rowspan="2">Mitigation measures recommended</th></tr>
<tr><th>Sensitivity</th><th>Magnitude</th><th>Significance</th></tr>
<tr><td>Second Ponds Creek downstream of the discharge location (entire reach)</td><td>Adversely affecting the ecological health of waterways, riparian vegetation, and other water dependent ecosystems by altering natural hydrology</td><td>Change to hydrologic metrics outlined in Table 4.2</td><td>Low</td><td>Moderate*</td><td>Low</td><td rowspan="5">- Ongoing monitoring of the creek banks should continue for the entire reach through to the confluence with Cattai Creek. Photo logs should be kept of at-risk locations and if required localised stabilisation of the banks should be done.
- Erosion issues should be addressed early to prevent loss of vegetation or loss of usable land in adjacent floodplain</td></tr>
<tr><td>A</td><td>Dislodgement of macrophytes</td><td>Erosion risk based on shear-stress</td><td>Medium</td><td>Low</td><td>Low</td></tr>
<tr><td>B</td><td>Impeding fish passage</td><td>Eco-hydraulic thresholds</td><td>Medium</td><td>Medium</td><td>Moderate</td></tr>
<tr><td>B</td><td>Increased erosion risk</td><td>Erosion risk based on shear-stress</td><td>Medium</td><td>Medium</td><td>Moderate</td></tr>
<tr><td>C</td><td>Impeding fish passage</td><td>Eco-hydraulic thresholds</td><td>Medium</td><td>Low</td><td>Low</td></tr>
</table>

*While change in natural hydrology has been significant, the relative change from existing wastewater discharge represents only a moderate change.

4.2 Increased discharge at Castle Hill WRP

4.2.1 Potential Impacts

The average discharge rate at the Castle Hill Water Recycling Plant (WRP) to Cattai Creek is expected to increase from 6.9 to 7.0 ML/d. This is a relatively minor change as the discharge patterns and ranges are expected to remain similar to the current regime.

Impacts are limited to operational impacts, as no construction is currently expected at this site.

The potential impacts are similar to what has been assessed for the Rouse Hill WRP, these include:

- Increased erosion risk of the creek banks and bed due to more frequent higher flows and velocities
- Impeding fish passage due to excessive exceedances of the swimming velocities
- Dislodgement of local macrophytes, which create valuable habitat for the local ecology

4.2.2 Mitigation measures

Due to the minimal change in average discharge rates and limited potential for exacerbating current impacts, the mitigation measures are limited to the operational practices at the plant:

- The discharge regime and range of instantaneous discharge rates should remain similar to the current practices, to insure no short-term significant velocity surges occur.
- Where possible, the discharge regime should mimic natural flow conditions, with higher discharge rates during high flow conditions and lower during low-flows. This will result in minimising the relative change. These conditions are expected to inevitably occur, as wet weather flows (resulting in higher treatment plant discharge rates) occur during wet weather and subsequently higher flows in the local waterways.
- Ongoing monitoring of the downstream reaches, specifically in erosion prone areas, is recommended to confirm the current expectation of minimal geomorphological changes.

4.2.3 Residual impact

As the impacts from the proposal are typically considered to be transient in nature, a moderate magnitude of disturbance is expected downstream of the discharge location. The residual impact assessment (refer Table 4-8) was considered as the remaining general impact to hydrology and geomorphology after implementation of the mitigation measures identified in Section 4.2.1.

Table 4-8 Residual hydrological and geomorphological impact from increased discharge at Castle Hill WRP

Potential impact	Initial impact significance			Mitigation measures required	Residual significance	
	Sensitivity	Magnitude	Significance		Magnitude	Significance
Increased erosion risk	Medium	Low	Likely insignificant	■ Maintain similar discharge regime to current ■ Mimic natural flow patterns	Low	Likely insignificant
Impeding fish passage	Low	Low	Likely insignificant		Low	Likely insignificant

Potential impact	Initial impact significance			Mitigation measures required	Residual significance	
	Sensitivity	Magnitude	Significance		Magnitude	Significance
Dislodgement of macrophytes	Medium	Low	Likely insignificant		Low	Likely insignificant

4.3 Sludge pipelines

4.3.1 Potential Impacts

Potential impacts to geomorphology and hydrology from the construction and operation of the sludge pipeline between the Riverstone and Rouse Hill treatment plants principally revolve around sedimentation issues arising from construction.

Due to limited detail on pipeline construction methodology, impacts for construction have been based on conventional trenching methods. It is expected that directional drilling or hydro excavation will have no impact on waterways.

Trenching impacts will be temporary but may include:

- Disturbance of saline, sodic soils causing erosion and downstream water quality impacts resulting from increased turbidity and sediment loads during flow events
- Discharge of saline groundwater during dewatering of the construction trench
- Potential erosion risk associated with soils exposed during topsoil stripping, earthworks, excavation and trenching activities
- Inappropriate rehabilitation of riparian vegetation work areas.

Operation impacts are considered to be limited to the following:

- Changes to hydrology from disturbance to the riparian corridor which may result in erosion and scouring of streambanks if inappropriate rehabilitation of riparian vegetation work areas occurs.

4.3.2 Mitigation measures

Impacts to receptors will be reduced through the following hierarchical process:

avoid construction during wet weather wherever possible,

minimise the extent of trenching in wet weather as far as is practical and

mitigate impacts by pumping flows around the trench area or protecting the trench area with shoring and rock works.

Mitigation during construction includes environmental management measures to prevent or limit erosion and sedimentation through the design, planning and construction process, principally through the design and implementation of construction environmental management plan which will define requirements to:

- Minimisation of clearing
- Minimise sediment reaching adjacent waterways
- Diversion of clean waters from areas of disturbance
- Early installation of all drainage, erosion and sediment control measures,
- Protection of exposed soil surfaces from erosion using shoring and armouring
- Progressive stabilisation and revegetation of disturbed areas.

4.3.3 Residual impact

As the impacts from the proposal are typically considered to be transient in nature (especially during construction), a moderate magnitude of disturbance is effective across the potential disturbance area. The residual impact assessment (refer Table 4-9) was considered as the remaining general impact to hydrology and geomorphology after implementation of the mitigation measures identified in Section 4.3.2.

Table 4-9 Residual general hydrological and geomorphological impact from pipeline construction

Potential impact	Phase	Initial impact significance			Mitigation measures required	Residual significance	
		Sensitivity	Magnitude	Significance		Magnitude	Significance
Changes to hydrology from disturbance to riparian corridor	Construction	Low	Low	Likely insignificant	▪ Minimise sediment reaching adjacent waterways ▪ Work area capture of sediment ▪ Diversion of clean waters from areas of disturbance ▪ Management of topsoil	Low	Likely insignificant
	Operations		Low	Likely insignificant		Low	Likely insignificant
Changes to geomorphology due to dewatering	Construction	Low	Low	Likely insignificant	▪ Minimise sediment reaching adjacent waterways ▪ Early installation of all drainage, erosion and sediment control measures	Low	Likely insignificant
	Operations		Low	Likely insignificant		Low	Likely insignificant
Erosion risk from earthworks and excavation	Construction	Low	Low	Likely insignificant	▪ Early installation of all drainage, erosion and sediment control measures ▪ Diversion of clean waters from areas of disturbance ▪ Work area capture of sediment ▪ Management of topsoil	Low	Likely insignificant
	Operations		Low	Likely insignificant		Low	Likely insignificant
Changes to hydrology from inappropriate rehabilitation of riparian vegetation work areas	Construction	Low	Low	Likely insignificant	▪ Progressive stabilisation and revegetation of disturbed areas.	Low	Likely insignificant
	Operations		Low	Likely insignificant		Low	Likely insignificant

5 Conclusion

To service population growth in Western Sydney, Sydney Water will increase treatment capacity of their existing Wastewater Treatment facilities including Rouse Hill and the Castle Hill WRPs, which currently discharge treated effluent to Second Ponds Creek and Cattai Creek respectively.

The Cattai Creek and Second Ponds Creek catchments upstream of the discharge locations have undergone significant development which has affected the hydrology and the subsequent flow regimes within these waterways. The waterways are already moderately impacted by these impacts, the proposed increase in discharge will likely exacerbate these conditions, however the modelling indicates no major loss of habitat than that which has occurred already.

Rouse Hill WRP – Quantitative assessment

The treatment capacity at the plant will be upgraded and discharge to Second Ponds Creek will increase from 16 ML/d to 31 ML/d. A hydraulic assessment of a typical reach of Second Ponds Creek indicates that the increase in flows may result in the following impacts:

- An increase in the proportion of time that shear stress thresholds for particles smaller than 2mm will be exceeded, resulting in pockets of increased erosion. This may extend beyond the reach investigated and extend to a downstream location in the Cattai Creek
- Small amount of redistribution of macrophyte habitat
- A relatively small increase in the occurrence of velocities that impede fish passage.

Castle Hill WRP – Qualitative assessment

The treatment capacity at the plant is proposed to be increased resulting in an increase in average discharge rate from 6.9 ML/d to 7 ML/d (including wet weather flows which will be transferred via the sewage network). This is a relatively minor change as the discharge patterns and ranges are expected to remain similar to the current regime. Incorporating the recommended mitigation measures will result in minimal change in the risk to impacting hydrology and geomorphology in the creek compared to the current conditions.

Sludge transfer pipelines – Qualitative assessment

The majority of the potential impacts to the local waterways are expected during the construction phase. Incorporating the recommended mitigation measures is expected to result in negligible impacts to the waterways hydrology and geomorphology.

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Appendix A – Sediment sample and particle size distribution lab reports

Certificate of Analysis

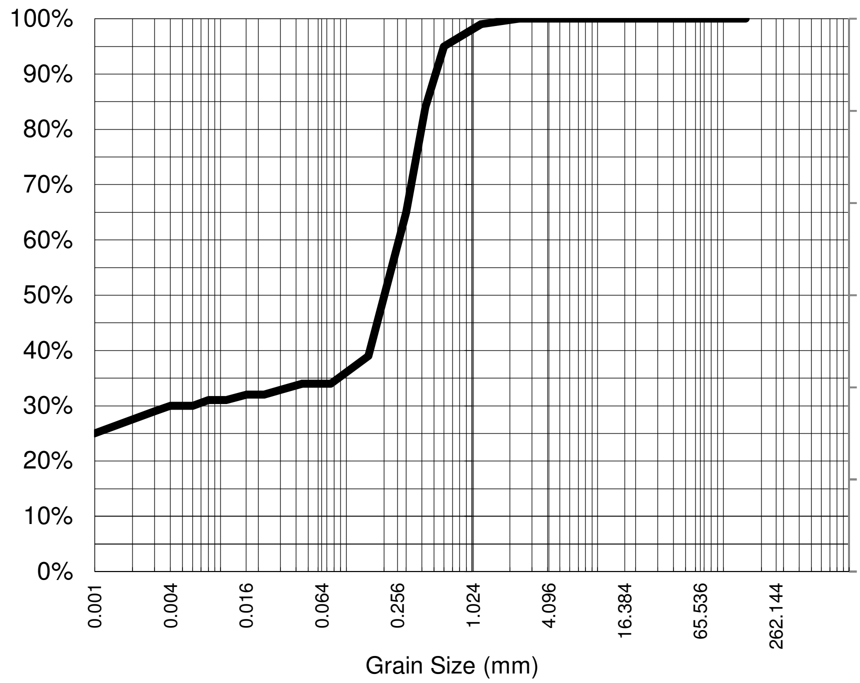
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	AMELIA BASSON	**DATE REPORTED:**	22-Jun-2021
COMPANY:	AURECON AUSTRALASIA PTY LTD	**DATE RECEIVED:**	11-Jun-2021
ADDRESS:	PO Box 538 Neutral Bay NSW, Australia	**REPORT NO:**	ES2121996-001 / PSD
PROJECT:	505018	**SAMPLE ID:**	505018_NWTH_SD01_010621

Particle Size Distribution



Particle Size (mm)	% Passing
2.36	100%
1.18	99%
0.600	95%
0.425	84%
0.300	65%
0.150	39%
0.075	34%
Particle Size (microns)	
44	34%
31	33%
22	32%
16	32%
11	31%
8	31%
6	30%
4	30%
1	25%

Median Particle Size (mm)*	0.213

Analysis Notes

Samples analysed as received.
** Soil Particle Density required for Hydrometer analysis according to AS 1289.3.5.1—2006 was not requested by the client . Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results*

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 18-Jun-21

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: SAND, FINES

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) #N/A

NATA Accreditation: 825 Site: Newcastle
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NATA
WORLD RECOGNISED ACCREDITATION

Aleksandar Vujkovic
Laboratory Supervisor
Authorised Signatory