Memo

From	Brandon Goeller, Riparian & Wetland Scientist, NIWA
To	Trevor James, Resource Scientist, Tasman District Council
CC	Tony Reilly, Landowner Annette Litherland, NZ Landcare Trust
Date	20 March 2020
Subject	Reilly Farm Floodplain Reconnection Planning for Berkett Creek, Tasman
File path *(right click to update)*	Attachment: Conceptual design plans for Reilly Farm, Berkett Creek Floodplain Reconnection

Project aim & objectives

The aim of this project is to improve the water quality and in-stream and riparian habitat of Berkett Creek and the downstream waterways (Powell Creek and Motupipi River). This will be achieved by "reconnecting" a portion of Berkett Creek with its floodplain as it used to be prior to channel straightening in the 1970's to 1980's. The floodplain reconnection will consist of creating in-stream sediment traps, constructing shallow, vegetated, surface flow treatment wetlands, and planting riparian vegetation. Livestock access will be excluded by fencing both sides of the floodplain where restoration work will be undertaken (including the sediment traps, wetland areas, and riparian planting).

The water quality and ecological status of this reach of Berkett Creek is poor[1]. TDC monthly water quality data sampled from July 2006 to June 2007 indicate relatively high concentrations of faecal indicator bacteria and nitrate-nitrogen, but relatively low concentrations of phosphorus (Table 1). The current ecological health of the reach considered for this project is degraded, as it is trampled by cattle and the only cover for fish is grass (Trevor James, TDC, personal communication). Moreover, this is the only reach in the Berkett Creek catchment that is not fenced as of January 2020 (Trevor James, TDC, personal communication). The culvert at the outlet of Reilly Creek in the base of the gully is currently non-passable to fish. The current fish fauna in Berkett Creek is species poor, consisting of bullies (*Gobiomorphus cotidianus*) and shortfin eels (*Anguilla australis)*. However, historical records indicate the presence of Banded kōkopu (*Galaxias fasciatus*) upstream in Reilly Creek (Trevor James, TDC, personal communication).

Table 1: Summary statistics for flow and water quality data sampled monthly by TDC from July 2006 to June 2007 Berkett Creek upstream of its confluence with Powell Creek.

Statistic	Flow (L/sec)	E. coli (CFU)	NO_3-N (g/m^3)	DRP (g/m^3)	TSS (g/m^3)
No. cases	12	11	12	12	11
Median	8	1300	1.2	0.005	4
Mean	16	1644	1.3	0.006	5
STDEV	24	1394	0.8	0.004	4
95% CI	15	885	0.5	0.002	2

The objective of the planned floodplain restoration is to settle out disease-causing organisms (faecal microbes) and fine sediment that are released to the stream during small to moderate rainfall events. The

[1] James, T., McLarin, M. (2008) Water quality in the Powell Creek catchment, Motupipi (Draft Report). Tasman Disctric Council Report 08001. 50 pages.

stream rises quickly in response to rainfall, causing short and sharp flood events, due to the low permeability of the silt-loam soils and rolling, hilly topography of the catchment (James and McLarin 2008). This results in high rates of erosion and high concentrations of suspended sediment runoff from the catchment. It is acknowledged that high rainfall events will cause flooding and water velocities such that very little settling will occur in this area.

Wetland construction

This work will be located in a gully on the Reilly Farm near Motupipi (Figure 1). For this location, NIWA has delineated the 75.9 ha sub-catchment of Berkett Creek and the surface flow network using 1-m grid LiDAR data collected from a 2016 aerial survey. The entire sub-catchment includes three main landowners who farm beef cattle. NIWA generally recommends scaling the size of constructed wetlands for diffuse agricultural contaminant treatment to be between 1-5% of the contributing catchment area. However, TDC and the Reilly family have acknowledged that this floodplain restoration on the Reilly Farm will not in itself treat pasture runoff from the whole catchment, but it should, however, provide an appropriate contribution for treating runoff from the Reilly Farm. The proposed floodplain reconnection, including shallow wetlands and sediment traps, is only ~0.3% of the contributing 75.9 ha upstream catchment of Berkett Creek.

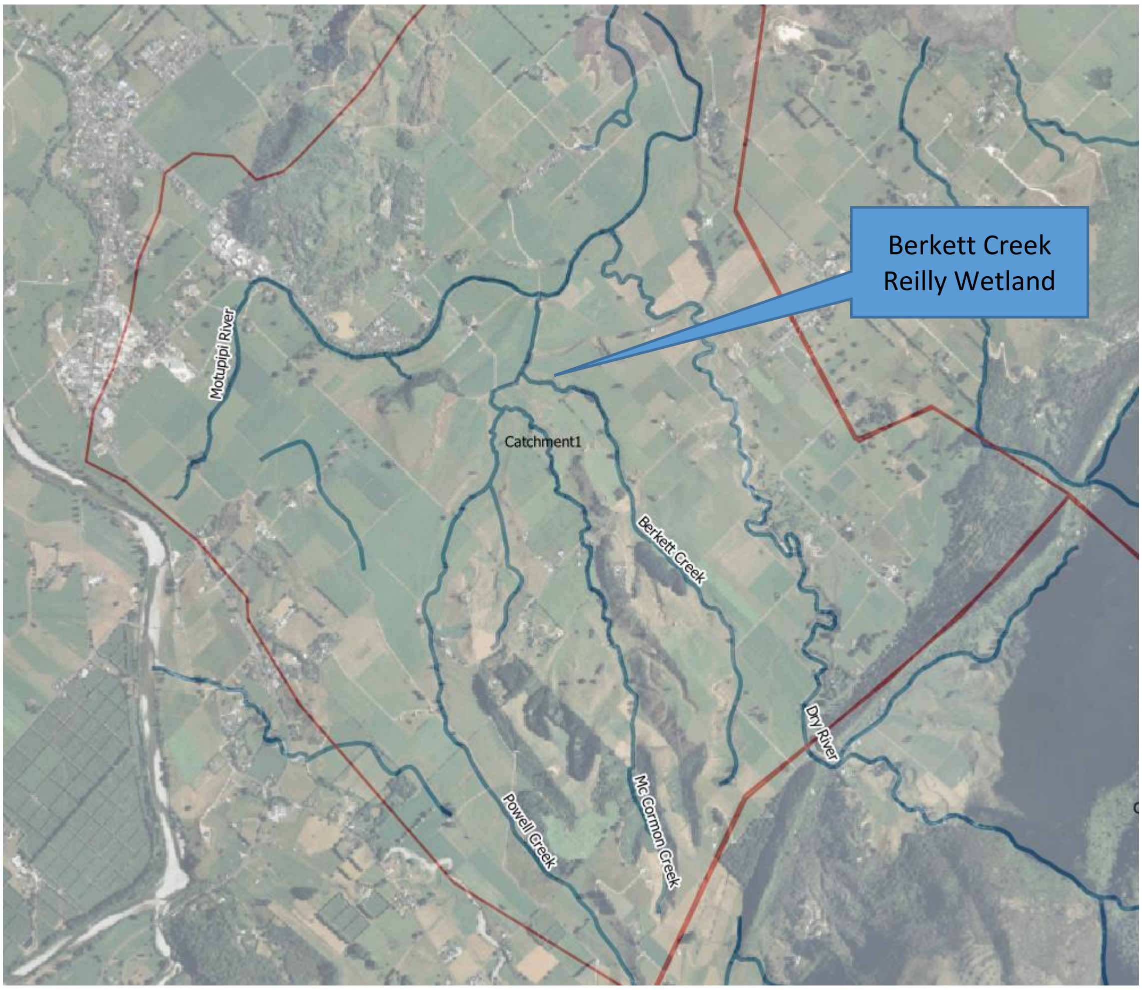

Figure 1: Aerial view of the Motupipi River showing the site of the proposed wetland in lower Berkett Creek. The Red line is the approximate catchment boundary excluding upper Dry River. Dashed line box indicates the inset area shown below. Figure provided by Trevor James, TDC.

NZ Landcare Trust is providing ~$6,000 NZD to fund the floodplain reconnection in Berkett Creek. A resource consent for the Motupipi has been obtained by TDC. The landowner Tony Reilly will supply the land and provide logistical support. In consultation with TDC and Tony Reilly, NIWA has supplied plan and transverse views of the constructed wetland. The proposed design could be implemented over two years to spread construction costs. The main actions associated with re-connecting the floodplain include excavating new shallow channel sections, shallow wetland areas, and deep sediment traps, as well as using low bunds to help inundate the upstream wet areas.

Since the objective is to maximise the attenuation of faecal microbes, NIWA proposes using multiple, deep open water areas and planting shallow wetland areas with a mix of native sedges to provide a relatively open canopy for sunlight penetration and promotion of solar disinfection. Moreover, the open water areas will be large and deep enough to serve as sediment traps for attenuating fine silt and larger-sized particles at or below baseflows. Sediment traps have limited capacity to remove very fine silt and clay, which have the biggest risk for transporting sediment-associated contaminants, such as phosphorus. Given the flashy nature of the streamflow in Berkett Creek and the likelihood that the majority of the annual sediment load is transported during flood events, sizing sediment traps to be large and effective enough to retain the finest sediment fractions from above average flows would be impractical. Therefore, creating and routinely cleaning-out a series of sediment traps sized large enough to capture fine to medium silt at or below baseflows from the lower portion of the catchment is recommended.

We have analysed the available flow and sediment data from July 2006 to June 2007 for Berkett Creek upstream of its confluence with Powell Creek (Table 1) to design the sediment traps. The design target was to create traps that would be sized large enough to attenuate fine silt at baseflow and small to moderate stream flows. Under these conditions, the sediment traps should attenuate 100% of medium silt and virtually all larger-sized sediment particles, 50% of fine silt, and retain some very fine silt and smaller particles.

At an estimated baseflow of 8 L s^{-1} (0.008 m^3 s^{-1}), an individual sediment trap of 34.7 m^2 would not be expected to retain particles as fine as clay, but would likely retain some very fine silt, 50% of fine silt, and virtually all larger size particles. The sediment particle size capture within different size sediment traps at baseflow is shown in Figure 2.

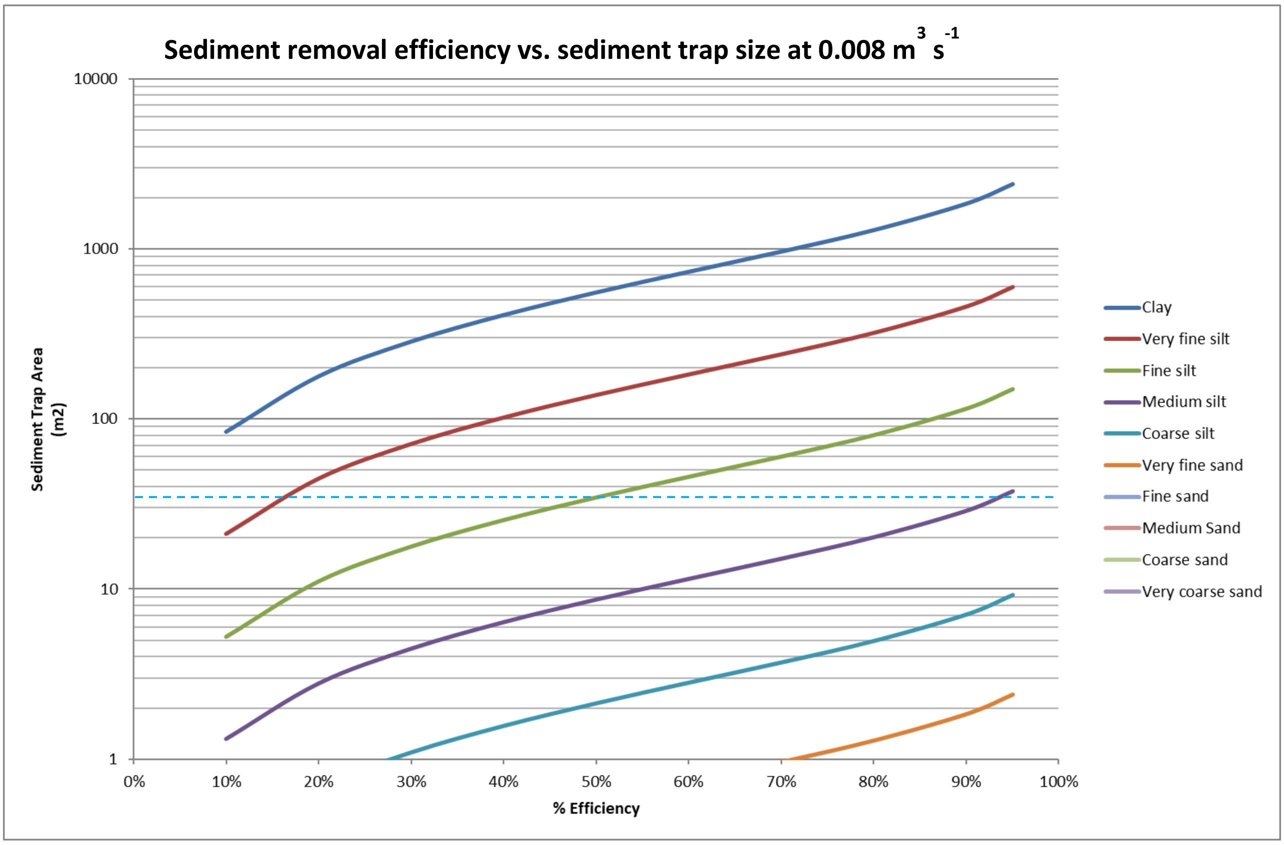

Figure 2: Particle size capture efficiency for a sediment trap with flows of 0.008 m^3 s^{-1} for a range of suspended solid particle sizes[2]. Sediment trap size shown as a dashed horizontal blue line.

During small to moderate drainage events with an estimated flow of 16 L s^{-1} (0.016 m^3 s^{-1}), an individual sediment trap of 69.3 m^2 would not be expected to retain particles as fine as clay, but would likely retain some very fine silt, 50% of fine silt, and virtually all larger size particles. The sediment particle size capture within different size sediment traps at baseflow is shown in Figure 3.

NIWA has scaled the sediment traps to be between 93-126 m^2, with widths of ~8 m and lengths varying from 16-18 m and depths of 0.8-1.5 m. The sediment traps have been located in the gully bottom to allow for periodic digger access for excavating accumulated sediments. Assuming that the sediment traps have been maintained to provide adequate storage capacity of 1-1.5 m depth, approximately 60% of fine silt and virtually all larger particle sizes should be retained within these traps at an estimated flow of 16 L s^{-1} (Figure 3).

[2] Particle size capture efficiencies, sediment trap sizes, and flows based on:
Hudson, H.R. (2002) Development of an in-channel coarse sediment trap best management practice, p. 43, Environmental Management Associates Limited, Prepared for Ministry of Agriculture and Forestry, Christchurch.

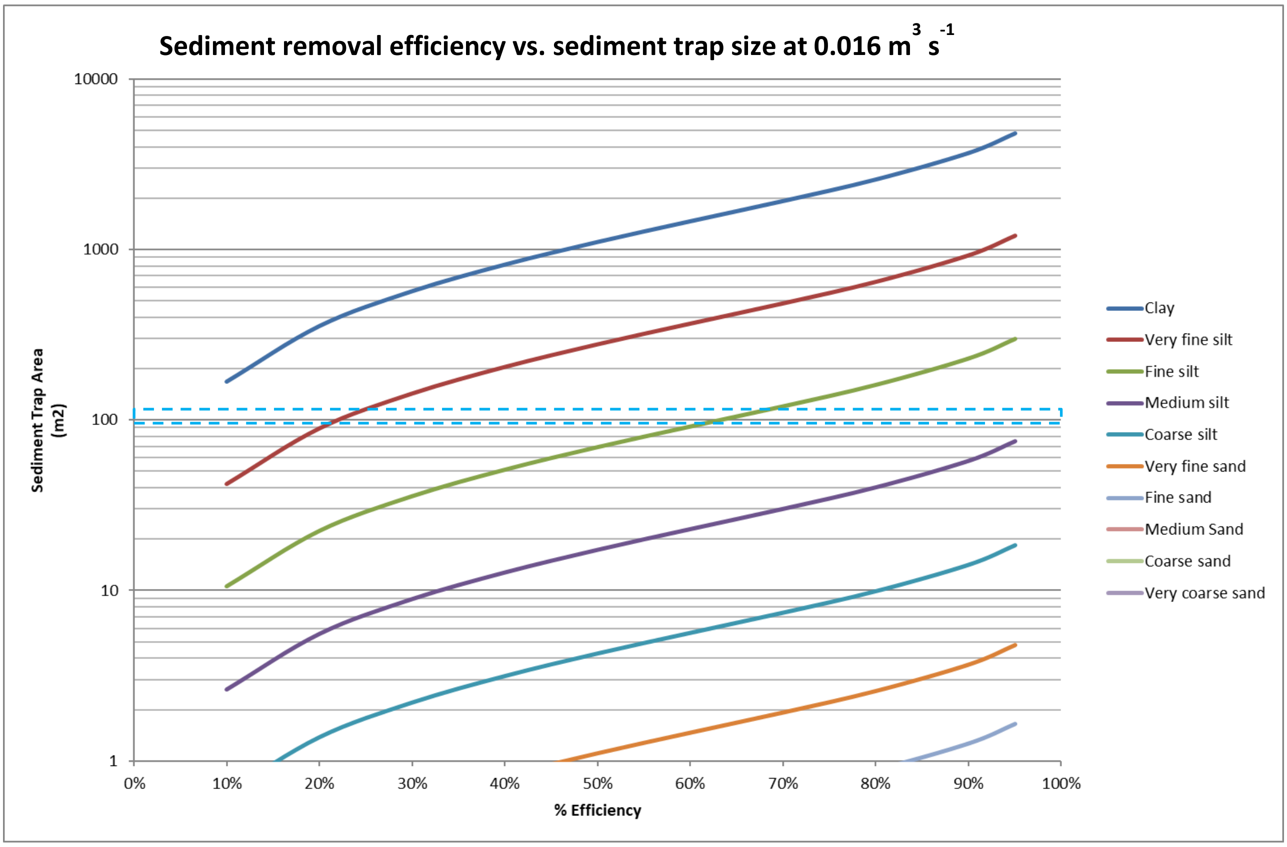

Figure 3: Particle size capture efficiency for a sediment trap with flows of 0.016 m^3 s^{-1} for a range of suspended solid particle sizes[3]. Sediment trap sizes shown as a dashed horizontal blue box.

Wetland & riparian planting

NIWA recommends planting the main canopy-forming wetland and floodplain species, with diversity provided by self-establishment of species brought in by birds and wind dispersion. The proposed shallow wetland planting assumes planting of 60% of the shallow wetland area, with ~40% open water to maximise solar disinfection of faecal microbes. NIWA has specified the wetland plant species and quantities, and NZ Landcare Trust is responsible for ordering the plants. NZ Landcare Trust has obtained ~600 wetland plants to contribute to the project. The landowner, Tony Reilly, will be managing the project, including organising the planting, weeding and pest control. NIWAs wetland planting recommendations for this project are provided in Table 2.

The main wetland plants should be planted within the shallow vegetated area of the flooded area upstream of the bunds. The wetland edge/shallow water margin should be planted as a 1m buffer around the wetland areas. The wetland bunds should be planted with grass species. *Carex secta* could be planted on the upstream side of the bunds to help dissipate high flow velocities during flood events. The wetland gully embankments should be planted as a 2-3m buffer around the wetland edge/shallow water margin. The lowland area surrounding the wetland embankments should be fenced and planted with additional native species such as kahikatea to increase biodiversity and amenity values.

[3] Particle size capture efficiencies, sediment trap sizes, and flows based on:
Hudson, H.R. (2002) Development of an in-channel coarse sediment trap best management practice, p. 43, Environmental Management Associates Limited, Prepared for Ministry of Agriculture and Forestry, Christchurch.

Table 2: Overview of wetland planting zones, plant species, and recommended planting densities for the Berkett Creek floodplain reconnection. Other species can be substituted or planted interspersed with the embankment plants such as other native hardwood shrubs and trees. TDC provides suitable resources for determining other appropriate wetland and terrestrial plant species for enhancing biodiversity[4,5].

Species name	**Depth range (mm)**	**Plants[1] per m^2**
Wetland gully embankments and wetland surroundings (total area = 2,000 m^2)		
Harakeke / *Phormium tenax /* flax	-	2
Toetoe / *Austroderia richardii* / toetoe	-	2
Ti kouka / *Cordyline australis* / cabbage tree		1
Kahikatea / *Dacrycarpus dacrydioides* / kahikatea		1
Wetland edges (total area = 460 m^2)		
Purei or makura / *Carex secta* / carex	300	2
Toetoe upoko tangata / *Cyperus ustulatus* / giant umbrella sedge	100	3
Shallow wetland area (total area = 1,500 m^2)		
Kōpūpū / *Schoenoplectus tabernaemontani* / lake clubrush, soft-stem bulrush	0-300	3
Purau grass or ririwaka / Bolboschoenus fluviatilis	0-150	3
Kuta / *Eleocharis sphacelata* / tall spike-rush	150-400	2

[1] Plant grades = well established seed-propagated plants in 1-2 L pot e.g. PB3

NIWA recommends the following basic riparian planting design, consisting of a combination of:

- a paddock-edge dense, grass filter strip to intercept sediment in runoff and create a physical separation between farmland and the riparian buffer. The absence of shrubs and trees will prevent plants from shorting electric wires or being grazed,
- a second zone of taller trees, flaxes, and shrubs downslope of the paddock-edge and along the upper stream bank to provide stream shade, intercept shallow groundwater aquifers (<2 m from soil surface) and associated nutrients, and provide habitat, and
- a third stream margin zone planted with flexible native sedges and rushes to provide further habitat and stream bank stabilisation, while also being resilient to more frequent waterlogging and inundation during higher stream flows.

The Riparian Planner tool can be used to calculate riparian plant spacings and numbers, budgeting, scheduling planting in manageable stages, and communicating the plan to others (e.g. nurseries, suppliers, and trades-people, etc). The riparian planner is available online[6].

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[4] 2017 'Wetland Practice Note for Nelson and Tasman Councils'

[5] https://www.tasman.govt.nz/my-region/environment/environmental-management/biodiversity/native-plant-restoration-lists/

[6] https://www.dairynz.co.nz/environment/waterways/riparian-planner