Appendix I. Menu of practices for dairy farms to improve water quality in Southland

This menu of practices to improve water quality is designed to guide dairy farmers on the best options for their individual situation to reduce farm impacts on water quality. It is based on the MENU of practices collated by Waikato Regional Council and DairyNZ (http://www.waikatoregion.govt.nz/menus), but has been re-freshed to reflect cost and effectiveness metrics for Southland farms. The menu includes a general rating of effectiveness for each practice based on recent research and best guess; these assessments consider the flow pathway targeted by each mitigation and have been scaled to a whole-farm system equivalent. The rating indicates the likely effectiveness (low, medium or high) of each practice in reducing the amount of N, P, sediment and harmful micro-organisms likely to enter waterways on farm. Because every farm has unique topography and management regimes, the need for and effectiveness of different practices will differ. This rating is an indicative best estimate and assumes generally accepted industry good practice is followed when putting any of the practices into place; it can thus help you identify a short-list of practices for the farm management team to consider in more detail.

	Estimated reduction in loss:					**Potential impact on farm business:**	
	Nitrogen	**Phosphorus**	**Sediment**	**Microorganisms**		**Cost**	**Benefit**
Low (L)	<10%	---------- Less than 20% ----------			$	Limited input of time and cost	Little change to farm profit or infrastructure required
Medium (M)	10 to 25%	---------- From 20 to 40% ----------			$$	Moderate input of time and expenditure. Some practice change required.	Practice likely to result in a moderate increase in profitability or improved management
High (H)	>25%	---------- More than 40% ----------			$$$	Significant input of farmer time and significant expenditure. Significant practice change required.	Very profitable practice or results in improved management e.g. reduced farm operational costs.

Mitigation	GMP examples	Likely Water Quality Benefit				Potential Impact on Farm Business		Factors to Consider
		N	P	Sediment	Micro-organisms	Cost	Benefit	
Whole Farm Planning	Whole farm business and systems analysis	Whole farm analysis will identify water quality risks. Likely water quality benefits will depend on farm contour, management challenges and practices used to manage risks on farm.				$-$$	$$$	Involves assessment of farm resources, stocking policies and farm business risks. A good starting point that will help clarify the most useful practices to consider below.
Nutrient Management	Do a whole farm nutrient budget	Likely water quality benefits will depend on the range of practices used to manage nutrients as a result of nutrient budget recommendations.				$	$$	Farm consultant/advisor should use the latest version of the OVERSEER® Nutrient Budgeting model to create a nutrient budget for the whole farm, with recommendations to be included in a nutrient management plan (NMP).
	Keep Olsen P at biological optimum using soil testing	-	L to M (depends on soil P test)			$	$$$	Avoiding unnecessary applications of P will reduce costs. To minimise runoff, apply P fertiliser when soil moisture is good and no large rainfall events are forecasted. Consider use of lower solubility P fertiliser if soil conditions allow.
	Use proof of placement for fertiliser and/or farm dairy effluent application	L	M	-	L - M	$$ - $$$	$$$	Delivers more precise nutrient inputs for expected crop or pasture yield. Likely to become more widely used as equipment is upgraded over time.
Effluent management	Increase land application area	L	L	L	L	$	$$	Can be beneficial where effluent K loads are above pasture requirements with potential to affect animal health. Maximum nutrient gains can be achieved by using a whole farm nutrient budget, ensuring total nutrient loadings to blocks are appropriate. Will depend on whether further suitable land (topography and soil type) is available and is likely to require changes to irrigation system design. Can allow better fit with grazing rotation.

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	Minimise effluent volumes at source (by reducing wash water volumes and rainwater in the system)	L	L	L	L	$	$$	Reduces pumping cost and need for storage. Improves water efficiency on-farm.
Avoid preferential flow of effluent through drains	Increase storage volume and use deferred irrigation to avoid preferential flow of effluent through drains	L	M	L	H	$$ - $$$	$$	Cost of upgrading or building new pond storage can be high. Can be challenges with mechanical de-sludging. Lowers risk of effluent runoff during wet and/or busy periods.
	Low rate and/or low depth effluent irrigation	L	L	L	L or M	$ - $$$	$$	Requires some solid separation. Allows more "safe" irrigation days per year and lowers overall effluent storage need. Allows application to steeper land but can be challenging to keep application rates consistent. Cost dependent on system choice.
	Avoid placing effluent applicators directly over tile or pipe drains	L	M	L	H	$	$	Knowledge of tile or pipe drain locations required
Reduce the accumulation of N in the soil, particularly during autumn and winter	Reduce inputs of nitrogen, such as fertiliser or N contained in imported feed.	M	-	-	-	$ - $$	$	Requires sound nutrient and feed budgeting, soil and pasture monitoring and accurate timing of N applications to avoid feed shortfalls. Achieves much better N conversion to dry matter and is more cost efficient. Fertiliser should be applied in accordance with the Code of Practice for Nutrient Management – see www.fertiliser.org.nz.
	Control the duration of grazing of pasture and forage	M	L on well-drained	L on well-drained soils; M	L on well-drained soils; M on	$-$$$	$	On-off grazing requires a stand-off pad and effluent storage but feed wastage and soil compaction are reduced.

Mitigation	GMP examples	Likely Water Quality Benefit				Potential Impact on Farm Business		Factors to Consider
		N	P	Sediment	Micro-organisms	Cost	Benefit	
	crops (on-off grazing)		soils; M on poorly-drained soils or sloping land	on poorly-drained soils or sloping land	poorly-drained soils or sloping land			
	Winter stock off-paddock	M	M	H	H	$ - $$	$$	Water quality benefit for catchment but exports the issue elsewhere. Farmer loses some control of stock health and condition when off farm.
	Plant catch crops to capture N from grazed winter forages (e g oats)	L - M	-	-	-	$	$$	Sequence cropping will only be successful on free-draining soils where machinery can operate soon after winter crop grazing is completed, where there is irrigation or good rainfall from early December onwards, and where kale is well-utilised during winter grazing so the residues do not interfere with sowing of the catch crop
	Substitute autumn diets with low-N feed (such as whole crop silage)	L	-	-	-	$$	$	Good quality low N feed such as cereal silage or grain is required, preferably for autumn feeding. Addition of a feed pad will reduce feed wastage, but increases costs. The benefit of substitution will be lost if the farmer continues to offer the same quantity of high protein feed as well as the new low protein feed to their herd.
	Optimize timing and amounts of irrigation input	L - M	L	L	L	$$	$	Goal is to minimise the amount of water applied, thus minimising pumping costs and reducing potential losses of water via drainage or surface runoff flows

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	Cut and carry feed management with feeding facilities	H	H	H	H	$$$	$	Requires a feed pad, loafing area and appropriate effluent capture facilities. Management skills required are very different to those developed in traditional NZ farm systems.
	Time N application to meet crop demand using split applications	L	-	-	-	$	$	By targeting crop demand, better uptake of nutrients by crops and lower losses occur. Split applications are more costly and management intensive
Protect soil structure, particularly in gullies and near stream areas	Use minimum or no-til cultivation practices such as direct drilling	L - M	L - H	L - H	-	$	$$	Effective for reducing runoff and soil loss, and improving soil quality and infiltration. Soils that have been grazed over the winter may be compacted or pugged, requiring more cultivation or resulting in rough paddocks. Requires modified planter machinery to deliver good seed placement for even plant establishment. Additional expenditure might be required for insect pest control. FAR trials show cost benefit of $200/ha if crop establishes/yields similarly.
	Re-sow areas of bare or damaged soil as soon as possible	L	L - H	L- H	-	$	$	Aim to re-establish ground cover as quickly as possible to minimise the window of loss risk
	Match stock management to land use capability, e.g. avoid grazing heavy stock on steeper, more vulnerable soils, especially when wet.	L	M	M	M	$	$ - $$$	Keeping stock off saturated soils may be as easy as shifting stock to a different soil type on the farm, through to using a stand-off facility. Cost-benefit depends on options chosen to take stock off pasture. Highest benefit on high risk soils.

Mitigation	GMP examples	Likely Water Quality Benefit				Potential Impact on Farm Business		Factors to Consider
		N	P	Sediment	Micro-organisms	Cost	Benefit	
	Cultivate along contours on sloping ground	L	H	H	-	$	$$	Slows down runoff and reduces erosion. Row orientation should follow contour.
Manage critical source areas (CSA)	Restrict grazing of crop and pasture CSAs when soils are near saturation	L	M	M	M	$	$	Rolling and steep pastoral lands often have clearly identifiable CSAs that are frequently wet and prone to damage by stock trampling. Protecting these locations from stock damage, even just temporarily during wet periods, is likely to minimise contaminant losses (by reducing both the volume of overland flow and the quantity of animal excreta deposited in such areas).
	Avoid working CSAs and their margins	L	M	M	M	$	$	The areal extent of CSAs is often minimal; thus there can be little loss of productive area whilst still achieving good benefits for water quality.
	Leave grassed areas (or native vegetation) around CSA and margins	L	L	L	L	$ - $$	$	Effectiveness improves with a grass margin to help filter runoff, especially on steeper slopes. Effectiveness of planting depends on species. Ongoing weed and pest management is an added cost but reduces with time.
	Move troughs and gateways away from water flow paths	L	M	M	H	$	$	These areas of concentrated stock use have high nutrient loads and reduced vegetative cover; runoff risk is accordingly greater. Cost and effectiveness depends on contour of farm; benefit greatest on farms with high risk soils (poorly-drained soils and/or sloping topography).
	Reduce runoff from tracks and races (using cut offs and shaping)	L	L	L	M	$	$	Cost and effectiveness depends on contour of farm (higher risk of soil loss on steeper land but will also require more work). Requires regular maintenance but can reduce lameness, water damage and long term maintenance costs.

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	Graze from the top of the slope toward the CSA (such as a stream or gully), or leave a buffer zone to be grazed last	L	M	H	M	$	$	These areas have reduced vegetative cover so are at greater risk of runoff. Graze from top to bottom of paddock contour. Cost and effectiveness depends on contour of farm (higher risk of soil loss on steeper or poorly drained land, but greater benefit).
	Use low solubility P fertilizer if applying to CSA	-	M	-	-	$	$$$	To minimise runoff, apply P fertiliser when soil moisture is good and no large rainfall events are forecasted.
Reduce P use	Reduce use of P fertilizer where Olsen P values are above agronomic optimum	-	L to M (depends on soil P test)			$	$$$	Avoiding unnecessary applications of P will reduce costs. Where practical, avoid fertilising stock camp areas that are located in CSAs – these areas likely have more than adequate fertility due to stock transfers of excretal nutrients.
	Use low solubility P fertilizer forms if runoff risk is high; or fertilize outside risk months (May to September inclusive)	-	L to M (depends on soil P test)			$	$$$	Consider use of lower solubility P fertiliser if soil conditions allow. To minimise runoff, apply P fertiliser when soil moisture is good and no large rainfall events are forecasted.
	Plant split grass/clover swards in near-stream areas	-	H	-		$	$$	Ensure that plants that have a relatively high P demand, such as clover, are located away from near-streams areas. Conversely, grasses that have a lower P demand can be located in near-stream areas (the CSA) and fertilised to maintain a lower soil Olsen P test and thus a smaller reservoir of P that could potentially be transported in overland flow (or subsurface drainage).
Riparian management	Fence stock out of waterways	L	M	H	H	$	$$	Lower stock losses in waterways are a key farm benefit. Fencing can sometimes be used to improve subdivision and pasture utilisation.

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	Put in culverts or bridges at regular stock crossings	L	M	H	H	$ - $$$	$$	Cost will depend on whether culvert or bridge is required. Bridges also require resource consent. Improved crossings reduce lameness and reduce stock and vehicle travel time.
	Improve on-farm infrastructure to keep stock out of waterways (reticulate stock water, improve stock crossings, plant shade trees away from water)	L	M	M	H	$$ - $$$	$$	These improvements all add capital value to the farm and provide animal health and welfare benefits alongside water quality benefits. Important to locate new troughs away from areas of high water flow and high stock traffic e.g. gateways.
	Undertake riparian planting	L	L	L	L	$ - $$	$	Effectiveness improves with a grass margin to help filter runoff, especially on steeper slopes. Effectiveness of planting depends on species. Ongoing weed and pest management is an added cost but reduces with time. Can improve bank stability, provide habitat for wildlife and in-stream shade for fish and insects.
Capture nutrients sediment and microbes in wetlands and sediment traps	Protect and enhance natural wetlands by fencing (temporary or permanent) to exclude cattle and leaving buffers when over sowing, topdressing and burning - Alpine PZ	L (well-drained flat land) – M (poorly drained or sloping land)	L	H	M	$ - $$	$	N removal effectiveness depends on wetland type, paddock slope, how long water stays in the wetland (the longer the better), and stock management (no pugging or erosion). Fenced wetlands reduce stock losses and improve habitat for wildlife and fish. Appropriate planting and weed/pest management can further increase benefits.

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	Install sediment traps where relevant (an engineered structure to slow water flows, reduce energy, filter sediment and allow grass growth, e g decanting dam, detainment bunds)	L	M	M	L	$ - $$$	$	Most useful where there is a steady flow of runoff to waterways during wet periods and sediment/P is an issue. Detainment bunds designed to allow ponding for no more than three days to maintain pasture. Require water storage of around 120 m^3/ha of draining catchment. Can be costly where not using existing structures. Requires sound engineering design and on-going maintenance.
	If constructing a wetland, incorporate appropriate plants (such as red tussock, New Zealand flax, purei (carex secta), raupo, and South Island toetoe) and sediment traps; consider locating near seepage zones where relevant	L on well-drained soils; M on poorly-drained soils	L or M	L or M	L or M	$$ - $$$	$	High cost option to improve water quality of runoff before it enters a stream or river e.g. from tile drainage. Not effective if little or no surface runoff can be intercepted. Factors to consider include optimal wetland size for catchment area, ability to harvest vegetation occasionally and weed and pest control. Can provide habitat for wildlife and fish.
	Where landscapes allow, run tile drainage outflows into wetlands prior to entering ditches	M	L	M	M	$	$	Dependent on contour and landscape