Subject:	NPSFM Horticulture Mapping and DIN-E.coli Review
Attention:	Michelle Sands
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Date	09 October 2019

1 Introduction

1.1 Objectives

In response to the proposed 2019 updates to the National Policy Statement for Freshwater Management (NPS-FM), Horticulture New Zealand engaged Collaborations to undertake a high level assessment of the rivers and streams that drain through potential horticultural areas (more specifically targeting crop vegetables). The objectives of this work were:

- Spatially map the likely horticultural growing areas around New Zealand and identify the main rivers and streams (and their catchments) which are likely to be connected to these (in terms of water quality leaching contributions).
- Using nationally available data, compile current state water quality data for each of these rivers on nitrogen, phosphorus (and their sub-species, i.e. Nitrate-Nitrogen) and *E.coli*.

The outputs from this assessment are summarised in this memorandum, including a table that breaks down the water quality metrics per river/stream and relates this to the River Environment Classification (REC) order, catchment area and associated vegetable growing areas.

2 Methodology

2.1 Water Quality Analysis

Horticulture New Zealand provided a list of rivers within the north and south island that had known horticultural land within their drainage catchment. Each river was located on the national Land, Air, Water Aotearoa (LAWA) website, and was then refined to river water quality sites which had a monitoring record of nitrogen, *E.coli* and phosphorus.

In large river catchments (i.e. the Manawatu River), two lowland water quality sites were selected to provide context of changes in nutrient concentrations upstream and downstream. For the remaining rivers, the most appropriate downstream lowland site was selected based on the assumption most of the horticultural land would likely be on lowland fertile soils.

LAWA presents 5-year median nutrient concentrations, which were considered suitable for a high level assessment of the draft NPS-FM dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) national objective framework (NOF) median percentile limits. For *E.coli*, the 5 year median concentration was presented as well as the current swimmability band which is based on a number of additional statistical parameters. This band was recorded, however no quality checks were undertaken to verify these were accurate.

Nitrogen was presented as Total Nitrogen (TN), Ammoniacal Nitrogen (NH_4-N) and Total Oxidised Nitrogen (TON, made up of Nitrate and Nitrite-Nitrogen) within the LAWA website. DIN was therefore considered to be the sum of NH_4-N and TON concentrations.

These median DIN and DRP concentrations were then compared against the draft NPS-FM NOF attribute states to predict the current water quality band and were coupled with the catchment and horticultural area (see Section 2.2). Finally, the results (presented in Table 1 and 2) were filtered from highest DIN concentration to lowest.

2.2 Horticultural Land Analysis

Horticultural land was identified using the following methods:

1) The most recent Land Cover Database (LCDB 4.1) was filtered for 'Short Rotation Cropland' (**Hort Area - LCDB 4.1 Tables 1 & 2)**. It is noted that this cover class likely includes some arable crops and is not necessarily representative of only vegetable growing. However, a comparison carried out in the Lake Horowhenua, Pukekohe and Gisborne catchments between short rotation cropland and grower submitted block maps showed a close match (highlighted in green in Tables 1 and 2). To that end, the LCDB short rotation cropland is a proxy for vegetable growing areas in locations where GIS data is not yet available.
2) Previous studies commissioned by Horticulture New Zealand has yielded some regional GIS information detailing the location of vegetable growing (**Hort Area - Mapped Properties Tables 1 & 2)**. This was sourced and combined to form a 'known horticulture' GIS layer. The layer itself consisted of areas in the Pukekohe region, Horowhenua region, Selwyn and Gisborne regions. Outside of these areas, known horticultural areas were either not available in GIS format, or not previously assessed. The catchments highlighted green in tables 1 & 2 are where the LCDB cropland and known horticulture areas align well.
3) A version of the NZGAP Certified Grower database with a total cropping area attribute was also analysed but not presented. In many cases, associating a grower's total footprint with their certified address wasn't an accurate reflection of their actual horticultural growing area.

The areas of vegetable growing were then overlaid with the LINZ Rivers dataset to identify what rivers needed to be assessed from a water quality perspective. The list provided by Horticulture New Zealand was confirmed with a few additions in both the north and south islands. The water quality monitoring locations were then accessed from the LAWA website and associated watersheds created using the REC (River Environment Classification) GIS database.

The watershed catchments and associated areas of vegetable growing were summarized for each monitoring site as detailed in Table 1 and 2.

Table 1 - Tabulated Results by river (highest DIN concentration to lowest)

River	Site Name	TON (NO_3-N + NO_2-N)	NH_4-N	DIN	TN	DIN BAND	DRP	TP	DRP BAND	E.coli	State	REC Order	Catchment Area (ha)	Hort Area - LCDB 4.1	Hort Area - Mapped Properties
Whangamarie	Whangamarie Stream	14	0.014	14.01	14.55	D	0.010	0.022	B	835	E Band	2	805	327	16
Arawhata	Arawhata at Hokio Beach Road	10.5	0.090	10.59	10.90	D	0.024	0.059	D	770	E Band	4	1152	349	294
Patiki	Patiki Stream at Kawiu Road	6.08	0.014	6.09	6.49	D	0.034	0.069	D	482	E Band	2	378	66	30
Selwyn	Selwyn River at Coes Ford	5.9	0.005	5.91	6.10	D	0.011	0.015	C	160	D Band	5	107485	10291	177
Whakapipi	Whakapipi Stm at SH22 Br	3.9	0.012	3.91	4.29	D	0.022	0.050	D	340	E Band	4	1483	197	221
Ngakaroa	Ngakaroa Stream	3.15	0.012	3.16	3.40	D	0.006	0.015	A	155	D Band	3	470	130	2
Wairoa	Waipao at Draffin Road	2.6	0.011	2.61	2.75	D	0.034	0.047	D	675	E Band	4	3646	87	
Waitangi	Waitangi Stream	2.45	0.006	2.46	2.70	D	0.009	0.017	B	270	D Band	3	1917	232	
Koputaroa	Koputaroa at Tavistock Road	2.395	0.005	2.40	2.75	D	0.017	0.046	C	1100	E Band	4	1967	119	69
Mangaone	Mangaone Stream at Sims Road Bridge	1.705	0.050	1.76	2.25	D	0.027	0.063	D	1100	E Band	4	4978	80	16
Piako	Piako River at Paeroa-Tahuna Rd Br	1.55	0.045	1.60	2.24	D	0.143	0.275	D	560	E Band	6	53908	419	
Awaroa	Awaroa River (Waiuku) at Otaua Rd Br opp Moseley Rd	1.51	0.047	1.56	2.11	D	0.002	0.041	A	290	D Band	3	2684	86	77
Mangaonua	Mangaonua Stm at Hoeka Rd	1.46	0.078	1.54	1.87	D	0.012	0.057	C	1100	E Band	4	8138	127	15
Waihou	Waihou River at Okauia	1.2	0.012	1.21	1.42	D	0.061	0.084	D	290	D Band	6	80141	879	
Tarueru	Taruheru at Tuckers Road Br	1.085	0.100	1.19	2.30	D	0.110	0.210	D	1400	E Band	4	8400	1426	
Waikawa	Waikawa Stream at Huritini	1.015	0.020	1.04	1.21	D	0.015	0.042	C	308	D Band	5	7720	116	62
Asburton	Ashburton River at SH1	0.97	0.005	0.98	1.11	C	0.002	0.007	A	115.5	D Band	6	159963	11769	
Opihi	Opihi River mouth	0.8	0.005	0.81	0.97	C	0.003	0.009	A	29.5	A Band	7	237607	14170	
Tukituki	Tukituki at Red Bridge	0.61	0.006	0.62	0.78	C	0.008	0.017	B	24.35	C Band	7	246138	4205	
Tukituki	Tukituki at Black Bridge	0.56	0.005	0.57	0.70	C	0.009	0.016	B	34	A Band	7	250432	4366	
Opaoa	Opaoa River at Swamp Road	0.555	0.003	0.56	-	C	0.013	-	C	50	B Band	6	30515	382	
Manawatu	Manawatu at u/s PPCS Shannon	0.5074	0.050	0.56	0.90	C	0.020	0.062	D	255	E Band	7	557886	5834	
Karamu	Karamu-Clive River upstream of the Whakatu Rail Bridge	0.43	0.026	0.46	0.82	B	0.090	0.116	D	230	D Band	5	50421	5752	
Manawatu	Manawatu at Teachers College	0.434	0.005	0.44	0.71	B	0.015	0.036	C	150	E Band	7	391812	1079	
Wairoa	Wairua at Purua (tributary)	0.4	0.028	0.43	0.80	B	0.025	0.068	D	129.9	D Band	6	54889	46	
Waitohu	Waitohu Stream at Norfolk Crescent	0.39	0.026	0.42	0.73	B	0.017	0.042	C	800	E Band	4	4583	25	
Ruamahanga	Ruamāhanga River at Gladstone Bridge	0.395	0.005	0.40	0.57	B	0.009	0.018	B	36	C Band	6	134031	2632	
Ruamahanga	Ruamāhanga River at Pukio	0.37	0.007	0.38	0.55	B	0.013	0.024	C	45	A Band	7	246324	4772	
Waitara	Maketawa Stream at Tarata Rd (tributary)	0.36	0.011	0.37	0.47	B	0.031	0.044	D	410	E Band	3	29493	14	
Kumeu	Kumeu River	0.32	0.020	0.34	0.71	B	0.013	0.049	C	350	E Band	4	6599	147	
Ohau	Ohau at Haines Property	0.3064	0.005	0.31	0.41	B	0.008	0.015	B	82	B Band	5	18905	467	377
Waimea	Waimea at SH60 Appleby	0.305	0.003	0.31	0.37	B	0.002	0.004	A	20	A Band	6	77059	421	
Mangawhero	Mangawhero at Raupiu Road	0.274	0.005	0.28	0.55	B	0.011	0.030	C	150	D Band	5	66813	559	
Kakanui	Kakanui River at McCones	0.2	0.006	0.21	0.47	A	0.004	0.009	A	90	B Band	6	89524	2754	
Ashley	Ashley River at SH1	0.178	0.005	0.18	0.26	A	0.004	0.005	A	17.5	A Band	7	114913	2077	
Awapuni Drain	Awapuni Drain Site 6	0.056	0.125	0.18	1.70	A	0.350	0.610	D	200	-	3	1245	337	
Waipaoa	Waipaoa River at Matawhero Bridge	0.16	0.014	0.17	0.33	A	0.010	0.063	B	350	E Band	7	190619	3530	2889
Waipaoa	Waipaoa River at Kanakanaia	0.163	0.009	0.17	0.37	A	0.008	0.069	B	184.4	E Band	7	157516	953	

Karamu	Herehere Stream at Te Aute Rd	0.108	0.007	0.12	0.49	A	0.065	0.078	D	600	E Band	3	947	15	
Ngaruroro	Ngaruroro at Fernhill	0.097	0.005	0.10	0.18	A	0.008	0.014	B	39	D Band	6	194760	642	
Rangitikei	Rangitikei at McKelvies	0.065	0.005	0.07	0.26	A	0.014	0.034	C	75	D Band	7	392819	3540	
Rakaia	Rakaia River at SH 1 north channel	0.05	0.005	0.06	0.07	A	0.002	0.005	A	99	D Band	7	282965	1858	
Uawa River	Hikuwai at Willowflat	0.035	0.011	0.05	0.19	A	0.007	0.020	B	100	-	5	30710	273	

Table 2 - Tabulated Results by region and site name (highest DIN concentration to lowest)

Region	Site Name	TON (NO_3-N + NO_2-N)	NH_4-N	DIN	TN	DIN BAND	DRP	TP	DRP BAND	E.coli	State	REC Order	Catchment Area (ha)	Hort Area - LCDB 4.1	Hort Area - Mapped Properties
Auckland	Whangamarie Stream	14	0.014	14.01	14.55	D	0.010	0.022	B	835	E Band	2	805	327	16
Horizons	Arawhata at Hokio Beach Road	10.5	0.090	10.59	10.90	D	0.024	0.059	D	770	E Band	4	1152	349	294
Horizons	Patiki Stream at Kawiu Road	6.08	0.014	6.09	6.49	D	0.034	0.069	D	482	E Band	2	378	66	30
Canterbury	Selwyn River at Coes Ford	5.9	0.005	5.91	6.10	D	0.011	0.015	C	160	D Band	5	107485	10291	177
Waikato	Whakapipi Stm at SH22 Br	3.9	0.012	3.91	4.29	D	0.022	0.050	D	340	E Band	4	1483	197	221
Auckland	Ngakaroa Stream	3.15	0.012	3.16	3.40	D	0.006	0.015	A	155	D Band	3	470	130	2
Northland	Waipao at Draffin Road	2.6	0.011	2.61	2.75	D	0.034	0.047	D	675	E Band	4	3646	87	
Auckland	Waitangi Stream	2.45	0.006	2.46	2.70	D	0.009	0.017	B	270	D Band	3	1917	232	
Horizons	Koputaroa at Tavistock Road	2.395	0.005	2.40	2.75	D	0.017	0.046	C	1100	E Band	4	1967	119	69
Wellington	Mangaone Stream at Sims Road Bridge	1.705	0.050	1.76	2.25	D	0.027	0.063	D	1100	E Band	4	4978	80	16
Waikato	Piako River at Paeroa-Tahuna Rd Br	1.55	0.045	1.60	2.24	D	0.143	0.275	D	560	E Band	6	53908	419	
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Canterbury	Ashburton River at SH1	0.97	0.005	0.98	1.11	C	0.002	0.007	A	115.5	D Band	6	159963	11769	
Canterbury	Opihi River mouth	0.8	0.005	0.81	0.97	C	0.003	0.009	A	29.5	A Band	7	237607	14170	
Hawkes Bay	Tukituki at Red Bridge	0.61	0.006	0.62	0.78	C	0.008	0.017	B	24.35	C Band	7	246138	4205	
Hawkes Bay	Tukituki at Black Bridge	0.56	0.005	0.57	0.70	C	0.009	0.016	B	34	A Band	7	250432	4366	
Marlborough	Opaoa River at Swamp Road	0.555	0.003	0.56	-	C	0.013	-	C	50	B Band	6	30515	382	
Horizons	Manawatu at u/s PPCS Shannon	0.5074	0.050	0.56	0.90	C	0.020	0.062	D	255	E Band	7	557886	5834	
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Canterbury	Ashley River at SH1	0.178	0.005	0.18	0.26	A	0.004	0.005	A	17.5	A Band	7	114913	2077	
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