

## Explanatory note to the CSG to accompany spreadsheets of contaminant loads

Prepared by the TLG

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At CSG #18 the CSG requested the detailed sub-catchment contaminant load data emanating from the 'stepping stone' scenario modelling to assist them in their deliberations on policy options and allocation. The accompanying spreadsheet contains the model data requested in the forms requested by the CSG.

As explained at CSG #18, in the timeframe available and with the other commitments to the project over the last week it has not yet been possible for the TLG to 'sanity' check the outputs (so therefore results are draft), to prepare maps of the load data (which will visually show 'hotspots'), or to prepare an interpretive narrative. This document is merely an explanatory note to help interested CSG members understand what they are looking at.

The load data for the four contaminants (nitrogen, phosphorus, sediment and microbes) for the current state (Base) and for the stepping-stone scenarios '10%', '25%', '50%', '75%' and '100%' of Scenario 1 are set out in the accompanying spreadsheet *Load data for CSG* for each of the 74 sub-catchments in the model. Location of each of the numbered sub-catchments and their FMU are shown in Map 1 at the end of this note.

The database contains two sets of four sheets, with the data set out either by parameter or contaminant – i.e., parameter (e.g., load/ha) for all 4 contaminants, or contaminant for all 4 parameters – take your choice.

The first four sheets in the excel database are:

- **Catchment load:** the total load of contaminant per year for each sub-catchment at the current state (base) and after the mitigations applied in the '10%', '25%', '50%', '75%' and '100%' Scenarios.
- **Load per total ha:** the load of contaminant for each sub-catchment expressed as kg/ha/year (except *E.coli* expressed as number per ha per year), for current state (base) and after the mitigations applied in the '10%', '25%', '50%', '75%' and '100%' Scenarios.
- **Load removed:** the total load of contaminant removed from each sub-catchment per year by the mitigations applied in the '10%', '25%', '50%', '75%' and '100%' Scenarios compared to current state (base).
- **Load removed per productive ha:** the annual load of contaminant removed from each sub-catchment expressed as kg/ha in production (i.e., excluding miscellaneous areas such as native forest), by the mitigations applied in the '10%', '25%', '50%', '75%' and '100%' Scenarios compared to current state (base). This is a measure of the 'intensity' of the load reduction as it relates to that area of the sub-catchment that is treatable by the mitigations.

The second four sheets repeat these data, arranged by contaminant. Each of the sheets labelled **nitrogen**, **phosphorus**, **ecoli** and **sediment** contain for the respective contaminant the catchment load, load per total ha, load removed and load removed per productive ha.

Please note that point sources are included in the above within the sub-catchment that they fall. These can often be spotted as 'odd-ball' high loads per hectare (e.g. Central Waikato sub-catchment #25 which includes the point source load from the Hamilton City Council Wastewater Plant).

*Terms in italics below refer to the named sheets in the excel database.*

### Total contaminant loads

The total annual mass load of each contaminant in the current state (base) for each scenario is summarised by FMU in Table 1. Total load from each sub-catchment within each FMU is shown for all contaminants in *catchment load* and for individual contaminants in *nitrogen, phosphorus, ecoli, and sediment*.

Comparing FMUs shows that current state (base) total mass loads of nitrogen and phosphorus are highest from the Upper Waikato FMU and lowest from the Central Waikato. Sediment load and microbial load are greatest from the Waipa FMU. Microbial load is lowest from the Central Waikato FMU.

**Table 1:** The total mass load entering water in the current state (base) and for scenarios '10%', '25%', '50%', '75%' and 100% of Scenario 1, for each contaminant and each FMU

	scenario	Upper Waikato	Central Waikato	Lower Waikato	Waipa
<b>Nitrogen load (tonnes/yr)</b>	Base	4135	871	3833	3887
	10%	3943	852	3547	3766
	25%	3636	794	3325	3499
	50%	3370	640	2795	3037
	75%	3102	384	2219	2347
	100%	3219	382	2223	2347
<b>Phosphorus load (tonnes/yr)</b>	Base	391	124	257	231
	10%	321	122	237	214
	25%	296	116	219	200
	50%	271	80	171	171
	75%	247	32	142	138
	100%	256	32	142	138
<b>Sediment load (tonnes/yr)</b>	Base	165,000	20,478	223,997	224,525
	10%	121,628	19,458	203,641	199,446
	25%	120,099	16,388	171,195	172,602
	50%	117,785	13,662	120,505	133,112
	75%	112,916	11,197	84,033	110,501
	100%	112,962	11,153	83,894	110,431
<b>Microbial load (10<sup>15</sup>/yr)</b>	Base	13.5	6.3	26.2	40.2
	10%	11.1	5.9	21.8	35.6
	25%	10.5	5.2	18.8	31.5
	50%	10.2	4.0	13.2	22.3
	75%	8.2	2.8	10.6	18.3
	100%	8.0	2.8	10.5	18.3

Total mass load per FMU depends on catchment size, land use mix, and point sources. Total land area and area of productive land are given in *catchment load* for each sub-catchment. The areas of total and productive land in each FMU are summarised in Table 2. The percentage of the total area in each FMU that is classified as productive land is slightly higher for Upper Waikato than for the other FMUs (83, 71, 73 and 75%, respectively, for Upper, Central, Lower and Waipa).

Sub-catchment areas both within each FMU and across FMUs vary substantially in both total size and in the fraction of land classified as productive (see *catchment load*).

**Table 2** Area of each FMU (ha)

<b>FMU</b>	<b>Productive ha</b>	<b>Total ha</b>
<b>Upper Waikato</b>	364,408	440,795
<b>Central Waikato</b>	39,946	56,573
<b>Lower Waikato</b>	216,265	295,604
<b>Waipa</b>	233,327	309,332

Contaminant loads and loads removed can therefore be expressed on a per ha basis for better comparison between sub-catchments and FMUs (*load per ha* and *load removed per productive ha*).

### **Load removed**

The total load removed by mitigations for each of the stepwise scenarios to reach Scenario 1 is shown in *Load removed* for each sub-catchment and for each FMU or separately for each contaminant in *nitrogen, phosphorus, ecoli, and sediment*. The load to be removed is that derived from all land in the catchment.

Mitigations used in the model are management practices on productive land or at the edge of field of productive land, **only**. Total load removed and load removed per ha of productive land for each sub-catchment within each FMU are shown in the excel sheets *load removed* and *load removed per productive ha*, and for each contaminant in *nitrogen, phosphorus, ecoli, and sediment*. The loads to be removed are summarised in Tables 3 and 4.

Within any given scenario and FMU, sub-catchments vary widely in the load removed per hectare of productive land (Table 4). For example, in the Lower Waikato at 10%, the load of N to be removed ranges from 0.23 to 4.14 kg N/ha/yr for individual sub-catchments. The high extremes of load removal required per hectare of productive land can be distorted by point sources within those sub-catchments.

Relative differences between sub-catchments at the '10%' level may not be reflected at the '25', '50', '75' or '100%' level, e.g. sub-catchment 20 in the Lower Waikato has the lowest removal rate at 10% but the highest at 50, 75 and 100%. This reflects the way in which the model optimises the use of mitigations at least cost. This is particularly obvious when sub-catchments with point sources are part of the comparison – e.g. sub-catchment 25 in the Central Waikato, where the mitigation of improved point source treatment only gets invoked in scenarios of '50%' and above.

**Table 3:** The total load entering water in the current state (base) and the load removed by mitigations to achieve 10%, 25%, 50%, 75% and 100% of the change in concentration of contaminant to meet Scenario 1, for each contaminant and each FMU

	scenario	Upper Waikato	Central Waikato	Lower Waikato	Waipa
<b>Nitrogen (tonnes/yr)</b>	Base	4135	871	3833	3887
<b>N load removed (tonnes/yr)</b>	10%	192	19	286	122
	25%	499	78	507	389
	50%	765	231	1038	850
	75%	1033	488	1613	1541
	100%	916	489	1610	1541
<b>Phosphorus (tonnes/yr)</b>	Base	391	124	257	231
<b>P load removed (tonnes/yr)</b>	10%	70	1.9	20	17
	25%	95	7.5	38	31
	50%	119	44	86	60
	75%	144	91	115	93
	100%	135	91	115	93
<b>Sediment (tonnes/yr)</b>	Base	165,000	20,478	223,997	224,525
<b>Sediment load removed (tonnes/yr)</b>	10%	43,372	1019	20,355	25,079
	25%	44,901	4089	52,802	51,922
	50%	47,215	6816	103,492	91,413
	75%	52,084	9281	139,964	114,024
	100%	52,038	9325	140,103	114,093
<b>Microbial load (10<sup>15</sup>/yr)</b>	Base	13.5	6.3	26.2	40.2
<b>Microbial load removed (10<sup>15</sup>/yr)</b>	10%	2.4	0.5	4.3	4.6
	25%	2.9	10.1	7.3	8.7
	50%	3.3	2.4	13.0	17.9
	75%	5.3	3.6	15.5	22.0
	100%	5.5	3.6	15.6	22.0

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**Table 4** Average, median and range across sub-catchments within each FMU of load removed per ha productive land

	FMU	Upper Waikato			Central Waikato			Lower Waikato			Waipa		
	scenario	average	median	range	average	median	range	average	median	range	average	median	range
<b>N load removed (kg/ha)</b>	10%	1.39	0.92	-3.88-6.33	0.63	0.49	0.11-1.34	1.05	0.73	0.23-4.14	0.60	0.60	-0.16-2.06
	25%	2.16	1.69	-3.88-8.33	1.74	1.54	0.26-4.45	1.99	1.80	0.30-7.71	1.62	1.64	0.22-3.93
	50%	3.03	2.22	-3.88-17.5	9.09	3.90	0.44-52.61	3.96	2.83	0.44-15.1	3.04	2.86	0.29-6.03
	75%	3.75	2.49	-3.88-23.5	21.84	7.74	1.37-155.2	6.57	5.22	0.99-21.7	5.66	5.27	0.80-9.18
	100%	3.54	2.49	-3.88-23.5	21.89	7.74	1.37-155.3	6.61	5.25	0.99-21.7	5.66	5.27	0.80-9.18
<b>P load removed (kg/ha)</b>	10%	0.26	0.28	-0.10-0.55	0.08	0.05	0.00-0.27	0.12	0.06	0.02-0.40	0.08	0.07	0.03-0.25
	25%	0.33	0.30	0.03-0.86	0.19	0.17	0.11-0.37	0.18	0.16	0.02-0.40	0.16	0.16	0.05-0.33
	50%	0.39	0.31	0.03-1.14	2.62	0.48	0.14-22.46	0.39	0.33	0.02-1.53	0.30	0.29	0.05-0.53
	75%	0.46	0.36	0.07-1.78	5.94	0.55	0.17-55.06	0.55	0.49	0.02-1.55	0.43	0.44	0.09-0.77
	100%	0.44	0.32	0.04-1.78	5.95	0.55	0.18-55.06	0.56	0.50	0.02-1.55	0.43	0.44	0.09-0.80
<b>Sediment load removed (kg/ha)</b>	10%	149	124	3.2-586	24	25	0.0-62	250	60	0.0-1845	193	43	0.0-834
	25%	157	134	3.1-586	103	103	1.2-229	342	97	0.0-1875	355	306	35.3-1156
	50%	164	150	7.2-586	171	188	1.6-385	517	269	6.8-1875	597	365	36.9-1696
	75%	173	155	8.0-586	211	194	22.2-576	651	433	6.8-1875	735	588	36.9-2299
	100%	173	155	8.0-586	212	198	22.2-576	653	433	6.8-1875	737	588	36.9-2299
<b>Microbial load removed (10<sup>18</sup>/ha)</b>	10%	0.25471	0.010765	-0.006-0.026	0.02260	0.01202	0-0.08	0.01956	0.01214	0-0.09	0.44703	0.014944	0.003-0.06
	25%	0.31181	0.015568	-0.006-0.035	0.04843	0.03267	0.007-0.12	0.03030	0.02266	0.001-0.12	0.87469	0.034862	0.02-0.086
	50%	0.35282	0.015836	-0.006-.05	0.10314	0.07708	0.007-0.25	0.05227	0.04646	0.01-0.10	1.84923	0.083287	0.03-0.16
	75%	0.45498	0.022981	0.003-0.07	0.15423	0.08637	0.04-0.64	0.06600	0.06107	0.01-0.15	2.29771	0.100389	0.03-0.185

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	<b>100%</b>	0.47463	0.022993	0.003-0.07	0.15423	0.08637	0.04-0.64	0.06700	0.06107	0.01-0.15	2.29772	0.100389	0.03-0.185
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Map 1 Sub-catchment number and FMU map

