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Prediction of Contaminant Accumulation in the Upper Waitemata Harbour – Results: Copper

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Prediction of Contaminant Accumulation in the Upper Waitemata Harbour – Results: Copper

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Prepared for
Auckland Regional Council, North Shore City Council, Rodney District Council, Waitakere City Council, and Transit New Zealand.

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Contents

Executive Summary

The background to the Upper Waitemata Harbour contaminant-accumulation study and the methodology used therein to predict contaminant accumulation are reported in NIWA Client Report HAM2003-087/1 – Methods.

The original goal of the Upper Waitemata Harbour contaminant-accumulation study was to predict the temporal development and spatial patterns of contaminant accumulation associated with (1) the existing pattern of landuse in the catchment, and (2) two proposed patterns/sequences of development.

The original goal of the study has matured somewhat over the course of the study. This has culminated in pursuing the following scenarios, the results of which are presented herein:

- Existing scenario. This is the "baseline" simulation: it extrapolates the "current-day" (i.e., 2001) landuse into the future based on the assumption that landuse does not change. It also assumes no stormwater contaminant controls. This scenario serves as a baseline.

- Development #1 scenario. This is the "realistic" simulation: it models development proposed in each subcatchment for each year in the future. At each modelled stage, therefore, the spatial pattern of earthworks sites and completed (mature) urban land is captured, complete with associated contaminant loads and projected stormwater contaminant controls.

- Response-envelope scenario. Here, the sediment loads and contaminant loads used in the development #1 scenario are run with each of two stormwater contaminant controls, these being zero controls and maximum attainable controls. The two results bracket the results of the development #1 scenario, forming an "envelope" of responses in the harbour

Inputs used in the simulations are presented, including sediment loads, contaminant loads, stormwater controls, and initial contaminant concentrations in the harbour bed sediments. There are two simulation periods: 54 years and 108 years.

Results are presented as:

Contaminant concentrations in the harbour
(a) Existing scenario versus development #1 scenario
(b) Response envelope around development #1 scenario
Time for total-sediment concentrations to reach "traffic lights"
(a) Existing scenario versus development #1 scenario
(b) Response envelope around development #1 scenario
Sedimentation[1] in the harbour
(a) Existing scenario versus development #1 scenario

[1] Refer to the zinc results report [NIWA Client Report HAM2003-087/2 – Results: Zinc] for results concerning sediments.

(b) Response envelope around development #1 scenario
Origin of sediments[1] / contaminants that deposit in harbour (%)
(a) Existing scenario versus development #1 scenario
Origin of sediments[1] / contaminants that deposit in harbour (mass)
(a) Existing scenario versus development #1 scenario
Fate of sediments[1] / contaminants that derive from land (%)
(a) Existing scenario versus development #1 scenario
Fate of sediments[1] / contaminants that derive from land (mass)
(a) Existing scenario versus development #1 scenario

The kinds of questions that may be answered with the results as a part of informing management choices include:

- *Where does contaminant deposited in each part of the harbour come from?*
- *Which subestuary is most at risk? Why?*
- *How might this risk be lessened?*
- *Will there be other benefits associated with source control in particular subcatchments?*
- *Which subestuary is least at risk? Why?*

The way the response-envelope predictions may be interpreted is explained. Further questions that may be addressed include:

- *Are there parts of the harbour where contaminant concentrations still exceed traffic lights even under the maximum attainable controls? What should be done in this case?*
- *Are there parts of the harbour where environmental targets will be reached without any intervention?*
- *Are there subestuaries where significant gains in time-to-traffic-light can be had for modest control improvements?*

1. Introduction

The background to the Upper Waitemata Harbour contaminant-accumulation study and the methodology used therein to predict contaminant accumulation are reported in NIWA Client Report HAM2003-087/1 – Methods.

The original goal of the Upper Waitemata Harbour contaminant-accumulation study was to predict the temporal development and spatial patterns of contaminant accumulation associated with (1) the existing pattern of landuse in the catchment, and (2) two proposed patterns/sequences of development.

The original goal of the study has matured somewhat over the course of the study. This has culminated in pursuing the following scenarios, the results of which are presented herein:

- Existing scenario. This is the "baseline" simulation: it extrapolates the "current-day" (i.e., 2001) landuse into the future based on the assumption that landuse does not change. It also assumes no stormwater contaminant controls. In addition to serving as a baseline, this simulation is used as a model test and validation, as described in the Methods report (NIWA Client Report HAM2003-087/1 – Methods) and in the zinc results report (NIWA Client Report HAM2003-087/2 – Results: Zinc).

- Development #1 scenario. This is the "realistic" simulation: it models development proposed in each subcatchment for each year in the future. At each modelled stage, therefore, the spatial pattern of earthworks sites and completed (mature) urban land is captured, complete with associated contaminant loads and projected stormwater contaminant controls.

- Response-envelope scenario. Here, the sediment loads and contaminant loads used in the development #1 scenario are run with each of two stormwater contaminant controls, these being zero controls and maximum attainable controls. The two results bracket the results of the development #1 scenario, forming an "envelope" of responses in the harbour. That is, under the zero-control simulation, contaminant concentrations rise quickly compared to under the maximum-attainable-control simulation, and the concentrations under the realistic simulation (i.e., development #1 scenario) fall somewhere between those two extremes.

2. Simulation Inputs

There are two simulation periods: 54 and 108 years.

The following parameters remain fixed throughout the simulation period:

- subestuary areas over which deposition of sediments and contaminants is allowed to occur;
- freshwater runoff associated with each event;
- pattern of sediment and contaminant dispersal throughout the estuary (*R*);
- pattern of sediment and contaminant redispersal throughout the estuary (*R3*);
- bioturbation depth (*BEDPTH*).

The following are initial conditions:

- Copper concentrations in estuarine sediments, which are expressed in three ways:
  - mass of copper attached to size fraction 1 (silt) per total mass of size fraction 1 (silt) sediment;
  - mass of copper attached to size fraction 2 (sand) per total mass of size fraction 2 (sand) sediment;
  - total mass of copper per total mass of sediment.
- The initial split of estuarine bed sediments into size fractions.

The following parameters may be varied throughout the simulation period in order to generate the scenarios:

- Sediment load.
  - The existing scenario assumes that sediment yield under the "current" (2001) landuse within the UWH catchment applies for the duration of the simulation. The catchment is characterised predominantly by pastoral land, with bush and pine also present. In addition, both established and ongoing urban development is found, e.g., in Lucas Creek subcatchment. These landuses and their spatial patterns are incorporated within the catchment model. The level of development in 2001 is assumed to continue for the whole period of the simulation. Sediment loss from established urban land is not modelled directly; instead, a constant loss of 150 kg ha-1 yr-1 is assumed. A comparison of predicted mean annual sediment yields with observed values (e.g., van Roon, 1983) has enabled catchment model validation under the existing scenario to be undertaken for all subcatchments except Hellyers Creek. This validation has confirmed that

predicted catchment yields closely match observed values, providing confidence in the parameters used within the model. Under the existing scenario, the model predictions are of hillslope sediment loss only and do not incorporate in-stream sediment dynamics. However, since downstream travel distance is generally short in the UWH subcatchments, it is assumed that sediment generated on hillsides is delivered to the estuary without further attenuation. This is likely to be a reasonable assumption during large storms, and it is these events that transport most of the annual sediment load to the estuary. Furthermore, under the existing scenario the stream banks are likely to be relatively stable.

  - For development #1 scenario, the spatial pattern of earthworks and completed development was incorporated into the model for each different stage of the proposed development. Sediment control measures were applied during the prediction of sediment yield at 50% of earthworks sites. These control measures had an average annual efficiency of 65–70%. The remaining 50% of earthworks sites had no sediment control measures in place. The efficiency and application of sediment controls implemented within scenario #1 was determined through discussions between NIWA, ARC and the TA's. In addition to the simulation of hillside erosion (including earthwork sites), bank erosion, which is caused by increased flows associated with urbanisation, was predicted under the scenario #1 development. This was achieved using a relation between the degree of imperviousness in a catchment and the increase in channel area, derived from the work of Herald (1989) in the Albany basin, coupled with numerous overseas studies.

  - For the response-envelope scenario, sediment loads from development #1 scenario were applied.

- Sediment partitioning. The sediment load was partitioned across particle sizes 1 and 2 based on the GLEAMS output.

- Contaminant load.

  - The derivation of copper loads followed a similar process to that described for zinc (NIWA Client Report HAM2003-087/2 – Results: Zinc) although for copper more weight was given to stormwater monitoring data collected for Auckland City. This monitoring produced best estimates of 100 g ha-1 for residential catchments equivalent to 8.3 g dwelling-1, 140 g ha-1 for commercial catchments and 110 g ha-1 for industrial catchments after subtraction of the small natural load. These estimates are consistent with the median load for all available data given in Williamson (1991) of 90 g ha-1 (10 to 90%ile range 20 to 200 g ha-1). The similarity of loads among the three landuses and the slightly higher load for the commercial landuse are understandable because the main contributor of copper is likely to be vehicle brake pads and linings and the vehicle.km are higher in commercial catchments. Also, there is greater use of copper building materials in commercial buildings. The per vehicle.km copper load used for estimating the load from through-traffic was 0.00016 g vehicle-1 km-1 (Macaskill and Williamson 1994).

  - The existing scenario assumes that the copper load under the "current" (2001) landuse within the UWH catchment applies for the duration of the simulation. The derivation of the 2001 annual copper load for each subcatchment is explained in the next paragraph on the development #1 scenario.

- o The development #1 scenario copper loads generated within each subcatchment for each year were derived by adding together: (1) the total number of existing and proposed new dwellings in the year multiplied by the dwelling copper load of 8.3 g per annum; (2) the existing and proposed new commercial areas in the year multiplied by 140 g ha-1; (3) the existing and proposed new industrial areas in the year multiplied by 110 g ha-1, and; (4) the distance travelled by through traffic as vehicle.km in the year multiplied by the copper load of 0.00016 g per vehicle.km.

  Estimates of the numbers of dwellings, areas of commercial and industrial landuse and through traffic were obtained as described in the zinc results report (NIWA Client Report HAM2003-087/2 – Results: Zinc).

- o For the response-envelope scenario, the copper loads used were the same as those derived for the development #1 scenario.

- Contaminant partitioning. Copper is distributed between the silt and sand in the catchment soils in the same proportion as was measured in the estuarine bed sediments. This copper concentration silt:sand ratio varied between approximately 1 to 2.5. The specific partitioning used for each subcatchment is given in the model results.

- Stormwater contaminant controls.

  - o For the existing scenario, stormwater contaminant controls were set at zero, meaning that there is no retention of sediment and associated contaminants. Although this is not strictly correct, the assumption makes no material difference to the model results; it simply means that all new controls included in the model are additional to those that existed in 2001.

  - o The development #1 scenario stormwater contaminant controls are based on the responses to two questionnaires, one from NIWA and one from the ARC, to the participating TLAs as explained in the zinc results report (NIWA Client Report HAM2003-087/2 – Results: Zinc). The rationale for the copper controls is the same as that for zinc with the only difference being the somewhat higher retention efficiency usually achieved for copper. This higher efficiency is mainly a consequence of the much lower solubility of copper compared with zinc. The exception to this general difference is the control for copper from through traffic. The control is assumed to be the same as the control for zinc because the maximum retention of any metal in pond–swale systems is about 80%. The development #1 scenario controls are given in the following table. These controls apply only to new development, i.e., retrofitting is excluded.

Copper source	Realistic controls (% retained)	Explanation
Existing dwellings	0	No retrofitting.
Existing commercial	0	No retrofitting.
Existing industrial	0	No retrofitting.
Existing through traffic	30% to 2005, then 80%	Assumed to follow controls on future traffic because same roads are used.
Future dwellings	60	80% of dwellings connected to controls with 75% retention.
Future commercial	60	As for future dwellings.
Future industrial	60	As for future dwellings.
Future through traffic	30% to 2005, then 80%	Up to 2005, 40% of runoff from new roads controlled with 80% retention. From 2006 on, 100% of runoff treated with 80% retention.

- The response-envelope scenario addressed the two extreme options for contaminant controls; zero and the maximum attainable as explained in detail in the zinc results report (NIWA Client Report HAM2003-087/2 – Results: Zinc). The maximum-attainable controls for copper are listed and described in the following table. As explained for zinc, for dwellings and commercial and industrial landuses, a generic level of control for copper equivalent to the retention achieved in a wetland, i.e., 75%, was assumed. The maximum attainable controls for roads are the same as for development #1 scenario. Note that the only difference between the controls for development #1 scenario and the response-envelope scenario is the inclusion of retrofitting in the envelope scenario.

Copper source	Maximum attainable control (% retained)	Explanation
Existing dwellings	50	60% of dwellings connected to controls with 75% retention.
Existing commercial	50	As for existing dwellings.
Existing industrial	50	As for existing dwellings.
Existing through traffic	30% to 2005, then 80%	Assumed to follow controls on future traffic because same roads are used.
Future dwellings	60	80% of dwellings connected to controls with 75% retention.
Future commercial	60	As for future dwellings.
Future industrial	60	As for future dwellings.
Future through traffic	30% to 2005, then 80%	Up to 2005, 40% of runoff from new roads controlled with 80% retention. From 2006 on, 100% of runoff treated with 80% retention.

3. Simulation Inputs – Details

3.1 Simulation period: 54 years (2808 weeks)

For the 54-year simulation, the following inputs were used.

- Total area of each subestuary and area of channel and banks/intertidal flats in each subestuary (Table 4.2 in Methodology Report).
- Bioturbation model – uniform, with a bioturbation depth of 0.11 m .
- Event time series – four different magnitude events (E1, E2, E3, E4; Table 4.3 and Table 4.4 in Methodology Report) spread uniformly throughout simulation period of 54 years (1–2808 weeks, Figure A.3 in Methodology Report).
- R (Figure 4.6 in Methodology Report).
- R3(Figure 4.7 in Methodology Report).

- Contaminant partitioning across size fractions:

				Fraction of contaminant load on each size fraction	
Period #	**Week start**	**Week end**	**Subcatchment**	**Size fraction 1 (silt)**	**Size fraction 2 (sand)**
1	1	2808	1=Hellyers	0.98	0.02
1	1	2808	2=Lucas	0.95	0.05
1	1	2808	3=Paremoremo	0.92	0.08
1	1	2808	4=Rangitopuni	0.95	0.05
1	1	2808	5=Brighams	0.95	0.05
1	1	2808	6=Rarawaru	0.95	0.05
1	1	2808	7=Waiarohia	0.98	0.02

- Sediment partitioning across size fractions:

				Fraction of sediment load on each size fraction	
Period #	**Week start**	**Week end**	**Subcatchment**	**Size fraction 1 (silt)**	**Size fraction 2 (sand)**
1	1	2808	1=Hellyers	0.93	0.07
1	1	2808	2=Lucas	0.88	0.12
1	1	2808	3=Paremoremo	0.90	0.10
1	1	2808	4=Rangitopuni	0.91	0.09
1	1	2808	5=Brighams	0.95	0.05
1	1	2808	6=Rarawaru	0.95	0.05
1	1	2808	7=Waiarohia	0.95	0.05

- Contaminant loads – soil (natural or "background" load):

    - For all subcatchments: 20 mg copper per kg of silt (size fraction 1) yield and 6 mg copper per kg of sand (size fraction 2) yield.

- Initial contaminant concentrations in estuarine bed sediment size fractions:

Subestuary	Cu conc, mg/kg	
	Size fraction 1 (silt)	Size fraction 2 (sand)
1 = Hellyers	22	6
2 = Lucas	24	9
3 = Paremoremo	22	23
4 = Rangitopuni	23	12
5 = Brighams	24	24
6 = Rarawaru	24	24
7 = Waiarohia	23	10
8 = MWH	-	-
9 = Upper main UWH	25	21
10 = Middle main UWH	27	4
11 = Lower main UWH	28	5

- Initial split of estuarine bed sediments into size fractions:

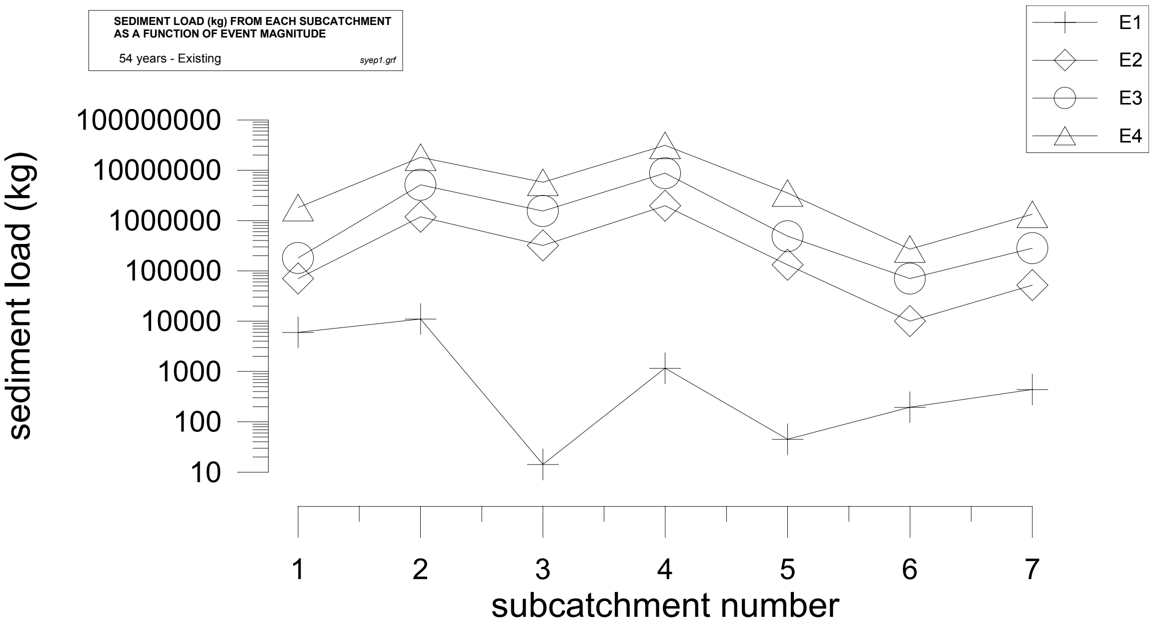
	% of bed sediment in each size fraction	
Subestuary	Size fraction 1 (silt)	Size fraction 2 (sand)
1 = Hellyers	77.77	22.23
2 = Lucas	66.68	33.32
3 = Paremoremo	68.80	31.20
4 = Rangitopuni	56.84	43.16
5 = Brighams	77.30	22.70
6 = Rarawaru	77.30	22.70
7 = Waiarohia	26.09	73.91
8 = MWH	-	-
9 = Upper main UWH	82.34	17.66
10 = Middle main UWH	33.55	66.45
11 = Lower main UWH	33.35	66.65

- Initial contaminant concentrations in estuarine bed sediments – total:

Subestuary	Cu conc, mg/kg
1 = Hellyers	20
2 = Lucas	19
3 = Paremoremo	21
4 = Rangitopuni	18
5 = Brighams	24
6 = Rarawaru	24
7 = Waiarohia	13
8 = MWH	-
9 = Upper main UWH	22
10 = Middle main UWH	6
11 = Lower main UWH	13

- Sediment loads from each subcatchment as a function of event magnitude, 54 years, existing scenario:

				sediment load, kg			
Period #	Week start	Week end	Subcatchment	Event E1	Event E2	Event E3	Event E4
1	1	2808	1=Hellyers	6,000	70,000	180,000	1,800,000
1	1	2808	2=Lucas	11,037	1,190,000	5,130,000	18,100,000
1	1	2808	3=Paremoremo	14.3	319,000	1,540,000	5,730,000
1	1	2808	4=Rangitopuni	1,160	1,960,000	8,720,000	31,200,000
1	1	2808	5=Brighams	45	132,000	488,000	3,520,000
1	1	2808	6=Rarawaru	195	10,000	69,900	271,000
1	1	2808	7=Waiarohia	437	52,100	282,000	1,330,000



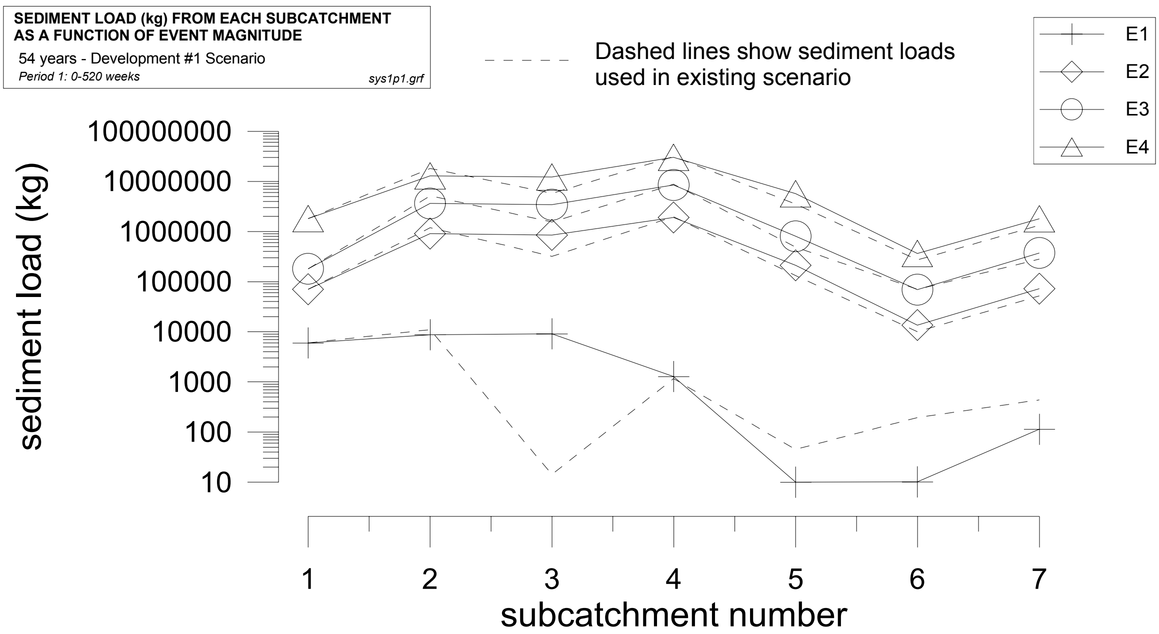
These are the same sediment loads that were used in the existing scenario, zinc.

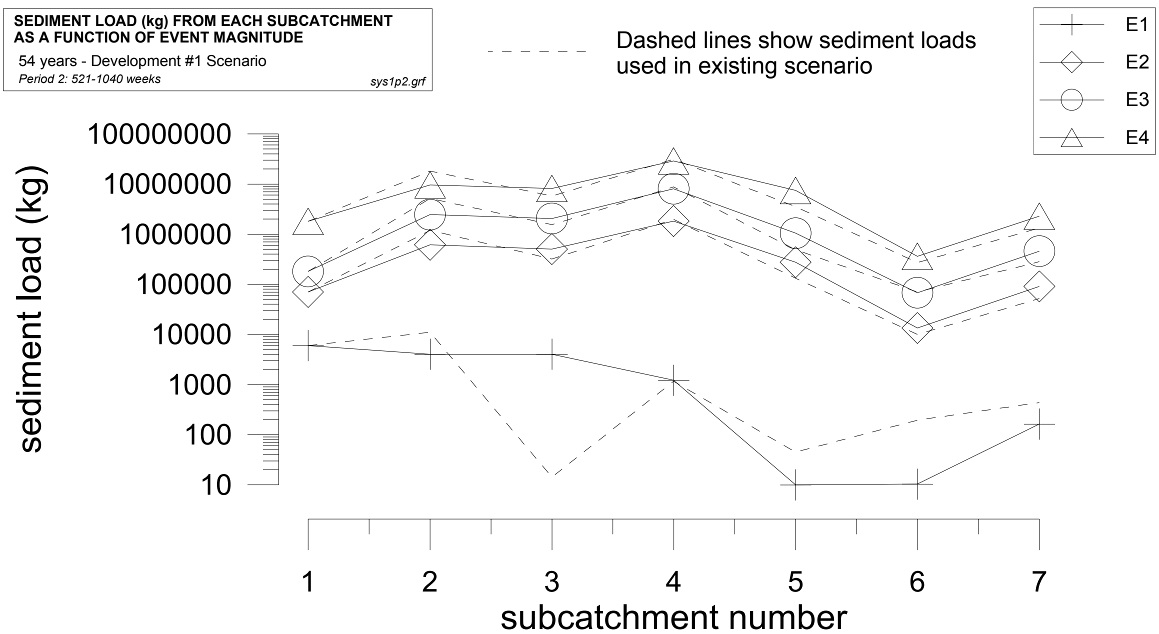
- Sediment loads from each subcatchment as a function of event magnitude, 54 years, development #1 scenario and response-envelope scenario (change in loads through time is a result of landuse change):

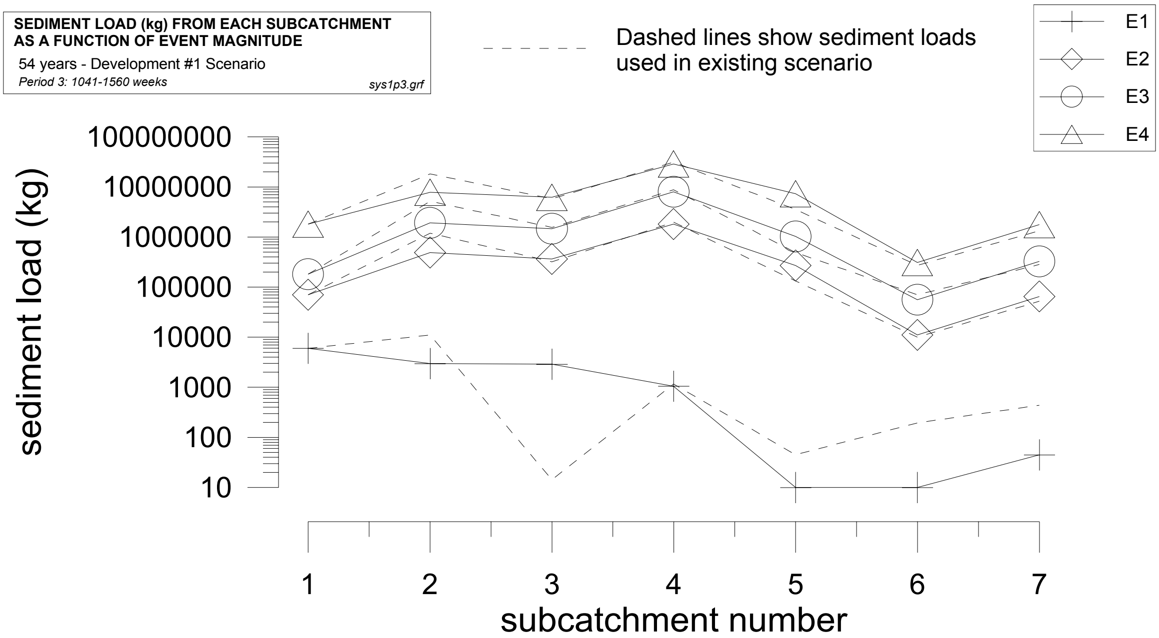
				sediment load, kg			
Period #	**Week start**	**Week end**	**Subcatchment**	**Event E1**	**Event E2**	**Event E3**	**Event E4**
1	1	520	1=Hellyers	6,000	70,000	180,000	1,800,000
1	1	520	2=Lucas	8,726	906,917	3,616,680	12,842,993
1	1	520	3=Paremoremo	9,146	848,914	3,428,741	12,167,005
1	1	520	4=Rangitopuni	1,280	1,901,862	8,414,052	30,149,116
1	1	520	5=Brighams	10	210,801	800,788	5,660,463
1	1	520	6=Rarawaru	10	13,536	68,872	365,385
1	1	520	7=Waiarohia	113	72,258	371,658	1,794,805
2	521	1040	1=Hellyers	6,000	70,000	180,000	1,800,000
2	521	1040	2=Lucas	4,038	611,016	2,443,164	9,575,109
2	521	1040	3=Paremoremo	4,018	500,403	2,048,763	8,169,509
2	521	1040	4=Rangitopuni	1,223	1,818,339	8,045,166	28,886,503
2	521	1040	5=Brighams	10	274,786	1,043,837	7,400,884
2	521	1040	6=Rarawaru	10	13,374	67,732	363,100
2	521	1040	7=Waiarohia	163	90,426	456,730	2,275,890
3	1041	1560	1=Hellyers	6,000	70,000	180,000	1,800,000
3	1041	1560	2=Lucas	2,973	489,639	1,912,042	7,811,152
3	1041	1560	3=Paremoremo	2,874	363,223	1,456,753	6,164,793
3	1041	1560	4=Rangitopuni	1,051	1,798,170	7,985,930	28,667,845
3	1041	1560	5=Brighams	10	268,811	1,019,490	7,256,593
3	1041	1560	6=Rarawaru	10	11,011	55,789	310,707
3	1041	1560	7=Waiarohia	45	64,648	325,179	1,768,049
4	1561	2080	1=Hellyers	6,000	70,000	180,000	1,800,000
4	1561	2080	2=Lucas	1,962	414,417	1,613,499	7,045,243
4	1561	2080	3=Paremoremo	1,913	290,643	1,170,328	5,456,592
4	1561	2080	4=Rangitopuni	1,051	1,798,170	7,985,930	28,667,845
4	1561	2080	5=Brighams	10	258,709	981,120	7,006,161
4	1561	2080	6=Rarawaru	10	10,774	54,577	304,129
4	1561	2080	7=Waiarohia	34	46,081	229,720	1,273,534
5	2081	2808	1=Hellyers	6,000	70,000	180,000	1,800,000
5	2081	2081	2=Lucas	1,569	368,319	1,426,442	6,429,850
5	2081	2081	3=Paremoremo	1,491	238,573	959,891	4,731,769
5	2081	2081	4=Rangitopuni	1,051	1,798,170	7,985,930	28,667,845
5	2081	2081	5=Brighams	10	274,208	1,039,830	7,450,822
5	2081	2081	6=Rarawaru	10	10,756	54,473	303,724
5	2081	2081	7=Waiarohia	38	47,819	235,964	1,337,167

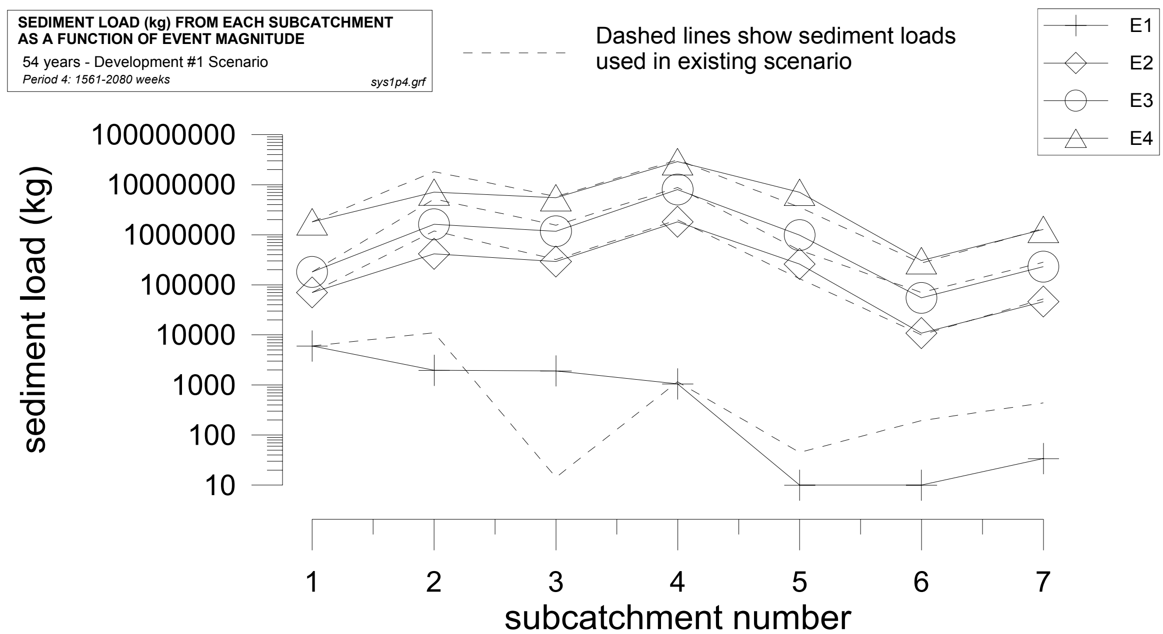
The next pages show plots, with comparisons to sediment loads used in existing scenario.

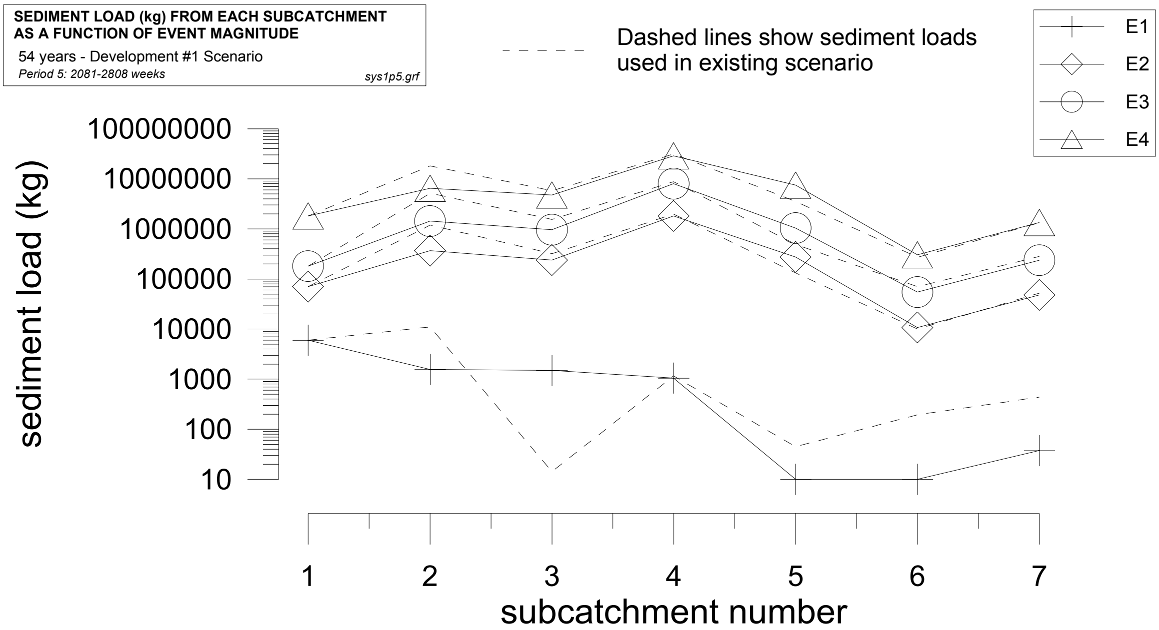
These are the same sediment loads that were used in the development #1 and response-envelope scenarios, zinc.


SEDIMENT LOAD (kg) FROM EACH SUBCATCHMENT
AS A FUNCTION OF EVENT MAGNITUDE
54 years - Development #1 Scenario
Period 1: 0-520 weeks
sys1p1.grf
Dashed lines show sediment loads
used in existing scenario
E1
E2
E3
E4
sediment load (kg)
100000000
10000000
1000000
100000
10000
1000
100
10
1
2
3
4
5
6
7
subcatchment number


SEDIMENT LOAD (kg) FROM EACH SUBCATCHMENT
AS A FUNCTION OF EVENT MAGNITUDE
54 years - Development #1 Scenario
Period 2: 521-1040 weeks
sys1p2.grf
Dashed lines show sediment loads
used in existing scenario
E1
E2
E3
E4
sediment load (kg)
100000000
10000000
1000000
100000
10000
1000
100
10
1
2
3
4
5
6
7
subcatchment number

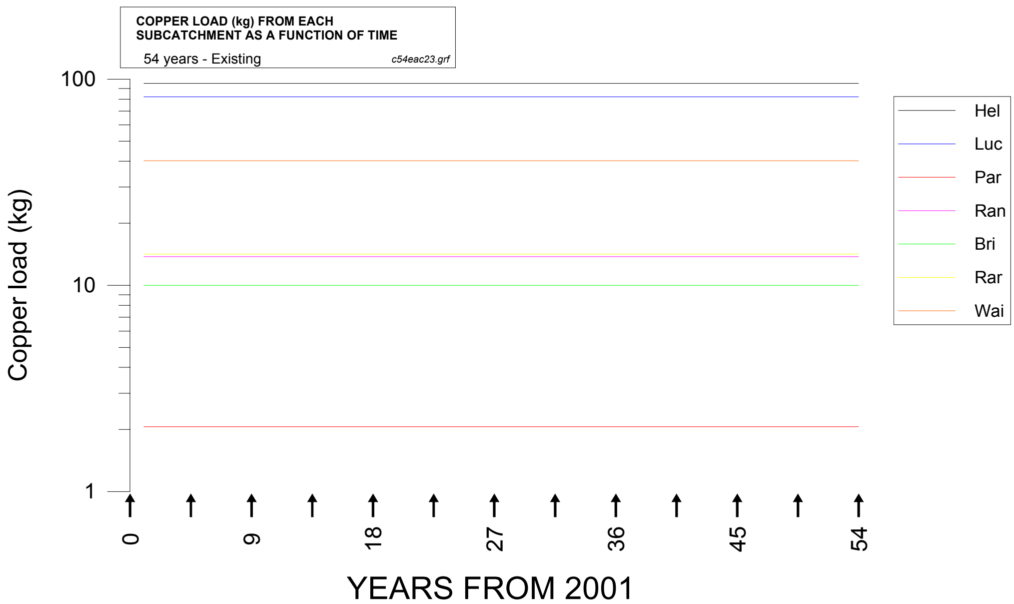

SEDIMENT LOAD (kg) FROM EACH SUBCATCHMENT
AS A FUNCTION OF EVENT MAGNITUDE
54 years - Development #1 Scenario
Period 3: 1041-1560 weeks
sys1p3.grf
Dashed lines show sediment loads used in existing scenario
E1
E2
E3
E4
sediment load (kg)
100000000
10000000
1000000
100000
10000
1000
100
10
1
2
3
4
5
6
7
subcatchment number


SEDIMENT LOAD (kg) FROM EACH SUBCATCHMENT
AS A FUNCTION OF EVENT MAGNITUDE
54 years - Development #1 Scenario
Period 4: 1561-2080 weeks
sys1p4.grf
Dashed lines show sediment loads used in existing scenario
E1
E2
E3
E4
sediment load (kg)
100000000
10000000
1000000
100000
10000
1000
100
10
1
2
3
4
5
6
7
subcatchment number



- Contaminant loads – dwellings, roads, traffic ("urban load") – existing scenario:

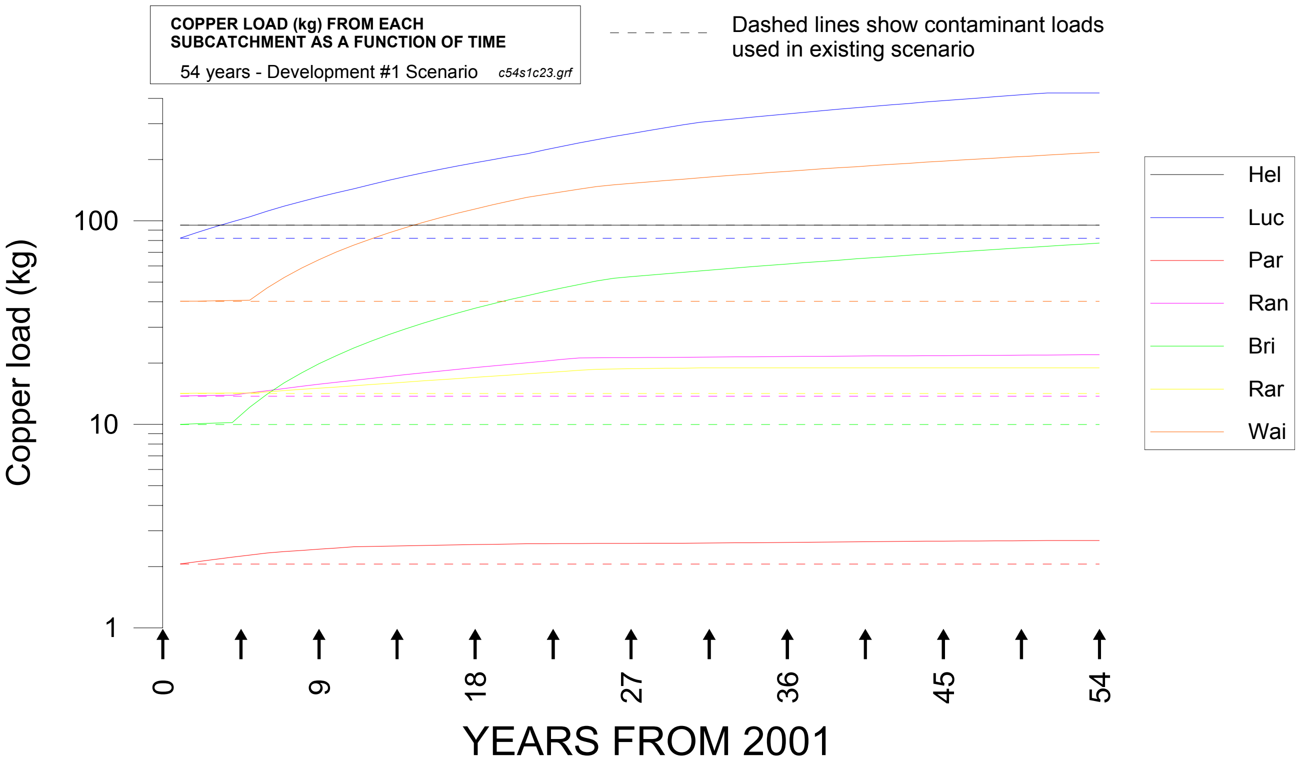
Period #	Week start	Week end	kg copper from each subcatchment						
			1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai
1	1	2808	95.45	82.14	2.06	13.78	10.00	14.19	40.23



- Contaminant loads – dwellings, roads, traffic ("urban load") – development #1 scenario and response-envelope scenario:

Period #	Week start	Week end	kg copper from each subcatchment						
			1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai
1	1	52	95.45	82.14	2.06	13.78	10.00	14.19	40.23
2	53	104	95.45	87.74	2.11	13.82	10.07	14.20	40.34
3	105	156	95.45	93.33	2.17	13.86	10.13	14.22	40.44
4	157	208	95.45	98.96	2.22	13.89	10.20	14.23	40.58
5	209	260	95.45	104.56	2.27	14.26	12.13	14.24	40.69
6	261	312	95.45	111.32	2.33	14.63	14.05	14.44	46.73
7	313	364	95.45	117.91	2.36	14.99	15.98	14.64	52.69
8	365	416	95.45	124.43	2.40	15.36	17.91	14.84	58.58
9	417	468	95.45	130.88	2.43	15.73	19.83	15.04	64.40
10	469	520	95.45	137.26	2.46	16.09	21.76	15.24	70.15
11	521	572	95.45	143.58	2.50	16.46	23.68	15.44	75.85
12	573	624	95.45	150.77	2.51	16.82	25.61	15.66	81.49
13	625	676	95.45	157.91	2.52	17.19	27.53	15.89	87.08
14	677	728	95.45	164.99	2.52	17.55	29.45	16.12	92.62
15	729	780	95.45	172.03	2.53	17.91	31.37	16.34	98.11
16	781	832	95.45	179.03	2.54	18.28	33.30	16.57	103.56
17	833	884	95.45	185.98	2.55	18.64	35.22	16.79	108.96
18	885	936	95.45	192.89	2.56	19.00	37.14	17.02	114.33
19	937	988	95.45	199.77	2.57	19.37	39.06	17.24	119.66
20	989	1040	95.45	206.61	2.58	19.73	40.98	17.47	124.96
21	1041	1092	95.45	213.43	2.59	20.09	42.89	17.70	130.22
22	1093	1144	95.45	222.65	2.59	20.45	44.81	17.93	134.54
23	1145	1196	95.45	231.86	2.59	20.81	46.73	18.17	138.84
24	1197	1248	95.45	241.03	2.59	21.17	48.65	18.41	143.10
25	1249	1300	95.45	250.18	2.59	21.20	50.56	18.64	147.34
26	1301	1352	95.45	259.30	2.59	21.23	52.18	18.69	149.94
27	1353	1404	95.45	268.40	2.60	21.26	53.09	18.74	152.51
28	1405	1456	95.45	277.49	2.60	21.29	54.01	18.79	155.07
29	1457	1508	95.45	286.55	2.60	21.32	54.92	18.84	157.60
30	1509	1560	95.45	295.59	2.60	21.35	55.84	18.89	160.12
31	1561	1612	95.45	304.62	2.60	21.38	56.75	18.94	162.61
32	1613	1664	95.45	310.72	2.61	21.41	57.67	18.94	165.09
33	1665	1716	95.45	316.81	2.61	21.44	58.58	18.94	167.56
34	1717	1768	95.45	322.88	2.62	21.47	59.49	18.94	170.01
35	1769	1820	95.45	328.94	2.62	21.49	60.41	18.94	172.45
36	1821	1872	95.45	334.99	2.62	21.52	61.32	18.94	174.87
37	1873	1924	95.45	341.02	2.63	21.55	62.23	18.94	177.29
38	1925	1976	95.45	347.04	2.63	21.58	63.14	18.94	179.69
39	1977	2028	95.45	353.06	2.64	21.60	64.05	18.94	182.08
40	2029	2080	95.45	359.06	2.64	21.63	64.96	18.94	184.46
41	2081	2132	95.45	365.05	2.65	21.65	65.87	18.94	186.83
42	2133	2184	95.45	371.06	2.65	21.68	66.78	18.94	189.20
43	2185	2236	95.45	377.07	2.65	21.71	67.69	18.94	191.55
44	2237	2288	95.45	383.06	2.66	21.73	68.60	18.94	193.90
45	2289	2340	95.45	389.05	2.66	21.76	69.51	18.94	196.24
46	2341	2392	95.45	395.03	2.66	21.78	70.42	18.94	198.57
47	2393	2444	95.45	401.00	2.67	21.81	71.33	18.94	200.90
48	2445	2496	95.45	406.97	2.67	21.83	72.23	18.94	203.22
49	2497	2548	95.45	412.93	2.67	21.85	73.14	18.94	205.53
50	2549	2600	95.45	418.89	2.68	21.88	74.04	18.94	207.84
51	2601	2652	95.45	424.84	2.68	21.90	74.95	18.94	210.14
52	2653	2704	95.45	424.91	2.68	21.92	75.86	18.94	212.44
53	2705	2756	95.45	424.98	2.68	21.95	76.76	18.94	214.74
54	2757	2808	95.45	425.05	2.68	21.97	77.67	18.94	217.03

The next page shows a plot, with comparisons to contaminant loads used in existing scenario.



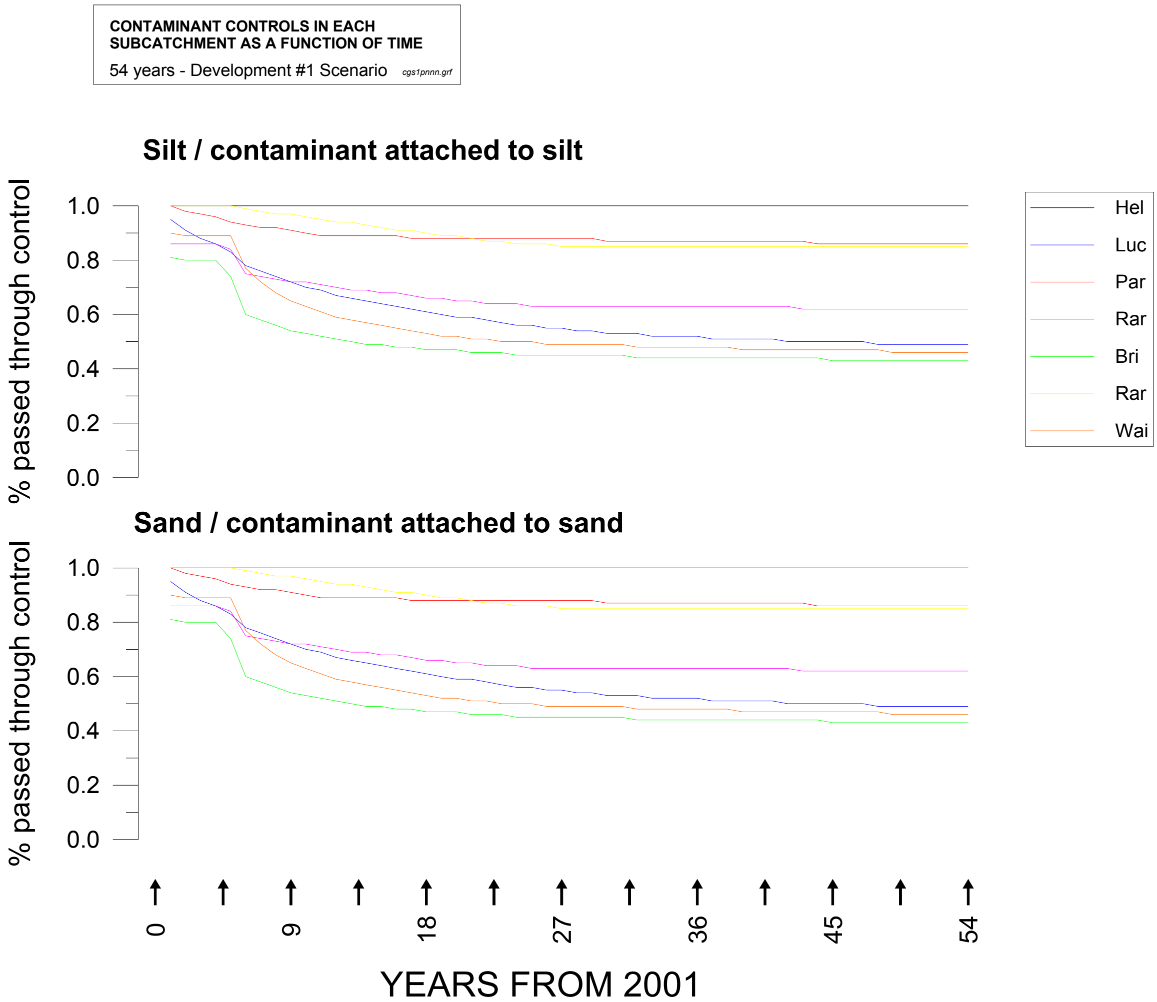
- Stormwater contaminant controls – existing scenario:

				Fraction of sediment load (with attached contaminant) <u>passed</u> through controls													
				1=Hel		2=Luc		3=Par		4=Ran		5=Bri		6=Rar		7=Wai	
Period #	**Week start**	**Week end**	**Events**	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand
1	1	2808	1,2,3,4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

- Stormwater contaminant controls – development #1 scenario:

				Fraction of sediment load (with attached contaminant) passed through controls													
				1=Hel		2=Luc		3=Par		4=Ran		5=Bri		6=Rar		7=Wai	
Period #	Week start	Week end	Events	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand
1	1	52	1,2,3,4	1.00	1.00	0.95	0.95	1.00	1.00	0.86	0.86	0.81	0.81	1.00	1.00	0.90	0.90
2	53	104	1,2,3,4	1.00	1.00	0.91	0.91	0.98	0.98	0.86	0.86	0.80	0.80	1.00	1.00	0.89	0.89
3	105	156	1,2,3,4	1.00	1.00	0.88	0.88	0.97	0.97	0.86	0.86	0.80	0.80	1.00	1.00	0.89	0.89
4	157	208	1,2,3,4	1.00	1.00	0.86	0.86	0.96	0.96	0.86	0.86	0.80	0.80	1.00	1.00	0.89	0.89
5	209	260	1,2,3,4	1.00	1.00	0.83	0.83	0.94	0.94	0.84	0.84	0.74	0.74	1.00	1.00	0.89	0.89
6	261	312	1,2,3,4	1.00	1.00	0.78	0.78	0.93	0.93	0.75	0.75	0.60	0.60	0.99	0.99	0.77	0.77
7	313	364	1,2,3,4	1.00	1.00	0.76	0.76	0.92	0.92	0.74	0.74	0.58	0.58	0.98	0.98	0.72	0.72
8	365	416	1,2,3,4	1.00	1.00	0.74	0.74	0.92	0.92	0.73	0.73	0.56	0.56	0.97	0.97	0.68	0.68
9	417	468	1,2,3,4	1.00	1.00	0.72	0.72	0.91	0.91	0.72	0.72	0.54	0.54	0.97	0.97	0.65	0.65
10	469	520	1,2,3,4	1.00	1.00	0.70	0.70	0.90	0.90	0.72	0.72	0.53	0.53	0.96	0.96	0.63	0.63
11	521	572	1,2,3,4	1.00	1.00	0.69	0.69	0.89	0.89	0.71	0.71	0.52	0.52	0.95	0.95	0.61	0.61
12	573	624	1,2,3,4	1.00	1.00	0.67	0.67	0.89	0.89	0.70	0.70	0.51	0.51	0.94	0.94	0.59	0.59
13	625	676	1,2,3,4	1.00	1.00	0.66	0.66	0.89	0.89	0.69	0.69	0.50	0.50	0.94	0.94	0.58	0.58
14	677	728	1,2,3,4	1.00	1.00	0.65	0.65	0.89	0.89	0.69	0.69	0.49	0.49	0.93	0.93	0.57	0.57
15	729	780	1,2,3,4	1.00	1.00	0.64	0.64	0.89	0.89	0.68	0.68	0.49	0.49	0.92	0.92	0.56	0.56
16	781	832	1,2,3,4	1.00	1.00	0.63	0.63	0.89	0.89	0.68	0.68	0.48	0.48	0.91	0.91	0.55	0.55
17	833	884	1,2,3,4	1.00	1.00	0.62	0.62	0.88	0.88	0.67	0.67	0.48	0.48	0.91	0.91	0.54	0.54
18	885	936	1,2,3,4	1.00	1.00	0.61	0.61	0.88	0.88	0.66	0.66	0.47	0.47	0.90	0.90	0.53	0.53
19	937	988	1,2,3,4	1.00	1.00	0.60	0.60	0.88	0.88	0.66	0.66	0.47	0.47	0.89	0.89	0.52	0.52
20	989	1040	1,2,3,4	1.00	1.00	0.59	0.59	0.88	0.88	0.65	0.65	0.47	0.47	0.89	0.89	0.52	0.52
21	1041	1092	1,2,3,4	1.00	1.00	0.59	0.59	0.88	0.88	0.65	0.65	0.46	0.46	0.88	0.88	0.51	0.51
22	1093	1144	1,2,3,4	1.00	1.00	0.58	0.58	0.88	0.88	0.64	0.64	0.46	0.46	0.87	0.87	0.51	0.51
23	1145	1196	1,2,3,4	1.00	1.00	0.57	0.57	0.88	0.88	0.64	0.64	0.46	0.46	0.87	0.87	0.50	0.50
24	1197	1248	1,2,3,4	1.00	1.00	0.56	0.56	0.88	0.88	0.64	0.64	0.45	0.45	0.86	0.86	0.50	0.50
25	1249	1300	1,2,3,4	1.00	1.00	0.56	0.56	0.88	0.88	0.63	0.63	0.45	0.45	0.86	0.86	0.50	0.50
26	1301	1352	1,2,3,4	1.00	1.00	0.55	0.55	0.88	0.88	0.63	0.63	0.45	0.45	0.86	0.86	0.49	0.49
27	1353	1404	1,2,3,4	1.00	1.00	0.55	0.55	0.88	0.88	0.63	0.63	0.45	0.45	0.85	0.85	0.49	0.49
28	1405	1456	1,2,3,4	1.00	1.00	0.54	0.54	0.88	0.88	0.63	0.63	0.45	0.45	0.85	0.85	0.49	0.49
29	1457	1508	1,2,3,4	1.00	1.00	0.54	0.54	0.88	0.88	0.63	0.63	0.45	0.45	0.85	0.85	0.49	0.49
30	1509	1560	1,2,3,4	1.00	1.00	0.53	0.53	0.87	0.87	0.63	0.63	0.45	0.45	0.85	0.85	0.49	0.49
31	1561	1612	1,2,3,4	1.00	1.00	0.53	0.53	0.87	0.87	0.63	0.63	0.45	0.45	0.85	0.85	0.49	0.49
32	1613	1664	1,2,3,4	1.00	1.00	0.53	0.53	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
33	1665	1716	1,2,3,4	1.00	1.00	0.52	0.52	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
34	1717	1768	1,2,3,4	1.00	1.00	0.52	0.52	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
35	1769	1820	1,2,3,4	1.00	1.00	0.52	0.52	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
36	1821	1872	1,2,3,4	1.00	1.00	0.52	0.52	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
37	1873	1924	1,2,3,4	1.00	1.00	0.51	0.51	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
38	1925	1976	1,2,3,4	1.00	1.00	0.51	0.51	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
39	1977	2028	1,2,3,4	1.00	1.00	0.51	0.51	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.47	0.47
40	2029	2080	1,2,3,4	1.00	1.00	0.51	0.51	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.47	0.47
41	2081	2132	1,2,3,4	1.00	1.00	0.51	0.51	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.47	0.47
42	2133	2184	1,2,3,4	1.00	1.00	0.50	0.50	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.47	0.47
43	2185	2236	1,2,3,4	1.00	1.00	0.50	0.50	0.87	0.87	0.62	0.62	0.44	0.44	0.85	0.85	0.47	0.47
44	2237	2288	1,2,3,4	1.00	1.00	0.50	0.50	0.86	0.86	0.62	0.62	0.44	0.44	0.85	0.85	0.47	0.47
45	2289	2340	1,2,3,4	1.00	1.00	0.50	0.50	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.47	0.47
46	2341	2392	1,2,3,4	1.00	1.00	0.50	0.50	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.47	0.47
47	2393	2444	1,2,3,4	1.00	1.00	0.50	0.50	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.47	0.47
48	2445	2496	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.47	0.47
49	2497	2548	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
50	2549	2600	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
51	2601	2652	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
52	2653	2704	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
53	2705	2756	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46

54	2757	2808	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46



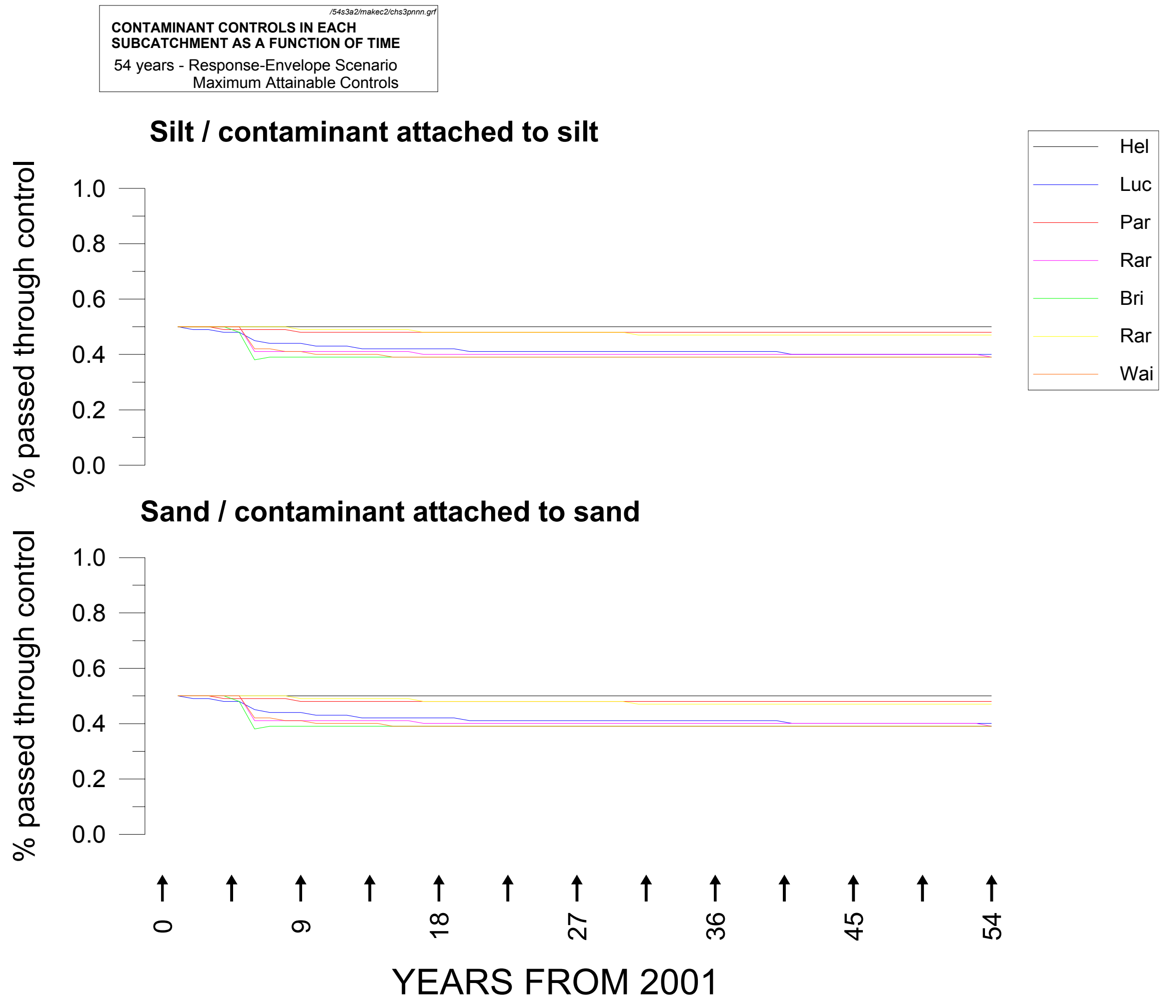
- Stormwater contaminant controls – response-envelope scenario, zero controls:

				Fraction of sediment load (with attached contaminant) passed through controls													
				1=Hel		2=Luc		3=Par		4=Ran		5=Bri		6=Rar		7=Wai	
Period #	**Week start**	**Week end**	**Events**	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand
1	1	2808	1,2,3,4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

- Stormwater contaminant controls – response-envelope scenario, maximum attainable controls:

				Fraction of sediment load (with attached contaminant) **passed** through controls													
				1=Hel		2=Luc		3=Par		4=Ran		5=Bri		6=Rar		7=Wai	
Period #	**Week start**	**Week end**	**Events**	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand
1	1	52	1,2,3,4	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
2	53	104	1,2,3,4	0.50	0.50	0.49	0.49	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
3	105	156	1,2,3,4	0.50	0.50	0.49	0.49	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
4	157	208	1,2,3,4	0.50	0.50	0.48	0.48	0.49	0.49	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
5	209	260	1,2,3,4	0.50	0.50	0.48	0.48	0.49	0.49	0.50	0.50	0.48	0.48	0.50	0.50	0.50	0.50
6	261	312	1,2,3,4	0.50	0.50	0.45	0.45	0.49	0.49	0.41	0.41	0.38	0.38	0.50	0.50	0.42	0.42
7	313	364	1,2,3,4	0.50	0.50	0.44	0.44	0.49	0.49	0.41	0.41	0.39	0.39	0.50	0.50	0.42	0.42
8	365	416	1,2,3,4	0.50	0.50	0.44	0.44	0.49	0.49	0.41	0.41	0.39	0.39	0.50	0.50	0.41	0.41
9	417	468	1,2,3,4	0.50	0.50	0.44	0.44	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.41	0.41
10	469	520	1,2,3,4	0.50	0.50	0.43	0.43	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.40	0.40
11	521	572	1,2,3,4	0.50	0.50	0.43	0.43	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.40	0.40
12	573	624	1,2,3,4	0.50	0.50	0.43	0.43	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.40	0.40
13	625	676	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.40	0.40
14	677	728	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.40	0.40
15	729	780	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.39	0.39
16	781	832	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.39	0.39
17	833	884	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
18	885	936	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
19	937	988	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
20	989	1040	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
21	1041	1092	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
22	1093	1144	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
23	1145	1196	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
24	1197	1248	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
25	1249	1300	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
26	1301	1352	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
27	1353	1404	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
28	1405	1456	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
29	1457	1508	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
30	1509	1560	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
31	1561	1612	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
32	1613	1664	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
33	1665	1716	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
34	1717	1768	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
35	1769	1820	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
36	1821	1872	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
37	1873	1924	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
38	1925	1976	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
39	1977	2028	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
40	2029	2080	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
41	2081	2132	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
42	2133	2184	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
43	2185	2236	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
44	2237	2288	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
45	2289	2340	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
46	2341	2392	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
47	2393	2444	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
48	2445	2496	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
49	2497	2548	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
50	2549	2600	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
51	2601	2652	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39

52	2653	2704	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
53	2705	2756	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
54	2757	2808	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39



3.2 Simulation period: 108 years (5616 weeks)

For the 108-year simulation, the following inputs were used:

- Total area of each subestuary and area of channel and banks/intertidal flats in each subestuary (Table 4.2 in Methodology Report).
- Bioturbation model – uniform, with a bioturbation depth of 0.11 m.
- Event time series – four different magnitude events (E1, E2, E3, E4; Table 4.3 and Table 4.4 in Methodology Report) spread uniformly throughout simulation period of 108 years (1–5616 weeks, Figure A.3 in Methodology Report).
- R (Figure 4.6 in Methodology Report).
- R3 (Figure 4.7 in Methodology Report).

- Contaminant partitioning across size fractions: as 54-year simulation.
- Sediment partitioning across size fractions: as 54-year simulation.

- Initial contaminant concentrations in estuarine bed sediments – size fractions: as 54-year simulation.
- Initial split of estuarine bed sediments into size fractions: as 54-year simulation.
- Initial contaminant concentrations in estuarine bed sediments – total: as 54-year simulation.

- Sediment loads – existing scenario: as 54-year simulation.
- Sediment loads – development #1 scenario and response-envelope scenario: as 54-year simulation.

- Contaminant loads – soil (natural or "background" load): as 54-year simulation.

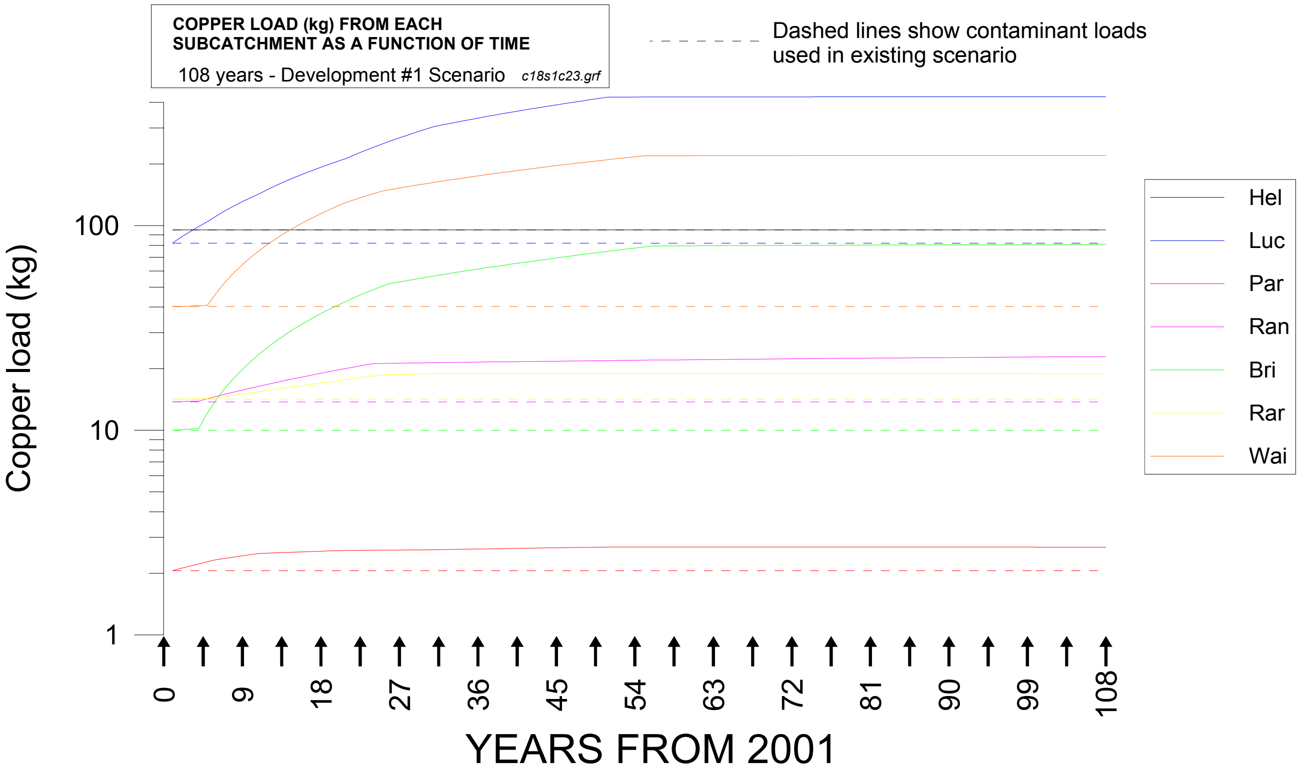
- Contaminant loads – existing scenario, dwellings, roads, traffic ("urban" load): as 54-year simulation.

- Contaminant loads – dwellings, roads, traffic ("urban load") – development #1 scenario and response-envelope scenario:

Period #	Week start	Week end	kg copper from each subcatchment						
			1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai
1	1	52	95.45	82.14	2.06	13.78	10.00	14.19	40.23
2	53	104	95.45	87.74	2.11	13.82	10.07	14.20	40.34
3	105	156	95.45	93.33	2.17	13.86	10.13	14.22	40.44
4	157	208	95.45	98.96	2.22	13.89	10.20	14.23	40.58
5	209	260	95.45	104.56	2.27	14.26	12.13	14.24	40.69
6	261	312	95.45	111.32	2.33	14.63	14.05	14.44	46.73
7	313	364	95.45	117.91	2.36	14.99	15.98	14.64	52.69
8	365	416	95.45	124.43	2.40	15.36	17.91	14.84	58.58
9	417	468	95.45	130.88	2.43	15.73	19.83	15.04	64.40
10	469	520	95.45	137.26	2.46	16.09	21.76	15.24	70.15
11	521	572	95.45	143.58	2.50	16.46	23.68	15.44	75.85
12	573	624	95.45	150.77	2.51	16.82	25.61	15.66	81.49
13	625	676	95.45	157.91	2.52	17.19	27.53	15.89	87.08
14	677	728	95.45	164.99	2.52	17.55	29.45	16.12	92.62
15	729	780	95.45	172.03	2.53	17.91	31.37	16.34	98.11
16	781	832	95.45	179.03	2.54	18.28	33.30	16.57	103.56
17	833	884	95.45	185.98	2.55	18.64	35.22	16.79	108.96
18	885	936	95.45	192.89	2.56	19.00	37.14	17.02	114.33
19	937	988	95.45	199.77	2.57	19.37	39.06	17.24	119.66
20	989	1040	95.45	206.61	2.58	19.73	40.98	17.47	124.96
21	1041	1092	95.45	213.43	2.59	20.09	42.89	17.70	130.22
22	1093	1144	95.45	222.65	2.59	20.45	44.81	17.93	134.54
23	1145	1196	95.45	231.86	2.59	20.81	46.73	18.17	138.84
24	1197	1248	95.45	241.03	2.59	21.17	48.65	18.41	143.10
25	1249	1300	95.45	250.18	2.59	21.20	50.56	18.64	147.34
26	1301	1352	95.45	259.30	2.59	21.23	52.18	18.69	149.94
27	1353	1404	95.45	268.40	2.60	21.26	53.09	18.74	152.51
28	1405	1456	95.45	277.49	2.60	21.29	54.01	18.79	155.07
29	1457	1508	95.45	286.55	2.60	21.32	54.92	18.84	157.60
30	1509	1560	95.45	295.59	2.60	21.35	55.84	18.89	160.12
31	1561	1612	95.45	304.62	2.60	21.38	56.75	18.94	162.61
32	1613	1664	95.45	310.72	2.61	21.41	57.67	18.94	165.09
33	1665	1716	95.45	316.81	2.61	21.44	58.58	18.94	167.56
34	1717	1768	95.45	322.88	2.62	21.47	59.49	18.94	170.01
35	1769	1820	95.45	328.94	2.62	21.49	60.41	18.94	172.45
36	1821	1872	95.45	334.99	2.62	21.52	61.32	18.94	174.87
37	1873	1924	95.45	341.02	2.63	21.55	62.23	18.94	177.29
38	1925	1976	95.45	347.04	2.63	21.58	63.14	18.94	179.69
39	1977	2028	95.45	353.06	2.64	21.60	64.05	18.94	182.08
40	2029	2080	95.45	359.06	2.64	21.63	64.96	18.94	184.46
41	2081	2132	95.45	365.05	2.65	21.65	65.87	18.94	186.83
42	2133	2184	95.45	371.06	2.65	21.68	66.78	18.94	189.20
43	2185	2236	95.45	377.07	2.65	21.71	67.69	18.94	191.55
44	2237	2288	95.45	383.06	2.66	21.73	68.60	18.94	193.90
45	2289	2340	95.45	389.05	2.66	21.76	69.51	18.94	196.24
46	2341	2392	95.45	395.03	2.66	21.78	70.42	18.94	198.57
47	2393	2444	95.45	401.00	2.67	21.81	71.33	18.94	200.90
48	2445	2496	95.45	406.97	2.67	21.83	72.23	18.94	203.22
49	2497	2548	95.45	412.93	2.67	21.85	73.14	18.94	205.53
50	2549	2600	95.45	418.89	2.68	21.88	74.04	18.94	207.84
51	2601	2652	95.45	424.84	2.68	21.90	74.95	18.94	210.14
52	2653	2704	95.45	424.91	2.68	21.92	75.86	18.94	212.44
53	2705	2756	95.45	424.98	2.68	21.95	76.76	18.94	214.74
54	2757	2808	95.45	425.05	2.68	21.97	77.67	18.94	217.03
55	2809	2860	95.45	425.11	2.68	21.99	78.57	18.94	219.32
56	2861	2912	95.45	425.17	2.68	22.02	79.47	18.94	219.37
57	2913	2964	95.45	425.22	2.68	22.04	79.51	18.94	219.43
58	2965	3016	95.45	425.28	2.68	22.06	79.55	18.94	219.48
59	3017	3068	95.45	425.32	2.68	22.08	79.59	18.94	219.53

60	3069	3120	95.45	425.37	2.68	22.10	79.62	18.94	219.57
61	3121	3172	95.45	425.41	2.68	22.12	79.66	18.94	219.62
62	3173	3224	95.45	425.45	2.68	22.15	79.69	18.94	219.66
63	3225	3276	95.45	425.49	2.68	22.17	79.73	18.94	219.69
64	3277	3328	95.45	425.52	2.68	22.19	79.76	18.94	219.73
65	3329	3380	95.45	425.56	2.68	22.21	79.80	18.94	219.76
66	3381	3432	95.45	425.59	2.68	22.23	79.83	18.94	219.79
67	3433	3484	95.45	425.62	2.68	22.25	79.87	18.94	219.82
68	3485	3536	95.45	425.65	2.68	22.27	79.90	18.94	219.85
69	3537	3588	95.45	425.67	2.68	22.29	79.93	18.94	219.88
70	3589	3640	95.45	425.70	2.68	22.31	79.97	18.94	219.90
71	3641	3692	95.45	425.72	2.68	22.33	80.00	18.94	219.92
72	3693	3744	95.45	425.74	2.68	22.34	80.03	18.94	219.94
73	3745	3796	95.45	425.76	2.68	22.36	80.06	18.94	219.97
74	3797	3848	95.45	425.78	2.68	22.38	80.10	18.94	219.98
75	3849	3900	95.45	425.80	2.68	22.40	80.13	18.94	220.00
76	3901	3952	95.45	425.81	2.68	22.42	80.16	18.94	220.02
77	3953	4004	95.45	425.83	2.68	22.44	80.19	18.94	220.03
78	4005	4056	95.45	425.85	2.68	22.46	80.22	18.94	220.05
79	4057	4108	95.45	425.86	2.68	22.47	80.25	18.94	220.06
80	4109	4160	95.45	425.87	2.68	22.49	80.28	18.94	220.08
81	4161	4212	95.45	425.89	2.68	22.51	80.31	18.94	220.09
82	4213	4264	95.45	425.90	2.68	22.53	80.34	18.94	220.10
83	4265	4316	95.45	425.91	2.68	22.54	80.37	18.94	220.11
84	4317	4368	95.45	425.92	2.68	22.56	80.39	18.94	220.12
85	4369	4420	95.45	425.93	2.68	22.58	80.42	18.94	220.13
86	4421	4472	95.45	425.94	2.68	22.59	80.45	18.94	220.14
87	4473	4524	95.45	425.95	2.68	22.61	80.48	18.94	220.15
88	4525	4576	95.45	425.95	2.68	22.63	80.51	18.94	220.16
89	4577	4628	95.45	425.96	2.68	22.64	80.53	18.94	220.16
90	4629	4680	95.45	425.97	2.68	22.66	80.56	18.94	220.17
91	4681	4732	95.45	425.97	2.68	22.67	80.59	18.94	220.18
92	4733	4784	95.45	425.98	2.68	22.69	80.61	18.94	220.18
93	4785	4836	95.45	425.99	2.68	22.70	80.64	18.94	220.19
94	4837	4888	95.45	425.99	2.68	22.72	80.67	18.94	220.20
95	4889	4940	95.45	426.00	2.68	22.73	80.69	18.94	220.20
96	4941	4992	95.45	426.00	2.68	22.75	80.72	18.94	220.21
97	4993	5044	95.45	426.01	2.68	22.76	80.74	18.94	220.21
98	5045	5096	95.45	426.01	2.68	22.78	80.77	18.94	220.22
99	5097	5148	95.45	426.02	2.68	22.79	80.79	18.94	220.22
100	5149	5200	95.45	426.02	2.68	22.81	80.82	18.94	220.22
101	5201	5252	95.45	426.02	2.68	22.82	80.84	18.94	220.23
102	5253	5304	95.45	426.03	2.68	22.84	80.86	18.94	220.23
103	5305	5356	95.45	426.03	2.68	22.85	80.89	18.94	220.23
104	5357	5408	95.45	426.03	2.68	22.86	80.91	18.94	220.24
105	5409	5460	95.45	426.03	2.68	22.88	80.93	18.94	220.24
106	5461	5512	95.45	426.04	2.68	22.89	80.96	18.94	220.24
107	5513	5564	95.45	426.04	2.68	22.91	80.98	18.94	220.24
108	5565	5616	95.45	426.04	2.68	22.92	81.00	18.94	220.25

The next page shows a plot, with comparisons to contaminant loads used in existing scenario.



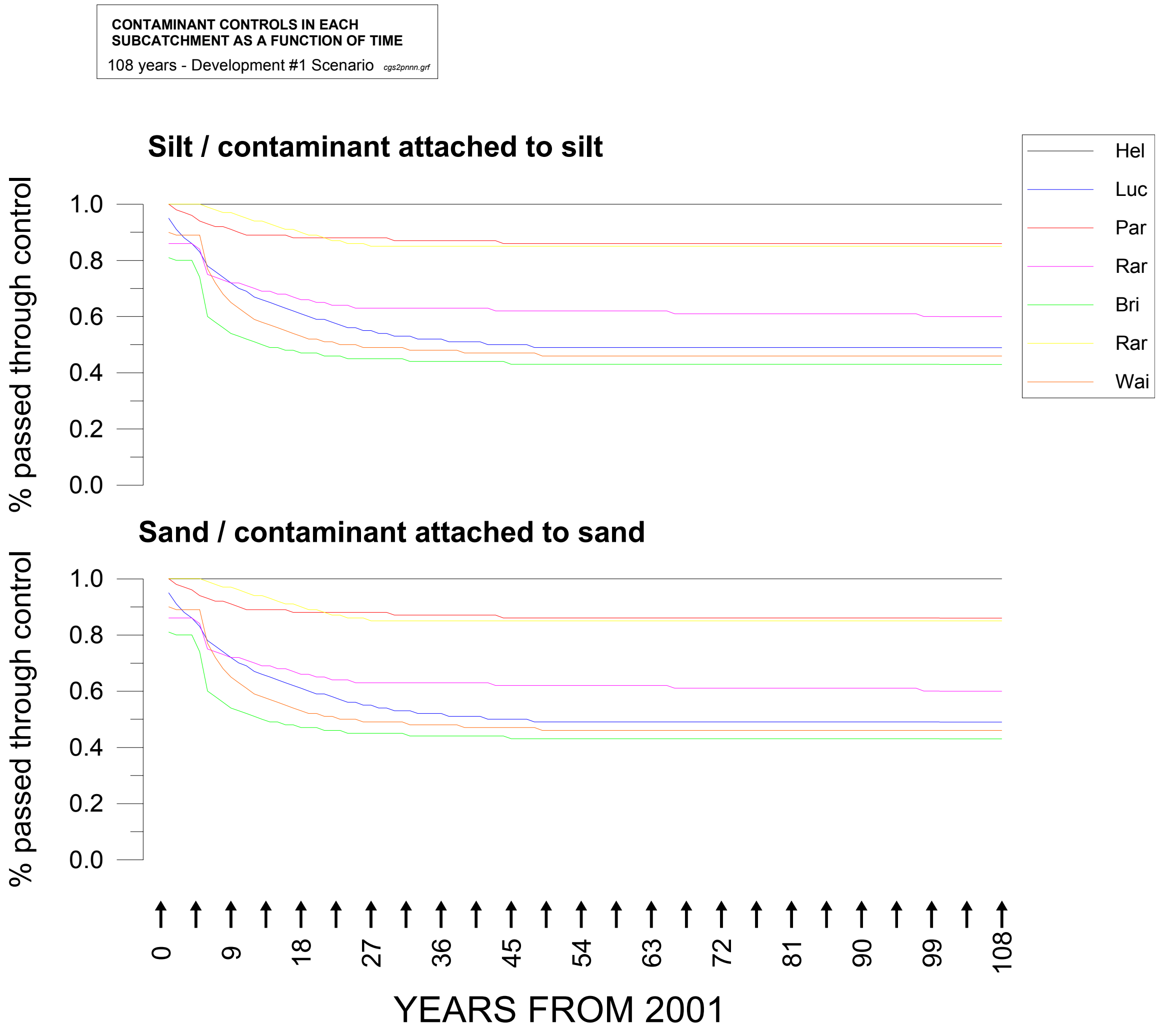
- Stormwater contaminant controls – existing scenario: as 54-year simulation.
- Stormwater contaminant controls – development #1 scenario:

				Fraction of sediment load (with attached contaminant) passed through controls													
				1=Hel		2=Luc		3=Par		4=Ran		5=Bri		6=Rar		7=Wai	
Period #	**Week start**	**Week end**	**Events**	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand
1	1	52	1,2,3,4	1.00	1.00	0.95	0.95	1.00	1.00	0.86	0.86	0.81	0.81	1.00	1.00	0.90	0.90
2	53	104	1,2,3,4	1.00	1.00	0.91	0.91	0.98	0.98	0.86	0.86	0.80	0.80	1.00	1.00	0.89	0.89
3	105	156	1,2,3,4	1.00	1.00	0.88	0.88	0.97	0.97	0.86	0.86	0.80	0.80	1.00	1.00	0.89	0.89
4	157	208	1,2,3,4	1.00	1.00	0.86	0.86	0.96	0.96	0.86	0.86	0.80	0.80	1.00	1.00	0.89	0.89
5	209	260	1,2,3,4	1.00	1.00	0.83	0.83	0.94	0.94	0.84	0.84	0.74	0.74	1.00	1.00	0.89	0.89
6	261	312	1,2,3,4	1.00	1.00	0.78	0.78	0.93	0.93	0.75	0.75	0.60	0.60	0.99	0.99	0.77	0.77
7	313	364	1,2,3,4	1.00	1.00	0.76	0.76	0.92	0.92	0.74	0.74	0.58	0.58	0.98	0.98	0.72	0.72
8	365	416	1,2,3,4	1.00	1.00	0.74	0.74	0.92	0.92	0.73	0.73	0.56	0.56	0.97	0.97	0.68	0.68
9	417	468	1,2,3,4	1.00	1.00	0.72	0.72	0.91	0.91	0.72	0.72	0.54	0.54	0.97	0.97	0.65	0.65
10	469	520	1,2,3,4	1.00	1.00	0.70	0.70	0.90	0.90	0.72	0.72	0.53	0.53	0.96	0.96	0.63	0.63
11	521	572	1,2,3,4	1.00	1.00	0.69	0.69	0.89	0.89	0.71	0.71	0.52	0.52	0.95	0.95	0.61	0.61
12	573	624	1,2,3,4	1.00	1.00	0.67	0.67	0.89	0.89	0.70	0.70	0.51	0.51	0.94	0.94	0.59	0.59
13	625	676	1,2,3,4	1.00	1.00	0.66	0.66	0.89	0.89	0.69	0.69	0.50	0.50	0.94	0.94	0.58	0.58
14	677	728	1,2,3,4	1.00	1.00	0.65	0.65	0.89	0.89	0.69	0.69	0.49	0.49	0.93	0.93	0.57	0.57
15	729	780	1,2,3,4	1.00	1.00	0.64	0.64	0.89	0.89	0.68	0.68	0.49	0.49	0.92	0.92	0.56	0.56
16	781	832	1,2,3,4	1.00	1.00	0.63	0.63	0.89	0.89	0.68	0.68	0.48	0.48	0.91	0.91	0.55	0.55

17	833	884	1,2,3,4	1.00	1.00	0.62	0.62	0.88	0.88	0.67	0.67	0.48	0.48	0.91	0.91	0.54	0.54
18	885	936	1,2,3,4	1.00	1.00	0.61	0.61	0.88	0.88	0.66	0.66	0.47	0.47	0.90	0.90	0.53	0.53
19	937	988	1,2,3,4	1.00	1.00	0.60	0.60	0.88	0.88	0.66	0.66	0.47	0.47	0.89	0.89	0.52	0.52
20	989	1040	1,2,3,4	1.00	1.00	0.59	0.59	0.88	0.88	0.65	0.65	0.47	0.47	0.89	0.89	0.52	0.52
21	1041	1092	1,2,3,4	1.00	1.00	0.59	0.59	0.88	0.88	0.65	0.65	0.46	0.46	0.88	0.88	0.51	0.51
22	1093	1144	1,2,3,4	1.00	1.00	0.58	0.58	0.88	0.88	0.64	0.64	0.46	0.46	0.87	0.87	0.51	0.51
23	1145	1196	1,2,3,4	1.00	1.00	0.57	0.57	0.88	0.88	0.64	0.64	0.46	0.46	0.87	0.87	0.50	0.50
24	1197	1248	1,2,3,4	1.00	1.00	0.56	0.56	0.88	0.88	0.64	0.64	0.45	0.45	0.86	0.86	0.50	0.50
25	1249	1300	1,2,3,4	1.00	1.00	0.56	0.56	0.88	0.88	0.63	0.63	0.45	0.45	0.86	0.86	0.50	0.50
26	1301	1352	1,2,3,4	1.00	1.00	0.55	0.55	0.88	0.88	0.63	0.63	0.45	0.45	0.86	0.86	0.49	0.49
27	1353	1404	1,2,3,4	1.00	1.00	0.55	0.55	0.88	0.88	0.63	0.63	0.45	0.45	0.85	0.85	0.49	0.49
28	1405	1456	1,2,3,4	1.00	1.00	0.54	0.54	0.88	0.88	0.63	0.63	0.45	0.45	0.85	0.85	0.49	0.49
29	1457	1508	1,2,3,4	1.00	1.00	0.54	0.54	0.88	0.88	0.63	0.63	0.45	0.45	0.85	0.85	0.49	0.49
30	1509	1560	1,2,3,4	1.00	1.00	0.53	0.53	0.87	0.87	0.63	0.63	0.45	0.45	0.85	0.85	0.49	0.49
31	1561	1612	1,2,3,4	1.00	1.00	0.53	0.53	0.87	0.87	0.63	0.63	0.45	0.45	0.85	0.85	0.49	0.49
32	1613	1664	1,2,3,4	1.00	1.00	0.53	0.53	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
33	1665	1716	1,2,3,4	1.00	1.00	0.52	0.52	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
34	1717	1768	1,2,3,4	1.00	1.00	0.52	0.52	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
35	1769	1820	1,2,3,4	1.00	1.00	0.52	0.52	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
36	1821	1872	1,2,3,4	1.00	1.00	0.52	0.52	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
37	1873	1924	1,2,3,4	1.00	1.00	0.51	0.51	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
38	1925	1976	1,2,3,4	1.00	1.00	0.51	0.51	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.48	0.48
39	1977	2028	1,2,3,4	1.00	1.00	0.51	0.51	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.47	0.47
40	2029	2080	1,2,3,4	1.00	1.00	0.51	0.51	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.47	0.47
41	2081	2132	1,2,3,4	1.00	1.00	0.51	0.51	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.47	0.47
42	2133	2184	1,2,3,4	1.00	1.00	0.50	0.50	0.87	0.87	0.63	0.63	0.44	0.44	0.85	0.85	0.47	0.47
43	2185	2236	1,2,3,4	1.00	1.00	0.50	0.50	0.87	0.87	0.62	0.62	0.44	0.44	0.85	0.85	0.47	0.47
44	2237	2288	1,2,3,4	1.00	1.00	0.50	0.50	0.86	0.86	0.62	0.62	0.44	0.44	0.85	0.85	0.47	0.47
45	2289	2340	1,2,3,4	1.00	1.00	0.50	0.50	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.47	0.47
46	2341	2392	1,2,3,4	1.00	1.00	0.50	0.50	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.47	0.47
47	2393	2444	1,2,3,4	1.00	1.00	0.50	0.50	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.47	0.47
48	2445	2496	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.47	0.47
49	2497	2548	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
50	2549	2600	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
51	2601	2652	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
52	2653	2704	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
53	2705	2756	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
54	2757	2808	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
55	2809	2860	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
56	2861	2912	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
57	2913	2964	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
58	2965	3016	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
59	3017	3068	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
60	3069	3120	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
61	3121	3172	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
62	3173	3224	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
63	3225	3276	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
64	3277	3328	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
65	3329	3380	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.62	0.62	0.43	0.43	0.85	0.85	0.46	0.46
66	3381	3432	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
67	3433	3484	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
68	3485	3536	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
69	3537	3588	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
70	3589	3640	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
71	3641	3692	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
72	3693	3744	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
73	3745	3796	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
74	3797	3848	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
75	3849	3900	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
76	3901	3952	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
77	3953	4004	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
78	4005	4056	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
79	4057	4108	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46

80	4109	4160	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
81	4161	4212	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
82	4213	4264	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
83	4265	4316	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
84	4317	4368	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
85	4369	4420	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
86	4421	4472	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
87	4473	4524	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
88	4525	4576	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
89	4577	4628	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
90	4629	4680	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
91	4681	4732	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
92	4733	4784	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
93	4785	4836	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
94	4837	4888	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
95	4889	4940	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
96	4941	4992	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
97	4993	5044	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.61	0.61	0.43	0.43	0.85	0.85	0.46	0.46
98	5045	5096	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.60	0.60	0.43	0.43	0.85	0.85	0.46	0.46
99	5097	5148	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.60	0.60	0.43	0.43	0.85	0.85	0.46	0.46
100	5149	5200	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.60	0.60	0.43	0.43	0.85	0.85	0.46	0.46
101	5201	5252	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.60	0.60	0.43	0.43	0.85	0.85	0.46	0.46
102	5253	5304	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.60	0.60	0.43	0.43	0.85	0.85	0.46	0.46
103	5305	5356	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.60	0.60	0.43	0.43	0.85	0.85	0.46	0.46
104	5357	5408	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.60	0.60	0.43	0.43	0.85	0.85	0.46	0.46
105	5409	5460	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.60	0.60	0.43	0.43	0.85	0.85	0.46	0.46
106	5461	5512	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.60	0.60	0.43	0.43	0.85	0.85	0.46	0.46
107	5513	5564	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.60	0.60	0.43	0.43	0.85	0.85	0.46	0.46
108	5565	5616	1,2,3,4	1.00	1.00	0.49	0.49	0.86	0.86	0.60	0.60	0.43	0.43	0.85	0.85	0.46	0.46

The next page shows a plot.



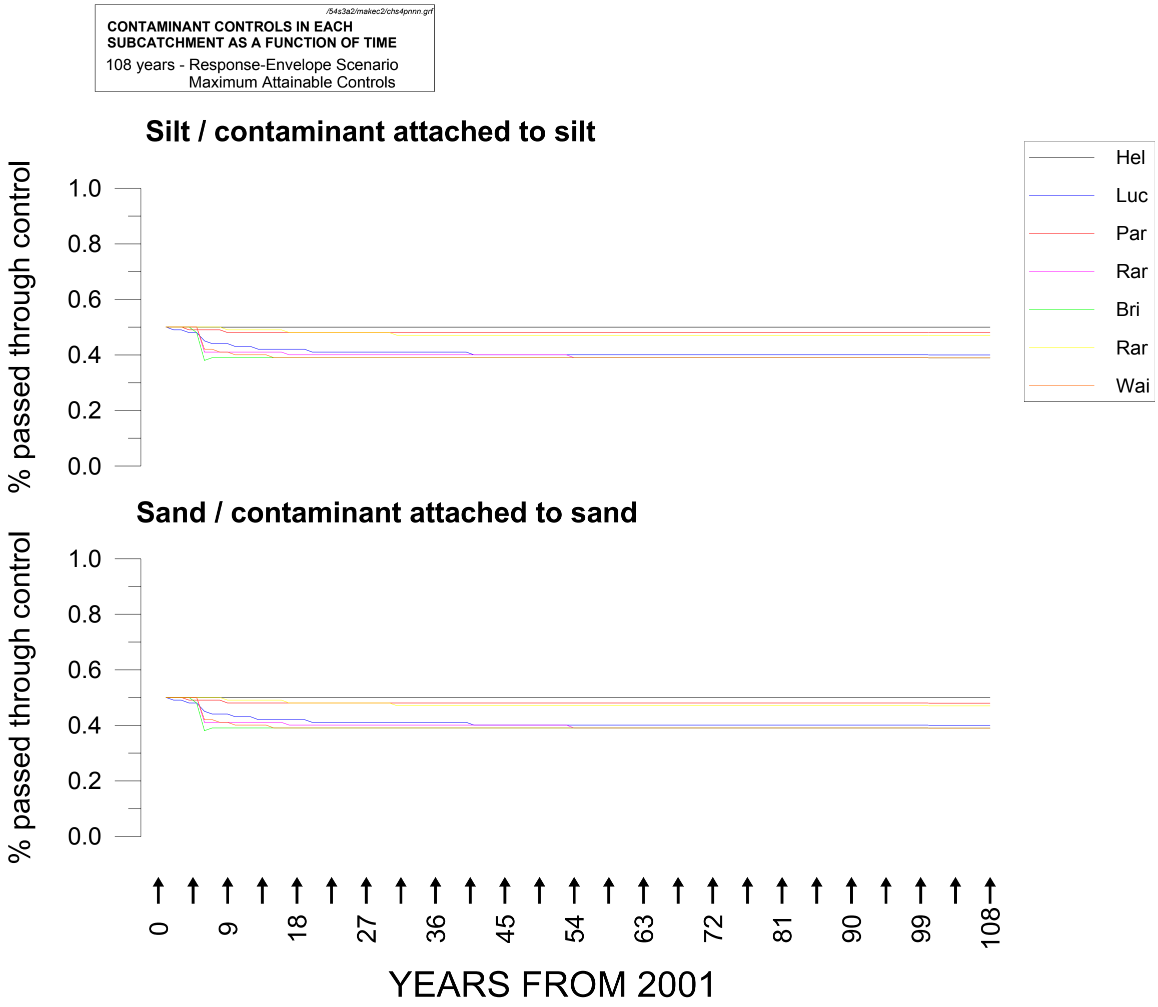
- Stormwater contaminant controls – response-envelope scenario, zero controls: as 54-year simulation.

- Stormwater contaminant controls – response-envelope scenario, maximum attainable controls:

				Fraction of sediment load (with attached contaminant) <u>passed</u> through controls													
				1=Hel		2=Luc		3=Par		4=Ran		5=Bri		6=Rar		7=Wai	
Period #	**Week start**	**Week end**	**Events**	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand	silt	sand
1	1	52	1,2,3,4	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
2	53	104	1,2,3,4	0.50	0.50	0.49	0.49	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
3	105	156	1,2,3,4	0.50	0.50	0.49	0.49	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
4	157	208	1,2,3,4	0.50	0.50	0.48	0.48	0.49	0.49	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
5	209	260	1,2,3,4	0.50	0.50	0.48	0.48	0.49	0.49	0.50	0.50	0.48	0.48	0.50	0.50	0.50	0.50
6	261	312	1,2,3,4	0.50	0.50	0.45	0.45	0.49	0.49	0.41	0.41	0.38	0.38	0.50	0.50	0.42	0.42
7	313	364	1,2,3,4	0.50	0.50	0.44	0.44	0.49	0.49	0.41	0.41	0.39	0.39	0.50	0.50	0.42	0.42
8	365	416	1,2,3,4	0.50	0.50	0.44	0.44	0.49	0.49	0.41	0.41	0.39	0.39	0.50	0.50	0.41	0.41
9	417	468	1,2,3,4	0.50	0.50	0.44	0.44	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.41	0.41
10	469	520	1,2,3,4	0.50	0.50	0.43	0.43	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.40	0.40
11	521	572	1,2,3,4	0.50	0.50	0.43	0.43	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.40	0.40
12	573	624	1,2,3,4	0.50	0.50	0.43	0.43	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.40	0.40
13	625	676	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.40	0.40
14	677	728	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.40	0.40
15	729	780	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.39	0.39
16	781	832	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.41	0.41	0.39	0.39	0.49	0.49	0.39	0.39
17	833	884	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
18	885	936	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
19	937	988	1,2,3,4	0.50	0.50	0.42	0.42	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
20	989	1040	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
21	1041	1092	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
22	1093	1144	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
23	1145	1196	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
24	1197	1248	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
25	1249	1300	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
26	1301	1352	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
27	1353	1404	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
28	1405	1456	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
29	1457	1508	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
30	1509	1560	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.48	0.48	0.39	0.39
31	1561	1612	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
32	1613	1664	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
33	1665	1716	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
34	1717	1768	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
35	1769	1820	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
36	1821	1872	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
37	1873	1924	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
38	1925	1976	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
39	1977	2028	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
40	2029	2080	1,2,3,4	0.50	0.50	0.41	0.41	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
41	2081	2132	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
42	2133	2184	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
43	2185	2236	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
44	2237	2288	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
45	2289	2340	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
46	2341	2392	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
47	2393	2444	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
48	2445	2496	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
49	2497	2548	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
50	2549	2600	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
51	2601	2652	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39

52	2653	2704	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
53	2705	2756	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.40	0.40	0.39	0.39	0.47	0.47	0.39	0.39
54	2757	2808	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
55	2809	2860	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
56	2861	2912	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
57	2913	2964	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
58	2965	3016	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
59	3017	3068	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
60	3069	3120	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
61	3121	3172	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
62	3173	3224	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
63	3225	3276	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
64	3277	3328	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
65	3329	3380	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
66	3381	3432	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
67	3433	3484	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
68	3485	3536	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
69	3537	3588	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
70	3589	3640	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
71	3641	3692	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
72	3693	3744	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
73	3745	3796	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
74	3797	3848	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
75	3849	3900	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
76	3901	3952	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
77	3953	4004	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
78	4005	4056	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
79	4057	4108	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
80	4109	4160	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
81	4161	4212	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
82	4213	4264	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
83	4265	4316	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
84	4317	4368	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
85	4369	4420	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
86	4421	4472	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
87	4473	4524	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
88	4525	4576	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
89	4577	4628	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
90	4629	4680	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
91	4681	4732	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
92	4733	4784	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
93	4785	4836	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
94	4837	4888	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
95	4889	4940	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
96	4941	4992	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
97	4993	5044	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
98	5045	5096	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
99	5097	5148	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
100	5149	5200	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
101	5201	5252	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
102	5253	5304	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
103	5305	5356	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
104	5357	5408	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
105	5409	5460	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
106	5461	5512	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
107	5513	5564	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39
108	5565	5616	1,2,3,4	0.50	0.50	0.40	0.40	0.48	0.48	0.39	0.39	0.39	0.39	0.47	0.47	0.39	0.39

The next page shows a plot.


/54s3a2/makec2/chs4pnnn.grf
CONTAMINANT CONTROLS IN EACH
SUBCATCHMENT AS A FUNCTION OF TIME
108 years - Response-Envelope Scenario
Maximum Attainable Controls
Silt / contaminant attached to silt
% passed through control
1.0
0.8
0.6
0.4
0.2
0.0
Hel
Luc
Par
Rar
Bri
Rar
Wai
Sand / contaminant attached to sand
% passed through control
1.0
0.8
0.6
0.4
0.2
0.0
0
9
18
27
36
45
54
63
72
81
90
99
108
YEARS FROM 2001

4. Results

A range of results is presented in this section, for both 54-year and 108-year simulations, including:

- Contaminant concentrations in the harbour:

  (a) Existing scenario versus development #1 scenario

  (b) Response envelope around development #1 scenario

- Time for total-sediment concentrations to reach "traffic lights":

  (a) Existing scenario versus development #1 scenario

  (b) Response envelope around development #1 scenario

- Sedimentation[2] in the harbour:

  (a) Existing scenario versus development #1 scenario

  (b) Response envelope around development #1 scenario

- Origin of sediments[2] 2 / contaminants that deposit in harbour (%):

  (a) Existing scenario versus development #1 scenario

- Origin of sediments[2] / contaminants that deposit in harbour (mass):

  (a) Existing scenario versus development #1 scenario

- Fate of sediments[2] / contaminants that derive from land (%):

  (a) Existing scenario versus development #1 scenario

- Fate of sediments[2] / contaminants that derive from land (mass):

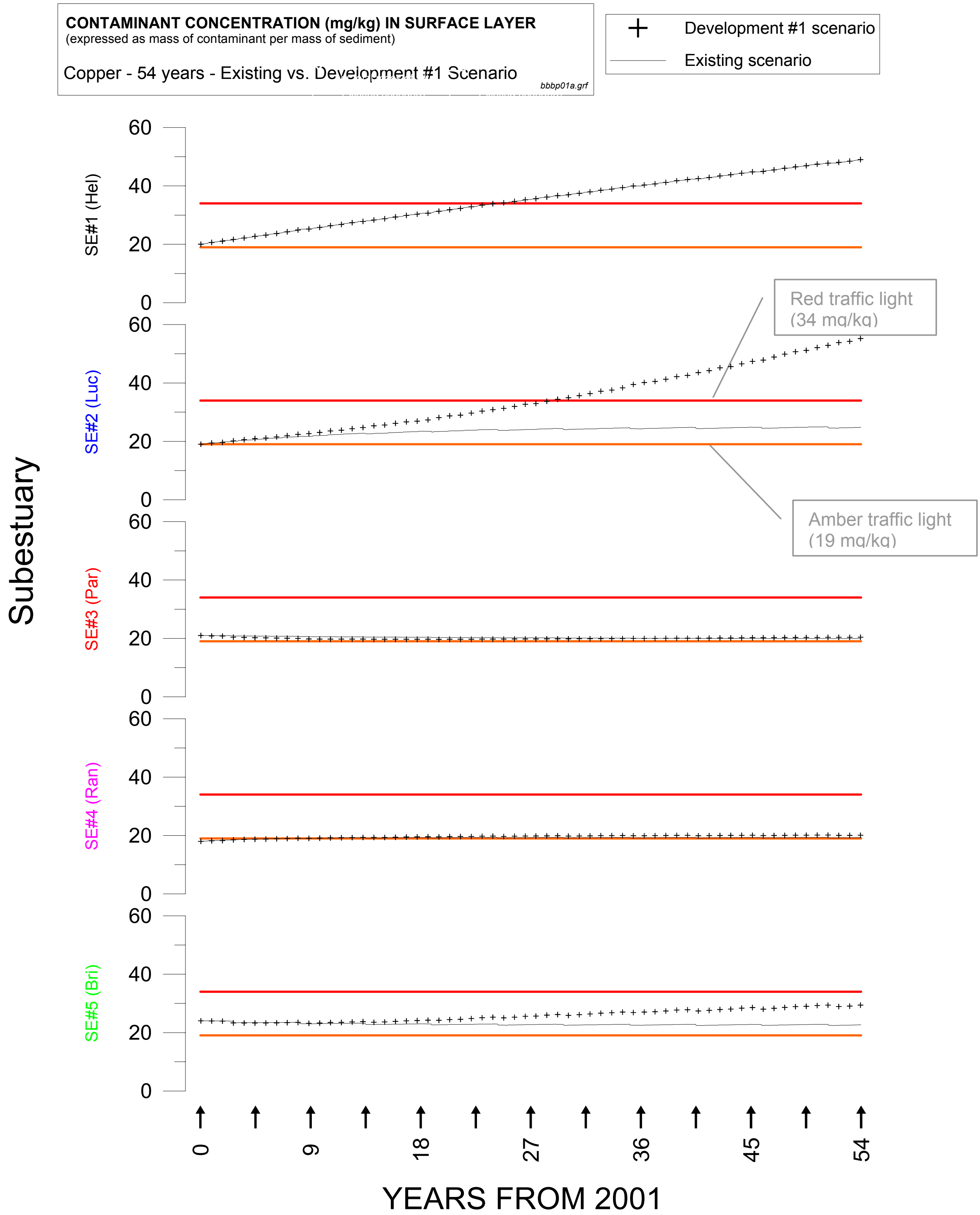
  (a) Existing scenario versus development #1 scenario

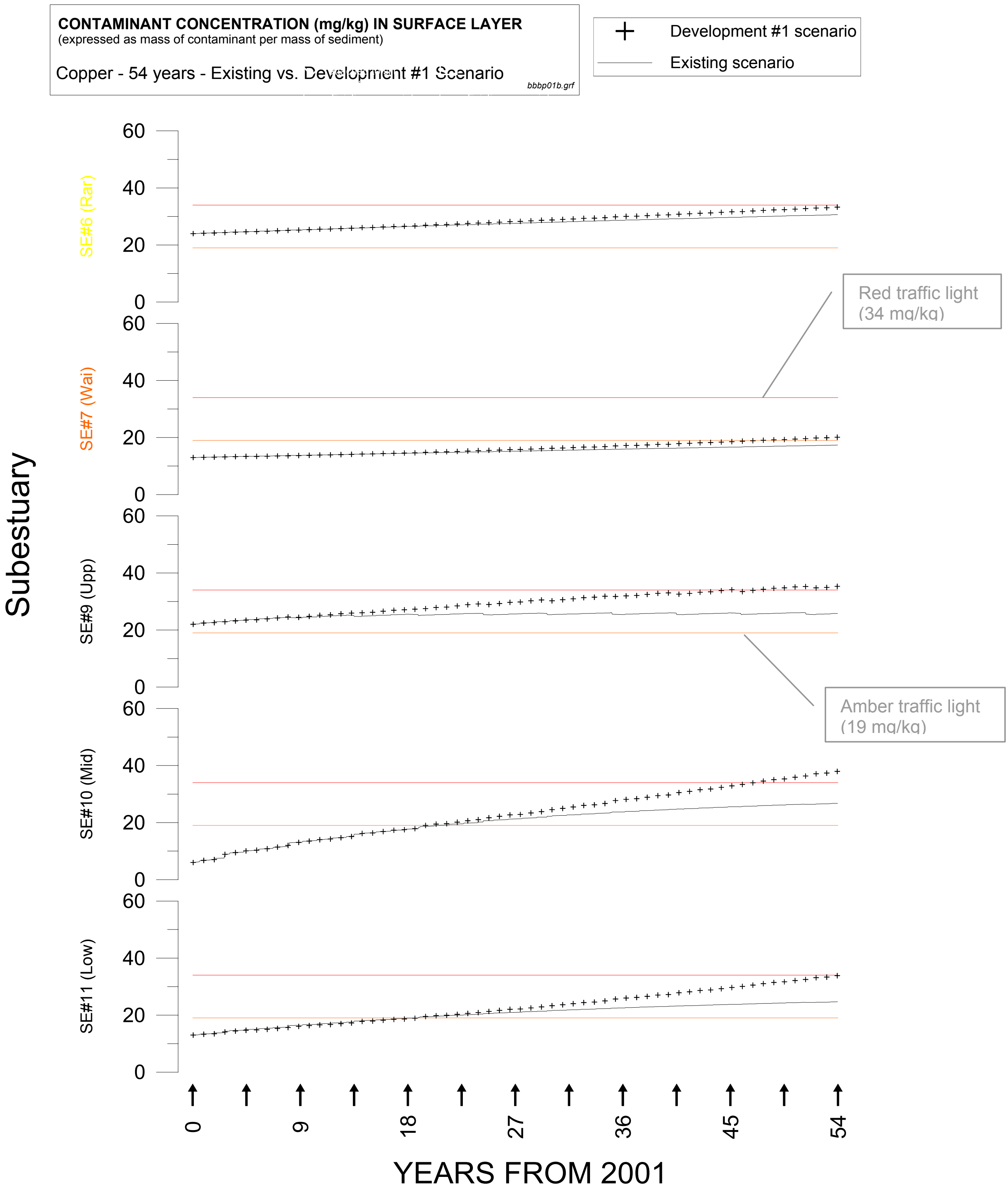
[2] Refer to the zinc results report (NIWA Client Report HAM2003-087/2 – Results: Zinc) for sediment results.

4.1 Simulation period: 54 years

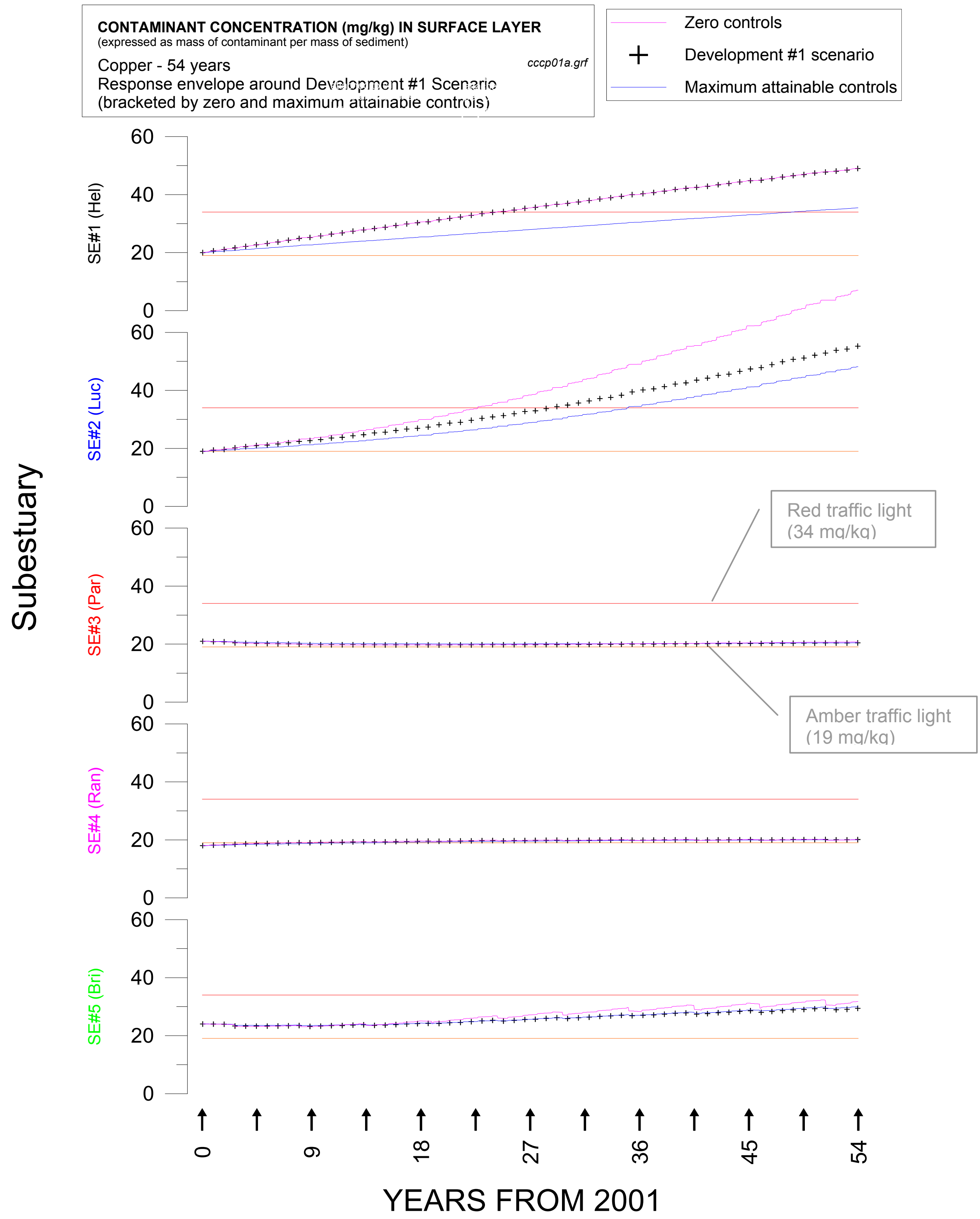
4.1.2 Contaminant concentrations in the harbour

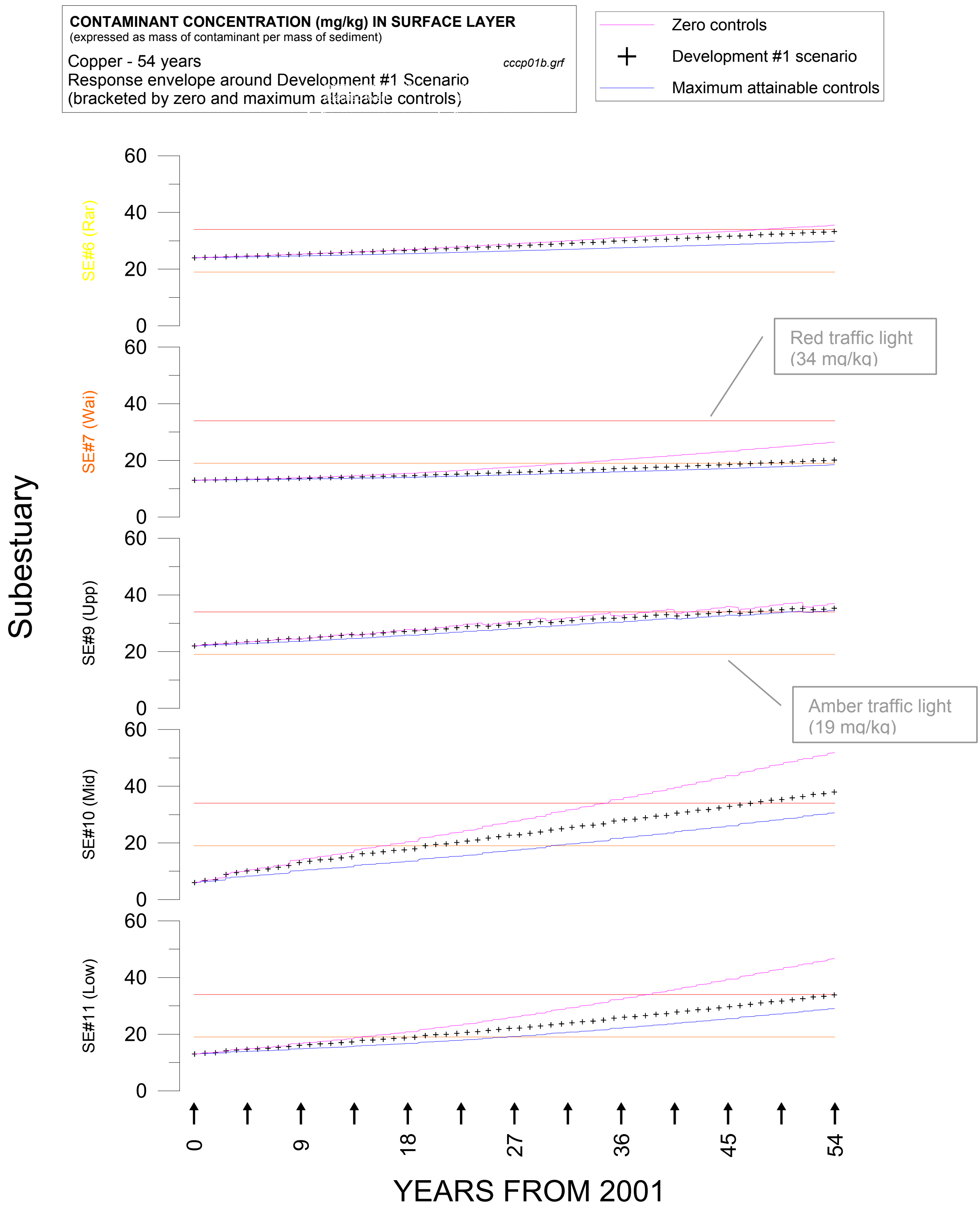
(a) Existing scenario versus development #1 scenario




CONTAMINANT CONCENTRATION (mg/kg) IN SURFACE LAYER
(expressed as mass of contaminant per mass of sediment)
Copper - 54 years - Existing vs. Development #1 Scenario
bbbp01b.grf
Development #1 scenario
Existing scenario
Subestuary
SE#6 (Rar)
SE#7 (Wai)
SE#9 (Upp)
SE#10 (Mid)
SE#11 (Low)
Red traffic light
(34 mg/kg)
Amber traffic light
(19 mg/kg)
0
9
18
27
36
45
54
YEARS FROM 2001

(b) Response envelope around development #1 scenario




CONTAMINANT CONCENTRATION (mg/kg) IN SURFACE LAYER
(expressed as mass of contaminant per mass of sediment)
Copper - 54 years
cccp01b.grf
Response envelope around Development #1 Scenario
(bracketed by zero and maximum attainable controls)
Zero controls
Development #1 scenario
Maximum attainable controls
Red traffic light
(34 mg/kg)
Amber traffic light
(19 mg/kg)
Subestuary
SE#6 (Rar)
SE#7 (Wai)
SE#9 (Upp)
SE#10 (Mid)
SE#11 (Low)
0
20
40
60
0
9
18
27
36
45
54
YEARS FROM 2001

4.1.3 Time for total-sediment concentrations to reach "traffic lights"

(a) Existing scenario versus development #1 scenario

Results from development #1 scenario.

Subestuary	Years to Amber (19 mg/kg)	Years to Red (34 mg/kg)
1=Hellyers	*	24.35
2=Lucas	*	28.85
3=Paremoremo	*	0
4=Rangitopuni	7.98	0
5=Brighams	*	0
6=Rarawaru	*	0
7=Waiarohia	47.27	0
9=Upper main body of UWH	*	44.81
10=Middle main body of UWH	19.48	47.1
11=Lower main body of UWH	18.9	0
"*" signifies initial concentration exceeds traffic light "0" signifies traffic light is not exceeded within 54 years		

It takes 47.1 years from 2001 for contaminant concentrations to pass through the red traffic light in the Middle main body.

Results from existing scenario.

Subestuary	Years to Amber (19 mg/kg)	Years to Red (34 mg/kg)
1=Hellyers	*	24.35
2=Lucas	*	0
3=Paremoremo	*	0
4=Rangitopuni	6.92	0
5=Brighams	*	0
6=Rarawaru	*	0
7=Waiarohia	0	0
9=Upper main body of UWH	*	0
10=Middle main body of UWH	20.44	0
11=Lower main body of UWH	18.9	0
"*" signifies initial concentration exceeds traffic light "0" signifies traffic light is not exceeded within 54 years		

(b) Response envelope around development #1 scenario

Subestuary	Years to Amber (19 mg/kg)		
	No controls	Development #1 scenario	Maximum attainable controls
1=Hellyers	*	*	*
2=Lucas	*	*	*
3=Paremoremo	*	*	*
4=Rangitopuni	6.75	7.98	14.13
5=Brighams	*	*	*
6=Rarawaru	*	*	*
7=Waiarohia	31.67	47.27	0
9=Upper main body of UWH	*	*	*
10=Middle main body of UWH	16.25	19.48	30.13
11=Lower main body of UWH	14.13	18.9	26.42
"*" signifies initial concentration exceeds traffic light "0" signifies traffic light is not exceeded within 54 years			

Subestuary	Years to Red (34 mg/kg)		
	No controls	Development #1 scenario	Maximum attainable controls
1=Hellyers	24.25	24.35	48.52
2=Lucas	22.71	28.85	34.98
3=Paremoremo	0	0	0
4=Rangitopuni	0	0	0
5=Brighams	0	0	0
6=Rarawaru	47.75	0	0
7=Waiarohia	0	0	0
9=Upper main body of UWH	38.65	44.81	50.33
10=Middle main body of UWH	34.87	47.1	0
11=Lower main body of UWH	38.38	0	0
"*" signifies initial concentration exceeds traffic light "0" signifies traffic light is not exceeded within 54 years			

It takes 47.1 years from 2001 for contaminant concentrations to pass through the red traffic light in the Middle main body under development #1 scenario.

4.1.4 Sedimentation in the harbour

(a) Existing scenario versus development #1 scenario

See report showing zinc results (NIWA Client Report HAM2003-087/2) for annual-average sediment deposition rate for each subestuary predicted by the model.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for evolution of bed sediment in each subestuary (% silt/sand, height of bed surface) predicted by the model.

4.1.5 Origin of sediments / contaminants that deposit in harbour (%)

(a) Existing scenario versus development #1 scenario

Results from development #1 scenario.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for percentage of the total amount of sediment (i.e., from all subcatchments) deposited in each subestuary.

Subestuary	Percentage of the total amount of contaminant (i.e., from all subcatchments) deposited in each subestuary.						
	Subcatchment						
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai
1=Hellyers	99.6	0.1	0	0.1	0	0	0.2
2=Lucas	2.1	95.2	0.6	0.2	0	0.3	1.5
3=Paremoremo	3	0.5	91.3	3.6	0	0.4	1.1
4=Rangitopuni	1.6	0.1	0.2	96.7	0.3	0.4	0.7
5=Brighams	0.6	0	0.4	46.4	48.9	3.6	0.2
6=Rarawaru	0.8	4.9	0	5.6	29.8	58.1	0.8
7=Waiarohia	5.5	0	0	0	0	0.9	93.5
8=Middle WH	8.8	11.2	5.9	16.2	3.7	1.6	52.5
9=Upper main body of UWH	12.4	8.9	7.6	40.6	16.3	7.1	7.1
10=Middle main body of UWH	11.4	49.5	19.2	2.2	0.8	4.3	12.5
11=Lower main body of UWH	3.6	80.5	2.2	5.8	0.4	0.3	7.1

Results from existing scenario are shown on next page for comparison.

19.2% of the contaminant that gets deposited in the Middle main body comes from Paremoremo subcatchment

These are the results from the existing scenario for comparison.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for percentage of the total amount of sediment (i.e., from all subcatchments) deposited in each subestuary.

Subestuary	Percentage of the total amount of contaminant (i.e., from all subcatchments) deposited in each subestuary.						
	Subcatchment						
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai
1=Hellyers	99.6	0.1	0	0.1	0	0	0.1
2=Lucas	1.5	96.9	0.4	0.3	0	0.2	0.7
3=Paremoremo	3.3	0.8	88.4	6.2	0	0.4	0.9
4=Rangitopuni	1	0	0.1	98.1	0.2	0.2	0.3
5=Brighams	0.5	0	0.3	63.3	32.9	2.9	0.1
6=Rarawaru	0.8	7.4	0	9.2	24.4	57.6	0.6
7=Waiarohia	8	0	0	0	0	1.3	90.7
8=Middle WH	9.2	17.5	5.6	26.8	3.1	1.5	36.3
9=Upper main body of UWH	10.4	10.5	5.6	53.4	10.6	5.5	4.1
10=Middle main body of UWH	9.9	61	14.6	3	0.6	3.5	7.3
11=Lower main body of UWH	2.7	84.9	1.5	6.9	0.3	0.2	3.5

4.1.6 Origin of sediments / contaminants that deposit in harbour (mass)

(a) Existing scenario versus development #1 scenario

Results from development #1 scenario.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for mass of sediment deposited in each subestuary.

Subestuary	Mass (kg) of contaminant deposited in each subestuary.						
	Subcatchment						
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai
1=Hellyers	3.94E+03	2.73E+00	1.88E+00	2.57E+00	3.20E-01	5.19E-01	8.37E+00
2=Lucas	1.55E+02	7.07E+03	4.15E+01	1.75E+01	1.95E+00	2.60E+01	1.11E+02
3=Paremoremo	7.69E+01	1.34E+01	2.36E+03	9.30E+01	1.61E-01	1.11E+01	2.94E+01
4=Rangitopuni	1.30E+02	4.54E+00	1.76E+01	7.89E+03	2.46E+01	3.20E+01	5.73E+01
5=Brighams	1.61E+01	5.23E-01	1.00E+01	1.27E+03	1.34E+03	9.85E+01	5.88E+00
6=Rarawaru	1.56E+00	1.02E+01	1.27E-02	1.15E+01	6.14E+01	1.20E+02	1.64E+00
7=Waiarohia	5.94E+01	1.70E-01	1.06E-01	1.17E-01	1.68E-02	1.03E+01	1.02E+03
8=Middle WH	3.36E+02	4.30E+02	2.27E+02	6.21E+02	1.43E+02	6.16E+01	2.01E+03
9=Upper main body of UWH	7.90E+02	5.65E+02	4.83E+02	2.58E+03	1.04E+03	4.50E+02	4.54E+02
10=Middle main body of UWH	4.28E+02	1.86E+03	7.20E+02	8.34E+01	3.19E+01	1.62E+02	4.71E+02
11=Lower main body of UWH	5.15E+01	1.15E+03	3.21E+01	8.33E+01	6.34E+00	3.90E+00	1.02E+02

Results from existing scenario are shown on next page for comparison.

Of the contaminant that gets deposited in the Middle main body, 7.20x10^2 kg comes from Paremoremo subcatchment

These are the results from the existing scenario for comparison.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for mass of sediment deposited in each subestuary.

Subestuary	Mass (kg) of contaminant deposited in each subestuary.						
	Subcatchment						
	1=Hel	2=Luc	3=Par	4=Ran	5=Bin	6=Rar	7=Wai
1=Hellyers	3.94E+03	4.58E+00	1.72E+00	4.07E+00	2.62E-01	4.81E-01	5.64E+00
2=Lucas	1.55E+02	9.99E+03	3.69E+01	2.77E+01	1.61E+00	2.42E+01	7.55E+01
3=Paremoremo	7.69E+01	1.92E+01	2.08E+03	1.47E+02	1.30E-01	1.03E+01	2.01E+01
4=Rangitopuni	1.30E+02	6.06E+00	1.57E+01	1.24E+04	1.91E+01	2.98E+01	3.96E+01
5=Brighams	1.61E+01	7.58E-01	8.84E+00	2.01E+03	1.05E+03	9.29E+01	4.14E+00
6=Rarawaru	1.56E+00	1.44E+01	1.32E-02	1.81E+01	4.78E+01	1.13E+02	1.20E+00
7=Waiarohia	5.94E+01	2.85E-01	9.52E-02	1.83E-01	1.14E-02	9.35E+00	6.73E+02
8=Middle WH	3.36E+02	6.42E+02	2.04E+02	9.82E+02	1.12E+02	5.62E+01	1.33E+03
9=Upper main body of UWH	7.90E+02	7.99E+02	4.25E+02	4.07E+03	8.06E+02	4.22E+02	3.10E+02
10=Middle main body of UWH	4.28E+02	2.65E+03	6.35E+02	1.32E+02	2.50E+01	1.52E+02	3.17E+02
11=Lower main body of UWH	5.15E+01	1.63E+03	2.85E+01	1.32E+02	5.60E+00	3.62E+00	6.78E+01

4.1.7 Fate of sediments / contaminants that derive from land (%)

Results from development #1 scenario.

(a) Existing scenario versus development #1 scenario

See report showing zinc results (NIWA Client Report HAM2003-087/2) for percentage of the total amount of sediment originating in each subcatchment and passing through controls and entering each subestuary.

Subcatchment	Percentage of the total amount of contaminant originating in each subcatchment and passing through controls and entering each subestuary.										
	Subestuary										
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai	8 = MWH	9 = Upp	10 = Mid	11 = Low
1=Hellyers	65.8	2.6	1.3	2.2	0.3	0	1	5.6	13.2	7.2	0.9
2=Lucas	0	63.7	0.1	0	0	0.1	0	3.9	5.1	16.7	10.4
3=Paremoremo	0	1.1	60.6	0.5	0.3	0	0	5.8	12.4	18.5	0.8
4=Rangitopuni	0	0.1	0.7	62.3	10.1	0.1	0	4.9	20.4	0.7	0.7
5=Brighams	0	0.1	0	0.9	50.7	2.3	0	5.4	39.1	1.2	0.2
6=Rarawaru	0.1	2.7	1.1	3.3	10.1	12.3	1.1	6.3	46.1	16.6	0.4
7=Waiarohia	0.2	2.6	0.7	1.3	0.1	0	23.8	47.1	10.6	11	2.4

Results from existing scenario are shown on next page for comparison.

2.7% of the contaminant that originates in Rarawaru subcatchment gets deposited in Lucas subestuary

These are the results from the existing scenario for comparison.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for percentage of the total amount of sediment originating in each subcatchment and passing through controls and entering each subestuary.

Subcatchment	Percentage of the total amount of contaminant originating in each subcatchment and passing through controls and entering each subestuary.										
	Subestuary										
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai	8 = MWH	9 = Upp	10 = Mid	11 = Low
1=Hellyers	65.8	2.6	1.3	2.2	0.3	0	1	5.6	13.2	7.2	0.9
2=Lucas	0	63.4	0.1	0	0	0.1	0	4.1	5.1	16.8	10.3
3=Paremoremo	0	1.1	60.5	0.5	0.3	0	0	5.9	12.4	18.5	0.8
4=Rangitopuni	0	0.1	0.7	62.3	10.1	0.1	0	4.9	20.4	0.7	0.7
5=Brighams	0	0.1	0	0.9	50.7	2.3	0	5.4	39.1	1.2	0.3
6=Rarawaru	0.1	2.6	1.1	3.3	10.2	12.3	1	6.2	46.2	16.7	0.4
7=Waiarohia	0.2	2.7	0.7	1.4	0.1	0	23.7	46.8	10.9	11.2	2.4

4.1.8 Fate of sediments / contaminants that derive from land (mass)

Results from development #1 scenario.

(a) Existing scenario versus development #1 scenario

See report showing zinc results (NIWA Client Report HAM2003-087/2) for mass of sediment originating in each subcatchment.

Subcatchment	Mass (kg) of contaminant originating in each subcatchment. Subestuary										
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai	8 = MWH	9 = Upp	10 = Mid	11 = Low
1=Hellyers	3.94E+03	1.55E+02	7.69E+01	1.30E+02	1.61E+01	1.56E+00	5.94E+01	3.36E+02	7.90E+02	4.28E+02	5.15E+01
2=Lucas	2.73E+00	7.07E+03	1.34E+01	4.54E+00	5.23E-01	1.02E+01	1.70E-01	4.30E+02	5.65E+02	1.86E+03	1.15E+03
3=Paremoremo	1.88E+00	4.15E+01	2.36E+03	1.76E+01	1.00E+01	1.27E-02	1.06E-01	2.27E+02	4.83E+02	7.20E+02	3.21E+01
4=Rangitopuni	2.57E+00	1.75E+01	9.30E+01	7.89E+03	1.27E+03	1.15E+01	1.17E-01	6.21E+02	2.58E+03	8.34E+01	8.33E+01
5=Brighams	3.20E-01	1.95E+00	1.61E-01	2.46E+01	1.34E+03	6.14E+01	1.68E-02	1.43E+02	1.04E+03	3.19E+01	6.34E+00
6=Rarawaru	5.19E-01	2.60E+01	1.11E+01	3.20E+01	9.85E+01	1.20E+02	1.03E+01	6.16E+01	4.50E+02	1.62E+02	3.90E+00
7=Waiarohia	8.37E+00	1.11E+02	2.94E+01	5.73E+01	5.88E+00	1.64E+00	1.02E+03	2.01E+03	4.54E+02	4.71E+02	1.02E+02

Results from existing scenario are shown on next page for comparison.

Of the contaminant that originates in Rarawaru subcatchment, 2.60x10^1 kg gets deposited in Lucas subestuary

These are the results from the existing scenario for comparison.

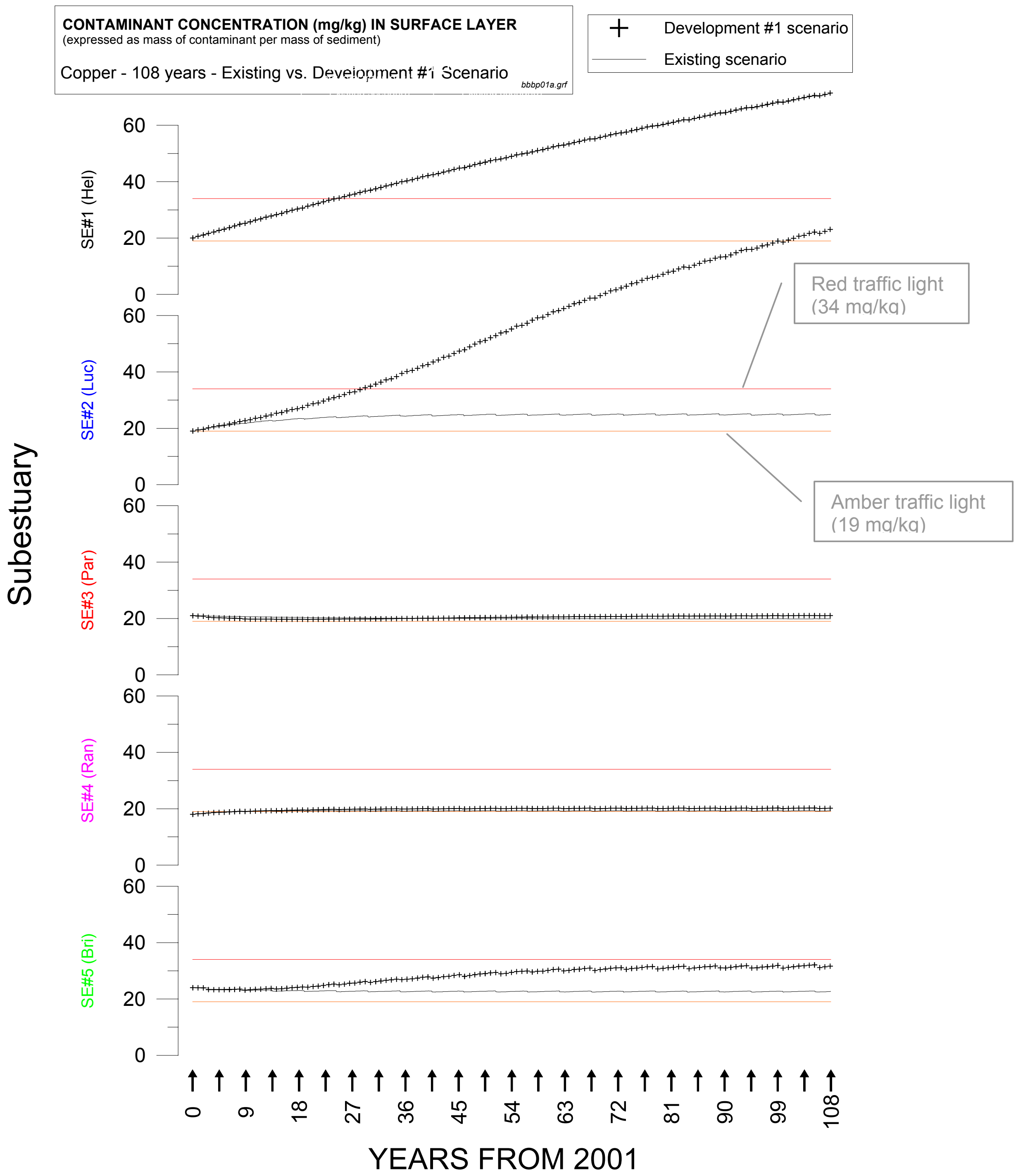
See report showing zinc results (NIWA Client Report HAM2003-087/2) for mass of sediment originating in each subcatchment.

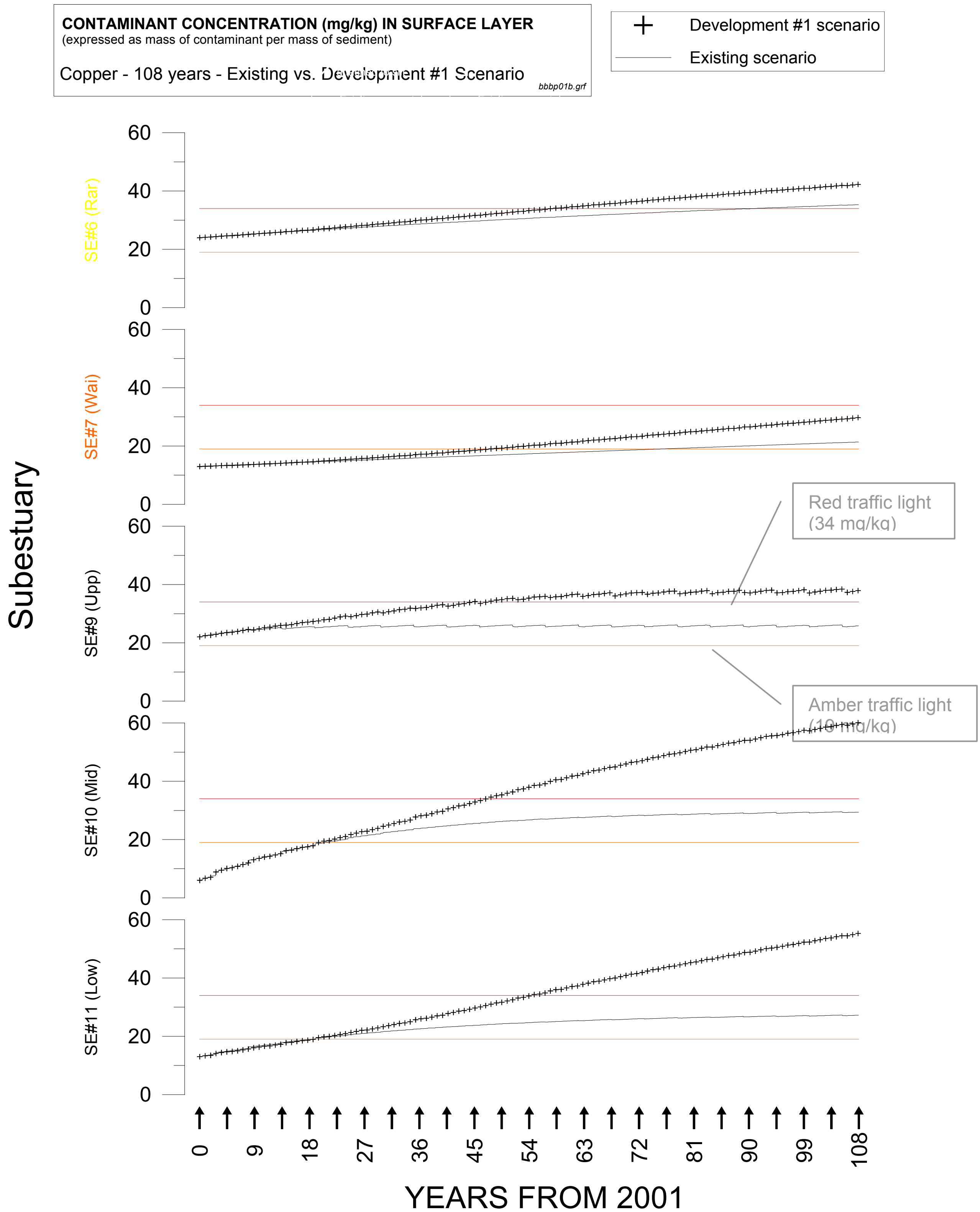
Subcatchment	Mass (kg) of contaminant originating in each subcatchment.										
	Subestuary										
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai	8 = MWH	9 = Upp	10 = Mid	11 = Low
1=Hellyers	3.94E +03	1.55E +02	7.69E +01	1.30E +02	1.61E +01	1.56E +00	5.94E +01	3.36E +02	7.90E +02	4.28E +02	5.15E +01
2=Lucas	4.58E +00	9.99E +03	1.92E +01	6.06E +00	7.58E-01	1.44E +01	2.85E-01	6.42E +02	7.99E +02	2.65E +03	1.63E +03
3=Paremoremo	1.72E +00	3.69E +01	2.08E +03	1.57E +01	8.84E +00	1.32E-02	9.52E-02	2.04E +02	4.25E +02	6.35E +02	2.85E +01
4=Rangitopuni	4.07E +00	2.77E +01	1.47E +02	1.24E +04	2.01E +03	1.81E +01	1.83E-01	9.82E +02	4.07E +03	1.32E +02	1.32E +02
5=Brighams	2.62E-01	1.61E +00	1.30E-01	1.91E +01	1.05E +03	4.78E +01	1.14E-02	1.12E +02	8.06E +02	2.50E +01	5.60E +00
6=Rarawaru	4.81E-01	2.42E +01	1.03E +01	2.98E +01	9.29E +01	1.13E +02	9.35E +00	5.62E +01	4.22E +02	1.52E +02	3.62E +00
7=Waiarohia	5.64E +00	7.55E +01	2.01E +01	3.96E +01	4.14E +00	1.20E +00	6.73E +02	1.33E +03	3.10E +02	3.17E +02	6.78E +01

4.2 Simulation period: 108 years

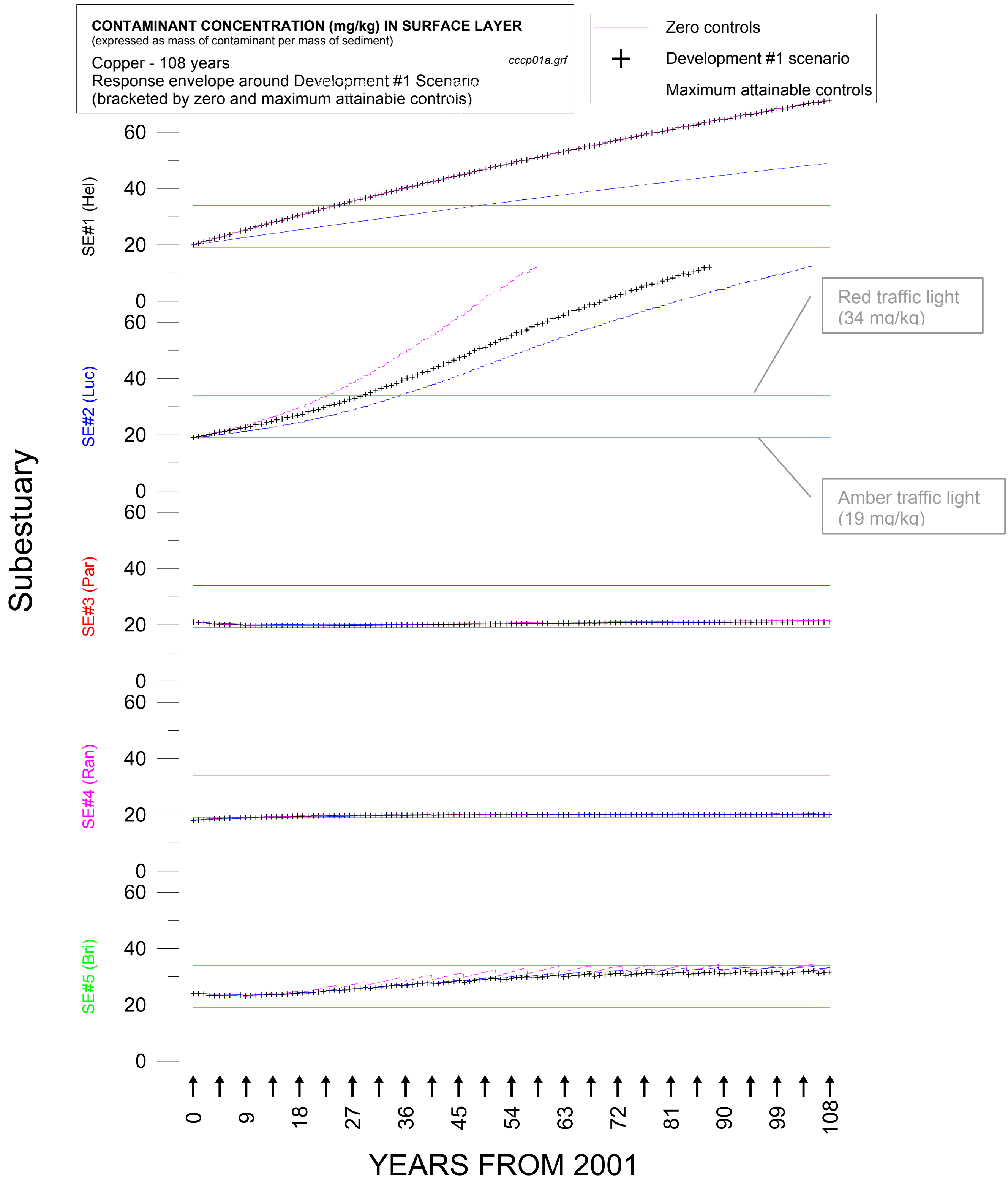
4.2.2 Contaminant concentrations in the harbour

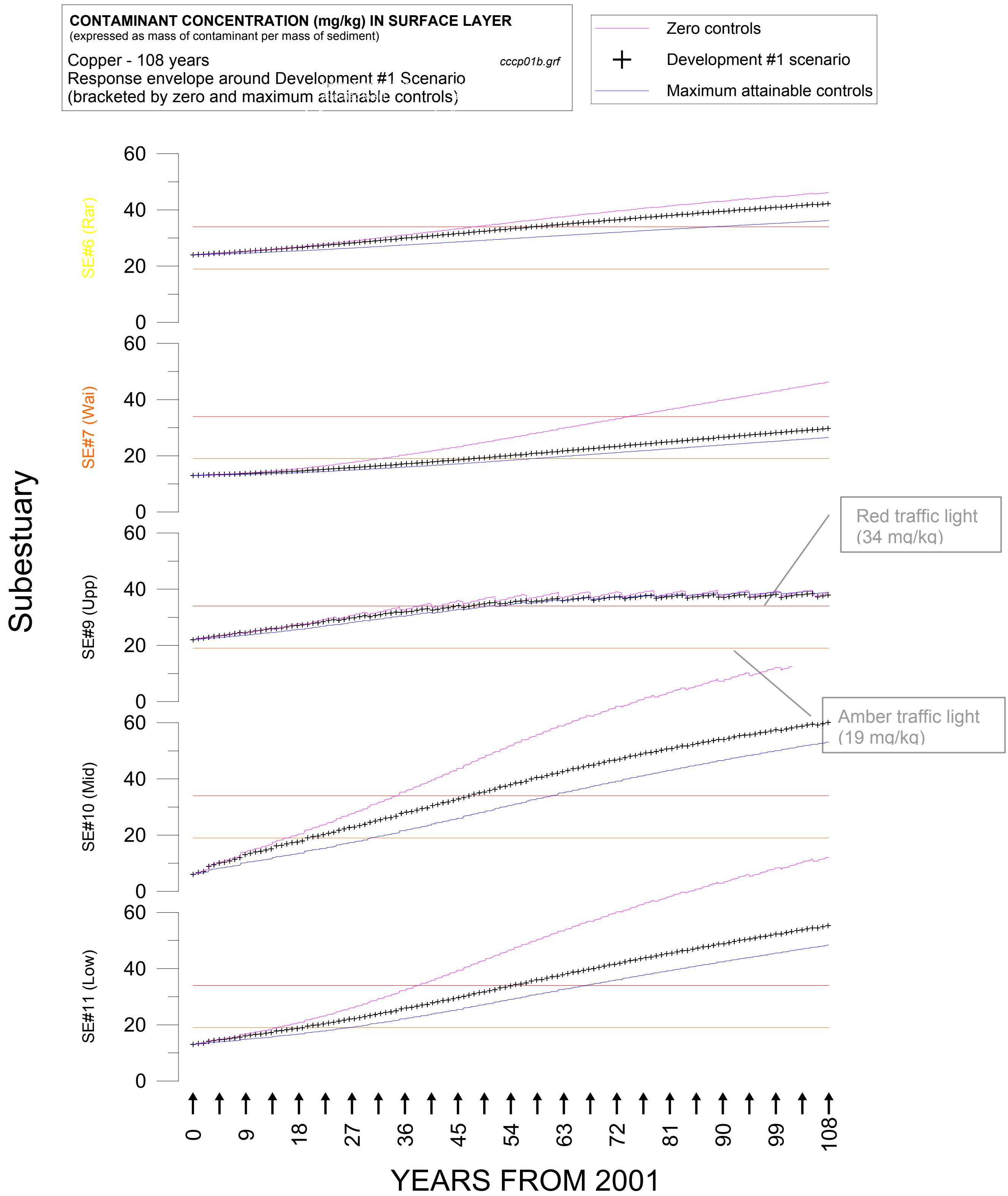
(a) Existing scenario versus development #1 scenario




CONTAINANT CONCENTRATION (mg/kg) IN SURFACE LAYER
(expressed as mass of contaminant per mass of sediment)
Copper - 108 years - Existing vs. Development #1 Scenario
bbbp01b.grf
Development #1 scenario
Existing scenario
Subestuary
SE#6 (Rar)
SE#7 (Wai)
SE#9 (Upp)
SE#10 (Mid)
SE#11 (Low)
Red traffic light (34 mg/kg)
Amber traffic light (19 mg/kg)
0
20
40
60
0
9
18
27
36
45
54
63
72
81
90
99
108
YEARS FROM 2001

(b) Response envelope around development #1 scenario





CONTAMINANT CONCENTRATION (mg/kg) IN SURFACE LAYER
(expressed as mass of contaminant per mass of sediment)
Copper - 108 years
cccp01b.grf
Response envelope around Development #1 Scenario
(bracketed by zero and maximum attainable controls)
Zero controls
Development #1 scenario
Maximum attainable controls
Subestuary
SE#6 (Rar)
SE#7 (Wai)
SE#9 (Upp)
SE#10 (Mid)
SE#11 (Low)
Red traffic light
(34 mg/kg)
Amber traffic light
(19 mg/kg)
YEARS FROM 2001

4.2.3 Time for total-sediment concentrations to reach "traffic lights"

(a) Existing scenario versus development #1 scenario

Results from development #1 scenario.

Subestuary	Years to Amber (19 mg/kg)	Years to Red (34 mg/kg)
1=Hellyers	*	24.35
2=Lucas	*	28.85
3=Paremoremo	*	0
4=Rangitopuni	7.98	0
5=Brighams	*	0
6=Rarawaru	*	58.02
7=Waiarohia	47.27	0
9=Upper main body of UWH	*	44.81
10=Middle main body of UWH	19.48	47.1
11=Lower main body of UWH	18.9	54.62
"*" signifies initial concentration exceeds traffic light "0" signifies traffic light is not exceeded within 108 years		

It takes 47.27 years from 2001 for contaminant concentrations to pass through the amber traffic light in the Waiarohia subestuary.

Results from existing scenario.

Subestuary	Years to Amber (19 mg/kg)	Years to Red (34 mg/kg)
1=Hellyers	*	24.35
2=Lucas	*	0
3=Paremoremo	*	0
4=Rangitopuni	6.92	0
5=Brighams	*	0
6=Rarawaru	*	91.42
7=Waiarohia	75.52	0
9=Upper main body of UWH	*	0
10=Middle main body of UWH	20.44	0
11=Lower main body of UWH	18.9	0
"*" signifies initial concentration exceeds traffic light "0" signifies traffic light is not exceeded within 108 years		

(b) Response envelope around development #1 scenario

Subestuary	Years to Amber (19 mg/kg)		
	No controls	Development #1 scenario	Maximum attainable controls
1=Hellyers	*	*	*
2=Lucas	*	*	*
3=Paremoremo	*	*	*
4=Rangitopuni	6.75	7.98	14.13
5=Brighams	*	*	*
6=Rarawaru	*	*	*
7=Waiarohia	31.67	47.27	57.44
9=Upper main body of UWH	*	*	*
10=Middle main body of UWH	16.25	19.48	30.13
11=Lower main body of UWH	14.13	18.9	26.42
"*" signifies initial concentration exceeds traffic light "0" signifies traffic light is not exceeded within 108 years			

It takes 19.48 years from 2001 for contaminant concentrations to pass through the amber traffic light in the Middle main body under development #1 scenario.

Subestuary	Years to Red (34 mg/kg)		
	No controls	Development #1 scenario	Maximum attainable controls
1=Hellyers	24.25	24.35	48.52
2=Lucas	22.71	28.85	34.98
3=Paremoremo	0	0	0
4=Rangitopuni	0	0	0
5=Brighams	77.63	0	0
6=Rarawaru	47.75	58.02	88.23
7=Waiarohia	74.27	0	0
9=Upper main body of UWH	38.65	44.81	50.33
10=Middle main body of UWH	34.87	47.1	60.75
11=Lower main body of UWH	38.38	54.62	66.88
"*" signifies initial concentration exceeds traffic light "0" signifies traffic light is not exceeded within 108 years			

4.2.4 Sedimentation in the harbour

(a) Existing scenario versus development #1 scenario

See report showing zinc results (NIWA Client Report HAM2003-087/2) for annual-average sediment deposition rate for each subestuary predicted by the model.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for evolution of bed sediment in each subestuary (% silt/sand, height of bed surface) predicted by the model.

4.2.5 Origin of sediments / contaminants that deposit in harbour (%)

(a) Existing scenario versus development #1 scenario

Results from development #1 scenario.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for percentage of the total amount of sediment (i.e., from all subcatchments) deposited in each subestuary.

Subestuary	Percentage of the total amount of contaminant (i.e., from all subcatchments) deposited in each subestuary.						
	Subcatchment						
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai
1=Hellyers	99.6	0.1	0	0.1	0	0	0.2
2=Lucas	1.9	95.5	0.4	0.2	0	0.3	1.6
3=Paremoremo	3.7	0.7	89.1	4.3	0	0.5	1.6
4=Rangitopuni	1.7	0.1	0.2	96.5	0.4	0.4	0.9
5=Brighams	0.6	0	0.3	42.8	52.6	3.5	0.2
6=Rarawaru	0.7	5.2	0	5.1	31.9	56.3	0.9
7=Waiarohia	4.7	0	0	0	0	0.8	94.5
8=Middle WH	8.1	11.1	4.3	14.3	3.8	1.5	56.9
9=Upper main body of UWH	12.4	9.6	5.9	38.6	18.1	7.1	8.3
10=Middle main body of UWH	11.2	52.5	14.7	2.1	0.9	4.3	14.4
11=Lower main body of UWH	3.4	81.3	1.7	5.2	0.4	0.3	7.8

14.7% of the contaminant that gets deposited in the Middle main body comes from Paremoremo subcatchment

Results from existing scenario are shown on next page for comparison.

These are the results from the existing scenario for comparison.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for percentage of the total amount of sediment (i.e., from all subcatchments) deposited in each subestuary.

Subestuary	Percentage of the total amount of contaminant (i.e., from all subcatchments) deposited in each subestuary.						
	Subcatchment						
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai
1=Hellyers	99.6	0.1	0	0.1	0	0	0.1
2=Lucas	1.5	96.9	0.4	0.3	0	0.2	0.7
3=Paremoremo	3.3	0.8	88.4	6.2	0	0.4	0.9
4=Rangitopuni	1	0	0.1	98.1	0.2	0.2	0.3
5=Brighams	0.5	0	0.3	63.3	32.9	2.9	0.1
6=Rarawaru	0.8	7.4	0	9.2	24.4	57.6	0.6
7=Waiarohia	8	0	0	0	0	1.3	90.7
8=Middle WH	9.2	17.5	5.6	26.8	3.1	1.5	36.3
9=Upper main body of UWH	10.4	10.5	5.6	53.4	10.6	5.5	4.1
10=Middle main body of UWH	9.9	61	14.6	3	0.6	3.5	7.3
11=Lower main body of UWH	2.7	84.9	1.5	6.9	0.3	0.2	3.5

4.2.6 Origin of sediments / contaminants that deposit in harbour (mass)

Results from development #1 scenario.

(a) Existing scenario versus development #1 scenario

See report showing zinc results (NIWA Client Report HAM2003-087/2) for mass of sediment deposited in each subestuary.

Subestuary	Mass (kg) of contaminant deposited in each subestuary. Subcatchment 1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai
1=Hellyers	7.88E+03	5.71E+00	3.02E+00	4.90E+00	6.99E-01	1.04E+00	1.96E+01
2=Lucas	3.09E+02	1.53E+04	6.54E+01	3.34E+01	4.23E+00	5.22E+01	2.60E+02
3=Paremoremo	1.54E+02	2.90E+01	3.70E+03	1.78E+02	3.54E-01	2.24E+01	6.85E+01
4=Rangitopuni	2.60E+02	1.00E+01	2.76E+01	1.51E+04	5.47E+01	6.43E+01	1.33E+02
5=Brighams	3.21E+01	1.14E+00	1.58E+01	2.43E+03	2.99E+03	1.98E+02	1.36E+01
6=Rarawaru	3.13E+00	2.21E+01	2.15E-02	2.19E+01	1.37E+02	2.41E+02	3.75E+00
7=Waiarohia	1.19E+02	3.56E-01	1.71E-01	2.22E-01	3.86E-02	2.08E+01	2.39E+03
8=Middle WH	6.71E+02	9.23E+02	3.59E+02	1.18E+03	3.16E+02	1.24E+02	4.72E+03
9=Upper main body of UWH	1.58E+03	1.23E+03	7.57E+02	4.92E+03	2.31E+03	9.06E+02	1.06E+03
10=Middle main body of UWH	8.57E+02	4.02E+03	1.13E+03	1.59E+02	7.06E+01	3.27E+02	1.10E+03
11=Lower main body of UWH	1.03E+02	2.49E+03	5.19E+01	1.59E+02	1.34E+01	7.83E+00	2.39E+02

Results from existing scenario are shown on next page for comparison.

Of the contaminant that gets deposited in the Middle main body, 1.13x10^3 kg comes from Paremoremo subcatchment

These are the results from the existing scenario for comparison.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for mass of sediment deposited in each subestuary.

Subestuary	Mass (kg) of contaminant deposited in each subestuary.						
	Subcatchment						
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai
1=Hellyers	7.88E+03	9.16E+00	3.43E+00	8.14E+00	5.23E-01	9.61E-01	1.13E+01
2=Lucas	3.09E+02	2.00E+04	7.38E+01	5.55E+01	3.22E+00	4.83E+01	1.51E+02
3=Paremoremo	1.54E+02	3.85E+01	4.16E+03	2.94E+02	2.60E-01	2.07E+01	4.03E+01
4=Rangitopuni	2.60E+02	1.21E+01	3.13E+01	2.49E+04	3.82E+01	5.95E+01	7.91E+01
5=Brighams	3.21E+01	1.52E+00	1.77E+01	4.02E+03	2.09E+03	1.86E+02	8.28E+00
6=Rarawaru	3.13E+00	2.88E+01	2.64E-02	3.62E+01	9.55E+01	2.26E+02	2.41E+00
7=Waiarohia	1.19E+02	5.70E-01	1.90E-01	3.67E-01	2.28E-02	1.87E+01	1.35E+03
8=Middle WH	6.71E+02	1.28E+03	4.08E+02	1.96E+03	2.24E+02	1.12E+02	2.66E+03
9=Upper main body of UWH	1.58E+03	1.60E+03	8.51E+02	8.14E+03	1.61E+03	8.44E+02	6.20E+02
10=Middle main body of UWH	8.57E+02	5.30E+03	1.27E+03	2.64E+02	5.01E+01	3.05E+02	6.35E+02
11=Lower main body of UWH	1.03E+02	3.25E+03	5.70E+01	2.64E+02	1.12E+01	7.24E+00	1.36E+02

4.2.7 Fate of sediments / contaminants that derive from land (%)

Results from development #1 scenario.

(a) Existing scenario versus development #1 scenario

See report showing zinc results (NIWA Client Report HAM2003-087/2) for percentage of the total amount of sediment originating in each subcatchment and passing through controls and entering each subestuary.

Subcatchment	Percentage of the total amount of contaminant originating in each subcatchment and passing through controls and entering each subestuary.										
	Subestuary										
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai	8 = MWH	9 = Upp	10 = Mid	11 = Low
1=Hellyers	65.8	2.6	1.3	2.2	0.3	0	1	5.6	13.2	7.2	0.9
2=Lucas	0	63.7	0.1	0	0	0.1	0	3.8	5.1	16.7	10.4
3=Paremoremo	0	1.1	60.6	0.5	0.3	0	0	5.9	12.4	18.5	0.8
4=Rangitopuni	0	0.1	0.7	62.3	10.1	0.1	0	4.9	20.4	0.7	0.7
5=Brighams	0	0.1	0	0.9	50.7	2.3	0	5.4	39.1	1.2	0.2
6=Rarawaru	0.1	2.7	1.1	3.3	10.1	12.3	1.1	6.3	46.1	16.6	0.4
7=Waiarohia	0.2	2.6	0.7	1.3	0.1	0	23.9	47.2	10.6	11	2.4

Results from existing scenario are shown on next page for comparison.

2.7% of the contaminant that originates in Rarawaru subcatchment gets deposited in Lucas subestuary

These are the results from the existing scenario for comparison.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for percentage of the total amount of sediment originating in each subcatchment and passing through controls and entering each subestuary.

Subcatchment	Percentage of the total amount of contaminant originating in each subcatchment and passing through controls and entering each subestuary.										
	Subestuary										
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai	8 = MWH	9 = Upp	10 = Mid	11 = Low
1=Hellyers	65.8	2.6	1.3	2.2	0.3	0	1	5.6	13.2	7.2	0.9
2=Lucas	0	63.4	0.1	0	0	0.1	0	4.1	5.1	16.8	10.3
3=Paremoremo	0	1.1	60.5	0.5	0.3	0	0	5.9	12.4	18.5	0.8
4=Rangitopuni	0	0.1	0.7	62.3	10.1	0.1	0	4.9	20.4	0.7	0.7
5=Brighams	0	0.1	0	0.9	50.7	2.3	0	5.4	39.1	1.2	0.3
6=Rarawaru	0.1	2.6	1.1	3.3	10.2	12.3	1	6.2	46.2	16.7	0.4
7=Waiarohia	0.2	2.7	0.7	1.4	0.1	0	23.7	46.8	10.9	11.2	2.4

4.2.8 Fate of sediments / contaminants that derive from land (mass)

Results from development #1 scenario.

(a) Existing scenario versus development #1 scenario

See report showing zinc results (NIWA Client Report HAM2003-087/2) for mass of sediment originating in each subcatchment.

Subcatchment	Mass (kg) of contaminant originating in each subcatchment. Subestuary										
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai	8 = MWH	9 = Upp	10 = Mid	11 = Low
1=Hellyers	7.88E+03	3.09E+02	1.54E+02	2.60E+02	3.21E+01	3.13E+00	1.19E+02	6.71E+02	1.58E+03	8.57E+02	1.03E+02
2=Lucas	5.71E+00	1.53E+04	2.90E+01	1.00E+01	1.14E+00	2.21E+01	3.56E-01	9.23E+02	1.23E+03	4.02E+03	2.49E+03
3=Paremoremo	3.02E+00	6.54E+01	3.70E+03	2.76E+01	1.58E+01	2.15E-02	1.71E-01	3.59E+02	7.57E+02	1.13E+03	5.19E+01
4=Rangitopuni	4.90E+00	3.34E+01	1.78E+02	1.51E+04	2.43E+03	2.19E+01	2.22E-01	1.18E+03	4.92E+03	1.59E+02	1.59E+02
5=Brighams	6.99E-01	4.23E+00	3.54E-01	5.47E+01	2.99E+03	1.37E+02	3.86E-02	3.16E+02	2.31E+03	7.06E+01	1.34E+01
6=Rarawaru	1.04E+00	5.22E+01	2.24E+01	6.43E+01	1.98E+02	2.41E+02	2.08E+01	1.24E+02	9.06E+02	3.27E+02	7.83E+00
7=Waiarohia	1.96E+01	2.60E+02	6.85E+01	1.33E+02	1.36E+01	3.75E+00	2.39E+03	4.72E+03	1.06E+03	1.10E+03	2.39E+02

Results from existing scenario are shown on next page for comparison.

Of the contaminant that originates in Rarawaru subcatchment, 5.22x10^1 kg gets deposited in Lucas subestuary

These are the results from the existing scenario for comparison.

See report showing zinc results (NIWA Client Report HAM2003-087/2) for mass of sediment originating in each subcatchment.

Subcatchment	Mass (kg) of contaminant originating in each subcatchment.										
	Subestuary										
	1=Hel	2=Luc	3=Par	4=Ran	5=Bri	6=Rar	7=Wai	8 = MWH	9 = Upp	10 = Mid	11 = Low
1=Hellyers	7.88E+03	3.09E+02	1.54E+02	2.60E+02	3.21E+01	3.13E+00	1.19E+02	6.71E+02	1.58E+03	8.57E+02	1.03E+02
2=Lucas	9.16E+00	2.00E+04	3.85E+01	1.21E+01	1.52E+00	2.88E+01	5.70E-01	1.28E+03	1.60E+03	5.30E+03	3.25E+03
3=Paremoremo	3.43E+00	7.38E+01	4.16E+03	3.13E+01	1.77E+01	2.64E-02	1.90E-01	4.08E+02	8.51E+02	1.27E+03	5.70E+01
4=Rangitopuni	8.14E+00	5.55E+01	2.94E+02	2.49E+04	4.02E+03	3.62E+01	3.67E-01	1.96E+03	8.14E+03	2.64E+02	2.64E+02
5=Brighams	5.23E-01	3.22E+00	2.60E-01	3.82E+01	2.09E+03	9.55E+01	2.28E-02	2.24E+02	1.61E+03	5.01E+01	1.12E+01
6=Rarawaru	9.61E-01	4.83E+01	2.07E+01	5.95E+01	1.86E+02	2.26E+02	1.87E+01	1.12E+02	8.44E+02	3.05E+02	7.24E+00
7=Waiarohia	1.13E+01	1.51E+02	4.03E+01	7.91E+01	8.28E+00	2.41E+00	1.35E+03	2.66E+03	6.20E+02	6.35E+02	1.36E+02

5. Discussion

5.1 Validation of predictions

It has proven to be impossible to validate the estimated urban loads for copper by using the copper concentration profile in the sediment core from the Lucas Creek estuary as was done for zinc. As can be seen from the table of initial sediment copper concentrations given earlier in this report, at all sites sampled throughout the harbour (about 70 sites) the surface sediment concentration of copper is similar despite the known loads from urban activities. This observation implies that the copper loads relative to the sediment loads are similar for all catchments and that, therefore, natural copper loads are of similar magnitude to urban copper loads. The accuracy of this implication has not been verified.

The apparent similarity of natural and urban loads for copper does not explain the copper concentration depth profile in the Lucas cores. Below a depth of about 30 cm the silt copper concentration is about 10 g m^{-3} and this increases sensibly over the period of urban development to about 20 to 25 g m^{-3} at the sediment surface. However, starting with a pre-urban sediment copper concentration of 10 g m^{-3} then adding the highest credible copper loads from development in the Lucas subcatchment over the period 1950 to 2001 as was done for zinc, produces a surface silt concentration of copper in 2001 only half of that observed. Present-day surface silt concentrations can be accurately predicted only by assuming a background concentration of about 20 g m^{-3}; an assumption apparently in conflict with the observed concentration of 10 g m^{-3} at depth in the Lucas core. On the other hand, a background concentration of about 20 g m^{-3} is consistent with concentrations of between 18 and 25 g m^{-3} found in stream sediments in the relatively undeveloped (in an urban sense) Rangitopuni, Brighams and Paremoremo subcatchments.

Similar sediment concentrations in all parts of the harbour was also seen to some extent for zinc as is discussed in the zinc report. For zinc, however, it was necessary to assume a higher background load only for the catchments with low amounts of urban development, i.e., Rangitopuni, Brighams and Paremoremo, in order to produce a sensible equilibrium situation for the existing scenario. This high background load was not assumed for the urbanised catchments because the urban zinc loads are high enough to swamp the background. This does mean, of course, that our estimates of urban zinc loads are possibly a little high but this error is small.

We suspect that adsorption of copper leached from catchment soils onto stream sediments might be the cause of the relatively high background copper concentrations and that remobilisation of copper in estuarine sediments subsequent to deposition could be moving copper from depth towards the surface. Confirming these suspicions would require a substantial investigation well beyond the scope of this project.

Faced with our lack of understanding of the mechanisms leading to the high background concentrations and the apparent inconsistencies in the Lucas core, we have modelled the fate of future copper loads on the basis of the following assumptions:

1. That all inputs up to 2001 are adequately described by the background load (the background concentration multiplied by the predicted sediment load).

2. That future urban copper loads will add on top of this background load.

This approach probably produces worst-case predictions of future sediment copper concentrations but until we better understand the behaviour of copper in catchment drainage and estuarine sediments we cannot improve on these predictions.

Bearing in mind these assumptions, the results produced in this report for the existing scenario can be interpreted in exactly the same way as was explained for zinc. For catchments with only small amounts of urban development, the estuarine copper concentrations would be expected to be in near-equilibrium with catchment loads, i.e. the estuarine sediment concentrations should show very little increase over the modelled period, whereas for catchments with high urban copper loads the sediment concentrations would be expected to increase over several years before reaching equilibrium with the catchment loads.

5.2 Examples of how to interrogate and interpret results

Examples of how to interpret and interrogate results are given in the zinc results report (NIWA Client Report HAM2003-087/2 – Results: Zinc). The following example questions are addressed:

- *Where does contaminant deposited in each part of the harbour come from?*
- *Which subestuary is most at risk?*
- *Why is that?*
- *How might this risk be lessened?*
- *Will there be other benefits associated with source control in particular subcatchments?*
- *Which subestuary is least at risk?*
- *Why are these subestuaries at least risk?*

The traffic lights represent an environmental target or goal. For instance, one may decide that the red traffic light should not be exceeded for at least 30 years in the future in a particular estuarine habitat. (Note: 30 years is chosen arbitrarily here as an example and is not a recommended time frame, nor does it represent current thinking in the ARC). Inspection of the response-envelope plots will show how this may be achieved.

- For instance, the response envelope for the subestuary in which the habitat of concern is located may show that, even under zero stormwater controls, the red light will not be exceeded within 30 years. Hence, the desired environmental target will be achieved with no management intervention.
- Or, the response-envelope plots may show that, even under the maximum attainable stormwater controls, the time to red traffic light is, say, 15 years. In that case, there is no practicable stormwater control that can be implemented that will achieve the desired outcome. In that case, attention should turn to reducing the contaminant source (generation) to achieve the environmental outcome (viz., stretching the traffic light exceedance out to at least 30 years).

Furthermore, efforts at source control must, of course, focus on the subcatchment that supplies the majority of the contaminant that deposits in the subestuary in question.

- Or, the response envelope might bracket the time of 30 years to the red light. This means that there will be some finite, attainable control level that will put the traffic light exceedance right on 30 years. One may estimate what that control level is by visually interpolating the response enveloped, or a series of trial-and-error simulations could be conducted to determine a more precise estimate.

The response-envelope simulations may also be examined to address points such as:

- *Are there parts of the harbour where contaminant concentrations still exceed traffic lights even under the maximum attainable controls?*

- *Are there subestuaries where significant gains in time-to-traffic-light can be had for modest control improvements?*

- *What subcatchments are the main polluters?*

- *Would maximum possible controls in these subcatchments have significant benefits throughout the whole harbour (which might justify the expense of maximum possible controls in those subcatchments)?*

Answers to these kinds of questions are also demonstrated in the zinc results report (NIWA Client Report HAM2003-087/2 – Results: Zinc).

6. Conclusions

The existing scenario extrapolates the "current-day" (i.e., 2001) landuse into the future based on the assumption that landuse does not change. The results from this scenario provide a baseline for comparison against a realistic development scenario developed in consultation with the Working Party. In addition, the same realistic development scenario is bracketed by two extremes (zero stormwater contaminant controls, and maximum attainable stormwater controls) to give an envelope of responses in the harbour.

A range of results is presented, for both 54-year and 108-year simulations, including:

- Contaminant concentrations in the harbour:

  (a) Existing scenario versus development #1 scenario

  (b) Response envelope around development #1 scenario

- Time for total-sediment concentrations to reach "traffic lights":

  (a) Existing scenario versus development #1 scenario

  (b) Response envelope around development #1 scenario

- Sedimentation[3] in the harbour:

  (a) Existing scenario versus development #1 scenario

  (b) Response envelope around development #1 scenario

- Origin of sediments[3] / contaminants that deposit in harbour (%):

  (a) Existing scenario versus development #1 scenario

- Origin of sediments[3] / contaminants that deposit in harbour (mass):

  (a) Existing scenario versus development #1 scenario

- Fate of sediments[3] / contaminants that derive from land (%):

  (a) Existing scenario versus development #1 scenario

- Fate of sediments[3] / contaminants that derive from land (mass):

  (a) Existing scenario versus development #1 scenario

[3] Refer to the zinc results report (NIWA Client Report HAM2003-087/2 – Results: Zinc) for sediment results.

The various results presented herein can be used to investigate a number of questions concerning management of the Upper Waitemata Harbour catchment with a view to achieving environment targets in the receiving waters of the harbour.

7. References

Herald, J.R. (1989). *Hydrological Impact of Urban Development in the Albany Basin, Auckland. Auckland, New Zealand*. Unpublished Ph.D. thesis, University of Auckland.

Macaskill J.B., Williamson, R.B. (1994) *Water Quality Impacts of Road Runoff*. NIWA Client Report MTR001.

Williamson, R. B. (1991) *Urban Runoff Handbook*. Water Quality Centre Publication No. 20.

APPENDIX A1. Programme Control Information

A1.1 54-year simulation – existing scenario

0. Construct database – **contam** [clcontam.bat to compile/link]	
SUBDIRECTORY	54EA2
Batfile	b54ea2.dat
Output	x54ea2.dat

1. Build estuary sediments – **builde** [clbuilde.bat to compile/link] event-by-event output to one file per ESTUARY

Prefix = aaa			
For tracking origin of sediments: seq='q1'			
For recording buildup of contconcs: seq2='c1'			
a. Average deposition rate over 54 years	Read from screen at end		
b. % sed/cont	seq='q1'	aaaq1e01-e11.dat	Last line of each file. Compile with extract1 --- sedt.dat/cont.dat
c. Cumulative (%) sed/cont	seq='q1'	aaaq1e01-e11.dat	*plots deleted*
f. surface layer cont concs	seq2='c1'	aaac1e01-e11.dat	aaap01a.grf, aaap01b.grf
g. bed sediment evolution	seq2='c1'	aaac1e01-e11.dat	aaat01.grf
h. time to reach traffic lights	seq='c1'	aaac1e01-e11.dat	Compile with extract3 --- traffic.dat

Prefix = aaa			
For tracking origin of sediments: seq='q2'			
For recording buildup of contconcs: seq2='xx'			
d. kg sed/cont	seq='q2'	aaaq2e01-e11.dat	Last line of each file. Compile with extract1 --- sedt.dat/cont.dat
e. Cumulative (kg) sed/cont	seq='q2'	aaaq2e01-e11.dat	*plots deleted*

2. Track catchment sediments – **buildc** [clbuildc.bat to compile/link] event-by-event output to one file per CATCHMENT

Prefix = aaa / seq='q1'			
a. % sediment/contaminant	seq='q1'	aaaq1c01-c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
b. Cumulative (%) sediment/contaminant	seq='q1'	aaaq1c01-c07.dat	*plots deleted*

Prefix = aaa / seq='q2'			
c. kg sediment/contaminant	seq='q2'	aaaq2c01-c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
d. Cumulative (kg) sediment/contaminant	seq='q2'	aaaq2c01-c07.dat	*plots deleted*

A1.2 108-year simulation – existing scenario

0. Construct database – **contam** [clcontam.bat to compile/link]	
SUBDIRECTORY	108EA2
Batfile	b108ea2.dat
Output	x108ea2.dat

1. Build estuary sediments – **builde** [clbuilde.bat to compile/link] event-by-event output to one file per ESTUARY

Prefix = aaa			
For tracking origin of sediments: seq='q1'			
For recording buildup of contconcs: seq2='c1'			
a. Average deposition rate over 54 years	Read from screen at end		
b. % sed/cont	seq='q1'	aaaq1e01-e11.dat	Last line of each file. Compile with extract1 --- sedl.dat/cont.dat
c. Cumulative (%) sed/cont	seq='q1'	aaaq1e01-e11.dat	*plots deleted*
f. surface layer cont concs	seq2='c1'	aaac1e01-e11.dat	aaap01a.grf, aaap01b.grf
g. bed sediment evolution	seq2='c1'	aaac1e01-e11.dat	aaal01.qrl
h. time to reach traffic lights	seq2='c1'	aaac1e01-e11.dat	Compile with extrac3 --- traffic.dat

Prefix = aaa			
For tracking origin of sediments: seq='q2'			
For recording buildup of contconcs: seq2='xx'			
d. kg sed/cont	seq='q2'	aaaq2e01-e11.dat	Last line of each file. Compile with extract1 --- sedl.dat/cont.dat
e. Cumulative (kg) sed/cont	seq='q2'	aaaq2e01-e11.dat	*plots deleted*

2. Track catchment sediments – **buildc** [clbuildc.bat to compile/link] event-by-event output to one file per CATCHMENT

Prefix = aaa / seq='q1'			
a. % sediment/contaminant	seq='q1'	aaaq1c01-c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
b. Cumulative (%) sediment/contaminant	seq='q1'	aaaq1c01-c07.dat	*plots deleted*

Prefix = aaa / seq='q2'			
c. kg sediment/contaminant	seq='q2'	aaaq2c01-c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
d. Cumulative (kg) sediment/contaminant	seq='q2'	aaaq2c01-c07.dat	*plots deleted*

A1.3 54-year simulation – development #1 scenario

0. Construct database – **contam** [clcontam.bat to compile/link]	
SUBDIRECTORY	54S1A2
Batfile	b54s1a2.dat
Output	x54s1a2.dat

1. Build estuary sediments – **builde** [clbuilde.bat to compile/link] event-by-event output to one file per ESTUARY

Prefix = bbb			
For tracking origin of sediments: seq='q1'			
For recording buildup of contconcs: seq2='c1'			
a. Average deposition rate over 54 years		Read from screen at end	
b. % sed/cont	seq='q1'	bbbq1e01-e11.dat	Last line of each file. Compile with extract1 --- sedt.dat/cont.dat
c. Cumulative (%) sed/cont	seq='q1'	bbbq1e01-e11.dat	*plots deleted*
f. surface layer cont concs	seq2='c1'	bbbc1e01-e11.dat	bbbp01a.grf, bbbp01b.grf
g. bed sediment evolution	seq2='c1'	bbbc1e01-e11.dat	bbbt01.grf
h. time to reach traffic lights	seq='c1'	bbbc1e01-e11.dat	Compile with extract3 --- traffic.dat

Prefix = bbb			
For tracking origin of sediments: seq='q2'			
For recording buildup of contconcs: seq2='xx'			
d. kg sed/cont	seq='q2'	bbbq2e01-e11.dat	Last line of each file. Compile with extract1 --- sedt.dat/cont.dat
e. Cumulative (kg) sed/cont	seq='q2'	bbbq2e01-e11.dat	*plots deleted*

2. Track catchment sediments – **buildc** [clbuildc.bat to compile/link] event-by-event output to one file per CATCHMENT

Prefix = bbb / seq='q1'			
a. % sediment/contaminant	seq='q1'	bbbq1c01-c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
b. Cumulative (%) sediment/contaminant	seq='q1'	bbbq1c01-c07.dat	*plots deleted*

Prefix = bbb / seq='q2'			
c. kg sediment/contaminant	seq='q2'	bbbq2c01-c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
d. Cumulative (kg) sediment/contaminant	seq='q2'	bbbq2c01-c07.dat	*plots deleted*

A1.4 108-year simulation – development #1 scenario

0. Construct database – **contam** [clcontam.bat to compile/link]	
SUBDIRECTORY	108S1A2
Batfile	b108s1a2.dat
Output	x108s1a2.dat

1. Build estuary sediments – **builde** [clbuilde.bat to compile/link] event-by-event output to one file per ESTUARY

Prefix = bbb			
For tracking origin of sediments: seq='q1'			
For recording buildup of contconcs: seq2='c1'			
a. Average deposition rate over 54 years	Read from screen at end		
b. % sed/cont	seq='q1'	bbbq1e01-e11.dat	Last line of each file. Compile with extract1 --- sedl.dat/cont.dat
c. Cumulative (%) sed/cont	seq='q1'	bbbq1e01-e11.dat	*plots deleted*
f. surface layer cont concs	seq2='c1'	bbbc1e01-e11.dat	bbbp01a.grf, bbbp01b.grf
g. bed sediment evolution	seq2='c1'	bbbc1e01-e11.dat	bbbt01.grf
h. time to reach traffic lights	seq2='c1'	bbbc1e01-e11.dat	Compile with extrac3 --- traffic.dat

Prefix = bbb			
For tracking origin of sediments: seq='q2'			
For recording buildup of contconcs: seq2='xx'			
d. kg sed/cont	seq='q2'	bbbq2e01-e11.dat	Last line of each file. Compile with extract1 --- sedl.dat/cont.dat
e. Cumulative (kg) sed/cont	seq='q2'	bbbq2e01-e11.dat	*plots deleted*

2. Track catchment sediments – **buildc** [clbuildc.bat to compile/link] event-by-event output to one file per CATCHMENT

Prefix = bbb / seq='q1'			
a. % sediment/contaminant	seq='q1'	bbbq1c01-c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
b. Cumulative (%) sediment/contaminant	seq='q1'	bbbq1c01-c07.dat	*plots deleted*

Prefix = bbb / seq='q2'			
c. kg sediment/contaminant	seq='q2'	bbbq2c01-c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
d. Cumulative (kg) sediment/contaminant	seq='q2'	bbbq2c01-c07.dat	*plots deleted*

A1.5 54-year simulation – response envelope – no controls

0. Construct database – **contam** [clcontam.bat to compile/link]	
SUBDIRECTORY	54S2A2
Batfile	b54s2a2.dat
Output	x54s2a2.dat

1. Build estuary sediments – **builde** [clbuilde.bat to compile/link] event-by-event output to one file per ESTUARY

Prefix = ccc			
For tracking origin of sediments: seq='q1'			
For recording buildup of contconcs: seq2='c1'			
a. Average deposition rate over 54 years		Read from screen at end	
b. % sed/cont	seq='q1'	cccq1e01-e11.dat	Last line of each file. Compile with extract1 sedt.dat/cont.dat
c. Cumulative (%) sed/cont	seq='q1'	cccq1e01-e11.dat	*plots deleted*
f. surface layer cont concs	seq2='c1'	cccc1e01-e11.dat	cccp01a.grf, cccp01b.grf
g. bed sediment evolution	seq2='c1'	cccc1e01-e11.dat	ccct01.grf
h. time to reach traffic lights	seq='c1'	cccc1e01-e11.dat bbb1e01-e11.dat dddc1e01-e11.dat	Compile with extract4 --- traffic.dat

Prefix = ccc			
For tracking origin of sediments: seq='q2'			
For recording buildup of contconcs: seq2='xx'			
d. kg sed/cont	seq='q2'	cccq2e01-e11.dat	Last line of each file. Compile with extract1 --- sedt.dat/cont.dat
e. Cumulative (kg) sed/cont	seq='q2'	cccq2e01-e11.dat	*plots deleted*

2. Track catchment sediments – **buildc** [clbuildc.bat to compile/link] event-by-event output to one file per CATCHMENT

Prefix = ccc / seq='q1'			
a. % sediment/contaminant	seq='q1'	cccq1c01-c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
b. Cumulative (%) sediment/contaminant	seq='q1'	cccq1c01-c07.dat	*plots deleted*

Prefix = ccc / seq='q2'			
c. kg sediment/contaminant	seq='q2'	cccq2c01-c07.dat	Last line of each file. Compile with extract2 sedm.dat/conm.dat
d. Cumulative (kg) sediment/contaminant	seq='q2'	cccq2c01-c07.dat	*plots deleted*

A1.6 108-year simulation – response envelope – no controls

0. Construct database – **contam** [clcontam.bat to compile/link]	
SUBDIRECTORY	108S2A2
Batfile	b108s2a2.dat
Output	x108s2a2.dat

1. Build estuary sediments – **builde** [clbuilde.bat to compile/link] event-by-event output to one file per ESTUARY

Prefix = ccc			
For tracking origin of sediments: seq='q1'			
For recording buildup of contconcs: seq2='c1'			
a. Average deposition rate over 54 years		Read from screen at end	
b. % sed/cont	seq='q1'	cccq1e01-e11.dat	Last line of each file. Compile with extract1 sedt.dat/cont.dat
c. Cumulative (%) sed/cont	seq='q1'	cccq1e01-e11.dat	*plots deleted*
f. surface layer cont concs	seq2='c1'	cccc1e01-e11.dat	cccp01a.grf, cccp01b.grf
g. bed sediment evolution	seq2='c1'	cccc1e01-e11.dat	ccct01.grf
h. time to reach traffic lights	seq='c1'	cccc1e01-e11.dat bbbc1e01-e11.dat dddc1e01-e11.dat	Compile with extract4 --- traffic.dat

Prefix = ccc			
For tracking origin of sediments: seq='q2'			
For recording buildup of contconcs: seq2='xx'			
d. kg sed/cont	seq='q2'	cccq2e01-e11.dat	Last line of each file. Compile with extract1 --- sedt.dat/cont.dat
e. Cumulative (kg) sed/cont	seq='q2'	cccq2e01-e11.dat	*plots deleted*

2. Track catchment sediments – **buildc** [clbuildc.bat to compile/link] event-by-event output to one file per CATCHMENT

Prefix = ccc / seq='q1'			
a. % sediment/contaminant	seq='q1'	cccq1c01-c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
b. Cumulative (%) sediment/contaminant	seq='q1'	cccq1c01-c07.dat	*plots deleted*

Prefix = ccc / seq='q2'			
c. kg sediment/contaminant	seq='q2'	cccq2c01-c07.dat	Last line of each file. Compile with extract2 sedm.dat/conm.dat
d. Cumulative (kg) sediment/contaminant	seq='q2'	cccq2c01-c07.dat	*plots deleted*

A1.7 54-year simulation – response envelope – maximum attainable controls

0. Construct database – **contam** [clcontam.bat to compile/link]	
SUBDIRECTORY	54S3A2
Batfile	b54s3a2.dat
Output	x54s3a2.dat

1. Build estuary sediments – **builde** [clbuilde.bat to compile/link] event-by-event output to one file per ESTUARY

Prefix = ddd			
For tracking origin of sediments: seq='q1'			
For recording buildup of contconcs: seq2='c1'			
a. Average deposition rate over 54 years		Read from screen at end	
b. % sed/cont	seq='q1'	cccq1e01-e11.dat	Last line of each file. Compile with extract1 --- sedt.dat/cont.dat
c. Cumulative (%) sed/cont f. surface layer cont concs	seq='q1' seq2='c1'	cccq1c01 c11.dat cccc1e01-e11.dat	*plots deleted* cccp01a.qrt, cccp01b.qrt
g. bed sediment evolution h. time to reach traffic lights	seq2='c1' seq='c1'	cccc1e01-e11.dat cccc1e01-e11.dat bbb1e01-e11.dat ddd1c01 c11.dat	cccl01.qrl Compile with extract4 --- traffic.dat

Prefix = ddd			
For tracking origin of sediments: seq='q2'			
For recording buildup of contconcs: seq2='xx'			
d. kg sed/cont	seq='q2'	cccq2c01 c11.dat	Last line of each file. Compile with extract1 --- sedt.dat/cont.dat
e. Cumulative (kg) sed/cont	seq='q2'	cccq2e01-e11.dat	*plots deleted*

2. Track catchment sediments – **buildc** [clbuildc.bat to compile/link] event-by-event output to one file per CATCHMENT

Prefix = ddd / seq='q1'			
a. % sediment/contaminant	seq='q1'	cccq1c01 c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
b. Cumulative (%) sediment/contaminant	seq='q1'	cccq1c01-c07.dat	*plots deleted*

Prefix = ddd / seq='q2'			
c. kg sediment/contaminant	seq='q2'	cccq2c01 c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
d. Cumulative (kg) sediment/contaminant	seq='q2'	cccq2c01-c07.dat	*plots deleted*

A1.8 108-year simulation – response envelope – maximum attainable controls

0. Construct database – **contam** [clcontam.bat to compile/link]	
SUBDIRECTORY	108S3A2
Batfile	b108s3a2.dat
Output	x108s3a2.dat

1. Build estuary sediments – **builde** [clbuilde.bat to compile/link] event-by-event output to one file per ESTUARY

Prefix = ddd			
For tracking origin of sediments: seq='q1'			
For recording buildup of contconcs: seq2='c1'			
a. Average deposition rate over 54 years		Read from screen at end	
b. % sed/cont	seq='q1'	cccq1e01 e11.dat	Last line of each file. Compile with extract1 --- sedt.dat/cont.dat
c. Cumulative (%) sed/cont	seq='q1'	cccq1e01-e11.dat	*plots deleted*
f. surface layer cont concs	seq2='c1'	cccc1e01 e11.dat	cccp01a.grf, cccp01b.grf
g. bed sediment evolution	seq2='c1'	cccc1e01-e11.dat	ccct01.grf
h. time to reach traffic lights	seq='c1'	cccc1e01-e11.dat bbbc1e01-e11.dat dddc1e01 e11.dat	Compile with extract4 --- traffic.dat

Prefix = ddd			
For tracking origin of sediments: seq='q2'			
For recording buildup of contconcs: seq2='xx'			
d. kg sed/cont	seq='q2'	cccq2e01 e11.dat	Last line of each file. Compile with extract1 --- sedt.dat/cont.dat
e. Cumulative (kg) sed/cont	seq='q2'	cccq2e01-e11.dat	*plots deleted*

2. Track catchment sediments – **buildc** [clbuildc.bat to compile/link] event-by-event output to one file per CATCHMENT

Prefix = ddd / seq='q1'			
a. % sediment/contaminant	seq='q1'	cccq1c01 c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
b. Cumulative (%) sediment/contaminant	seq='q1'	cccq1c01 c07.dat	*plots deleted*

Prefix = ddd / seq='q2'			
c. kg sediment/contaminant	seq='q2'	cccq2c01 c07.dat	Last line of each file. Compile with extract2 --- sedm.dat/conm.dat
d. Cumulative (kg) sediment/contaminant	seq='q2'	cccq2c01-c07.dat	*plots deleted*